International Journal of Computational and Engineering

DECEMBER 2023 VOLUME8 NUMBER4

Publisher: ACADEMIC PUBLISHING HOUSE
Address: Quastisky Building, Road Town, Tortola, British Virgin Islands
UK Postal Code: VG1110

E-mail: editor03@acadpubl.com
http://www.acadpubl.com/ijce.aspx

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CONTENTS

Research on the Current Situation and Development Trends of the Collaborative R&D Tool Chain for Civil Aircraft

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Abstract: A tool chain is a set of interrelated R&D tools that perform a specific R&D task or complete a generic R&D process in accordance with a specific process.Through the development of civil aircraft collaborative R&D tool chain, the data of development tools can be effectively integrated, the research efficiency and product quality can be improved, and the process experience and knowledge in the precipitation process can be improved.By reviewing the research and development status of tool chain, this paper introduces the research and development mode of civil aircraft products based on tool chain, summarizes practical experience according to the case analysis of typical tool chain of electronic hardware, and further analyzes the challenges and development trend of the development of civil aircraft tool chain.
Keywords: aviation products; Civil aircraft development; Research and development management; R&d tool chain

1. INTRODUCTION

With the continuous development of modern aviation industry, the research and development of civil aircraft shows the characteristics of integration, complexity and interdisciplinary.Development tools play a key role in the development process, providing strong support to designers and engineers.A tool chain is a set of interrelated R&D tools that follow a specific process to perform a specific R&D task or complete a generic R&D process.Through the development of civil aircraft collaborative R&D tool chain, data of development tools can be effectively integrated, R&D efficiency and product quality can be improved, and process experience and knowledge in the process can be accumulated[1]. Therefore, civil aircraft suppliers are actively carrying out collaborative R&D tool chain research.

2. RESEARCH STATUS OF CIVIL AIRCRAFT TOOL CHAIN

In recent years, tool chain related research has increasingly become a focus in the field of complex manufacturing [2].In the field of civil aircraft, at present, most research and development units remain in the stage of research and development tool construction, and a few departments such as avionics have carried out part of the tool chain construction in advance[3], but generally lack the overall planning of the tool chain, and there are problems such as small coverage, poor practicability, and poor cross-disciplinary and cross-professional applicability.

The following is an introduction to the tool chain technology and its application status in different disciplines of civil aircraft:

System development: The tool chain of system development includes requirements analysis, system design, verification and testing tools.Modern Systems Engineering tools, such as SysML and MBSE (Model-based Systems Engineering), are used to Model and simulate various aspects of a system[4], thereby helping engineers better understand and manage the system.

Four-character design: Four-character design includes safety, reliability, maintainability and testability[5], and four-character design runs through the whole system development process. Various simulation and analysis tools are used in the toolchain to evaluate the impact of different design parameters on these four properties. These tools can reduce the need for trials and tests and accelerate product development.

Embedded software: In the civil aircraft system, embedded software is a crucial component. The toolchain for embedded software includes integrated development environments (ides)[6], version control systems, automated testing tools, and continuous integration/continuous delivery (CI/CD) tools[7] to ensure efficient and reliable software development, testing, and deployment processes.

Electronic hardware: Hardware engineers use schematics, circuit simulation, and PCB tools to design and simulate circuit boards, chips, and other hardware components. These toolchains also include electromagnetic compatibility analysis tools and temperature analysis tools to optimize hardware designs[8].

Structural design: Structural engineers use CAD and finite element analysis tools to design aircraft structures and materials. These tool chains help them analyze aspects such as stress, vibration, and fatigue to ensure the safety and performance of the structure.

Engineering Design: The engineering design tool chain can include multidisciplinary optimization tools for finding the best balance between different design

parameters. This helps reduce costs, improve performance, and shorten development cycles.

Optical design: In civil aircraft systems, optical components and sensors are very important.The Optical Design Toolchain includes optical design software and simulation tools for designing and optimizing optical systems to meet specific performance requirements.

Process design: Process engineers use CAD and CAM (Computer Aided Manufacturing) tools to plan the production process, including the assembly and manufacturing of civil aircraft systems.This helps to improve production efficiency and quality.

Engineering Management: The engineering management tool chain includes project management software, collaboration tools, and scheduling tools to track project progress, resource allocation, and team collaboration.

While toolchains play an important role in the development of civil aircraft, there are potential problems and limitations, for example, integrating various tools can lead to increased complexity, requiring more time and resources to manage and maintain the toolchain, and data consistency and interoperability issues between different tools can cause problems such as errors and delays.The overall architecture of the tool chain will cause changes in the development model, so the tool chain needs to be planned, carefully selected and effectively managed to maximize its advantages and minimize potential challenges.

3. TOOL CHAIN CIVIL AIRCRAFT PRODUCT DEVELOPMENT MODEL

The introduction of collaborative R&D tool chain will bring about changes in R&D mode.In the development of civil aircraft products, the concept of the tool chain can drive a research and development model based on systems engineering ideas, resulting in more efficient research and development, higher cost effectiveness, and better product quality.Here we discuss this research and development model.

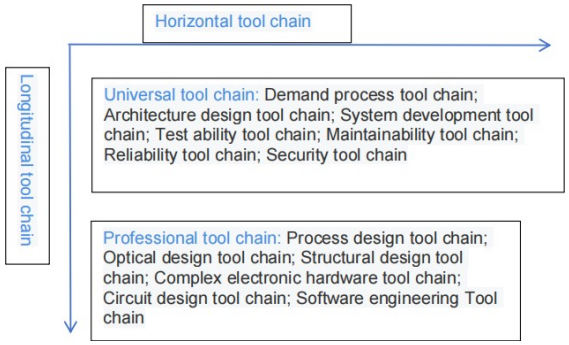

Figure 1 Overall block diagram of tool chain development mode

The overall framework of the civil aircraft collaborative R&D tool chain R&D model is shown in the figure.For example, for architecture design, the tool chain can be divided into architecture requirements configuration, functional architecture design, logical architecture design, physical architecture design, interface design and other stages in the vertical direction. Each stage corresponds to specific R&D tools and is the core of the tool chain.Horizontally, there are cross-chain calls between the tool chains. For example, for the three professional areas of requirements, architecture, and four-nature design, the requirements analysis phase needs to be carried out in parallel with the architecture configuration phase.For another example, when designing the functional architecture, it is necessary to consider the needs of the four characteristics, and then further design the logical architecture.Due to its strong professionalism, the vertical tool chain design can be clearly identified and efficiently customized based on a unified adaptation integration platform.For horizontal cross-stage call between tool chains, data processing module and automatic scheduling module need to be introduced to analyze and process the customized process, and the tool chain is divided into general tool chain and professional tool chain from a professional perspective.The universal tool chain includes the system tool chain (requirements, architecture design, system development) and the four-nature tool chain for high-level design and integration.

The whole R & D model presents the following three characteristics:

Systems engineering thought: Systems engineering thought emphasizes the comprehensiveness and synergy of the whole system.The Collaborative R&D tool chain is a powerful support for systems engineering by integrating various subject areas and treating the individual components of a product as one system to ensure they are coordinated, interoperable, and meet overall performance and requirements.

Differentiating professional applications: Collaborative R&D tool chains can be applied in different ways in different fields.For example, embedded software can use integrated development environments, version control systems, and automated testing tools to ensure that software development processes work together and automate build and test processes.Structural design can use finite element analysis tools to ensure a close synergy between structural engineering and material engineering to optimize the aircraft structure.

Integration of process activities: The collaborative R&D tool chain can help divide the R&D process into different phases and activities, enabling teams to work better together.This can include various activities such as requirements analysis, system design, hardware development, software development, testing, verification, etc.The Collaborative R&D Toolchain enables engineers in different areas of expertise to work in the same environment by integrating tools and data from different fields into a

shared platform.For example, systems engineers, structural engineers, software engineers, and optical designers can work together in the same system to share data and models.

4. CASE ANALYSIS AND PRACTICAL EXPERIENCE OF TOOL CHAIN

Collaborative research and development tool chain is of great significance in the field of electronic hardware design.The following is a case study based on Cadence design tool, simulation tool and PDM (Product Data Management) system to explore the application and effect of collaborative R&D tool chain in electronic hardware design.

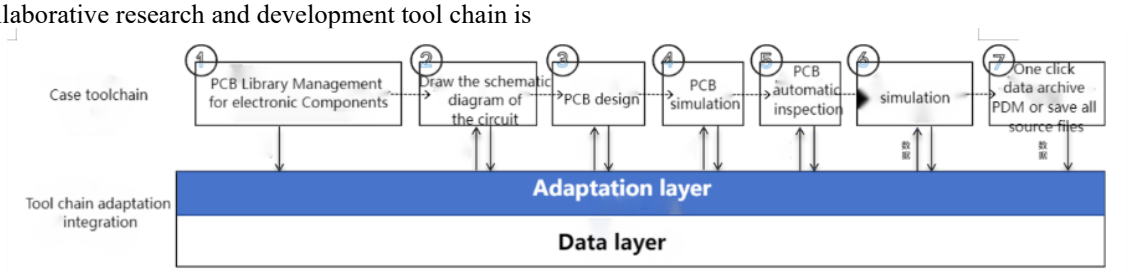

Figure 2 Case study of the electronic hardware design tool chain

4.1 Tool chain composition

Cadence tools: Include OrCAD or Allegro PCB Designer for Circuit design and PCB (Printed Circuit Board) layout.

Simulation tools: such as Cadence SPICE simulation or other simulation tools to verify the performance of the circuit.

PDM system: Used for collaborative management of design data, version control, and document management.

4.2 Case analysis

Under the unified scheduling of the adaptation integration center, the tool chain is automatically started and closed according to the preset process, and the data input and output in the process are exchanged by the design tool towards the adaptation layer.For example, the toolchain for PCB design consists of Cadence and associated simulation tools.The design data completed by Cadence enters the R & D tool adaptation integration environment through the data adapter, and is temporarily controlled by the process data control module inside. When the relevant design is completed, it enters the simulation process.The system supports the import of relevant design data required by simulation into corresponding simulation tools through the adaptation layer, so as to realize the flow of design data between different design tools and ensure the consistency and accuracy of data.

4.3 Practical experience

Circuit design Collaboration: Different team members can work together simultaneously to design circuit diagrams and PCB layouts in the Cadence tool.This ensures that design collaboration works smoothly by storing design data in the PDM system, enabling multiple people to access and edit the same design file.

Version control: The PDM system provides version control functions to ensure that different versions of the design data can be managed and tracked. This helps to avoid conflict and confusion of design data and improves the traceability of design data.

Simulation verification: Designers can use simulation tools to verify circuit performance, such as signal integrity, power distribution, etc.Simulation results can also be shared with the team for discussion and improvement.

Materials and supplier management: PDM systems can also be used to manage raw material information and supplier data to help designers select the right parts and materials.

Document management: PDM system is used to manage project documents, including design specifications, user manuals, test reports, etc.This ensures consistency and accessibility of project-related information.

4.4 Application and effects

Improved collaboration: The toolchain provides the ability for multiple people to collaborate on design, reducing information silos and barriers between different teams, and improving collaboration.

Increased efficiency: Through automation of circuit design and simulation verification, projects can progress faster, reducing design and verification cycles.

Reduce errors: The toolchain helps identify problems early, reducing the time and cost of fixing errors later.

Managing design data: PDM systems make design data management clearer and more controllable, helping teams share, collaborate, and manage project documents.

Improved project traceability: Version control and document management help project traceability to meet regulatory requirements and standards.

4.5 Key factors and precautions

Choose the right tool: Ensure that the Cadence tool and PDM system you choose meets your project needs and your team's workflow.

Train the team: Provide training for team members to fully utilize the potential of the tool chain.

Ensure data security: Protect the confidentiality and integrity of design data to prevent unauthorized access or data breaches.

4.6 Case summary

This case study highlights the practical application

and effect of the collaborative R&D tool chain in electronic hardware design, bringing clear advantages in the development of civil aircraft products by integrating Cadence tools, simulation tools and PDM systems.But there are also challenges that need to be addressed, such as appropriate tool selection, training teams, data security and interoperability.However, with effective planning and implementation, the collaborative R&D tool chain is expected to become a key driver of civil aircraft product development, improving efficiency and product quality.

5. CHALLENGES AND FUTURE PROSPECTS OF TOOL CHAIN DEVELOPMENT

Based on the above analysis, the introduction of tool chain will bring two advantages in two aspects.First, collaborate to improve R&D efficiency and product quality.The key advantage of the collaborative R&D tool chain is the ability to enable collaboration between different areas of expertise.By sharing data, models, and tools, engineers in different fields can better understand the overall requirements of the system, collaborate with each other to solve problems, and reduce misunderstandings and duplication of effort.Second, the process experience and knowledge in the process of precipitation.By collaborating on the development tool chain, you can not only accelerate the development process, reduce costs, but also improve product quality.Toolchains help reduce errors and identify problems early, while also better meeting customer needs.

However, the civil aircraft collaborative R&D tool chain faces multiple challenges, including technical, safety, management and cultural issues.We analyze these problems.

5.1 Challenges of tool chain development

5.1.1 Technical challenges:

Complexity of tool chain integration: Integrating tools from multiple different domains into a unified tool chain can be very complex, requiring sufficient technical knowledge and resources, and ensuring compatibility and smooth collaboration between tools is a challenge.

Data consistency and interoperability: Data formats, models, and standards generated by different tools may differ, and data consistency and interoperability issues need to be addressed to ensure the correct delivery and analysis of information.

5.1.2 Security challenges

Data security: In the collaborative R&D tool chain, sensitive data of civil aircraft systems may need to be shared between different teams.Therefore, data security and protection against unauthorized access become key issues.

Intellectual property protection: Collaborative toolchains can involve different organizations and vendors, requiring strict contracts and policies to ensure that intellectual property is protected and not misused or compromised.

5.1.3 Management challenges

Training and culture: Team members need to adjust to new ways of working and may need training and time to adjust to the tool chain.At the same time, the change of team culture is also a challenge.

Project Management: Effectively managing the different tools and data in the tool chain to ensure that the project is on schedule requires specialized project management skills.

5.1.4 Cultural challenges

Collaborative culture: Collaborative toolchains need to emphasize collaboration and knowledge sharing, and team members from different areas of expertise need to be willing to collaborate across domains, which may require changing the traditional culture of professional isolation.

Resistance to change: Some people may be resistant to new technologies such as tool chains, believing that traditional single-tool methods are more effective, and such problems will be gradually solved with the gradual landing and application of tool chains.

5.2 Development trend of tool chain

Looking forward to the future, combined with the development direction of civil aircraft research and development, the relevant research studies of collaborative research and development tool chain will further evolve with the introduction of new technologies, new trends and new demands, and its development trends include:

The application of artificial intelligence.Artificial intelligence, especially the emerging large language model, can be used to automate and optimize tasks in collaborative tool chains, such as data analysis, decision support, and automated design.

Virtual reality (VR)/Augmented Reality (AR).Virtual and augmented reality technologies can be used to create virtual collaborative environments that enable remote team members to work together more naturally, allowing team members to work together in a virtual world, sharing designs, simulations, and validations.

Data security.Data security will continue to be a key concern, and new technologies and standards will continue to emerge to improve data security.

Taking into account technical, safety, management and cultural challenges, the future civil aircraft collaborative R&D tool chain will continue to evolve and improve R&D efficiency, reduce costs and improve product quality through innovative technologies and closer interdisciplinary collaboration.

6. CONCLUSION

Taking the tool chain of civil aircraft research and development as the starting point, this paper summarizes the research and application status of tool chain in various fields involved in civil aircraft research and development, puts forward a civil aircraft product research and development model based on collaborative tool chain, discusses the application and effect of collaborative tool chain in

electronic hardware design based on case analysis, and reveals the key role of tool chain in civil aircraft research and development.The paper also discusses the challenges facing the tool chain, including technical, security, management and cultural issues, and looks at the future trends of the tool chain, including the application of artificial intelligence, virtual/augmented reality, data security and other technologies.

Through the typical tool chain case analysis of electronic hardware, we can see the great potential of tool chain in the field of civil aircraft research and development.The tool chain's R&D model supports systems engineering ideas, which can improve R&D efficiency, product quality and reduce R&D costs, bringing greater innovation and competitiveness to the aviation manufacturing industry.It is believed that with the in-depth study of tool chain in the field of civil aircraft research and development, the development level of domestic civil aircraft industry will be a higher level!

REFERENCES

[1] Xuzhou. Tool chain construction for civil aircraft design based on MBSE method [J].Aeronautical Manufacturing Technology,2017(5): 100-104. (in Chinese)

[2] Yuan Guanglong.Research and Implementation of System-level tool chain in Automotive Electronics [D]. Sichuan: University of Electronic Science and Technology of China,2014.

[3] Wu Pengcheng. Research and implementation of Safety_SysML /EA/AADL tool chain for avionics system [D].East China normal university, 2023.

[4] Fan Boshu, Interface generation and verification tool chain of large passenger aircraft Advanced display system.Shanghai, Aeronautical Radio-Electronic Research Institute of China,2017-11-26.

[5] Li Chang, Jiang Youyi, Song Yanxiang, et al.Computer Measurement and Control,2019,27(6):55-61.

[6] Zhang Zhenhua. Design and Implementation of traceable DevOps tool Chain [D].Shaanxi: Xidian University,2018.

[7] Li Ke, Niu Ying.Design and implementation of DSP Software Development Toolchain [J]. China New Communications,2019,21(20):98. (in Chinese)

[8] Li Yu. Research on Integrated Development Environment for advanced FPGA EDA toolchain [D].Xian university of electronic science and technology, 2022.

Research and Development Management System File Data Design Based on Object Storage

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Abstract: The construction and implementation of R & D management system in the process of product development, provides business processing data and process execution data information, R & D process implementation standardization, development efficiency and product quality improvement is of great significance.This paper designs a file data management mode, storing file business data in structured database, storing unstructured file content in object storage, establishing the correlation between the two through indexing, and associating files and R&D business data with business attributes to achieve efficient query of file data and ensure consistency between file management and R&D management.It provides powerful data support for project research and development process such as plan management and review management.

Keywords: object storage; Research and development management; File management

1. INTRODUCTION

In the process of product research and development, as the carrier of research and development management information and the implementation tool of system specifications, the R&D management platform plays an important technical support role.This kind of system involves a wide range of businesses, and shows obvious differences according to the user's information construction needs, its content can include plan management, time management, meeting management, process management, demand management and other functions.On the one hand, many types of complex business functions require detailed structured data design, such as planning data and review data. On the other hand, business data also contains many closely related unstructured data, such as time filling deliverables and process attachments.These unstructured data are mostly stored in the form of files on the computer, presenting the characteristics of diversified types, high data volume, and intensive read and write operations.At present, the development of information system shows the trend of cloud service, and system design often includes multi-tenant characteristics, which requires the system data to be isolated among tenants.In the functional framework of R&D management platform, file storage management and the relationship management between file objects and business objects play an important role.

With the development of network technology and the rapid growth of the number of network users and the volume of data information[1], object storage technology has become a new generation of popular storage technology after traditional NAS and SAN technologies due to its massive storage space, efficient read and write access speed and high availability guarantee based on error correction mechanism [2-4].This technology has been widely implemented commercially in major cloud service operators, and provides an HTTP-based application layer transport protocol, as well as SDK of java, JavaScript and other programming languages to support efficient integration in application systems.

In this paper, object storage technology is used as the storage mode of file in R&D management system, and a management mode of file business data is proposed. Establish an association between R & D service data and file service data based on actual service requirements. Map file service data items to files in object storage based on object storage keys to form a relationship chain. Based on the above relationship chain, a management scheme covering the process of file storage, query, upload and modification of R & D management system is designed to ensure the consistency of product development business and file management business[2-4].

2. DESIGN OF FILE DATABASE FOR R & D MANAGEMENT SYSTEM

The basis of the research and development of the file data management function in the management system is to store the content of the file in the object storage, comb the business information of the file and store it in the database, and establish the "index" relationship through the object storage key value.File service management information includes: 1) Basic file information, such as name, file size, creator, and creation time;2) File business information, file owning tenant, file owning business classification,

etc.;3) File object store key values.

File service information is the basis for establishing association between R & D service data and file service data, as well as file classification query.The information can be changed or expanded according to the specific needs of users. This paper proposes a basic design pattern, which is used to record the tenant, service classification and associated business data objects of files respectively through tenant identifier, service classification identifier and business object identifier.The three types of classification identifiers should be generated using the globally unique algorithm within the system, because in the R & D management platform, data statistics report is a common business scenario, in which the application program will filter the combined data from the system based on specific business attribute fields.As a common filtering attribute, the three types of service data can be used to collect statistics on files within a specified tenant, files within a specific R&D service (such as review service files), and files within a specified service object (such as internal files of a specific project). Ensure that identifiers are not repeated in the system.

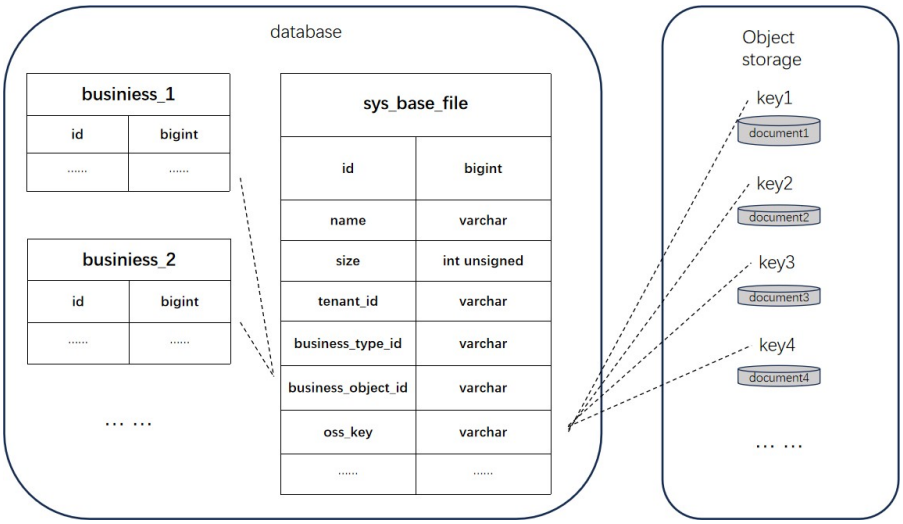

Figure 1 Association between file management service database and object storage

The design pattern of file relationship between file management business and object storage proposed in this paper is shown in Figure 1.In the database design, the base file table (sys_base_file) is used to store the base number attributes, business attributes and other attributes required by the R & D management system during the implementation of the project.In addition, the business object identifier (business_object_id), that is, the primary key in the target service table, is used to associate various R & D service tables with basic file tables.In an object storage system, each file is bound to a globally unique key value, which is stored in the oss_key property of the base file table of the database.In this way, an index chain of business object identification-base file table-object storage key-value-file object is established.

3. KEY VALUE DESIGN OF OBJECT STORAGE

3.1 Storage key design

In the traditional file storage management mode, the data is stored in the directory of the tree structure, and the file can be queried through the directory structure.The management modes of object storage systems are different. Files are distributed flat on the object storage system. Unique key values are used as indexes, and files are manipulated through application interfaces.Because uploading files with the same key value will result in overwriting of files, the design of the file system needs to ensure that each file generates a unique key value.

To adapt to user habits, all existing object storage applications provide a browser console for online file management based on file key values. At the same time, the separator '/' in key values simulates the splitting function of file directories on the console and manages flat files in a similar manner to file directories.At the same time, there is a maximum length limit on the key value stored in the object.

Based on the above characteristics of object storage system, this paper proposes a key value design scheme of object storage. On the one hand, the basic service fields of files are placed inside the key values, which has a good hierarchical division and improves the convenience of file management. On the other hand, the length of key values is limited through the conversion mechanism of file names, while ensuring the global uniqueness of key values. The key value stored by the object meets the following structure when it is generated:

System identifier/Tenant identifier/Service Class identifier/Owning business object identifier/File format name.File name extension.

3.2 Storage of key values at various levels

The system identifier is used to distinguish the application systems that use the object storage system.Most of the existing systems use cloud deployment, object storage cloud services, various cloud service providers on the market, the storage space of a single account is different, and each has a

ceiling, so the deployment of application systems may have shared storage space.The key values of files in the same storage space cannot be the same. Otherwise, file conflicts may occur. Setting the system identifier as the prefix can effectively distinguish files of different service systems and facilitate file management on the object storage console.

The tenant identifier, service class identifier, and owning business object identifier correspond to the three attributes in the file base table.The design makes the file under the file console, according to these three types of identifiers to form a tree structure, the same tenant, the same type of business, the same object file storage, in the console application is divided into the same "file directory".In the R&D management system, in addition to the data isolated between tenants, there is also a class of data that is shared among all tenants. A special identifier constant can be defined in the tenant identifier as the prefix of the file shared by tenants in a class of service systems.

The last level of the key value does not store the original name of the file, but formats the file name to generate random characters of fixed length.The design aims to deal with two problems. First, in some cases, the file name is too long, which may cause the key value to exceed the upper limit of the key value length of the object storage; second, only English and numbers are reserved in the file name, because other characters are encoded differently in the network transmission and different operating systems, which is easy to cause abnormal recognition.

3.3 Length limit for storing keys

There is a limit on the length of the key value stored in the object. Different vendors have different standards. The common limit is 1023 characters.

Set the upper Limit of the key-value length of the object storage service to Limit, the length of the tenant identifier to L1, the length of the service class identifier to L2, the length of the owning service object identifier to L3, and the total length of the file format name and suffix name to L4.It is necessary to ensure that the design of the system file module meets the following relations:

Limit >= L1 + L2 + L3 + L4

Considering that the three types of business identifiers and file formatting names need to have global uniqueness and limited length, a random number algorithm value with a fixed length can be used as an identifier, such as the UUID or snowflake algorithm, the former is a 32-bit string after removing the bar, and the latter is an 18-19 digit string.

4. R & D MANAGEMENT SYSTEM FILE MANAGEMENT

Develop the file management service of the management system, including uploading, obtaining, modifying, and deleting files.In the design of the research and development management system, the management of the file is often not only the processing of the file object itself, but also the generation relying on the change of the business data.For example, the feedback business of working hours is often accompanied by the submission of deliverables.This requires the system to be designed to ensure the consistency of R&D business and document operation.Because the database has a rollback mechanism, the write operation can be withdrawn when an exception occurs, and the object storage system does not have the operation rollback function, so the file system design needs to ensure that the process design meets the requirements of transaction consistency.

4.1 R&D management system file upload

The file upload process of the R&D management system is shown in Figure 2.Users first upload the project file, the system through the file management module, on the one hand, the file binary stream is transferred to the object storage for saving, on the other hand, the file name, size and other basic information as well as the key value of the file to the business form.When the user enters the form data and clicks Submit, the system transmits the form data and file data to the background at the same time, and executes the business database writing and file database writing transactions.If the transaction succeeds, the file is uploaded and data is written successfully. The upload ends.If the transaction fails, the database is rolled back and files in the object storage are deleted in the background through the interface to ensure service consistency.

4.2 Obtaining R&D management system files

The process of file query and acquisition is shown in Figure 3.When a user clicks to access an R&D management page and enters a service query, the system returns related service attributes to the background for query.First, the target object is searched in the service table through the service attribute, and the target file object is obtained in the file table according to its service identifier.The binary stream of the file is obtained from the object storage through the key value of the file object and returned to the browser.After receiving the complete file stream, users can browse the file online or download it from the browser.

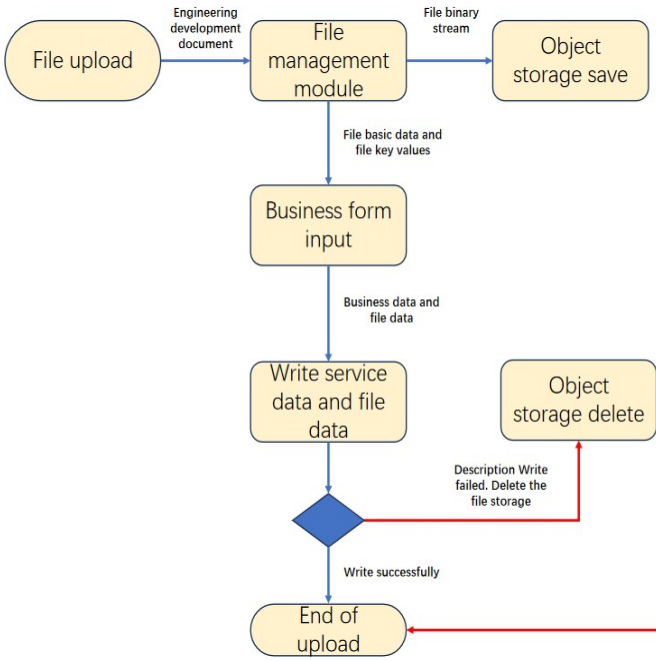

Figure 2 Flowchart of file uploading in R&D management system

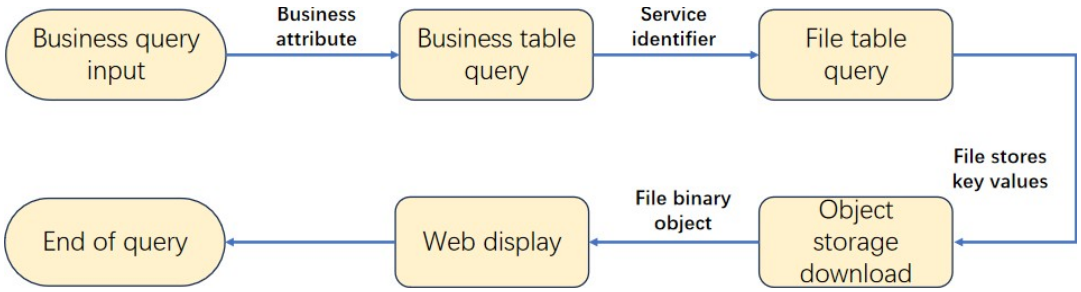

Figure 3 Flowchart of acquiring R & D management system files

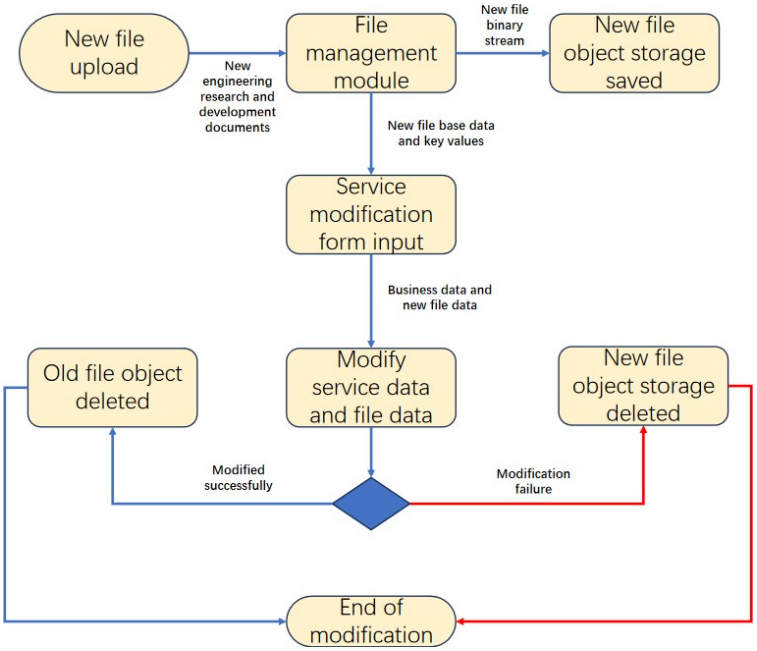

Figure 4 Flowchart of file modification of R&D management system

4.3 Modifying r&d management system files

The file modification process of R&D management system is shown in Figure 4.A user uploads a modified file on the R&D management page of a service. The file management module stores the file to the object storage and generates the basic information and key data of the new file.After the user enters the modified service form data, the system transmits the data of the new file and the service modification form to the background service at the same time.Background services perform service data modification and file data modification transactions. When the modification transaction is successfully executed, the old file objects in the object storage are deleted.If data modification fails, the newly uploaded file is deleted to ensure data consistency with storage devices.

4.4 Deleting a r&d management system file

The process of deleting system files is shown in Figure 5.The user selects the service object to be deleted and triggers the service deletion operation.The background searches the database table according to the inserted service attributes and queries the key value of the target business object and file.Delete a file object based on its service object identifier, and then delete it from the object storage according to its key value. If the object storage fails to be deleted, the database deletion operation is rolled back.If the object storage is successfully deleted, the deletion process ends.

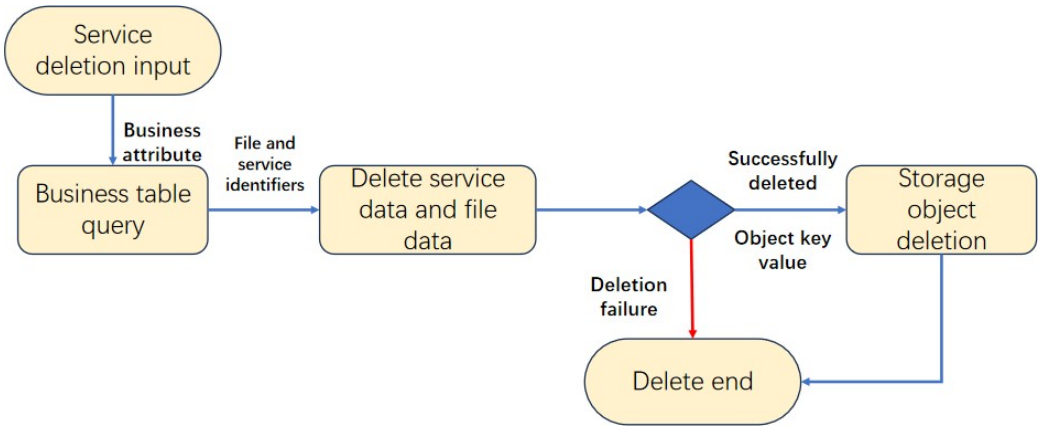

Figure 5 Flowchart of file deletion in R&D management system

5. CONCLUSION

R&d management system involves many kinds of business processes of product development and a large number of users' personalized construction needs, and there is an objective need for efficient query and management of file data.By storing the basic file data in a structured way, establishing business data association with various business attributes, and utilizing the query advantage of relational database, the file business data can be located efficiently.The object storage service is introduced to create unique object storage keys of fixed length based on system ids, tenant ids, service ids, owning service object ids, and formatted file names. These keys serve as indexes for structured database information and unstructured file data, ensuring secure file storage and efficient file access. In view of the fact that business operation and file storage are distributed in different modules, combined with the database transaction mechanism, this paper proposes the business processing flow of file upload, acquisition, modification and deletion, and processes file storage objects according to the execution of R & D management business, so as to ensure that the execution results of business data are consistent with the storage results of file data, and ensure the accurate operation of R & D management system business.

REFERENCES

[1] Rosa, E Haihong, Song Meina et al.Object storage research review [J]. Journal of new industrialization, 2012, 2 (11): 32-41.

[2] Wang Andong, ZHAO Yajie, Yu Hailing et al. Construction of bird thematic data platform based on cloud object storage [J]. Modern Computer, 2021(11): 92-96+101.

[3] Li Bing, Wang Lianzhong, Si Yuncheng. Application design of MinIO storage in monitoring System [J]. Industrial Control Computer, 2019,33(09): 79-80+82.

[4] Zhang Yansheng. Research and Application of distributed object storage in inspection system [J].Telecommunication engineering technology and standardization, 2022, 35 (5): 7-10 + 26.

Design and Analysis of Glow Tube Watch Based on STM32

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Abstract: This design uses STM32 as the main control chip for a glow tube watch. The hardware part consists of an STM32 main controller circuit, boost circuit, power management circuit, external RTC clock circuit, glow tube driver circuit, gyroscope circuit, and ADC voltage acquisition circuit. The software part consists of the main function of the program, ADC voltage acquisition program, glow tube driver program, RTC clock program, and gyroscope program. Glow tube watches can achieve precise display of time, wrist lift wake-up, battery detection, and other functions.
Keywords: STM32; Glow Tube; Watch; Time.

1. INTRODUCTION

In recent years, glow tubes have gradually become a new favorite for the fusion of contemporary technology and classical aesthetics due to their novel forms of expression and brilliant light and shadow effects. Currently, most electronic watches on the market use LCD or LED digital tubes to represent time and date. Compared to this, using this type of LED for digital display is highly favored by people who like retro style.

The main function of a glow tube watch is for the gyroscope to detect the lifting of the arm and start STM32 to read the time information generated by the clock module. After being processed by STM32, the voltage supplied to the glow tube is boosted by the boost circuit, and then the driving chip outputs the time displayed on the glow tube. The buttons on the watch can be used to call the ADC voltage collection program on the glow tube watch to calculate and display the battery level. When the watch runs out of power, it will prompt by flashing the LED light. During the charging process, the LED light will turn on normally, and when the charging is completed, the LED light will turn off and interrupt the charging.

2. DESIGN COMPONENTS

The glow tube watch can be divided into the following parts: MCU main control module, glow tube drive circuit, power management circuit, gyroscope circuit, external RTC clock circuit, boost circuit, ADC voltage collection circuit.

2.1 MCU main control module

The MCU main control chip uses STM32F103C8T6. STM32F103C8T6 is a 32-bit microcontroller developed by STF Semiconductor (ST) with Cortex-M3 as its core. Its operating voltage ranges from 2.0 to 3.6 V, with a maximum of 700MHz. It is equipped with 64 K or 128 K Flash memory and 20 K SRAM storage; The unique serial number of the chip with built-in CRC cyclic redundancy check and 96 bit encoding. Its main system includes D Code bus D-bus, system bus S-bus, universal DMA1, universal DMA2, and four controlled units, which are connected to each other through the AHB bus.

2.2 Glow tube driving circuit

The driving circuit of the glow tube uses a D1NPN high-voltage transistor to drive the brightness and extinction of the glow tube. Control the glow tube by providing a high level base to the transistor through the transistor switch circuit to ground the transistor. The D1 high-voltage transistor has a withstand voltage value of 300V and can pass a maximum current of 500mA, which is very suitable for the driving conditions of 170V glow tubes[1] .

2.3 Power management circuit

The control chip of the power management circuit adopts the power management chip of TP4046. TP4056 is a single cell lithium-ion battery constant voltage linear charging device with excellent characteristics. The TP4056 is packaged in ESOP8 and used with a small amount of peripheral components, making it very suitable for portable products as well as USB power supplies and adapters. TP4056 adopts a unique internal MOSFET structure and adopts an anti backcharging technology. Thermal feedback can adjust the charging current, thereby lowering the temperature of the low chip in high power situations or when the external environment temperature is too high. The charging voltage is 4.2V, and a resistor can be used to set the charging current externally. At the final float charging voltage, the charging current drops to 1/10, and the chip will end its charging cycle. After the power supply voltage is turned off, TP4056 will fall into sleep, and the leakage current of the battery will be lower than 1uA. When the static current of the chip drops to 35uA, TP4056 can be set to the off mode. TP4056 also provides other functions: battery temperature monitoring, low voltage locking, automatic recharging, and two status pins that display charging and ending. By using an external resistor, the charging current can be set up to a maximum of 1000 milliamperes. TP4056 has a status display, which has two outputs with open drain, one with a charging status display of CHRG, and one with a battery

charging end command output of STDBY. When the temperature of the chip exceeds 135 degrees Celsius, the power supply circuit inside the chip will automatically reduce the charging current. This function allows users to fully use the chip for charging without worrying about damage to the chip or external components due to excessive temperature.

2.4 Gyroscope circuit

The control chip of the gyroscope circuit adopts the MPU6050 three position angular acceleration gyroscope chip. MPU6050 is the first integrated six axis motion processing device developed by InvenSense company, with built-in three-axis gyroscope and three-axis acceleration sensor, and an IIC interface that can be connected to external magnetic field sensors. It uses DMP (Digital Motion Processor) hardware acceleration engine to transmit the complete data of 9-axis attitude fusion calculus to the application program.

2.5 External rtc clock circuit

The control chip of the external RTC clock circuit adopts the external DS1302RTC clock chip. DS1302 is a slow charging real-time clock chip that includes 31 bytes of nonvolatile static random access memory. Communicate with the microcontroller through a simple serial port. Real time clock/calendar can time seconds, minutes, hours, days, weeks, months, and years, automatically adjust months less than 31 months, and can correct leap years. The clock can be in 24-hour format or 12 hour format, with AM (noon)/PM (afternoon). 31 byte RAM can temporarily store certain critical data. The communication between DS1302 and microcontroller adopts synchronous serial communication. Only three wires are needed to communicate with the clock/RAM: (1) RST (reset), (2) I/O (data line), and (3) serial clock (SCLK). The transmission of data can be one byte per byte or 31 bytes. The DS1302 has very low power consumption, requiring only 1 milliwatt of power to store data and clock information.

Shift register, oscillator, timing clock, and RAM: When the RST signal is activated, the shift register unit continuously receives 8-bit command bytes from I/O under the control of SCLK's synchronous pulse signal, and concatenates and transforms the 8-bit command bytes into ROM instruction decoding units. The 8-bit instruction byte is decoded by the ROM instruction decoding unit to determine the address and read and write status of internal registers. The 8-bit data is then written or read out under the control of the SCLK synchronous pulse signal. Data transmission can also use multiple byte modes, which first write 8 corresponding instruction bytes, and then sequentially write or read data bytes to the calendar/clock register (or RAM device) under continuous SCLK pulse signals. The number of SCLK pulses is 8 plus 8, and in multi byte mode, the maximum number of SCLK pulses can be 248.

2.6 Booster circuit

The boost circuit uses a 5V to 160V 88% conversion efficiency power module. The input voltage of this module is 3.5V-9V, which can be powered by lithium batteries, USB, and chargers below 12V.

2.7 ADC acquisition voltage circuit

The ADC voltage acquisition circuit uses resistance voltage division to collect voltage. The voltage of the battery is generally around 3.7V to 4.2V, exceeding the maximum voltage of 3.3V of STM32. Therefore, two 1M resistors need to be used for voltage division first, and then STM32's built-in ADC is used to collect the battery voltage[2].

The ADC in STM32 is an analog-to-digital converter or analog-to-digital converter. ADC is a device that converts continuously transformed analog signals into discrete digital signals. In real life, simulation signals such as temperature, pressure, sound, and images must be converted into digital formats that are easier to store, process, and transmit. Analog/digital converters can accomplish this task and can be found in numerous products. A typical ADC converts an analog signal into a digital signal, which represents a specific proportional voltage. However, some analog-to-digital converters are not purely electronic devices, such as rotary encoders, and can also be considered as analog-to-digital converters.

The STM32f103 series has three analog-to-digital converters with a precision of 12 bits, each with a maximum of 16 outer diameters. Both ADC1 and ADC2 have 16 external channels, while ADC3 usually has 8 external channels. The A/D transformation of each channel can be performed in a single, continuous, scanning, or discontinuous manner. ADC transformation can align the results of ADC transformation to the left or right and store them in a 16 bit data register. The input clock of ADC cannot exceed 14 MHz, and its clock frequency is achieved through the division of PCLK2. The voltage range that ADC can measure is VREF+<VIN<VREF+. VSSA and VREF - are grounded, and VREF+and VDDA are connected to 3V3, so that ADC has an input voltage of 0-3.3V. The input of ADC adopts channel mode, and the signal is input to the MCU by the microcontroller, which then transforms it and outputs it into a digital signal. The ADC of STM32 has a total of 18 channels, and the 16 external channels are divided into regular channels and injection channels during transformation, with a maximum of 16 regular channels and 4 injection channels. The so-called regular channel is the most ordinary and common channel. The injection channel and the rule channel correspond, and once the rule channel changes, it will be forcibly converted, equivalent to an "interrupt channel". In cases where there is an injection channel that needs to be converted, the conversion of the regular channel will be aborted, and after completing the conversion of the injection channel, it will return to the original

regular channel.

ADC conversion trigger is the same as the communication protocol, and a start signal must be specified for signal transmission. ADC must also have a trigger signal to perform analog-to-digital conversion. The first method is to directly set the register trigger. When writing 1, configure the ADON bit of control register CR2. When writing, the transformation starts and writing 0 stops. When running a program, simply call the library function to convert the CR2 register ADON address 1. In addition, this transformation can also be triggered by a built-in timer or external IO, that is, the built-in clock can be used to achieve periodic switching of the ADC, and external IO can be used to achieve switching of the ADC. The specific triggering depends on the control register CR2.

3. DESIGN DEBUGGING ANALYSIS

When designing a transistor switch circuit, the transistor is turned on when the B pole current is greater than 1 MA. When conducting, the voltages of the B and C poles of the transistor are 0.7 V and 0.3 V, respectively. When the maximum transmission current of the glow tube is 5 Mach, and when the B electrode current exceeds 1 Mach, the transistor can operate normally. When R=U/I obtains R=2 K, the transistor meets the requirements, so R=2 K. When turned on, the B pole of the transistor has a current of 1.2 mA, and the transistor is in the on state. At this point, the voltage of the C electrode is 0.3 volts, and the pressure difference on the glow tube is 170 volts, and then the glow tube will emit light; If turned off, there is no current at the B pole, the transistor is not conductive, and the voltage at the C pole will be infinitely high, equivalent to 170 V, and the glow tube will stop emitting light. The simulation results indicate that the circuit can operate normally with a current limit of 2k.

Glow tube boost module in typical applications, output 170V, The current is 8mA (4 glow tubes) -16mA (8 glow tubes), which is suitable for making large glow tube electronic clocks. The power conversion efficiency of this module remains above 85%, reaching 88% of the power conversion efficiency and continuous stable operation. The module can output a current of over 24mA, but such a large output will cause the output voltage to be pulled down, the power conversion efficiency will decrease, and the module will generate heat. It is not suitable to stay in the limit state for a long time.

STM32 program controls the brightness and brightness of two in6 glow tubes at different high and low levels for each transistor, and causes the glow tubes to display different numbers. By successfully lighting up the glow tube and controlling the on-off of the transistor with a program, the glow tube can display different numbers[3].

4. CONCLUSION

This design uses STM32 as the main control chip for a glow tube watch, which can achieve precise display of time, wrist lift wake-up, battery detection, and other functions. It uses the gyroscope to detect the lifting of the arm and start STM32 to read the time information generated by the clock module. After being processed by STM32, the boost circuit is used to provide the voltage for the glow tube to light up, and then the driving chip outputs the time for the glow tube to light up. The buttons on the watch can be used to call the ADC voltage collection program on the glow tube watch to calculate and display the battery level. When the watch runs out of power, it will prompt by flashing the LED light. During the charging process, the LED light will turn on normally, and when the charging is completed, the LED light will turn off and interrupt the charging[4].

REFERENCES

[1] Yanfeng Xu. Discussion on LED indoor lighting engines and their dimming methods [J]. Shanghai Lighting Technology and Application Trends Forum, 2012

[2] Chongguang Yan. Low voltage drive technology for LED lamps [J]. Electronic Quality, 2009

[3] Yonghui Wei ,Wei Yang. Intelligent Table Lamp Design Based on BISS0001. Electronic Component Applications, 2010, Issue 7

[4]Yongyi Zheng . Digital Image Frequency Shift Pulse Width Modulation (F-PWM) Dimming [J]. Shanghai Energy Saving, 2012.

Characterization of Piston Rod Surfaces Using The Tactile Cutting And Scattered Light Method

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Abstract: The surfaces are represented by a frequency distribution for solution, so that the data of each piston rod is included in a diagram. The presentation is simple, clear and comparable. There is the option to delineate different areas of the measured surfaces. This allows the different positions in a piston rod to be compared or the unnecessary surface to be eliminated.
Keywords: Surfaces, Touch cutting methods, Scattered light sensor measurement.

1. INTRODUCTION

The gas nitriding layer consists of an oxide layer, a connecting layer and an underlying diffusion layer, Figure 1.

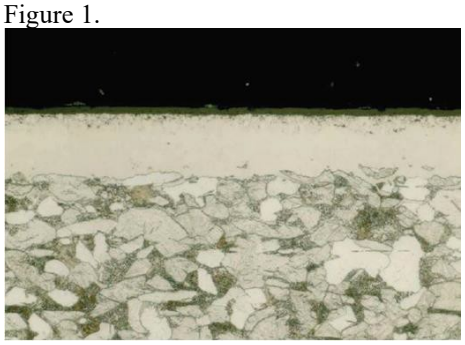

Figure 1 Structure of the boundary layer [1]

The gas spring must be able to operate in long-term continuous operation and in different environments. The surface must therefore have wear-resistant and rust-free properties. The connecting layer is formed during the gas or gas layer. Salt bath nitriding. While this layer is very wear resistant, the connecting layer together with the oxide layer serves to keep the surface rust-free. In addition, adhesion, wear resistance and roughness of the surface layer play an important role in operation. The adhesion and wear resistance can be checked by a wear test.

2. EXPERIMENTAL

Tactile and optical measuring devices are used to determine surface characteristics. For tactile devices (tactile cutting methods), the surface is brushed with a diamond tip. In contrast, optical measuring devices (scattered light sensor measurement) operate non-contact.

2.1 Touch cutting procedure

The tactile method is a tactile method for the measurement description of surfaces [2], Figure 2.

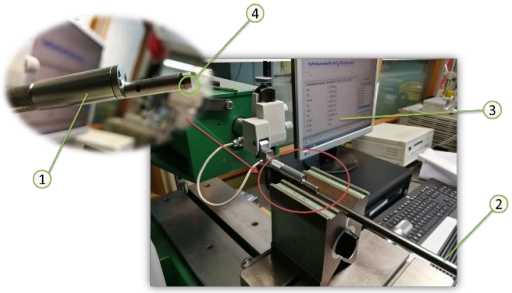

Figure 2 Contactor (pertometer)

(1)Buttons:
The probe is aligned perpendicular to the piston rod and moves at a constant speed over the surface of a sample (workpiece).
(2) Piston rod:
The piston rod is aligned and fixed by a magnetic force in a prism. The pad can be moved in any direction so that the probe tip can touch the highest point of the circle.
(3) Computer:
The computer receives information from the vertical position shift of the probe tip. This allows the different roughness parameters to be calculated.
(4)Probe tip:
Diamond cones with a rounded tip are used as the probe tip. Due to this geometry, measurement results can be influenced.

2.2 Scatter light sensor measurement

There are a wide variety of sensors for non-contact measurement of roughness characteristics. Here only the most common ,OptoSurf surface measuring system OS 500'-Figure 3[3].

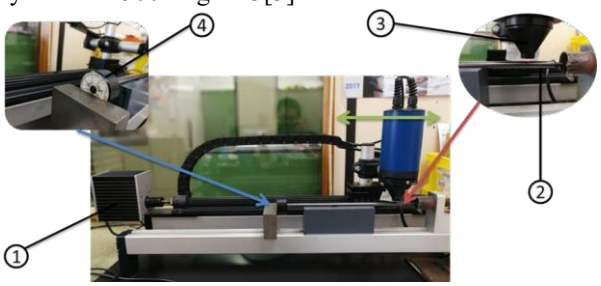

Figure 3 Scatter light sensor

(1) Linear motion motor:
The computer controls the engine speed. With the

help of a thread, the scattered light sensor is moved back and forth linearly.

(2) Piston rod:

The piston rod is placed parallel to the path of the sensor in a prism.

(3) Scatter light sensor:

The scattered light sensor sends a red light beam to the surface and receives the reflection of the light with a sensor. During the linear sequence, the scattered light sensor can measure 2,5005,0006,000 points. The number of measuring points depends on the length of the selected measuring distance, with each measuring point having an Aq, Ask, Aku, I and M value.

(4) Dial with marking in 4.5° increments:

By default, 1/8 of the sheath surface of each piston rod is measured, i.e. the piston rod is rotated by 4.5° degrees after each measuring line. In total, 10 lines are measured.

3. CONCLUSIONS

Eight standard measurements must be made to measure the entire piston rod. Each standard measurement consists of an Excel file with the five parameters mentioned, which are stored individually on a worksheet. In each worksheet there are ten columns with measurement data (according to the 10 measurement lines). The number of measurements per line can be 2,500; 5,000 or 6,000 points.

Figure 4 shows the Aq values of a series piston rod (batch, TN polishing machine; 5067-423534-412532-3) in the form of an Excel table. The piston rod of batch 5067 has a length of 170mm. According to the measurement point criteria in Table 1, there are therefore 5,000 points per line. The Aq matrix thus consists of 50,000 point data. With the help of a color scale, the Aq values are displayed in different colors:

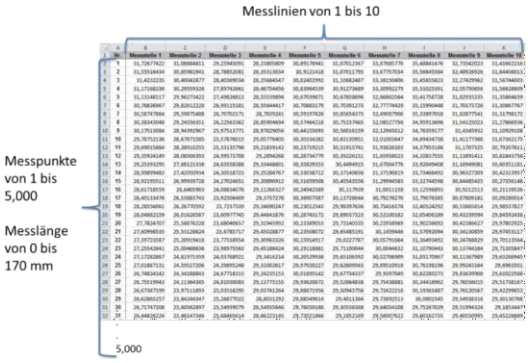

Figure 4 Aq value of one part (batch 5067)

REFERENCES

[1] Y. Zhang, "Influence on the," Stabilus GmbH, 2013.

[2] D. P. S. Jung, author, surface assessment - roughness measurement - . [Performance]. 2012.

[3] OptoSurf, user manual, 2009.

A Review on Machine Learning-assisted Digital Pathology Image Diagnosis of Breast Cancer

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Abstract: Machine learning has great potential for assisted diagnosis of breast cancer digital pathology images. By analyzing breast cancer images, machine learning algorithms can automatically detect abnormal features and provide valuable diagnostic information. These algorithms can be used for tasks such as tissue segmentation, nucleus detection, and tumor grading to help doctors make more accurate decisions. Despite the challenges, as technology advances and more data become available, machine learning will improve the accuracy and efficiency of early detection and prognostic assessment of breast cancer, providing better diagnostic and treatment support for patients.
Keywords: Breast cancer; Digital pathology images; Machine learning.

1. INTRODUCTION

Malignant tumors are where breast cancer begins when a cell's growth spirals out of control. Breast cancer is brought on by the abnormal proliferation of numerous fatty and fibrous breast tissues. Tumors that cause various stages of cancer have cancer cells that have spread throughout them. Breast cancer can take many different forms and manifests as the afflicted tissues and cells spread throughout the body. According to the World Health Organization, breast cancer is the type of cancer with the greatest incidence and fatality rates worldwide in the female population. The increased need for breast cancer screening in hospitals and screening locations around the world over the past ten years has revealed opportunities for new research. Early cancer detection significantly improves the likelihood of determining the right approach of action for an effective treatment plan. Breast cancer screening can be done non-invasively using clinical breast exams or imaging techniques like mammography, ultrasound, or magnetic resonance. However, a pathologist's histological examination of a sample from a suspicious location is the benchmark for conclusively diagnosing breast cancer [1-7].

This technique not only requires a pathologist to perform at a high level but also takes a lot of time. It is difficult for patients to obtain convincing results since clinicians' assessment of medical pictures is inherently qualitative and differs from person to person. Due to advancements in CAD and image scanning technology, Whole-slide Image (WSI) scanners are frequently utilized in the field of pathological diagnosis. Histopathologists can acquire more reliable and quantitative analytic results, save labor expenses, and increase diagnosis objectivity by combining WSI and CAD technologies for segmentation, classification, and prognosis[8].

Whole-slide imaging (WSI), sometimes known as "virtual microscopy," aims to replicate standard light microscopy in a computerized model. WSI provides images with enhanced resolution and quality, as well as annotation. Fast scanning speeds have increased image quality and decreased storage costs for scanners. Glass slides can be converted to digital files using whole-slide imaging technology, which also serves as the basis for automatic image analysis systems. The digital method can also help reduce the time required to transfer glass slides and the risk of breakage and deterioration. Some challenging pathology issues can be resolved by digital pathology networks based on WSI systems[9]. Additionally, it will enable pathologists to quantify prognostic indicators like iTILS and sTILS with greater efficiency, accuracy, and creativity. Nowadays, highly developed WSI technology provides the pathology community with innovative clinical, nonclinical, and research image-related applications. However, equally important is the fact that WSI develops CAD in concert with the rapidly advancing computer technologies of artificial intelligence, including machine learning and advanced deep learning. With the aid of the CAD system, pathologists can increase diagnosis accuracy and detection rates while lowering the overall misdiagnosis rate. Additionally, the computer offers better assistance to doctors because it is not impacted by fatigue or human error[10].

Recent advances in pathology image processing have resulted in the creation of novel algorithms and software for clinical diagnosis and the study of disease causes. Artificial intelligence (AI) has grown in popularity over the past ten years in the field of cancer research, where it has been demonstrated to improve diagnostic effectiveness and efficiency by delivering measurable outputs to forecast cancer behavior and prognosis. Traditional cancer detection

methods are based on a regression process that can detect the presence of cancer, while the foundation of the new machine learning algorithms and approaches is model design. Machine learning (ML), a subset of AI, has been demonstrated to inform treatment choices while also providing standardization and consistency in the grading of dysplasia and malignancies. DL algorithms are a subset of machine learning (ML) algorithms that are created to learn from examples without explicit human interaction when assessing the properties of the input to produce a desired (usually predictive) output given a certain input[11]. If given adequate instruction and knowledge, DL can execute many cognitive tasks better than human experts, including the analysis of huge and heterogeneous datasets. Major medical specialties, including oncology, radiology, neurology, and cardiology, have indeed benefited from DL approaches in terms of detecting aberrations, assisting with diagnosis, directing treatment, predicting results, and assessing prognosis. In contrast to ML algorithms, DL algorithms include a multi-layer computational architecture, and each layer is capable of condensing, extracting, and restructuring data that is passed on from earlier layers. Recently, a huge array of DL techniques has been created to enhance the decision-making process based on large-scale, intricate healthcare data[12].

The years are drawing nearer and nearer, while technology keeps evolving. Computers are being used to aid in diagnosis in an increasing number of cases. Classification, segmentation, and prognosis, the three main applications, have shown an annual increase in the number of cases. Pathologists have started to realize it considerably since 2008 thanks to CAD viewing WSI. Since 2014, there has been a rise in the number of computer-aided pathologists who have been identified as having WSI. By 2022, the growth rate of CAD had gradually grown, indicating the rapid advancement of this technology. An organizational structure is displayed in Figure 1 to describe and clarify the work context for computer-aided pathologists when studying WSI. The diagram depicts the general procedure of CAD and WSI processing. It illustrates seven crucial processes of the histopathology image analysis system.

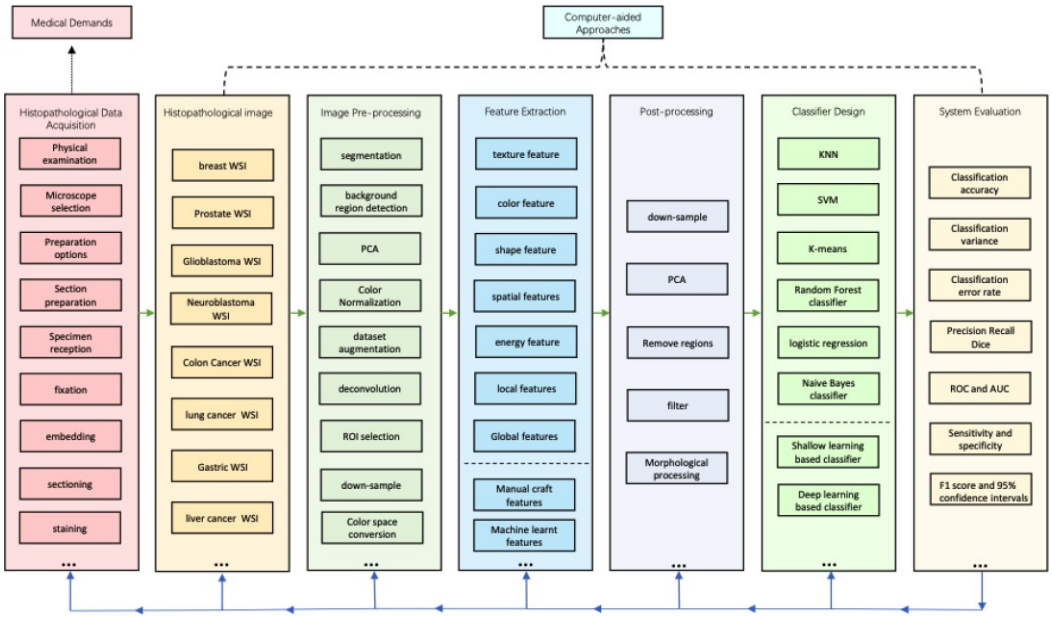

Figure 1 The organization chart of histopathology WSI analysis using computer-aided analysis approaches in this paper.

The purpose of this paper is to offer an overview of the existing and potential applications of artificial intelligence systems in breast cancer pathologic image interpretation. We begin by discussing the present obstacles and prospects for breast cancer pathologic imaging analysis. Next, we will examine segmentation, as well as new advances in artificial intelligence, particularly deep learning, that may have an impact on the digital pathology of breast cancer. Finally, we conclude with a summary of the limitations of existing methodologies and a proposal for the direction of future research.

2. SEGMENTATION

In recent years, as the size and quantity of medical images have increased, higher requirements have been placed on a computer-aided diagnosis. In particular, computer algorithms for outlining anatomical structures and other regions of interest are gaining importance in helping and automating particular histological processes. These are known as image segmentation algorithms. Segmentation of medical images is a complex and essential phase in the field of medical image processing and analysis(Li, 2021). The objective of this procedure is to segment certain sections of a medical image and extract pertinent characteristics. Tissue segmentation and cell

segmentation are the two most common types of medical image segmentation[13-15].

2.1 Cell segmentation

Cancer diagnosis and prognosis are greatly aided by the cellular morphology depicted in histological pictures. However, cells have intricate architectures shown in figure 2 and originate in a variety of circumstances.

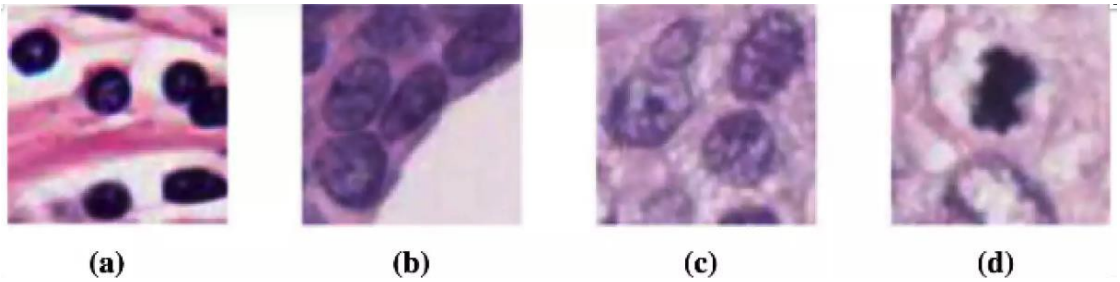

Figure 2 Different types of nuclei a LN, bEN, cEN (cancer), dEN (mitosis)

Researchers domestically and internationally have attempted a variety of algorithms to overcome the problem of cell segmentation in slide images. Despite the fact that many automated methods for segmenting nuclei have been proposed, pathologists have a tough time selecting the best one to utilize because there are so many competing segmentation techniques with various capabilities. In this part, we examine some of the key methods that have been published in recent years with a focus on automatic computational methods for nuclei/cells segmentation.

2.1.1 The threshold-based cell segmentation method

The simplest method for image segmentation is thresholding. The concept of thresholding is to replace each pixel in a picture with a white pixel if the pixel value exceeds a specific threshold, and a black pixel otherwise. The selection of the ideal threshold is a crucial concern among them. The manual experience selection method, the histogram method, the maximum between-class variance method (OTSU), and the adaptive threshold method are typical threshold selection methods. The threshold segmentation approach has dominated picture segmentation due to its ease of implementation, small quantity of calculation, and reasonably constant results. Summary of threshold-based cell segmentation method shows in table 1.

According to Jun Kong et al., a technique for image analysis was created to segment and characterize cell nuclei. The TCGA project's glioblastoma microscopic pictures are employed.

A new technique is suggested to separate colorectal cancer strongly aggregated overlapping cores. The suggested approach starts by extracting foreground regions using a combination of global and local criteria.

In Kowal et al., the suggested method locates nucleus regions in the image using isodata image thresholding and Canny edge detection[16]. The technique was used to separate the nuclei from microscopic pictures of cytological samples taken from breast tissue. For segmented nuclei, various morphometric, textural, colorimetric, and topological parameters were calculated to characterize cases (patients). The cases were divided into benign and malignant categories, and the achieved prediction accuracy was 98%. However, for new and larger datasets, the method cannot guarantee the detection of all nuclei.

In SahaM. et al., in order to distinguish overlapping breast cell nuclei, this work integrates Lagrange's interpolation with super pixels to create an automated and effective segmentation system (normal and malignant). The results imply a possible need for our suggested image-analysis method to enhance IC nuclei identification and categorization.

Abdolhoseini et al. indicates a novel technique that can be used to quickly, accurately, and to a high degree of automation, analyze a range of histopathological pictures stained for distinct proteins. This approach uses a locally adaptive thresholding method in watershed regions. followed by a massive splitting strategy based on multilayer thresholding and the watershed algorithm.

In Wang et al., the suggested method uses ensemble bagged tree and ensemble subspace discriminant classifiers. The technique achieves binary and multivariate classification for the first time, and the accuracy of both classifications exceeds 88%.

In Kabakci et al., an explainable artificial intelligence paradigm for the CerbB2/HER2 score is proposed. The suggested HER2 scoring technique can be updated without retraining or re-designing the model[17].

2.1.2 The watershed-based cell segmentation method

The watershed algorithm is a region-based picture segmentation algorithm based on the theory of morphology). Watershed corresponds to a multi-threshold adaptive segmentation algorithm. In this method, an image is a topographic map, and the gray value corresponds to terrain height. Mountains have high gray values, whereas lowlands have low ones. Low-lying areas where rain falls are basins, and the ridge between basins is a watershed[18]. Details about the watershed approach can be found in (Veta et al., 2019). Summary of watershed-based cell segmentation method shows in table 2.

If the position of the foreground object and background can be determined or noted, segmentation using the watershed transform is

effective. In M. Veta1, a marker-controlled watershed is utilized. This program takes the input image to be a topographic surface and simulates the flooding of that surface from particular seed locations or markers. In, an automatic cell nucleus segmentation technique is utilized to extract size-related morphometric properties of cell nuclei and evaluate their predictive significance in male breast cancer.

Table 1 Summary of threshold-based cell segmentation method

Published Year	Dataset	Description
2011	TCGA project on GBMs	Simple threshold watershed method
2013	Manually labeled Tissue Microarray (TMA) and Whole Slide Images (WSI) colorectal cancers stained for the biomarker P53	segmentation (seriously clustered overlapping cores for segmentation)
2016	50 H&E breast images	Thresholding and Fast Marching for Nuclei Extraction
2017	120 IC breast images	overlapped and nonoverlapped nuclei segmentation (concave point, Lagrange's interpolation, superpixels)
2019	UCSB dataset of breast cancer	segmentation (waterthreshed/multilevel thresholding)
2020	BreakHis	Ostu thresholding, minima transform, and median filtering
2021	ITU-MED-1 and ITU-MED-2	hybrid multi-level thresholding and radial line

Table 2 Summary of watershed-based cell segmentation method

Published Year	Dataset	Description
2011	19 H&E breast images	Mark controlled watershed
2012	101 male H&E breast images	multi-scale marker-controlled watershed segmentation
2013	39 H&E breast images	Mark controlled watershed
2019	-	core segmentation MapReduce architecture
2017	120 H&E breast images	Modified marker controlled watershed thresholding, Ostu, Hough transform

In (Veta et al., 2013), H&E stained breast cancer histopathology images are segmented using the same procedure as in (Veta et al., 2012).

A cloud-based implementation of a highly scalable and economical MapReduce-based image analysis framework is suggested in (Veta et al., 2013). The system uses a grid-based overlap segmentation method and offers MapReduce-based picture segmentation that may be done simultaneously. The nucleus is segmented using a threshold approach in the segmentation step[19-21].

Rajyalakshmi et al. achieved the best accuracy, with a modified marker-controlled watershed achieving a segmentation accuracy of 95.79% (normal) and 95.56 % (invasive).

2.1.3 The active contour models-based cell segmentation method

Active contour models (ACMs) or deformable models are extensively utilized in picture segmentation. A segmentation boundary is expressed as deformable splines in these approaches, and an energy function, which is specified by gradient information, generates the forms by attempting to minimize the energy function. In the instance of nuclei segmentation, the contour points that provide the lowest energy level constitute the nucleus's boundary. Typically, the energy function is defined to penalize curve form and gray-level discontinuities along the contour. Summary of ACM-based cell segmentation method show in table 3[21-25].

In (Qi et al., 2012), Xin Qi et al. provide a unique algorithm capable of consistently separating contacting cells in hematoxylin-stained breast TMA specimens obtained using a conventional RGB camera. A level-set approach based on an interactive model is used to determine the contour of each cell to handle topological changes.

In (Beevi et al., 2016), segmentation of nuclei from breast histopathology pictures is performed by a Localized Active Contour Model (LACM) employing bio-inspired optimization strategies in the detection stage in order to accommodate dispersed intensities along object boundaries.

In (Wan, 2016), images were segmented using a hybrid level set-based segmentation method, which describes the percentages of nuclei belonging to each grade.

High-resolution pictures of partially overlapping cervical cells were analyzed by Guan et al. (Guan et al., 2015) analyzed high-resolution pictures of partially overlapping cervical cells. The method of detecting nuclei with weak contours relies on an algorithm for dynamic sparse contours. An advanced snake model was then used to determine the exact shape of the cell. There was a limit of two overlapping cells that could be handled by the approach. Furthermore, low-quality photos degrade their performance.

Table 3 Summary of ACM-based cell segmentation method

Published Year	Dataset	Description
2012	234 H&E breast cancer	Level set based on an interactive model
2015	two cervical smear image datasets(77+182)	K-means clustering algorithm, Gradient Vector Flow Snake model
2016	MITOS	Localized active contour models
2016	89 H&E breast cancer slides	a level set that combines boundary and region data

2.1.4 The clustering-based cell segmentation method

Clustering is determined by the link between pixels and their neighbors. A pixel will be combined into the same class as its neighbors if they have a similar color, texture, or level of gray. The clustering algorithm k-means is more frequently employed. The average of all the pixels in each cluster in the sample is used to get the cluster center point. Filipczuk et al. explored a three-level binarization process by extracting the luminance component with the formula $L=0.2126R+0.7152G+0.0722B$. The second level employs clustering methods such as k-means, fuzzy c-means (FCM), and Gaussian mixture models (GMM) to divide the image into nucleus, cytoplasm, and backdrop by utilizing distinct color channels as characteristics. However, this approach has two significant disadvantages. Unsupervised clustering is limited to practical applications due to the necessity to determine optimal parameters and associated difficulties. Summary of clustering-based cell segmentation method shows in table 4[26-29].

In (Mittal & Saraswat, 2019), research presents a superpixel clustering method based on an intelligent gravitational search algorithm for autonomous nuclei segmentation. In the proposed method, an intelligent gravitational search algorithm, a novel form of the gravitational search algorithm, is used to identify the ideal cluster centroids.

In (Ray et al., 2022; Vishnoi et al., 2021), the fuzzy clustering approach based on the roulette wheel

selection whale optimization is presented for the nuclei segmentation of histopathology images. The suggested clustering approach discovers optimal clusters by reducing squared error or compactness. The results of the experiments support the effectiveness of the newly proposed method compared to prior clustering-based segmentation techniques.

Table 4 Summary of clustering-based cell segmentation method

Published Year	Dataset	Description
2013	FNB(675 breast cancer images)	thresholding, k-means, FCN, GMM
2019	H&E stained estrogen receptor-positive (ER+) breast cancer images	Superpixel clusteringGravitational search algorithm
2021	H&E stained histopathology image from TNBC patients	Whale optimization algorithm
2022	breast histopathological images	Whale optimization algorithm

2.1.5 The deep learning-based cell segmentation method

Artificial neural networks (ANN), a system that mimics the function of human nerve cells, are the foundation of deep learning (neurons) . Although the volume of learning data has a significant impact on how well deep learning approaches function, the algorithms are generally more intelligent than other approaches. Summary of deep learning-based cell segmentation method shows in table 5[27-31].

Kumar et al. provided a method and made the software for nuclear segmentation using a CNN accessible to the general audience.

In order to diagnose cell samples, this study compares multiple fine-tuned transfer learning classification approaches based on deep convolutional neural networks (CNN). The GoogLeNet architecture produced a maximum accuracy of 96.25 %.

A two-stage learning approach has been developed for the purpose of decreasing the consequences of class imbalance in the instance of histopathology images. Combing with transfer learning, on-the-shelf pretrained profundity CNNs were applied to the classification of histopathological pictures of breast cancer.

Krithiga & Geetha presents a method for the automatic detection, segmentation, and classification of breast cancer cell nuclei using a deep convolutional neural network (Deep-CNN) approach. The primary contribution of this study is the detection of nuclei in ductal carcinoma of breast cancer tissue utilizing anisotropic diffusion in a filter and a novel multilevel saliency nuclei detection model.

According to (Jin et al., 2020), the feature segmentation pipeline utilizing U-net can be extended to segment additional, more complex histological traits, including a variety of tumor tissues, inflammation, and necrosis, among others.

Chanchal et al. presented a CNN-based architecture dubbed a deep structured residual encoder-decoder network (DSREDN) for autonomous nucleus segmentation and showed that it had better discriminative power and was able to obtain meaningful and compact textural information.

Table 5 Summary of deep learning-based cell segmentation method

Published Year	Dataset	Description
2017	H&E breast images	Convolutional neural network，Deep learning
2019	212 breast images (99 benign and 113 malignant))	Convolutional neural network，Deep learning
2019	TUPAC16	CNN, transfer learning
2020	BreakHis	Anisotropic diffusion , Convolutional neural network , Deep learning
2020	PatchCamelyon	Convolutional neural network，Deep learning
2022	TNBC breast cancer	Convolutional neural network， U-Net

2.2 TISSUE SEGMENTATION

The degree of structural differentiation of the tissue has been recognized by pathologists as one of the earliest prognostic indicators for breast cancer patients. Cancer disrupts the nucleus' ability to communicate and causes it to arrange into tubules, which lack advanced malignant tumor markers. Tubule segmentation is difficult because it resembles other structures, such as torn adipose tissue and well-arranged epithelial cells without nuclei. Most of the early attempts at glandular segmentation used hand-made characteristics for segmentation[32-34].

In (Binder et al., 2019), a stroma segmentation strategy is suggested, and then a stroma to gland delineation technique is presented. When tested on breast cancer samples, the approach has a 78 percent accuracy rate.

The tissue region was initially separated into various components by Nosrati, Hamarneh, and Cohen before the glands were segmented using a limited level set technique.

Sirinukunwattana et al. defines a prior for spatial connectivity and layout of nearby epithelial nuclei, as well as a likelihood for the presence of a glandular structure, to formulate the RPM as a Bayesian inference issue. The RPM gives favorable quantitative and qualitative results for extracting glandular structures from normal, benign, and malignant human colon tissues, excluding undifferentiated carcinomas.

Paramanandam et al. presents a new segmentation algorithm for H&E stained breast histopathology images. This detection system predicts a nuclei saliency map using tensor voting, then extracts nuclei boundaries using Loopy Back Propagation (LBP) on a Markov Random Field (MRF).

3. CONCLUSION

From the reviewed content, it's evident that machine learning, when combined with Whole Slide Imaging (WSI) technology, plays a pivotal role in aiding diagnoses. In the realm of image segmentation, various methods are employed, including thresholding-based, region-based, graph-based, clustering-based, deep learning-based, and other segmentation techniques. The graph-based segmentation method stands out as a more traditional image algorithm, gaining popularity early on, with many subsequent algorithms drawing inspiration from it. Thresholding-based segmentation is frequently paired with the watershed algorithm found in region-based segmentation, especially within WSI contexts. Notably, three of the reviewed papers utilized both methods concurrently. As time progressed, clustering-based segmentation and other methods began to emerge. By 2017, deep learning techniques became widespread, marking a significant shift in WSI segmentation with promising outcomes. The multi-resolution U-net architecture, in particular, has been repeatedly employed[35].

REFERENCES

[1] Abed, B. M., Shaker, K., Jalab, H. A., Shaker, H., Mansoor, A. M., Alwan, A. F., & Al-Gburi, I. S. (2016, 20-22 Nov. 2016). A hybrid classification algorithm approach for breast cancer diagnosis. 2016 IEEE Industrial Electronics and Applications Conference (IEACon).

[2] Adem, K. (2020). Diagnosis of breast cancer with Stacked autoencoder and Subspace kNN. Physica A: Statistical Mechanics and its Applications, 551.

[3] Amrani, E., Ben-Ari, R., Shapira, I., Hakim, T., & Bronstein, A. (2020). Self-supervised object detection and retrieval using unlabeled videos. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops.

[4] Aswathy, M. A., & Jagannath, M. (2021). An SVM approach towards breast cancer classification from H&E-stained histopathology images based on integrated features [Article]. Medical & Biological Engineering & Computing, 59(9), 1773-1783.

[5] Bernard, S., Heutte, L., & Adam, S. (2009). On the selection of decision trees in random forests. 2009 International Joint Conference on Neural Networks.

[6] Cervantes, J., Garcia-Lamont, F., Rodríguez-Mazahua, L., & Lopez, A. (2020). A comprehensive survey on support vector machine classification: Applications, challenges and trends. Neurocomputing, 408, 189-215.

[7] Chudhey, A. S., Goel, M., & Singh, M. (2022). Breast Cancer Classification with Random Forest Classifier with Feature Decomposition Using Principal Component Analysis. In Advances in Data and Information Sciences (pp. 111-120).

[8] Cong, C., Liu, S. D., Di Ieva, A., Pagnucco, M., Berkovsky, S., & Song, Y. (2021, Sep 27-Oct 01). Semi-supervised Adversarial Learning for Stain Normalisation in Histopathology Images.Lecture Notes in Computer Science [Medical image computing and computer assisted intervention - miccai 2021, pt viii]. International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI), Electr Network.

[9] Creswell, A., White, T., Dumoulin, V., Arulkumaran, K., Sengupta, B., & Bharath, A. A. (2018). Generative adversarial networks: An overview. IEEE signal processing magazine, 35(1), 53-65.

[10] Das, A., Devarampati, V. K., & Nair, M. S. (2022). NAS-SGAN: A Semi-Supervised Generative Adversarial Network Model for Atypia Scoring of Breast Cancer Histopathological Images [Article]. Ieee Journal of Biomedical and Health Informatics, 26(5), 2276-2287.

[11] de Matos, J., Britto, A. D., Oliveira, L. E. S., Koerich, A. L., & Ieee. (2019, Jul 14-19). Double Transfer Learning for Breast Cancer Histopathologic Image Classification.IEEE International Joint Conference on Neural Networks (IJCNN) [2019

international joint conference on neural networks (ijcnn)]. International Joint Conference on Neural Networks (IJCNN), Budapest, HUNGARY.
[12] Elelimy, E., & Mohamed, A. A. (2018, Dec 18-19). Towards Automatic Classification of Breast Cancer Histopathological Image. [Proceedings of 2018 13th international conference on computer engineering and systems (icces)]. 13th International Conference on Computer Engineering and Systems (ICCES), Cairo, EGYPT.
[13] Elmannai, H., Hamdi, M., & AlGarni, A. (2021). Deep Learning Models Combining for Breast Cancer Histopathology Image Classification [Article]. International Journal of Computational Intelligence Systems, 14(1), 1003-1013.
[14] Hameed, Z., Zahia, S., Garcia-Zapirain, B., Aguirre, J. J., & Vanegas, A. M. (2020). Breast Cancer Histopathology Image Classification Using an Ensemble of Deep Learning Models [Article]. Sensors, 20(16), 17, Article 4373.
[15] He, W., Han, Y., Ming, W., Du, J., Liu, Y., Yang, Y., Wang, L., Wang, Y., Jiang, Z., Cao, C., & Yuan, J. (2022). Progress of Machine Vision in the Detection of Cancer Cells in Histopathology. IEEE Access, 10, 46753-46771.
[16] Hsu, C.-W., & Lin, C.-J. (2002). A comparison of methods for multiclass support vector machines. IEEE transactions on neural networks, 13(2), 415-425.
[17] Khan, S., Islam, N., Jan, Z., Din, I. U., & Rodrigues, J. (2019). A novel deep learning based framework for the detection and classification of breast cancer using transfer learning [Article]. Pattern Recognition Letters, 125, 1-6.
[18] Li, C. a. L., Xintong and Rahaman, Md and Li, Xiaoyan and Sun, Hongzan and Zhang, Hong and Zhang, Yong and Li, Xiaoqi and Wu, Jian and Yao, Yudong and Grzegorzek, Marcin. (2021). A Comprehensive Review of Computer-aided Whole-slide Image Analysis: from Datasets to Feature Extraction, Segmentation, Classification and Detection Approaches.
[19] Liu, H., Xu, W. D., Shang, Z. H., Wang, X. D., Zhou, H. Y., Ma, K. W., Zhou, H., Qi, J. L., Jiang, J. R., Tan, L. L., Zeng, H. M., Cai, H. J., Wang, K. S., & Qian, Y. L. (2022). Breast Cancer Molecular Subtype Prediction on Pathological Images with Discriminative Patch Selection and Multi-Instance Learning [Article]. Frontiers in Oncology, 12, 11, Article 858453.
[20] Liu, L., Ouyang, W., Wang, X., Fieguth, P., Chen, J., Liu, X., & Pietikäinen, M. (2020). Deep learning for generic object detection: A survey. International journal of computer vision, 128(2), 261-318.
[21] Nodet, P., Lemaire, V., Bondu, A., Cornuéjols, A., & Ouorou, A. (2021). From weakly supervised learning to biquality learning: an introduction. 2021 International Joint Conference on Neural Networks (IJCNN).
[22] Octaviani, T. L., & Rustam, Z. (2019, 2019). Random forest for breast cancer prediction.
[23] Oliveira, S. P., Pinto, J. R., Goncalves, T., Canas-Marques, R., Cardoso, M. J., Oliveira, H. P., & Cardoso, J. S. (2020). Weakly-Supervised Classification of HER2 Expression in Breast Cancer Haematoxylin and Eosin Stained Slides [Article]. Applied Sciences-Basel, 10(14), 11, Article 4728.
[24] Patil, A., Tamboli, D., Meena, S., Anand, D., Sethi, A., & Ieee. (2019, Nov 15-16). Breast Cancer Histopathology Image Classification and Localization using Multiple Instance Learning. [2019 5th ieee international wie conference on electrical and computer engineering (wiecon-ece 2019)]. 5th IEEE International Women in Engineering (WIE) Conference on Electrical and Computer Engineering (IEEE WIECON-ECE), Bengaluru, INDIA.
[25] Pawlovsky, A. P. (2018). A kNN method that uses a non-natural evolutionary algorithm for component selection. Journal of Fundamental and Applied Sciences, 9(4S).
[26] Qian, Y., Ye, M., & Zhou, J. (2012). Hyperspectral image classification based on structured sparse logistic regression and three-dimensional wavelet texture features. IEEE Transactions on Geoscience and Remote Sensing, 51(4), 2276-2291.
[27] Sen, P. C., Hajra, M., & Ghosh, M. (2020). Supervised classification algorithms in machine learning: A survey and review. In Emerging technology in modelling and graphics (pp. 99-111). Springer.
[28] Sudharshan, P. J., Petitjean, C., Spanhol, F., Oliveira, L. E., Heutte, L., & Honeine, P. (2019). Multiple instance learning for histopathological breast cancer image classification [Article]. Expert Systems with Applications, 117, 103-111. https://doi.org/10.1016/j.eswa.2018.09.049.
[29] Thuy, M. B. H., & Hoang, V. T. (2019, Dec 19-20). Fusing of Deep Learning, Transfer Learning and GAN for Breast Cancer Histopathological Image Classification.Advances in Intelligent Systems and Computing [Advanced computational methods for knowledge engineering (iccsama 2019)]. 6th International Conference on Computer Science, Applied Mathematics and Applications (ICCSAMA), Hanoi, VIETNAM.
[30] Triguero, I., Del Río, S., López, V., Bacardit, J., Benítez, J. M., & Herrera, F. (2015). ROSEFW-RF: the winner algorithm for the ECBDL'14 big data competition: an extremely imbalanced big data bioinformatics problem. Knowledge-Based Systems, 87, 69-79.
[31] Vapnik, V. N. (1999). An overview of statistical learning theory. IEEE transactions on neural networks, 10(5), 988-999.
[32] Wang, D., Khosla, A., Gargeya, R., Irshad, H., & Beck, A. H. (2016). Deep learning for identifying

metastatic breast cancer. arXiv preprint arXiv:1606.05718.
[33] Wang, X., Yu, K., Wu, S., Gu, J., Liu, Y., Dong, C., Qiao, Y., & Change Loy, C. (2018). Esrgan: Enhanced super-resolution generative adversarial networks. Proceedings of the European conference on computer vision (ECCV) workshops.
[34] Wei, B. Z., Han, Z. Y., He, X. Y., Yin, Y. L., & Ieee. (2017, Apr 28-30). Deep Learning Model Based Breast Cancer Histopathological Image Classification. [2017 2nd ieee international conference on cloud computing and big data analysis (icccbda 2017)]. 2nd IEEE International Conference on Cloud Computing and Big Data Analysis (ICCCBDA), Chengdu, PEOPLES R CHINA.
[35] Yang, X., Peng, H., Zhou, X., & Zhang, Y. (2013). PCA and SVM Based on Multiple Kernels for Breast Cancer Classification.

Collaborative Development of Distributed Power Generation Technology and Smart Grid Technology

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Abstract: With the rapid development of the times, the demand for electricity in society is increasing, and stricter standards are proposed for the electricity supply of power enterprises. The traditional power generation management model can no longer meet the high standards and high-quality requirements of the development of the power industry in the new era. The integration of distributed generation technology and smart grid technology can help overcome the limitations of traditional power supply models and improve power supply quality[1]. However, it should also be noted that the integration of distributed generation technology and smart grid technology also requires continuous technological upgrades, Only by addressing issues such as inadequate technical connectivity in the field of integrated applications can we ensure effective functionality. Strengthening the collaborative development of distributed generation technology and smart grid technology has profound social significance.

Keywords: Distributed generation; Smart Grid; Power supply

1. DISTRIBUTED POWER GENERATION

1.1 DEFINITION AND CONCEPT OF DISTRIBUTED POWER GENERATION

Distributed power generation was first mentioned in public utility management policies and laws in the United States in 1978. Its definition is that some power generation equipment directly installed in the distribution network or usually distributed near the load can achieve efficient power generation, improve the safety and economy of power generation, and make the power generation process safer and more reliable. As for the power supply of distributed power generation, it refers to the equipment that needs to be used in power generation, including but not limited to solar power generation, wind power generation, fuel cells, and other small-scale power generation equipment, which can not only be installed near users but also directly transmit electricity to places in need[2].

1.2 Characteristics of distributed power generation

The main characteristics of distributed generation are as follows: firstly, and most importantly, distributed generation has high reliability. Due to the simple and easy operation of distributed power generation, the power scale is also small, with micro or small units being the majority, and each power station is also independent of each other, distributed power generation is not prone to large-scale power supply accidents.

Secondly, distributed generation has economic benefits. Small-distance transmission can reduce the additional expenses caused by unnecessary losses, making line wear and instability less likely to occur. In addition, distributed power generation has strong flexibility. Due to the lower construction cost, smaller power volume, and shorter construction time required for distributed power generation, it is possible to solve power supply problems to the maximum extent in a very short time and with less capital investment.

Finally, distributed power generation is environmentally friendly. Due to the use of clean energy such as natural gas in distributed power generation, it is highly environmentally friendly[3].Moreover, distributed power generation usually provides power to nearby areas, reducing electromagnetic pollution during the construction of power supply lines, which is of great significance for environmental protection.

2. SMART GRID

2.1 Definition and concept of smart grid

Currently, there is no clear definition and concept in the academic community regarding smart grids. We usually believe that an advanced automated information network established using information technology and utilizing good sensing equipment as the center in the power grid can effectively, real-time, and comprehensively monitor all users and nodes, and achieve two-way communication and timely contact between power plants and sensors, as well as between power grid companies and ordinary users.

2.2 Characteristics of smart grid

One is the ability to self-manage operation and recovery. In addition to being able to self-manage, operate, evaluate, detect, and recover, smart grids can also quickly segment and store power grid components in special situations.

The second is the ability to provide two-way services for electricity. Both parties can purchase and sell electricity in the market through smart grid connections, which has resulted in more electricity products and services, better connecting various

electricity markets and enabling electricity energy to enter the market.

The third is the efficiency and safety of power quality. The smart grid is very safe and efficient, providing long-lasting and effective electricity energy, and is a reliable guarantee for economic development. The fourth is to have both compatibility and openness. The fifth is high operational efficiency. Mainly through the application of four advanced technologies in the smart grid, including high-level measurement, distribution, transmission, and asset management.

The significance and existing problems of the combination of distributed generation and smart grid.

The combination of distributed power generation and smart grid not only has a strong driving effect on the stable operation of the power supply system but also can ensure the good operation of power equipment. The essence of intelligent monitoring lies in effectively discovering and solving minor problems promptly, which has a strong guarantee for the safety and stability of the operation of the power system.

In addition, the combination of the two has a strong promoting effect on the market-oriented reform of power products and services[4].

At present, the market-oriented reform of electricity is facing a severe situation, and ordinary users are increasingly putting forward higher requirements for related services. So it is particularly important to continuously enhance the application of new technologies, which not only better meet the comprehensive needs of customers and the market, but also is necessary for improving the soft power of the power industry. The combination of distributed generation technology and smart grid technology has achieved good results in practical applications. However, the current application still highlights some issues that need to be addressed.

3. CURRENT SITUATION AND SOLUTIONS

3.1 System planning issues

With the continuous development of the economy, the services of electricity are also becoming increasingly complex[5]. Due to the diversity of electricity data at present, data has the characteristics of strong variability and high complexity. The combination of distributed generation and smart grid technology will greatly increase the complexity of data, with more data sources and a higher degree of data change. Therefore, it is necessary to enhance the overall planning of the power grid system and achieve effective management of different ports to avoid their impact on the overall system.

In the research on the combination of distributed generation technology and smart grid technology, there are many aspects of insufficient research efforts, especially in terms of overall planning and analysis of the entire system. To solve many problems in data processing faster and better, and make the entire system run more stable and secure, we must pay attention to the overall planning of the system. The increasing complexity of data is an unavoidable issue in the combination of distributed generation and smart grid technology, which will have many impacts on the overall performance. Many energy sources can be applied by distributed generation technology, and the overall design and planning of smart grid technology are necessary to ensure the reliability of the overall function.

3.2 Problems in the stable operation of the power grid system

It is important to ensure the stable output of electrical energy. In addition to using a single smart grid and matching corresponding modes, timely detection is also necessary to achieve intelligent management. The integration of distributed generation and smart grid technology has the following problems, as the solar power generation technology used in distributed generation has complex voltage and many ports that need to be managed. Therefore, to achieve comprehensive monitoring, a single monitoring mode cannot be used. The limitations of this technology are difficult to change, which will have a certain impact on the stability of the entire system's power supply and are prone to some power supply accidents.

3.3 Dynamic issues in data transmission management of distribution networks

To ensure the unity of power management, it is important to achieve effective monitoring of electricity, which requires dynamic monitoring, that is, adjusting the mode according to the specific situation of system operation. The combination of distributed generation and smart grid technology may encounter problems in the application of light energy, changing the nature of passive radial power grids and reducing the transmission rate of electricity. This makes it difficult to ensure the management and transmission of distribution network data and has a certain impact on subsequent judgment and processing[6].

In addition, the combination of distributed generation and smart grid technology can cause structural changes in the distribution network. If an accident occurs in the power system, it will have an impact on the troubleshooting of the problem. The hidden dangers of the fault may be multifaceted, such as in passive radial power grids or distributed generation technology, simple power outage protection cannot completely solve the accident, and it will also affect the protective devices of relays.

4. COLLABORATIVE DEVELOPMENT IDEAS AND SOLUTIONS FOR DISTRIBUTED GENERATION TECHNOLOGY AND SMART GRID TECHNOLOGY

4.1 Strengthen the construction of the standardization system

During the integration of distributed generation technology and smart grid, relevant technicians should strengthen in-depth research on the load changes, usage performance, and distribution of the

two, and then effectively integrate distributed generation technology into the smart grid based on the standards of power system functional operation and key technical parameters. At the same time, it is necessary to set the capacity and location of the access, and make dynamic adjustments based on the trial operation status. Configuration and selection can be implemented according to the IEEEP1574 standard content, continuously summarizing the operation rules, strengthening the construction of the standardized system of the smart grid, and maintaining the stable operation of the system in the later stage.

4.2 Strengthen the full process control of technology integration

In the integration of distributed generation technology and smart grids, there will be many difficult-to-control issues. Relevant personnel can effectively explore new technologies, such as introducing power electronics technology to control energy through "plug and play" methods. A parallel circuit with power electronic coupling technology needs to be constructed, which can not only quickly convert interfaces, but also limit short-circuit current and ensure that the short-circuit current remains below the rated value. Even in the event of a power fault, it can ensure the stable operation of the circuit. Of course, this technology also has its shortcomings, that is, when the power system malfunctions, the system's voltage, frequency, etc. cannot be restored to a normal state, affecting the smooth operation of the distribution system. In response, relevant experts have developed a power management system. In this system, several control modules can be set up to effectively control the active and reactive power flow in parallel circuits. They can be configured at the terminals of the power electronic coupling parallel circuit system, which can achieve full process control of power and enhance the safety of the power grid system[7].This technology is generally divided into three control methods, namely developing voltage adjustment strategies, adjusting the characteristics of voltage sags, and correcting power flow factors. It is conducive to stabilizing the voltage of the power system, timely correcting the power flow factor, and ensuring reactive power compensation of the bus-bar. This technology also has drawbacks, specifically manifested in its poor communication management function. To this end, advanced fault management technology from smart grids can be introduced to optimize communication functions, so that once a fault occurs in the power system, the communication system can be used to ensure the independent operation of the distributed power supply system, thereby affecting the operation of the entire power grid system[8].

5. CONCLUSIONS

The combination of smart grid and distributed generation technology, as well as their application in power grid systems, are issues that we need to explore now and in the future. Smart grid technology has elevated the efficiency of distributed generation technology to a new level. This is the goal and direction for the future development of China's power grid. At the same time, smart grid technology and distributed generation technology should not be separated. The two need to be interdependent and mutually reinforcing. Smart grid technology is a strong guarantee for distributed generation technology, and through the combination of the two, it can better meet the actual needs of China's power grid. At present, both the application of smart grid technology and distributed generation technology in China are not yet mature. We still have many difficulties to overcome. Only by strengthening the level of attention and seriously developing scientific and technological progress can we continuously improve the safety and reliability of smart grid and distributed generation technology, and achieve good application of technology shortly.

REFERENCES

[1] Linan Hu, Chang Su, Chong Tian, Xianwei Meng. "Chapter 11 Evaluation Model of Intelligent Anti-electric Theft Management",Springer Science and Business Media LLC,2022.

[2] Ren Yu-long, Zeng Shao-lun, Tang Song-lin. "A Model of Market Structure Design for Electricity Market and Its Empirical Research",2007 International Conference on Management Science and Engineering, 2007.

[3] Hao, X.. "Role of BCHP in energy and environmental sustainable development and its prospects in China", Renewable and Sustainable Energy Reviews, 2007.

[4]B. B. Huang, G. H. Xie, W. Z. Kong, Q. H. Li."Study on smart grid and key technology system to promote the development of distributed generation", IEEE PES Innovative Smart Grid Technologies, 2012.

[5] Haixin Xu, Cancan Yang. "Chapter 39 Analysis on the Path to Promote Carbon Peaking and Carbon Neutrality from the Consumer Side", Springer Science and Business Media LLC, 2022.

[6] Zhu Xiaojun, Zhu Jianhua, Zhu Zhenqi, Gan Middle School Exploration and Practice of Distributed Energy Network Systems [J] Science Bulletin, 2017.

[7] Wu Yijun Analysis of the Collaborative Development of Distributed Power Generation Technology and Smart Grid Technology [J], Communication World, 2018.

[8] Dong Chaoyang, Zhao Junhua, Wen Fushuan, From Smart Grid to Energy Internet: Basic Concepts and Research Framework Power System Automation [J],2014.

Application of Artificial Intelligence in Safe Operation of Power Transmission Lines

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Abstract: Based on the analysis of the current development status, smart grids have gradually become the main research direction and development goal of the power system in the field of electricity. Through research on the development trend of smart grids in the new era, it can be found that artificial intelligence technology is gradually being applied to the maintenance and online monitoring of transmission lines. Artificial intelligence technology has also provided new channels for the development of Chinese power enterprises.

Keywords: Artificial intelligence; Transmission lines; Safe operation; Application.

1. ANALYSIS OF ONLINE MONITORING SYSTERMS TO TRANSIMISSION LINES

1.1 Monitoring systerms composition

The design and development of an online monitoring system can accurately predict and diagnose the safe operation, jumper, icing, insulators, lightning arresters, etc. of transmission lines. By setting up various sensing devices, the transmission line can be promoted to achieve all-weather status monitoring throughout the entire process, improve the reliability and safety of line transportation, and achieve the goal of intelligent monitoring of the line[1].

The online monitoring system related to transmission lines can be divided into two parts. The first part includes modules such as data communication system and data acquisition system. Among them, data collection is mainly carried out through high-performance video probes and sensors, which can comprehensively monitor the safe operation, expansion, jumper, transmission line icing, insulators, lightning arresters, etc. of transmission lines. After preliminary processing of the collected data information by the front-end system, it can be smoothly transmitted to the control center through wireless communication network. The second part mainly consists of a backend processing and analysis system, which obtains corresponding signals through artificial intelligence methods to form real-time diagnostic conclusions for transmission lines. In order to achieve online monitoring of transmission lines, an intelligent monitoring framework has been developed.

Sensors are key modules in monitoring systems. Its main function is to simulate human senses and comprehensively monitor environmental conditions such as wind direction, wind speed, sunlight, temperature, as well as circuit operation status such as line temperature, voltage level, and current intensity within the transmission line. Online monitoring equipment mainly includes infrared sensors for measuring wire temperature, remote video devices, sensor devices for monitoring insulator and lightning arrester pollution, ice jumping and freezing, sensor devices for monitoring environmental and meteorological changes, current measurement sensor devices, etc. In recent years, various sensor devices have been installed in the detection hotspots of iron towers and transmission lines both domestically and internationally, which can collect real-time monitoring data and send it to the monitoring center[2-3].

1.2 Wireless transmission of information

The birth of wireless communication technology further enables network coverage and rapid signal transmission. Set up sensor equipment at the measurement points of the transmission line to collect real-time monitoring data. Using wireless communication networks to achieve real-time transmission of remote data and corresponding monitoring images. Wireless communication technology can directly transmit on-site video signals and monitoring data from transmission lines to the control center, thereby achieving synchronous transmission of monitoring data in intelligent monitoring systems. By utilizing GRRS technology, an effective integration of online monitoring information of transmission lines and artificial intelligence fault diagnosis technology is formed, forming a unified monitoring platform. The goal of intelligent control of transmission lines can be successfully achieved.

2. EFFECTIVE APPLICATION OF ARTIFICIAL INTELLIGENCE IN TRANSMISSION LINE OPERATION MANAGEMENT

2.1 Monitoring expert system

ES is one of the most active research topics in the field of artificial intelligence, with characteristics such as flexibility, transparency, and inspiration. Through active design and development of online monitoring of transmission lines, expert systems mainly use the data collected from monitoring to determine the causes of transmission line problems. The specific structure includes human-machine interface, inference mechanism, explanation mechanism, database, and knowledge base.

The online monitoring system for transmission lines can obtain data information through sensor monitoring and establish ES dynamic and static databases. The inference mechanism is mainly based on forward inference, and the knowledge base is the core of ES. The specific expression of monitoring systems is mainly based on production rules. Knowledge is regarded as a general condition conclusion form, and knowledge is obtained based on domain experience and domain knowledge. The monitoring system creates a knowledge base of modular mechanisms, with different modules in independent states. Each module is effectively coordinated and controlled through a coordinator. In the operation of the monitoring system, it is necessary to first start the remote monitoring module within the transmission line to obtain visual images of the site, and then start the safety operation module, dance monitoring module, ice cover monitoring module, and lightning arrester module. The analysis results of different modules need to be combined for comprehensive analysis and judgment. The online monitoring system can also provide early diagnosis of transmission lines, providing effective reference for on-site maintenance personnel[4].

2.2 Insulator monitoring

Insulators are insulation controls that can support wire insulators. When insulators are affected by industrial pollution and natural environmental pollution, a dirty layer will form on the surface of the porcelain. After the insulator is contaminated, surface contamination flashover may occur under the influence of voltage and specific external conditions. Pollution also directly threatens the safe operation of transmission lines. It can be seen that the quality of insulators plays an important role in the safe operation of the line, and it is necessary to maintain insulators with sufficient mechanical strength and good insulation performance.

The leakage current value can accurately reflect the degree of pollution on the surface of insulators, and the leakage current is more suitable for online measurement. After the birth of the leakage current monitoring device, a current sensing device was installed on the surface of the insulator, which can monitor the leakage current in real-time. By utilizing wireless communication networks, monitoring data can be smoothly transmitted to the monitoring center. Combining leakage current data with artificial intelligence to reasonably diagnose the degree of insulator surface pollution and form an early warning.

2.3 Lightning arrester monitoring

After the application of lightning arresters, various explosion accidents may occur in severe cases due to factors such as valve aging and internal moisture. Therefore, in daily maintenance, relevant technical personnel are required to regularly check the dirty condition of the surface of the lightning arrester porcelain sleeve, and reasonably measure the leakage current and insulation resistance. If the insulation resistance inside the lightning arrester is found to be broken or reduced, it should be replaced in a timely manner to ensure that the lightning arrester always maintains good performance. Through in-depth research on the online monitoring mechanism of lightning arresters, relevant experts have proposed the relationship between leakage current value and lightning arrester performance. The leakage current detection sensor can be reasonably installed at the corresponding monitoring position of the lightning arrester, comprehensively sampling the leakage current on the surface of the lightning arrester, and timely obtaining monitoring data information. By utilizing wireless communication networks, the collected information is transmitted to the control center. With the help of artificial intelligence, the status and performance of lightning arresters can be accurately identified, and fault prediction and diagnosis can be made in a timely manner[5].

2.4 Ice monitoring

The monitoring methods for ice thickness on transmission lines can be divided into weighing method and image method. The transmission line icing monitoring system mainly uses comprehensive technologies such as mechanical load calculation, line video monitoring, and inclination angle change arc to monitor the icing status of the transmission line. The corresponding system devices mainly consist of tension tilt sensing devices, micro weather sensing devices, front-end intelligent cameras, etc. Collect ice cover data and on-site image information through sensing devices, and transmit real-time collected signals to the control center through wireless communication networks. By diagnosing and analyzing the state of the ice sheet, the thickness and development trend of the ice sheet can be reasonably calculated, forming ice sheet warning information.

2.5 Lineoperation monitoring

By reasonably developing an online monitoring system for transmission lines, the maintenance effectiveness of transmission lines can be improved, and various sensing devices can be installed in towers and lines to facilitate comprehensive monitoring of the operation and status of transmission lines. The transmission line can obtain real-time monitoring signals from sensors through online monitoring, and transmit the signals to the monitoring center at any time through wireless networks. Artificial intelligence is used to diagnose the status and performance of transmission lines, as well as various potential faults.

2.6 Remote video monitoring

The remote monitoring system for transmission lines mainly consists of a power supply system, a low-power video host, and high-definition cameras. The core technologies of remote monitoring systems include signal processing and diagnosis, solar and battery power supply technology, wireless transmission technology, image data acquisition and

compression encoding and decoding technology. This system can comprehensively and real-time monitor transmission lines, lightning arresters, tower poles, wire wind deflection, icing, insulators, jumpers, and other devices, accurately grasp the surrounding conditions of the line, monitor the growth and construction of trees in real time, and facilitate the understanding of the safety status of the transmission line, thus smoothly achieving management and maintenance of the transmission line and optimizing production management level.

The video monitoring system related to the transmission line mainly consists of client monitoring software, image monitoring server, and image encoder. The image encoder can collect relevant data information in real-time and send it to the corresponding streaming media server in the monitoring center through compression encoding processing and wireless network. In the monitoring center, through computer control, it is possible to successfully log in to the monitoring software, decode video streams, and display complete on-site images. Then you can see the on-site photos taken by the camera. Successfully implemented image monitoring and browsing, and achieved unified processing through AI[6].

3. CONCLUSION

In summary, the application and development of artificial intelligence technology cannot be separated from the support of various basic hardware, and software is still the core technology of artificial intelligence. In recent years, the development and application of artificial intelligence related technology in transmission line fault diagnosis and condition detection. It improves the reliability and security of transmission lines, reduces the probability of accidents, and provides a new way for the development of online detection of transmission lines.

REFERENCE

[1] Zhang Weiya, Li Hongzhong. Research on the rapid diagnosis method of transmission line faults based on artificial intelligence [J]. Power System Protection and Control, 2019,47 (19): 94-99.

[2] Geng Junwei, Liu Weiguo. Research and Application of transmission Line Intelligent Control System based on deep Learning fusion Internet [J]. Rural Electrification, 2019 (8): 9-13.

[3] Wang Yanru, Liu Haifeng. Application of Image recognition technology 吗, , , based on edge intelligent Analysis in online monitoring of transmission lines [J]. Power Information and Communication Technology, 2019,17 (7): 35-40.

[4] Research on lightning winding and lightning protection of Li Ruhu transmission line []. China Southern Power Grid Technology, 2009 (1): 53-57.

[5] Fu Zifeng, Wu Qiji, Liu Jiji and other applications of AI deicing technology in transmission lines [J] Hubei Electric Power, 2018,42 (03): 15-18.

[6] Feng Qinhua, Hu Jinlei. On transmission line monitoring method [J] Communication power supply, 2017,34 (06): 263-265,269.

Research on Real-Time Data Reconstruction Method Based on Rain-Flow Counting Method-Taking International Automobile Standard Working Conditions as an Example

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Abstract: Vehicle driving conditions are used to describe the driving characteristics of a certain type of vehicle in a specific traffic environment.It is necessary to construct a vehicle driving condition curve that can reflect the driving characteristics of vehicles participating in data collection, so as to provide an important reference for motor vehicle fuel consumption and pollutant control.This paper innovatively proposes a vehicle driving condition construction model based on rain-flow counting theory.By comparing the corresponding motion feature index value of the vehicle driving condition and the actual data source collected in the city, the maximum error of the acceleration time ratio between the vehicle driving condition constructed in this paper and the original test data is only 7.06%, followed by 4.06%.This paper verifies the feasibility of the vehicle driving condition model based on the rain flow counting theory and the rationality of the vehicle driving condition curve.
Keywords: Rain-flow Count; Data Reconstruction; Vehicle Operating Condition

1. BACKGROUND OF THE PROBLEM

Vehicle driving condition describes the speed-time curve of vehicle driving and reflects the kinematic characteristics of vehicle road driving. It is an important and common basic technology in the automotive industry, the basis of vehicle energy consumption/emissions test methods and limit standards, and the main benchmark for the calibration and optimization of various performance indicators of vehicles.

At the beginning of this century, China directly adopted the European NEDC driving condition to certify the energy consumption/emissions of automobile products, which effectively promoted the development of automobile energy saving and emission reduction technology.In recent years, with the rapid growth of car ownership, China's road traffic conditions have undergone great changes. The government, enterprises and the public have gradually found that the actual fuel consumption of vehicles optimized and calibrated based on NEDC working conditions has increasingly deviated from the regulatory certification results, which has affected the credibility of the government [1].In addition, Europe has also found many deficiencies in NEDC conditions in practice for many years, and has turned to the world light vehicle test cycle.However, the idling time ratio and the average speed, the two most important working conditions, are more different from the actual driving conditions in China.As the most basic basis for vehicle development and evaluation, it is becoming more and more important to carry out in-depth research and formulate test conditions that reflect the actual road driving conditions in our country.

On the other hand, China's vast territory, the development degree of each city, climate conditions and traffic conditions are different, so that there are obvious differences in the characteristics of car driving conditions in each city.Therefore, it is increasingly urgent to conduct research on the construction of urban vehicle driving conditions based on the city's own vehicle driving data [2].

2. PRINCIPLE OF RAIN-FLOW COUNTING METHOD

The rain-flow counting method, also known as the "tower top method", was proposed by M. Matsuiski and T. Endo in the 1950s.It is mainly used to simplify the measured load history into several load cycles for fatigue life estimation and compilation of fatigue test load spectrum.The load-time history data record is turned 90°, the time axis is straight down, and the data record is like a series of roofing, and the rain flows down the roof, so it is called rain flow counting method [3][4].

The principle of rain-flow counting method is shown in Figure 1:

(1) Rotate the spectral history curve by 90° and place it as shown in the figure.Think of the load process as a multi-story roof, and imagine that rain droplets begin to flow down the largest peak or valley.If there is no roof to stop it, the raindrop reverses and continues to flow to the end.

(2) A rain-flow that begins at a trough and stops at a lower trough;A rain stream that begins at the peak of

a wave and stops at a higher peak than it.

(3) When the rain stream meets the rain flowing down from the roof above, it stops flowing and forms a cycle.

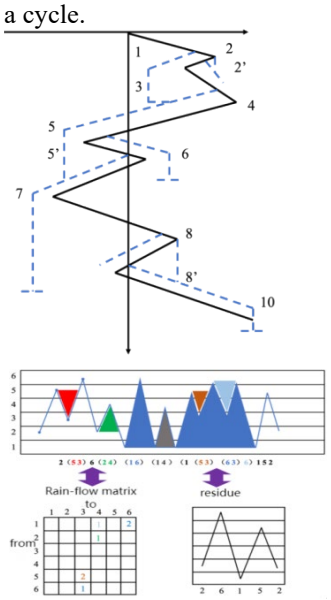

Figure 1 Schematic diagram of the rain flow counting method

The flow counting method has the following rules, as shown in Figure 2.

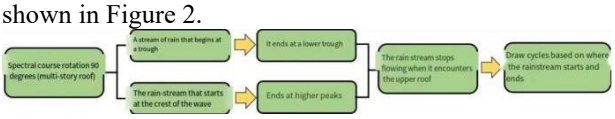

Figure 2 Rainflow counting method rule

(4) According to the starting point and end point of raindrop flow, draw each cycle, take out all cycles one by one, and record its peak and valley values.

(5) The horizontal length of each rain stream can be used as the amplitude of the cycle.

3. WORKING CONDITION CONSTRUCTION METHOD BASED ON RAIN-FLOW STATISTICAL THEORY

This paper innovatively proposed a vehicle driving condition construction method based on the rain-flow statistical principle, as shown in Figure 3. First, key data of kinematic segments were captured, including idle duration, total tail, speed-time matrix, etc. [5]-[12], and the values of main feature parameters and correlation verification of feature parameters were calculated.Then cut off the idle segment and splice the other effective motion segments.Then, the rain-flow technique is used to calculate the state transition matrix, and the distribution diagram of adaptive state transition matrix based on Gaussian function is drawn.Next, the velocity is segmented and mapped randomly according to the random number decreasing velocity matrix to compile the engineering spectrum and calculate the main core parameters of the engineering spectrum.Then, the speed and frequency are counted, the fragments are randomly screened, and the feature parameter errors between the fragments and the whole are computed, and the data fragments with the least error are stored.Finally, all the stored fragments are spliced, and idle zone fragments are added according to the idle time ratio to complete the construction of vehicle driving conditions.

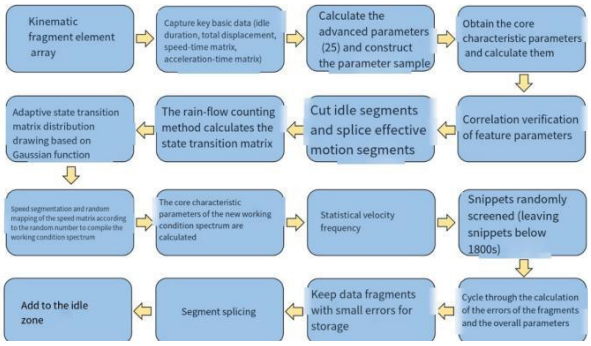

Figure 3 Flow chart of vehicle driving conditions based on rain flow statistical theory

4. PROGRAM IMPLEMENTATION OF VEHICLE DRIVING CONDITION CONSTRUCTION METHOD

This paper realizes the construction method of vehicle driving conditions based on rain-flow statistical theory through MATLAB, and its program block diagram is shown in Figure 4.

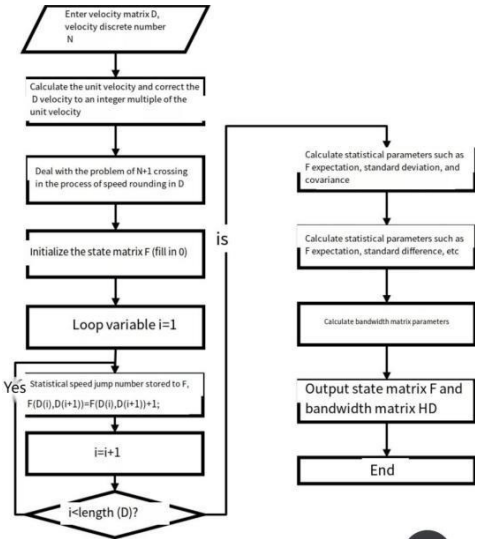

Figure 4 Block diagram of vehicle driving conditions based on rain statistical theory

The specific implementation process is as follows: First, the velocity matrix D is input and the velocity is discretized, the unit velocity is calculated, and the D velocity is modified to an integer multiple of the unit velocity;Then the state of the matrix F is initialized, starting from the first variable i=1, the number of velocity transitions is counted and stored in F;Continue searching for the next variable until all searches are complete;Then the statistical parameters such as expectation, standard deviation and covariance of F are calculated, and the bandwidth matrix parameters are selected by machine.Finally, all state matrices F and bandwidth matrices HD are

output.

The block diagram of the adaptive state transition matrix distribution drawing program based on Gaussian function is shown in Figure 5.

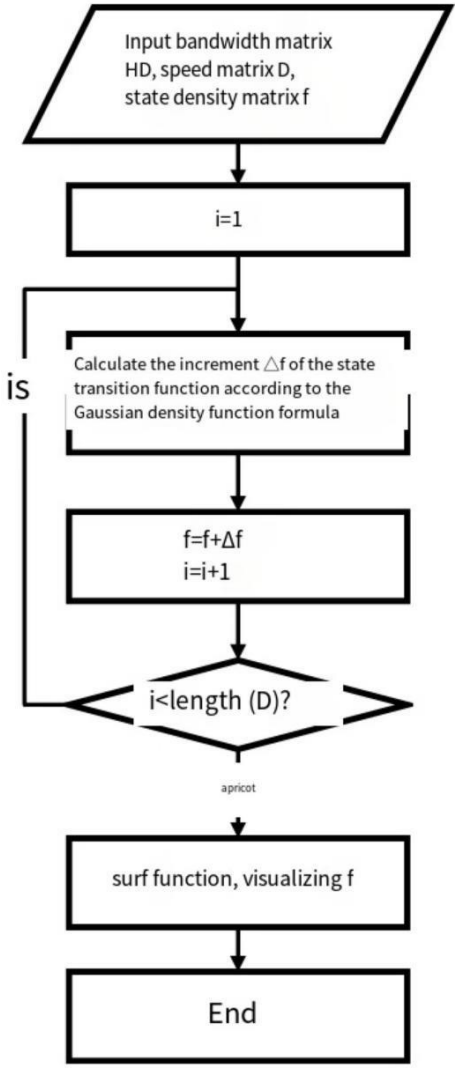

Figure 5 plots the distribution surface of the adaptive state transition matrix based on a Gaussian function

The specific implementation process is as follows: First input bandwidth matrix HD, speed matrix D, state density matrix f, then set the cycle starting point i=1, and enter the cycle program.In the loop program, the increment Δ of the state transition function is first calculated according to the Gaussian density function formula, then functions f and i are increased, and finally the program is judged whether i is less than the length function D. If yes, the program re-enters the loop function; if no, the loop program is terminated and the function f is surf visualized.

The program block diagram of velocity segmentation and random mapping of velocity matrix according to random number to compile working condition spectrum is shown in Figure 6.

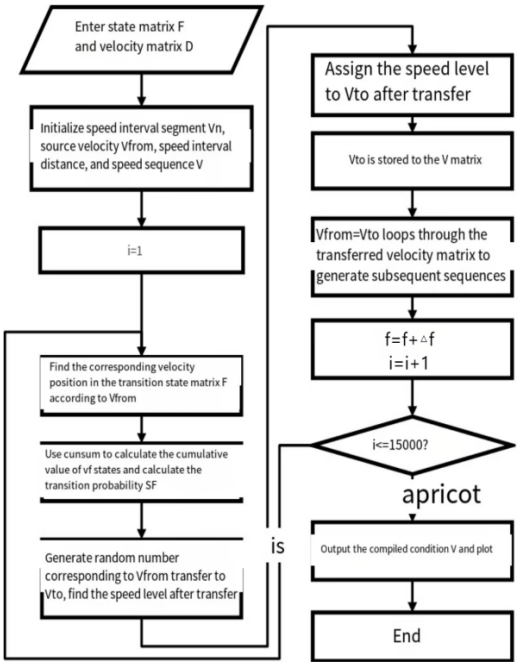

Figure 6 segment the speed and map the speed matrix randomly according to the random numbers to compile the working condition spectrum

The specific implementation process is as follows: firstly, input the state matrix F, velocity matrix D, initialise the interval segmentation function Vn, source velocity Vfrom, velocity interval distance, velocity sequence V, and then set the initial value of the loop variable to 1 to enter into the loop program, and then the loop program firstly searches for the corresponding velocity position in the transfer matrix F according to Vfrom, and then use the cunsum to calculate the cumulative value of Vf state, and calculate the transfer probability SF, generate the random number corresponding to the transfer of Vfrom to Vto, find the speed level after the transfer, assign the speed level after the transfer to Vto and store it into the V matrix, and then loop V from=Vto to generate the subsequent sequences with the transferred speed matrix, and then finally increase the loop cyclic variable and judge if i is less than equal to 15000, if yes, re-enter the loop procedure, if no, end the loop procedure and output the plotted conditions and graphs.

The block diagram of the programme such as piecewise random sieving is shown in Figure 7 below.

The implementation process is as follows: First, input the velocity matrix F and D, calculate the global characteristic parameter, quantity N, and initialize the initial evaluation error Emin=1000;Condition matrix length initialization L=0;The final working condition matrix DX, the intermediate temporary matrix NUM and num are initialized, the initial variable i of the cycle is set to 0, and the cycle program is entered. First, it is judged whether L+ idle period exceeds 1300. If yes, increment the initial variable i of the

cycle and re-enter the cycle program.The error E of eigenvector N2 and eigenvectors N1 and N2 is calculated, and then E is judged. If E is greater than or equal to Emin, increment the initial variable i of the loop and re-enter the loop program; if E is less than Emin, continue the loop program and store the fragment DI into DX.Then the loop variable is incremented and whether i is greater than the limit number of iterations of 1000000 is judged. If yes, the program is terminated; if no, the initial evaluation error is re-initialized and the loop program is entered.

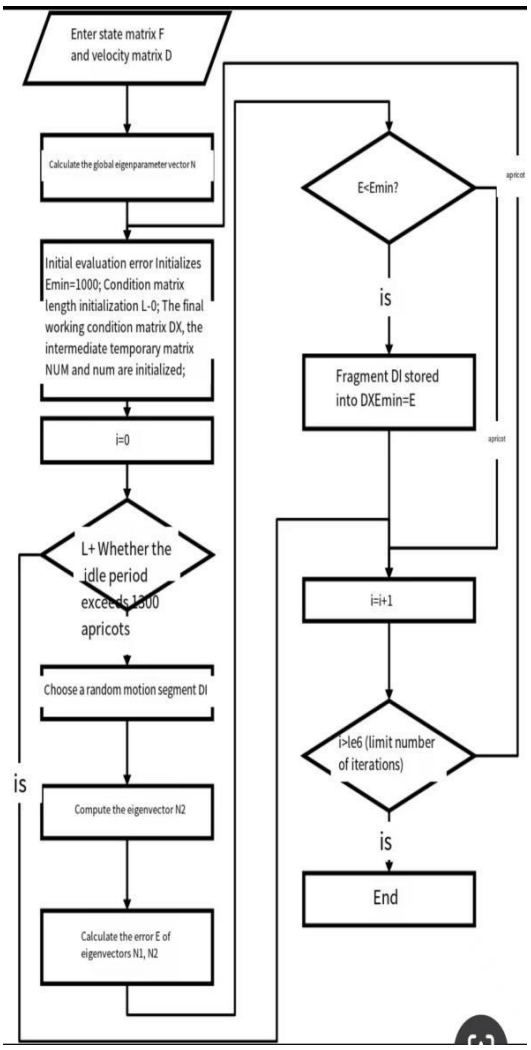

Figure 7 Block diagram of the fragment random screening program

5. ANALYSIS OF CONSTRUCTION RESULTS OF VEHICLE DRIVING CONDITIONS

After counting by the rain-flow counting method, the result of the velocity transfer state matrix is shown in Figure 8 below.

X coordinate is the speed before change, Y coordinate is the speed after change, and Z coordinate is the number of velocity transfers. The figure shows the number of times the car driving speed changes from the X-axis speed to the Y-axis speed in the source data. The high-frequency transfer in the figure occurs near X=Y, because the anomalies with excessive acceleration are washed out during the data screen. Similarly, the velocity transition probability density map can be calculated using the bandwidth matrix and Gaussian function.

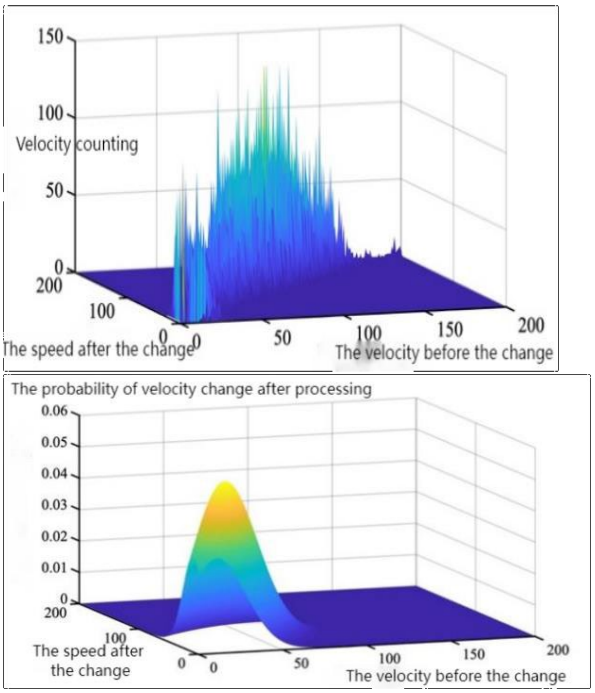

Figure 8 Results plot of the velocity transition state matrix

Finally, random mapping was carried out according to the random number speed drop matrix, all the stored fragments were splicing, and idle zone fragments were added according to the idle time ratio to complete the preparation of driving condition spectrum, and the vehicle driving condition curve in line with the characteristics of the city was obtained, as shown in Figure 9 below.

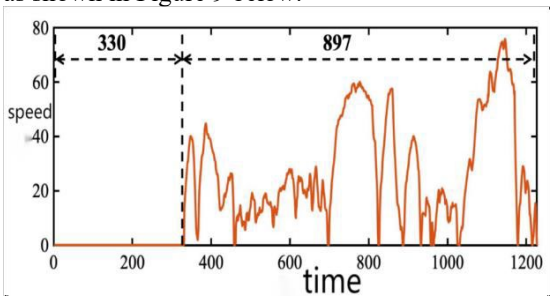

Figure 9 Car driving condition curve conforming to the characteristics of the city

6. MODEL OPTIMIZATION

In the process of random selection of segments (leaving the segment up to 1800s), the norm of difference between the characteristic parameter vectors of the selected segment and the source data was calculated and iterated to select the one with smaller norm and then splicing the final working condition curve.The number of iterations during this period needs to be customized. As can be seen from the block diagram 10 of this part of the program, with the progress of iteration, the error limit is gradually

reduced, the feature vector of the selected fragment is gradually closer to the source data, and the final working condition curve of the splicing becomes more accurate.However, the greater the number of iterations, the longer the computation time, and the greater the computational resources required.Therefore, it is necessary to draw the convergence diagram of the optimization process.The diagram on the left shows the convergence diagram in linear coordinates, and the diagram on the right shows the convergence diagram in logarithmic coordinates.It can be seen from the convergence diagram that the absolute error decreases significantly with the increase of the number of iterations. When the number of iterations reaches 10,000, the absolute error has dropped to the order of 1e-1, with extremely high precision.

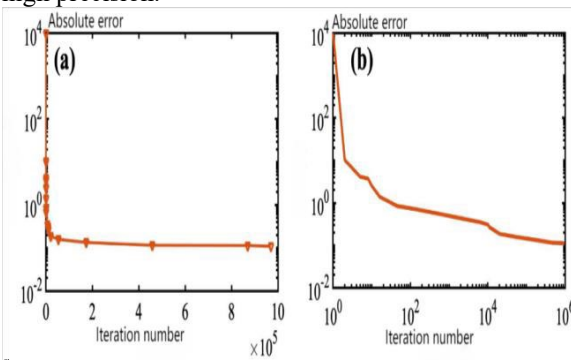

Figure 10 The preferred process convergence diagram

7. VALIDITY VERIFICATION OF VEHICLE DRIVING CONDITIONS

This paper analyzes the actual vehicle driving data collected to complete the construction of driving conditions, so it is necessary to verify the differences between the data of construction conditions and the original data.As shown in Table 1, the feature parameters in the table are used to verify the validity of driving conditions.

Table 1. Parameters used for the validity verification of driving conditions

characteristic	Feature	unit
V_m	average speed	km/h
V_s	Average driving	km/h
a_{am}	mean	m/s^2
a_{dm}	average	m/s^2
T_i	Idle time ratio	%
T_a	Acceleration	%
T_d	The	%
V_{sd}	Speed standard	km/h
a_{sd}	Acceleration	m/s^2

The validity verification of driving conditions is to calculate the absolute and relative errors of characteristic parameters of driving conditions and test data.The calculated error value is analyzed to verify whether the constructed driving condition is reasonable.The error calculation formula is as follows:

$$\varepsilon = \frac{|x_j - X_j|}{|X_j|}$$

Where, is the relative error between the constructed vehicle driving condition characteristic parameter j of a city and the corresponding original data, xj is the constructed vehicle driving condition characteristic parameter value of the city, and Xj is the test data characteristic parameter value.

The parameters used to verify the validity of driving conditions were calculated according to the formula, and the calculation results were shown in Table 2.

Table 2 Characteristic values of validity verification parameters for light vehicle driving conditions

characteristic	Feature parameter	eigenvalu	unit
V_m	mean velocity	6.970	km/h
V_s	Average driving speed	28.219	km/h
a_{am}	mean acceleration	1.440	m/s^2
a_{dm}	average retardation	1.711	m/s^2
T_i	Idle time ratio	0.247	%
T_a	Acceleration time	0.473	%
T_d	The deceleration time	0.397	%

V_{sd}	Speed standard	19.061	km/h
a_{sd}	Acceleration standard	1.487	m/s^2

The parameters of the actual collected driving data are calculated according to the formula, and the calculation results are shown in Table 3.

According to the values of the above characteristic parameters and the error calculation formula, the values of the working condition verification characteristic parameters in Table 2 and Table 3 were analyzed and compared to obtain the comparison results as shown in Table 4 and Figure 11.

Table 3 Characteristic values of actual collected data

characteristic parameter	Feature parameter meaning	eigenvalue	unit
Vm	average speed	6.980	km/h
Vs	Average driving speed	28.283	km/h
aam	mean acceleration	1.416	m/s2
adm	average retardation rate	1.709	m/s2
Ti	Idle time ratio	0.247	%
Ta	Acceleration time than	0.493	%
Td	The deceleration time is more than	0.408	%
Vsd	Speed standard deviation	19.043	km/h
asd	Acceleration standard	1.389	m/s2
adm	Speed reduction standard deviation	1.787	m/s2

Table 4 Absolute error between characteristic parameters of vehicle driving conditions constructed in this paper and original test data

characteristic parameter	Feature parameter meaning	deviation	unit
V_m	average speed	0.14	%
V_s	Average driving speed	0.23	%
a_{am}	average deviation	1.69	%
a_{dm}	average retardation rate	0.12	%
T_i	Idle time ratio	0	%
T_a	Acceleration time than	4.06	%
T_d	The deceleration time is more than	2.70	%

V_{sd}	Speed standard deviation	0.09	%
a_{sd}	Acceleration standard deviation	7.06	%

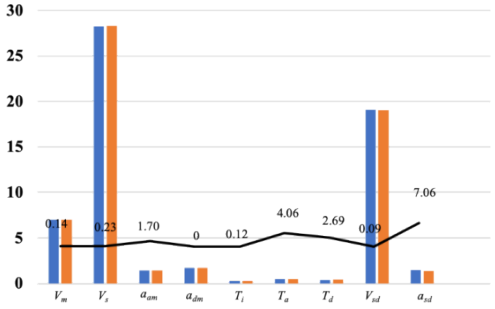

Figure 11 Comparison of characteristic parameter values of vehicle driving condition and characteristic index of actual collected data

Figure 11 shows the relative error between the characteristic parameters of vehicle driving conditions constructed in this paper and the original test data. It can be seen from the figure that the maximum error of the acceleration time ratio between the vehicle driving conditions constructed in this paper and the original test data is only 7.06%, followed by 4.06%.The errors of the average speed, average driving speed, average acceleration, average deceleration, acceleration time ratio, deceleration time ratio, speed standard deviation and acceleration standard deviation parameters in the construction condition and the original test data are less than 10%, and the errors are within a reasonable range.

8. CONCLUSION

The error between the driving condition of a light vehicle constructed in this paper and the characteristic value of the original test data is small, which is close to the characteristics of the vehicle driving data actually collected. Therefore, the vehicle driving condition construction method proposed in this paper based on the rain flow technology theory is effective, and the vehicle driving condition construction based on this method is reasonable and effective.It can accurately reflect the state of the light vehicle driving on the city road.

REFERENCES

[1] Guo Jiachen, Jiang Heng, Lei Shiying et al.Construction method of vehicle driving condition on urban road [J]. Journal of Traffic and Transportation Engineering,20,20(06):197-209.

[2] Xue Yuqiang, Jiang Rongchao, Zheng Xuguang.Construction method of Commercial vehicle Driving Conditions based on Vehicle Networking Data [J]. Journal of Highway and Transportation Science and Technology,2023,40(08):192-198.

[3] Zhao Xiaopeng, Jiang Ding, Zhang Qiang, et al.Application of rain-flow counting method in vehicle Load Spectrum Analysis [J]. Science and Technology Review, 2009, 27(3):67-73. (in Chinese)

[4] GAO Tianyu, LI Huanliang, WANG Pengfei, et al. Research on Load Spectrum Compilation System of Wheel Loader Based on Rain Flow Counting Method [J].Equipment Manufacturing Technology, 2015(11):40-42.

[5] Lu Kai Chao, Mei Xuefeng, Zhou Lijin et al.Construction of Vehicle Driving Condition Based on Statistical Method [J]. Mathematical Practice and Understanding,2021,51(06):1-9.

[6] Liu Jilong, Li Le, Yu Jun.Research on Construction method of Vehicle Driving Conditions based on improved K-means clustering [J].Agricultural Equipment and Vehicle Engineering, 2019,61(05):105-109.

[7] Chen Bao, Huang Chun, Xie Guangyi, et al.Research on Construction method of electric Vehicle Driving Condition based on Large sample [J]. Journal of Chongqing University of Technology (Natural Science),2022,36(08):45-55.

[8] Zhou Y. Construction of vehicle driving conditions and analysis of fuel consumption characteristics under different road classes in Fuzhou City [D].Fujian college of engineering, 2023. DOI: 10.27865 /, dc nki. Gfgxy. 2023.000041.

[9] Duan Yushuai. Construction of Vehicle Driving Conditions Based on Principal Component Analysis and K-means Clustering [J].Journal of Software Guide, 2012,21(05):175-180.

[10] Li Chunsheng, Yu Hu.Construction of Vehicle Driving Conditions based on improved K-means Clustering Algorithm [J]. Computer Technology and Development,202,32(03):169-174. (in Chinese)

[11] Xie Yuan-De, Zhang Lin, Luo Long et al.Construction and Evaluation of Light Vehicle Driving Conditions on Urban Roads [J]. Mathematical Practice and Understanding,202,52(01):18-27.

[12] Wang Zhen, Song Zhiyao.Construction of vehicle Driving Conditions based on K-means clustering Algorithm [J]. Agricultural Equipment and Vehicle Engineering,2021,59(06):45-49.

The Design of Integrated Product Development and Delivery Process Platform for Civil Aircraft Flight Control System

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Abstract: With the success of C919 type certificate and commercial operation, a golden era of China's civil aircraft products and systems development & production is on the horizon. Meanwhile, as China is the second largest region all around the world for civil aviation, the requirements for more civil aircraft is rapidly growing, and the development of China's civil aircraft industry is also a key factor in promoting the overall economic growth of our country. The traditional on-board system development process of civil aircraft is mostly defined in scattered text materials, and the process activities involved in product development and delivery are not clearly described, which often leads to the lack of customer demand delivery or the compliance with relevant airworthiness terms. Starting from the traditional civil aircraft development process, this paper designs a set of digital logic process platform which integrates the product development and delivery process and development activities of civil aircraft flight control system.
Keywords: Development and Delivery Process for Civil Aircraft; Development Activities, Digital Logic Process Platform

1. INTRODUCTION

Different from the characteristics of China's traditional military aircraft development process, the development, production, certification and delivery of civil large aircraft and its airborne systems have the characteristics of long development cycle, high complexity integration, high safety requirements, high risk and high investment[1][2].

Since China began to develop the large civil aircraft industry, we have experienced all kinds of difficulties and adversities. With the continuous accumulation of precious failed project experience, we finally made C919 Type Certificate (TC) a success, in accordance with the international general development process standards and airworthiness regulations. The development, production, certification and delivery of large civil aircraft and their airborne systems can only be accomplished by following a complete, clear, manageable and traceable development and delivery process[3][4].

Taking airborne flight control system as an example, this paper describes the design of one set of development and delivery process platform for large civil aircraft flight control system.

2. THE INTRODUCTION OF DEVELOPMENT AND DELIVERY PROCESS FOR FLIGHT CONTROL SYSTEM

This paper introduces one set of development and delivery process for large civil aircraft flight control system, which is FCIPDDP (Flight Control Integrated Product Development and Delivery Process for Civil Aircraft). The process system is a set of specified flight control system product development and delivery process system, which is derived from the foreign advanced company's civil aircraft product development and delivery process. This process system consists of seven phases, with the purpose for:

Provide a cross-functional integrated working mechanism for the whole life cycle of civil aircraft product development

Drive common processes and languages across departments

Support cross-functional collaboration to manage project execution throughout the product lifecycle to make better business decisions

User feedback and production feedback are set up to drive the continuous iteration of activities at each phase.

Define the activities and tasks that need to be completed in each phase to ensure the integrity of the project process and compliance with the standards

See Figure 1 for 7 phases defined in the FCIPDDP process system.

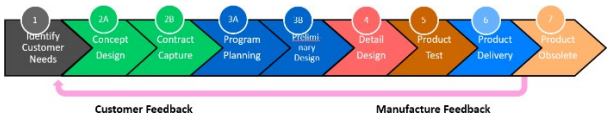

Figure 1 7 phases defined in the FCIPDDP process system

In the whole FCIPDDP process system, the leading responsible department is defined at each phase, and all departments are bound to follow the forward development process stipulated in the process system. Before each Phase exits into the next phase, a Phase Exit Review (PER) is required to ensure that all phase defined activities are completed. The FCIPDDP's seven-phase process and the leading departments are shown in Figure 2

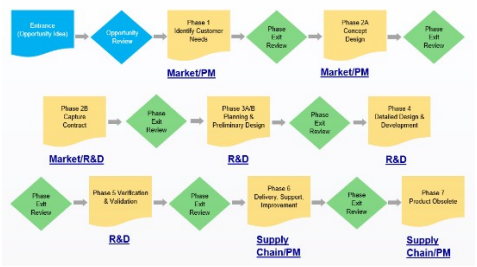

Figure 2 FCIPDDP's seven-phases process and the leading departments

3. THE DESIGN OF INTEGRATED PRODUCT DEVELOPMENT AND DELIVERY PROCESS PLATFORM FOR FLIGHT CONTROL SYSTEM

FCIPDDP process system platform is a digital logical process platform based on FCIPDDP process system, which integrates the product development and delivery process and the process activities of civil aircraft flight control system. The characteristics of the platform are as follows:

1) The platform is based on the FCIPDDP process system, which regulates the entry and exit conditions and activity processes of each phase

2) The core of the platform is the process activities, which standardize the outputs in the R&D process by defining the activities of each phase and each functional organization

3)The platform is supported by the tasks, products, templates, checklists, work instructions, design guidance and best practices involved in the process activities

4) The platform conforms to the processes of ARP4754A, DO-178,DO254.

The overall framework structure design of the platform is shown in Figure 3

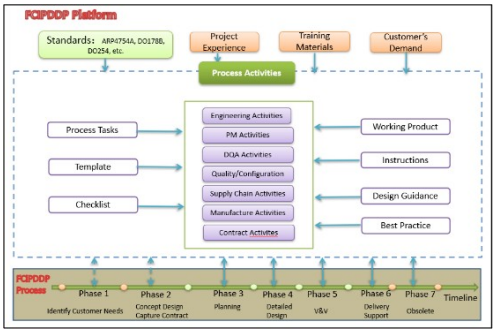

Figure 3 Overall framework structure of FCIPDDP Platform

The platform takes the form of a tree folder, each main folder can be clicked to open the subdirectory. The platform's tree folder classification is shown in Figure 4. The contents of each main folder are detailed in sections 2.1-2.4.

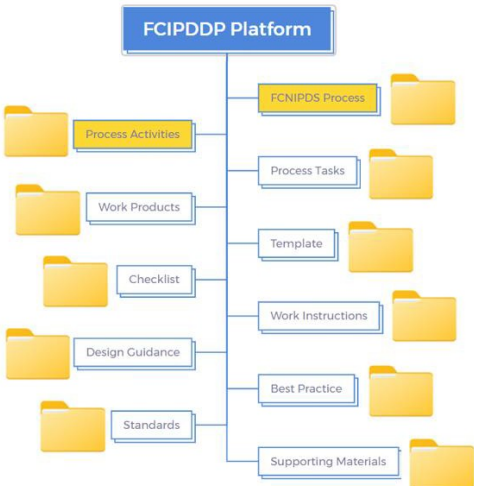

Figure 4 The Tree folder classification of FCIPDDP platform

3.1 Fcipddp process

This folder defines the company's FCIPDDP process and seven phases. All flight control system product development and delivery should follow this process (or tailoring process). This part also defines the entry and exit standards of each phase, the phase exit review and inspection sheet (PECA sheet), the Activities Flow, Work Products and corresponding templates of each department in each phase, and the following: Checklists, Design Guidance, Best Practice. An example of the subcontent that this folder contains is shown in Figure 5.

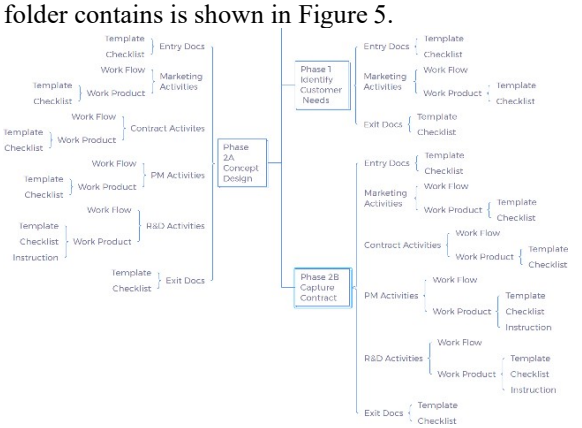

Figure 5 The example of FCIPDDP subfolder content

3.2 Process activities

This folder lists the detailed process activities involved in the development and delivery of all civil aircraft flight control system products, describes the content and process of the activities, and clarifies the types of responsibilities of personnel involved in the process activities. An example of the subcontent that this folder contains is shown in Figure 6.

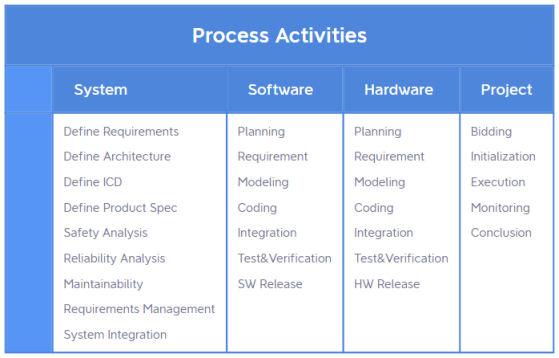

Figure 6 The subcontent of Process Activities Folder

3.3 Tasks, work products, templates, checklists, work instructions, design guidance, best practices

The contents of this folder are mentioned in the first two folders. It is only necessary to identify the Tasks to be completed in the FCIPDDP process and process activities. The category index is created to link to Work Products, Checklists, Templates, Work Instructions and Best Practice.

Standards, Supporting Materials

This folder contains industry standard documents, airworthiness clauses, advisory notices, training materials, experience summaries, etc. used in the product development and delivery process. This section can be updated periodically. An example of the subcontent that this folder contains is shown in Figure 7

Figure 7 Example of Standards, Supporting Materials Folder

4. CONCLUSION

FCIPDDP process system platform can greatly standardize the process of civil aircraft project development, shorten the project development cycle, and fully inherit the past project development experience for the future use of new projects. At the same time, the platform also collects the necessary process activities in the development and delivery of the flight control system, and contains the guidelines, templates, checklists, design guidance and best practices involved in the process activities, which can improve the work efficiency and document quality. The process activities in the platform also cover all the process activities defined in Chapter 4 (Aircraft and Systems Development Process) and Chapter 5 (Integration Process) of ARP-4754A and can demonstrate compliance with them to support the aircraft manufacturer's airworthiness certification activities.

REFERENCES

[1] Chen Yingchun , Commercial Aircraft R&D Management Handbook, Southwest Jiaotong University Press.

[2] Xu Jianyuan, Task Validation methods of civil aircraft system development based on life cycle process, China Science and Technology Information

[3] Yan Jianfeng, Policy design to support the development of commercial large aircraft industry in China, Scientific Development.

[4] Ren Qizhen, Research on product data management process in the development of civil aircraft project, China Standardization.

Research on the Application and Development Trend of Intelligent Sensors

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Abstract: The current world is witnessing a new round of technological revolution led by information technology, and global information technology development is in a historical period of cross-border integration, accelerated innovation, and profound adjustment, presenting the characteristics of interconnectedness and intelligence of all things. Intelligent sensors, as an important means of interaction with the external environment and the main source of perception information, are the foundation of the Internet of Things. In recent years, the global sensor market has maintained rapid growth, driven by the increasing demand from downstream emerging applications such as consumer electronics, automotive electronics, industrial electronics, and medical electronics. In particular, the market for smart sensor applications is experiencing explosive growth and has become one of the core and foundations for the future development of the information technology industry.

Keywords: Intelligent Sensors; Consumer Electronics, Internet of Things; Industrial Electronics; Medical Electronics

1. INTRODUCTION

With the advancement of computer technology and instrumentation technology, as well as the strong demand for applications such as the Internet of Things, intelligent sensors have experienced rapid development as a new type of sensor [1]. Intelligent sensors are a type of sensor that incorporates artificial intelligence and information processing technology to achieve functions such as analysis, judgment, automatic range conversion, drift compensation, nonlinearity, frequency response, environmental impact adaptation, self-learning, and over-limit alarm. They also have capabilities like automatic compensation, automatic calibration, fault diagnosis, etc. Compared to traditional sensors, intelligent sensors organically combine the functionality of sensor detection with the information processing capabilities of microprocessors, fully utilizing microprocessors for data analysis and processing, and allowing for adjustment and control of internal processes [2]. As a result, they possess certain artificial intelligence, compensating for the shortcomings of traditional sensor performance and improving the quality of collected data. It is worth noting that the level of intelligence of these sensors is still in the early stage, namely the low-level intelligence of data processing. They already have functions such as self-compensation, self-diagnosis, self-learning, data processing, storage memory, bidirectional communication, digital output, etc. [3]. The ultimate goal of intelligent sensors is to approach or achieve human-level intelligence, being able to continuously improve and perfect themselves through practice to achieve the best measurement schemes and obtain the most ideal measurement results. Intelligent sensors are sensors with information processing capabilities [4]. They are equipped with microprocessors and have the ability to collect, process, and exchange information [5]. Intelligent sensors are the result of the integration of sensors and microprocessors. Compared to general sensors, intelligent sensors have three advantages: they can achieve high-precision information acquisition at a low cost through software technology, they have certain programming and automation capabilities, and they offer diverse functionalities [6].

A good "intelligent sensor" is a sensor and instrument suite driven by a microprocessor, with communication and on-board diagnostic functions [7]. Intelligent sensors can store various detected physical quantities and process this data according to instructions, thereby creating new data [8]. Intelligent sensors can communicate with each other, make decisions on which data to transmit, discard abnormal data, and perform analysis and statistical calculations [9]. In China, the ecosystem of the intelligent sensor industry is steadily upgrading towards the mid-to-high-end. Since the introduction of the "Twelfth Five-Year Plan for the Development of the Internet of Things" by the government in 2011, the development of the intelligent sensor industry has entered the fast lane. According to statistics, in 2015, smart sensors have already replaced traditional sensors as the mainstream in the market, with a market share of 70%. In 2016, the global smart sensor market reached 25.8 billion US dollars, and by 2019, it reached 37.85 billion US dollars, with an average annual growth rate of 13.6%. The estimated market size of smart sensors in China in 2019 reached 13.7 billion US dollars, and the localization rate increased from 13% in 2015 to 27%.

In this era of informatization, many application scenarios require sensors to obtain information faster, more accurately, and more comprehensively [10]. Taking the Internet of Things as an example, sensors are located in the most critical perception layer,

responsible not only for information collection and transmission like traditional sensors but also for analyzing, processing, storing, and memorizing massive data [11]. Smart sensors can fully meet these requirements, and their advantageous functions include self-compensation and self-diagnosis, information storage and memory, self-learning and adaptation, digital output, etc. [12].

2. FUTURE DEVELOPMENT DIRECTIONS OF INTELLIGENT SENSORS

The next key development directions for smart sensors include integrating microprocessors and microsensors on a silicon chip through the fusion of MEMS technology and IC planar technology [13]. By relying on software technology, the accuracy, stability, and reliability of sensors can be greatly improved, and a new generation of fully digital smart sensors can be designed and manufactured. By adopting methods and technologies such as hardware softening, software integration, virtual reality, soft measurement, and artificial intelligence, intelligent sensors with human-like intelligence characteristics or functions can be researched and developed based on sensor technology and computer technology. The development direction includes high precision, high reliability, miniaturization, and networking [14].

The current status of the smart sensor industry is characterized by a long industrial chain and high technological barriers [15]. The industrial chain of smart sensors includes eight links: research and development, design, manufacturing, packaging, testing, software, chips and solutions, systems, and applications, and each link has high technological barriers [16]. In terms of process and technology, the design, manufacturing, packaging, and testing of smart sensors have many similarities with the corresponding links in the semiconductor integrated circuit industry. Companies with IC experience have inherent advantages, and based on the similarity between the two industries, the design link of smart sensors has the largest market space, and the packaging link will become the fastest-growing link in the domestic market. Although there is still a certain gap between the overall technical level in China and the top foreign technologies, technology-oriented companies that entered the segmented field earlier have accumulated independent research and development capabilities over the years and can already compete with foreign counterparts [17].

3. APPLICATION AREAS OF INTELLIGENT SENSORS

The key downstream application areas of intelligent sensors are consumer electronics, automotive electronics, industrial electronics, and medical electronics, with their corresponding market shares decreasing in that order [18]. Considering the size of the overall market and its growth rate, rapidly developing emerging applications such as fingerprint recognition, intelligent driving, smart robots, and intelligent medical devices will become the main driving force for the growth of the intelligent sensor market.

In the field of consumer electronics, the fingerprint sensor (including optical fingerprint sensors, capacitive fingerprint sensors, thermal fingerprint sensors, and ultrasonic fingerprint sensors, etc.) has the fastest growth rate. The compound annual growth rate from 2016 to 2019 reached 14.84%, and the global market size is expected to reach $4.7 billion in 2022. Automotive sensors are mostly used in extremely harsh operating environments, where sensors must have high stability, resistance to environmental interference, and the ability to adapt and self-compensate. In order to ensure mass production of electronic components and modules, costs also need to be reduced. New intelligent sensors can meet the aforementioned requirements in terms of technology and cost [19]. Intelligent sensors have been widely used in the automotive field, such as automotive power systems, safety driving systems, and body systems. As autonomous driving technology (equivalent to the underlying operating system of intelligent vehicles) becomes increasingly mature, intelligent sensors are no longer limited to the traditional automotive market but are extending into the intelligent vehicle market. Sensors that enable environmental perception include cameras (long-range cameras, surround cameras, and stereo cameras) and radars (ultrasonic radars, millimeter-wave radars, and laser radars). Currently, companies both domestically and internationally adopt two approaches to achieve autonomous driving: one is the camera + millimeter-wave radar solution (e.g., Tesla), and the other is the lidar solution (e.g., Google and Baidu). The market size of sensor modules in the global intelligent driving vehicles exceeded $5 billion in 2017 and is expected to reach $36 billion by 2030. In terms of sensor types, ultrasonic sensors, 360-degree panoramic cameras, and forward-facing cameras will continue to be the mainstream sensors in the market. It is projected that their market sizes will reach $12 billion, $8.7 billion, and $6.9 billion respectively by 2030. Radar has been applied in the field of autonomous driving since 2015, with high technological barriers. It will experience explosive growth in the next few years and reach $12.9 billion by 2030, including long-range radar at $7.9 billion and short-range radar at $5 billion. In the field of industrial electronics, robot manufacturing technology has become increasingly mature in recent years, with accelerated commercialization. The market space for intelligent sensors, as core components, is also expanding.

In the field of medical electronics, driven by the medical device industry, the demand for intelligent sensors will continuously expand [20]. According to the classification of application forms, medical

sensors can be divided into four categories: implantable sensors, external sensors, temporarily implanted body cavity sensors, and sensors used for external devices. An analysis report indicates that the global medical sensor market reached $9.8 billion in 2015 and is expected to increase to $18.5 billion by 2024. Currently, China has a limited presence in this field, mostly relying on imports and being in the initial stage. However, in the future, with continuous technological maturity, the market will experience explosive growth [21].

4.CONCLUSIONS

The rise of the Internet of Things, cloud computing, big data, and artificial intelligence is driving the transformation of sensing technology from single-point breakthroughs to systemic and systematic collaborative innovation, opening up a very promising path for innovation in sensor applications. Intelligent sensors are the result of technological evolution, meeting the requirements for the perception layer posed by the Internet of Things. It is expected that they will experience rapid growth along with the development of new industries such as smart consumer electronics, industrial Internet of Things, vehicle-to-vehicle communication and autonomous driving, smart cities, and intelligent medical devices.

REFERENCES

[1] Yamasaki H. New Trend of Sensing Technology: Sensing Systems and Intelligent Sensors[J].Tetsu-to-Hagane, 1993, 79(7):741-749.

[2] Qin S J. Neural Networks for Intelligent Sensors and Control—Practical Issues and Some Solutions - ScienceDirect[J]. Neural Systems for Control, 1997:213-234.

[3] Brignell J E. The future of intelligent sensors: a problem of technology or ethics?[J].Sensors & Actuators A Physical, 1996, 56(1-2):11-15.

[4] Li H, Zhao X. Research and application of piezo-intelligent sensors in civil engineering[J].Earthquake Engineering and Engineering Vibration, 2004, 24(6):165-172.

[5] Bialas,Andrzej. Intelligent Sensors Security[J].Sensors, 2010, 10(1):822-859..

[6] Powner E T, Yalcinkaya F. From basic sensors to intelligent sensors: Definitions and examples[J].Sensor Review, 1995, 15(4):19-22.

[7] Henry M.Plant asset management via intelligent sensors digital, distributed and for free[J].Computing & Control Engineering Journal, 2000, 11(5):211-213.

[8] Theisen M, Steudel A, Rychetsky M,et al. Fuzzy Logic and Neuro-Systems Assisted Intelligent Sensors[J].Sensors Update, 1998, 3(1):29-59.

[9] Dong-Sheng L I, Zhi Z, Jin-Ping O U. Sensing properties study and engineering applications for GFRP-OFBG intelligent sensors[J]. Guangdianzi Jiguang/Journal of Optoelectronics Laser, 2009, 20(10):1294-1297.

[10] Taymanov R E, Sapozhnikova K.Problems of Terminology in the Field of Intelligent Sensors and Systems[J].Key Engineering Materials, 2010, 437:434-438.

[11] Taner A H, Brignell J E. Virtual instrumentation and intelligent sensors[J].Sensors and Actuators A Physical, 1997, 61(1-3):427-430.

[12] Li H, Zhao X. Research and application of piezo-intelligent sensors in civil engineering[J].Earthquake Engineering and Engineering Vibration, 2004, 24(6):165-172.

[13] Bialas A. Security-Related Design Patterns for Intelligent Sensors Requiring Measurable Assurance[J]. Przeglad Elektrotechniczny, 2009, 85(7):92-99..

[14] Boverie S. A new class of intelligent sensors for the inner space monitoring of the vehicle of the future[J]. Control Engineering Practice, 2002, 10(11):1169-1178.

[15] Kanellakopulos I. Intelligent sensors and control for commercial vehicle automation[J]. Annual Reviews in Control, 1999, 23:117-124.

[16] Benoit E, Foulloy L. High functionalities for intelligent sensors, application to fuzzy color sensor[J]. Measurement, 2001, 30(3):161-170.

[17] Takahashi K, Nozaki S. From intelligent sensors to fuzzy sensors[J].Sensors & Actuators A Physical, 1994, 40(2):89-91.

[18] Powner E T, Yalcinkaya F. Intelligent sensors: structure and system[J]. Sensor Review, 2010, 15(3):31-35.

[19] Charniya N N. Design of Near-Optimal Classifier Using Multi-Layer Perceptron Neural Networks for Intelligent Sensors[J].International Journal of Modeling & Optimization, 2013, 3(1):56-60.

[20] Mercorelli P. Biorthogonal wavelet trees in the classification of embedded signal classes for intelligent sensors using machine learning applications[J]. Journal of the Franklin Institute, 2007, 344(6):813-829.

[21] Mkhida A, Thiriet J M,Jean-François Aubry. Integration of intelligent sensors in Safety Instrumented Systems (SIS)[J].Process Safety & Environmental Protection, 2014, 92(2):142-149.

Discussion on the Measurement and Calculation Method of P-V Indicator Diagram for Diesel Engines

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Abstract: The p-V indicator diagram is a graph of the variation of working fluid pressure in a cylinder with the cylinder volume. According to engineering thermodynamics, the area of the p-V indicator diagram represents the indicated work of a working cycle in a diesel engine cylinder. It is an important basis for studying the perfection of the working process in the cylinder of a diesel engine and calculating the indicated power of the diesel engine. In the daily management of ship diesel engines, the p-V indicator diagram of the running diesel engine should be regularly measured and recorded, and the working performance of the diesel engine should be judged based on the calculation and analysis results, and appropriate adjustments should be made to ensure that the diesel engine operates under the optimal working conditions.
Keywords: Diesel Engine; P-V Indicator Diagram

1. THE RECORDING PRINCIPLE AND PRECAUTIONS OF P-V INDICATOR DIAGRAM

At present, mechanical indicators are commonly used on ships. When measuring the indicator diagram, the indicator paper sandwiched on the rotary cylinder 8 is driven by a specially designed indicator transmission mechanism of the diesel engine through a rope 9, and deflects left and right around its own axis. the displacement of the deflection angle is proportional to the displacement of the diesel engine piston, reflecting the stroke of the diesel engine piston. the small piston 5 of the indicator moves up and down in the small cylinder under the pressure of the gas in the cylinder, and is balanced by the spring force. the movement of the small piston is driven by the piston rod to drive the transmission rod and brush of the mechanism, and its displacement is recorded on the indicator paper (which reflects the changing gas pressure in the diesel engine cylinder in a certain proportion). the graph drawn is the p-V indicator diagram (pressure volume indicator diagram) [1-3].

Mechanical indicators are generally equipped with three sets of pistons and one set of springs with different stiffness, which can be selected based on the maximum explosion pressure pz value of the diesel engine to obtain a suitable indicator diagram. the three sets of pistons and cylinder liners are represented by labels 1/1, 1/2, and 1/5, respectively. When measuring the p-V indicator diagram, a 1/5 small piston is used. the indicator spring is marked with the spring ratio M (the spring ratio unit of the indicator spring is mm/MPa, which represents the deformation of the spring (mm) for every 1Mpa change in cylinder pressure). When selecting the spring, it should be noted that the indicator has an appropriate height, so that the maximum height of the measured indicator diagram is close to the height of the indicator diagram to ensure the accuracy of the indicator diagram. When measuring the p-V indicator diagram of diesel engines, a 1/5 small piston is used. Generally, the available spring ratios are 12, 10, 8, 7, 6, 5, 4, and 3 (mm/MPa), and the corresponding maximum pressures are 4.0, 5.0, 6.0, 7.0, 8.0, 10.0, 12.5, and 15.0 (MPa), respectively.

In order to proportionally transmit the motion law of the diesel engine piston to the indicator cylinder mechanism, it is necessary to establish a dedicated transmission mechanism. Due to the fact that the circumference of the indicator cylinder is only 1/5-1/20 of the stroke of the diesel engine piston, the transmission mechanism not only needs to accurately reflect the motion law of the diesel engine piston, but also needs to proportionally reduce the stroke of the piston. At present, the power indicator transmission mechanism of large low-speed diesel engines is mostly cam type, and a specially designed cam is used to drive roller 2 and guide rod 3 to simulate the motion law of the diesel engine piston. Due to the fact that the appearance of the indicator cam is designed according to the motion law of the diesel engine piston and installed on the camshaft at a certain position, it can reflect the motion law of the piston. That is, when the diesel engine piston is at the top and bottom dead center positions, the indicator cam also precisely pushes the guide rod to the highest and lowest positions, making the motion law of the guide rod consistent with the motion law of the diesel engine piston, this ensures that the displacement of the indicator cylinder and the diesel engine piston is proportional and consistent with the timing. If the diesel engine does not need to measure the indicator diagram during operation, the guide rod can be lifted and inserted into the guide rod pin hole 6 through the hole 5 on the housing sleeve with a pin, so that the roller does not come into contact with the cam to prevent mutual wear between the two.

Before recording the indicator diagram, the indicator should be inspected and maintained to ensure good lubrication of

its movable parts and ensure that the small piston can slide evenly with its own weight in the cylinder; When the distance between the indicator and the transmission mechanism is greater than 1.5m, steel wire soft ropes should be used.

When recording the indicator diagram, the indicator should be inspected and maintained to ensure good lubrication of its movable parts and ensure that the small piston can slide evenly with its own weight in the cylinder; When the distance between the indicator and the transmission mechanism is greater than 1.5m, steel wire soft ropes should be used.

When recording the indicator diagram, appropriate sea and meteorological conditions should be selected to ensure stable diesel engine load. Before installing the indicator, the indicator valve must be opened to blow out any carbon deposits and impurities in the passage. After the installation of the indicator, the atmospheric pressure line should be drawn on the recording paper of the rotary cylinder first. After obtaining a satisfactory indicator diagram, the date, cylinder number, rotational speed, exhaust temperature, throttle grid number, spring ratio, etc. should be indicated. And contact the bridge to record climate, wind speed, wind direction, tide, draft, ship speed, etc. for reference during analysis. For accuracy, it is best to take 2 indicator diagrams per cylinder. After measuring 5 to 6 indicator diagrams, the indicator should be removed for cooling. After completing the measurement of the indicator, it should be thoroughly cleaned and maintained.

The p-V indicator diagram can be used to calculate the power of a diesel engine, adjust the uniformity of load on each cylinder, measure the maximum explosion pressure and judge the combustion situation of each cylinder, calculate the instantaneous temperature inside the cylinder, and qualitatively and quantitatively display the actual working process inside the cylinder.

2. CALCULATION OF P-V INDICATOR DIAGRAM

After measuring the p-V indicator diagram of each cylinder of a running diesel engine using a mechanical indicator, the average indicated pressure Pi value of each cylinder can be calculated based on the indicator diagram, and then substituted into the power calculation formula to calculate the indicated power of each cylinder.

2.1 Calculation method of average indicated pressure Pi

2.1.1 Area method

Use an area meter to measure the area of the indicator diagram, expressed in f (mm2), and then divide by L (mm) to obtain the average height of the indicator diagram. Namely

$$h_i = \frac{\mathrm{f}}{\mathrm{L}}(mm)$$

By dividing the average height hi by the spring ratio M (mm/MPa) of the indicator, the value of Pi can be obtained, which is

$$p_i = \frac{hi}{M}(MPa).$$

2.1.2 Ten equal parts method

Many materials are explained as follows:

If there is no area meter, the following drawing method can be used to obtain the average height of the indicator diagram, and the results are also accurate enough.

The ten equal division method (as shown in Figure 4) divides the length L of the indicator diagram into ten equal parts, and measures the height of the indicator diagram at each equal division point.. (mm). Two additional indicator diagram heights are added near the top and bottom dead centers. the average height of the indicator diagram can be calculated using the following equation:

$$h_i = \frac{1}{10}\left(\frac{y_0 + y_{10}}{2} + y_1 + y_2 + y_3 + \ldots\ldots + \mathrm{y}_9\right)(\mathrm{mm})$$

Then the average indicated pressure

Based on the above explanation, it is easy for us to mistakenly believe that the height of the indicator diagram at each equal division point in the formula is the vertical coordinate height of each equal division point. Once, during a discussion with a colleague, he mentioned that when working on a ship without an area meter, he used the ten equal division method to calculate the indicated power height at each equal division point.. which was calculated based on the vertical coordinate height of each equal division point. the final calculated indicated power value of the diesel engine was much larger than the maximum continuous operating power MCR. Therefore, it was determined that this algorithm was flawed, but the reason was unknown.

With this question in mind, the author made the following transformations to the formula (mm):

$$h_i = \frac{1}{10}\left(\frac{y_0 + y_{10}}{2} + \frac{2y_1 + 2y_2 + 2y_3 + \ldots\ldots + 2\mathrm{y}_9}{2}\right)(\mathrm{mm})$$

$$h_i = \frac{1}{10}\left(\frac{y_0 + y_1}{2} + \frac{y_1 + \mathrm{y}_2}{2} + \frac{y_2 + y_3}{2} + \ldots\ldots + \frac{y_8 + y_9}{2} + \frac{y_9 + y_{10}}{2}\right)(\mathrm{mm})$$

And because: $h_i = \frac{\mathrm{f}}{\mathrm{L}}(mm)$

So, the area of the indicator diagram should be

$$f = \mathrm{L}\, h_i\,(mm^2)$$

$$= \frac{L}{10}\left(\frac{y_0 + y_1}{2} + \frac{y_1 + \mathrm{y}_2}{2} + \frac{y_2 + y_3}{2} + \ldots\ldots + \frac{y_8 + y_9}{2} + \frac{y_9 + y_{10}}{2}\right)(mm^2)$$

$$= \left(\frac{L}{10} * \frac{y_0 + y_1}{2} + \frac{L}{10} * \frac{y_1 + \mathrm{y}_2}{2} + \frac{L}{10} * \frac{y_2 + y_3}{2} + \ldots\ldots + \frac{L}{10} * \frac{y_8 + y_9}{2} + \frac{L}{10} * \frac{y_9 + y_{10}}{2}\right)(mm^2)$$

$$= (S_1 + S_2 + S_3 + \ldots\ldots + S_9 + S_{10})(mm^2)$$

If the height of the indicator diagram on each partition point is calculated based on the vertical coordinate height of each partition point, then the sum of the areas of these ten small trapezoids not only includes the vast majority of the area of the p-V indicator diagram (only slightly less at the head),

but also a large part of the area between the compression line and the horizontal axis. This way, the calculated area is much larger than the actual area of the p-V indicator diagram, ultimately resulting in a much larger calculated indicated power value for the diesel engine.

Similarly, we can conclude that the value of two is the length of the line segment between the edge line of the p-V indicator diagram and the two intersection points below the decadal line. the sum of the areas of the ten small trapezoids calculated in this way is approximately equal to the area of the p-V indicator diagram.

2.2 Calculation of power

After calculating the average indicated pressure value of a certain cylinder, the indicated power of a single cylinder can be calculated based on the formula of indicated power=(KW). For a given diesel engine, it is a fixed value, usually given in the manual or calculated according to a formula, where: - cylinder working volume; m - working stroke per revolution, four stroke engine m=, two stroke engine m=1) the sum of the indicated power values of all horizontal bars is the indicated power of the entire diesel engine.

After recording the p-V indicator diagram of the diesel engine, the engine management personnel should pay attention to calculation and analysis, and record and archive the measurement and calculation results.

3. SUMMARY

In summary, when using the method of measuring the p-V indicator diagram of diesel engines to calculate the indicated power value, the engine management personnel should pay attention to the rigor of the implementation of the method, and record and archive the measurement results, concise calculation process, and calculation results.

REFERENCE

[1] Li Bin. Main Propulsion Power Unit [M]. Dalian: Dalian Maritime University Press, 2012.

[2] Liu Cihui. Judging diesel engine faults from indicator diagrams [J]. Navigation Technology, 2009(04).

[3] Zhang Yuewen. Example of Analyzing Mainframe Faults Using Electronic Indicator Diagrams [J]. Navigation Technology, 2015(05).

Automatic Detection System for Line Faults

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Abstract: The automatic detection system for circuit faults is based on the STM32F407VET6 microcontroller, which uses automation technology to quickly detect faults in electronic circuits. Analyzed the common types of line faults and proposed a fault detection method based on signal processing and machine learning. Secondly, hardware circuits and software input capture were designed to achieve functions such as signal acquisition, feature extraction, and fault diagnosis. Finally, system performance testing was conducted and compared with traditional manual detection methods. The results indicate that the automatic detection system has high accuracy and efficiency, and has significant advantages in fault detection. This provides a new approach and method for solving the problem of electronic circuit fault detection, which has certain theoretical and practical value.
Keywords: Line Failure; Automatic Detection System; Fault Diagnosis; Data Analysis

1. INTRODUCTION

With the widespread application of electronic devices, detecting and diagnosing circuit faults has become an important part of electronic production and manufacturing. Traditional line fault detection mainly relies on manual visual inspection and instrument testing, which has problems such as low efficiency, long testing time, and inability to achieve automation. To solve this problem, this article studies and designs a fault automatic detection system based on a combination of microcontroller and hardware circuit analysis. The system utilizes waveform frequency processing technology to obtain fault points, quickly diagnose and analyze line parameters, and achieve automatic identification of line fault types and detection of fault points[1]. This detection system combines hardware circuits with software to accurately and efficiently detect and locate line faults, greatly improving testing efficiency and reducing testing costs. The research content has important engineering application value and broad market prospects. This article introduces the system scheme for line fault monitoring, detailing the selection of hardware such as chips, screens, and power chips, theoretical analysis and calculation, hardware circuit design, and software programming

2. SYSTEM SCHEME

2.1 Chip selection

Option 1: STM32F103C6T6

In terms of processor, STM32F103C6T6 is an MCU with low cost, moderate energy consumption, and low power consumption rate. It is a member of the STM32F1 series and belongs to the earlier product line. Generally speaking, it is relatively inexpensive. Based on the Cortex-M3 core, it provides reasonable performance and is suitable for most general-purpose embedded applications. At the same time, it has a good low-power mode and is suitable for battery powered applications.

Option 2: STM32F407VET6

Compared to Cortex-M3 products such as STM32F1/F2, the biggest advantages of STM32F4 are as follows.

High performance: The STM32F407VET6 adopts the Cortex-M4 core, which has a high clock frequency and floating-point operation capability. This makes it suitable for applications with high performance requirements, such as digital signal processing (DSP) and real-time control

Rich peripherals: This microcontroller inherits a large number of peripherals, such as multiple serial interfaces (USART, SPI, I2C), multiple timers and counters, and multiple general-purpose input/output pins (GPIO). These peripherals provide rich connectivity and control options, making them suitable for a wide range of application areas.

Memory and storage: The STM32F407VET6 has larger Flash memory and SRAM, allowing it to support more complex applications. It also supports external memory interfaces such as SD cards and external SRAM, further expanding storage capacity.

Low Power Mode: The STM32F407VRET6 supports multiple low power modes, which can help reduce power consumption, extend battery life, and is suitable for battery powered portable devices and energy-saving applications[2].

Rich development ecosystem: STMicroelectronics' STM32 series is one of the popular microcontroller series, which has abundant development resources and community support. You can find a large number of documents, application notes, sample code, and third-party libraries to accelerate the product development process.

Flexible packaging options: STM32F407VET6 provides multiple packaging options, such as LQFP, WLCSP, BGA, etc., to meet the packaging requirements in different application scenarios[3].

Considering the high requirements for performance, peripherals, and memory, we have chosen option two.

2.2 Screen selection

Option 1: OLED screen
OLED screens have excellent display effects, high color contrast, and resolution, allowing for clearer display and faster response on the screen. However, OLED screens are expensive and prone to screen burning, resulting in high power consumption and a heavy burden on microcontrollers.
Option 2: Devin Screen (DMG8048043:02WTC)
Low power consumption: The Divan screen only consumes energy during refresh, so it hardly consumes electricity when displaying static content, making the battery life of devices such as e-book readers very long.
Eye protection: The Divan screen uses reflected light to display content, similar to paper, without the need for backlighting, making it more eye friendly and suitable for long-term reading
Reading experience: Due to its similarity to paper, the Devin screen also has good visibility outdoors and under strong light, without bright backlight reflection.
In summary, we have chosen the Diwen screen as the screen for this experimental project.
2.3 Selection of power chips
Option 1: LM2596
Wide input voltage range: LM2596 can operate over a wide range of input voltages and typically supports input voltages ranging from 4V to 40V or higher, making it suitable for various application scenarios.
High efficiency: LM2596 adopts PWM modulation technology, which has efficient energy conversion, which means it can minimize power consumption during power conversion and transfer more electrical energy to the load.
High output voltage stability: LM2596 usually has good output voltage stability and accuracy, which is very important for some applications with strict voltage requirements.
Built in protection function: The LM2596 integrates multiple protection functions, such as overcurrent protection, overheating protection, and short circuit protection, to protect the chip and external circuits from damage.
High cost-effectiveness: As LM2596 is a common linear regulator chip, its cost is relatively low, making it suitable for large-scale applications and cost sensitive projects.
Option 2: LP260
LP260 has the characteristics of low power consumption, small package, and type used for loT devices. It is commonly used for Internet applications. LP260 has low processing performance and serious functions. It is only suitable for use in circuits with a little over range and high cost.
In summary, we have chosen option one.
3. CIRCUIT DESIGN DEBUGGING AND ANALYSIS
Option 1: LC resonance method
Due to the formation of a rectangular circuit between the wire and the short circuit during a fault, which has a certain amount of inductance value, a capacitor is connected in series in the circuit. By measuring the resonant frequency, the circuit inductance value is calculated. The resonance method requires continuous adjustment of the frequency of the excitation signal to achieve resonance in the circuit. This method requires signal adjustment of the excitation signal, and the measurement speed is relatively slow.
Option 2: Partial pressure method
Due to the certain inductance value of the short-circuit circuit, it exhibits a certain inductance value under the stimulation of high-frequency signals. A resistor is connected in series in the coil circuit to obtain a corresponding relationship between the voltage and the short-circuit position by measuring the different inductance and standard resistance of the coil at different short-circuit positions. RS431 is used to identify the amplitude ratio of the two AC voltages and obtain the accurate change of inductance. Partial voltage generators have high stability in circuits.
In summary, Scheme 2 is used for measuring short-circuit fault points.
Using a NE555 pulse generator to generate oscillations, the voltage of the components is determined through waveforms of different frequencies, thereby detecting the fault point. As shown in Figure 1.

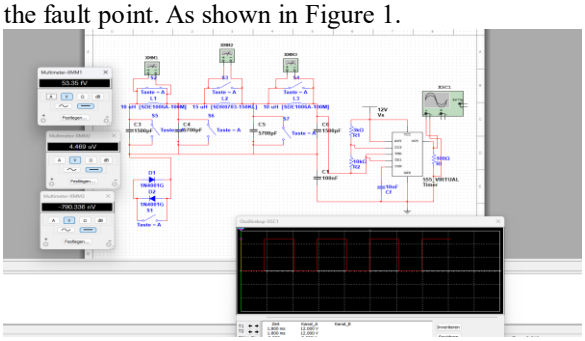

Figure 1. Detection diagram of NE555 circuit breaker fault point
Using the capacitor grounding trigger circuit of NE555 chip, oscillation is achieved through charging and discharging the grounded capacitor. The oscillation frequency is changed by adjusting the resistance value of the resistor. Different oscillation frequencies generate different voltages to test the circuit breaker. Different frequencies generate different voltages. STM32 input capture is used to collect signals, and different values are used to determine the location of the fault point. Use RS5532 for voltage amplification and RS431 for voltage division to test the fault point.
Use RS431 for voltage division. RS431 contains a precise reference voltage source (such as 2.5V) inside, and its regulating end Vref is connected to a variable resistor to form a voltage division circuit. The output voltage is adjusted by changing the resistance value of the variable resistor. By using the output voltage formula: Vout=Vref * (1+R2/R1) * (R3/(R3+R4)), different output voltages can be obtained by adjusting the ratio of R1 and R2.
Using RS5532 to amplify voltage, different components have different amplification factors for

voltage. Using a microcontroller to read the voltage value, RS431 divides the voltage in the circuit to provide 2.5V voltage to the main circuit. A stable voltage output environment keeps the microcontroller in a stable state. The key point in this circuit is to use the different voltage multiples generated by RS5532 to test the accurate location of the short-circuit fault point.

4. DETECTION OF DIODES

Use relays to control the forward and reverse conduction of diodes. STM32 controls the opening and closing of the relay through GPIO, while reading the voltage at both ends through ADC. Determine the function of the diode based on the forward and reverse conduction voltages.

The relay is located on either side of A - and B -, and when the diode is disconnected, the microcontroller connects to measure the level of port A. If the level of port A is high, the relay of port B is used for detection. If no response is found after detection, it can be concluded that the diode here is disconnected (faulty). Using STM32 for relay memory control, control the opening and closing of the relay by controlling the IO port, control the relay in the main program to achieve forward and reverse conduction of the diode, use ADC for collection, collect forward and reverse voltage drops and different level changes for voltage comparison, different voltage values indicate different diode states, The detected level is sent to the microcontroller through the serial port and then transmitted to the screen to display the fault point of the diode.

5. SUMMARY

This design realizes automatic detection of power lines, aiming to improve the efficiency and accuracy of power line fault detection. A stable automatic line detection system has been constructed through hardware circuit construction and software debugging. Improved the time-consuming, labor-intensive, and unstable methods generated by traditional manual detection. In the design and implementation of circuits and systems, the design concept, debugging methods, and theoretical practice of the fault location automatic detection system are elaborated in detail. The system uses software to read the voltage changes of different capacitors and inductors by generating oscillation circuits through NE555, and extracts and identifies them. It realizes intelligent detection of fault modes of open and short circuits in the circuit, improving the automation and accuracy of the system.

REFERENCES

[1] Editor in Chief of Hua Chengying Tong Shibai Fundamentals of Analog Electronic Technology, Higher Education Press, 2006.

[2] Huang Zhiwei. Design of the National College Student Electronic Design Competition System.

[3] Sergio Franco, circuit design based on operational amplifiers and analog integrated circuits.

The Development of Mobile Communication Technology and Its Application in the Internet of Things

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Abstract: Comprehensive information collection is the foundation of the Internet of Things. The collected object feature information needs to be transmitted from the sensor node to the gateway node through the bearer network and then to the processing unit. This requires the bearer network to be "ubiquitous" and able to transmit the collected information anytime and anywhere. Different IoT applications have different requirements on the bearer network, so the bearer network that can fully access and carry all IoT applications must have seamless wide-area coverage and flexible access methods.
Keywords: Mobile Communication Technology; Internet of Things; Information Collection

1. INTRODUCTION

The interconnection between people and things, and between things in the Internet of Things, as well as the use of a large number of information collection and exchange devices, makes information security and privacy protection urgent problems to be solved[1]. Although wired access can provide secure, stable, and high-speed channels for data transmission, the widespread and mobile nature of IoT sensor nodes determines that wired access has great limitations in application scenarios. The mobile communication network, with its unparalleled mobility and flexibility compared to wired networks, has become the preferred choice for nodes to transmit data remotely to remote control centers. Applying mobile communication technology to information access and transmission in the Internet of Things can greatly promote the popularization and application of the Internet of Things[2].

Mobile communication is composed of several wireless cells, with each cell equipped with a small power base station. As the number of users increases, system capacity can be improved through techniques such as cell splitting, frequency reuse, and sectorization. Over the past few decades, mobile communication technology has been developing steadily, from first-generation mobile communication systems to fifth-generation mobile communication systems. Mobile communication has always been committed to providing users with better, faster, and more valuable services. However, traditional mobile communication mainly meets the communication needs between people. The cost of devices is high and power consumption is huge, without considering the requirements of low cost, wide coverage, large capacity, and low power consumption in IoT scenarios. Therefore, it cannot be directly applied to the Internet of Things. In 4G/4.5G, standards have been added for IoT applications, such as LTE-eMTC, supporting lower power consumption and lower cost devices. 5G takes inter-device communication as a main scenario and effectively supports the massive connections of IoT devices. As IoT scenarios become increasingly complex, 6G intelligence will provide strong support for the Internet of Things.

2. THE FOURTH GENERATION MOBILE COMMUNICATIONS TECHNOLOGY

The fourth-generation mobile communication technology, also known as 4G, mainly includes two standards: TD-LTE and FDD-LTE at this stage. TD-LTE is mainly developed by China, with a maximum downlink rate of 100 Mbps and a maximum uplink rate of 50 Mbps. FDD-LTE has a maximum downlink rate of 150 Mbps and a maximum uplink rate of 50 Mbps[3]. The main core technologies of 4G networks include orthogonal frequency division multiplexing technology, IP-based core network technology, multi-user detection technology, multi-input multi-output technology, and smart antenna technology. 4G networks are an extension of 3G networks. Compared with 3G networks, 4G networks adopt new modulation methods, better coding schemes, and new technologies such as diversity reception. 4G networks use multi-carrier orthogonal frequency division multiplexing modulation technology to improve spectrum utilization. 4G networks have characteristics such as high speed, good compatibility and flexibility, coexistence of multiple types of users, integration of multiple services, etc. Compared with 3G networks, 4G networks have higher rates and can be compatible with 2G networks and 3G networks, providing global roaming and open interfaces. 4G networks adopt intelligent technologies that can automatically allocate resources according to user service changes and handle networks and channels dynamically for various users to coexist and interact with each other, meeting the diverse needs of various types of users. Due to the high-rate characteristics of 4G, 4G networks can not only perform voice calls but also support video

conferencing, mobile interviews, and other functions. LTE is the current technical standard adopted by 4G. To achieve organic integration of 4G and the Internet of Things (IoT), a clear understanding of the core technologies of LTE is required, and its technological advantages should be fully utilized[4].

3. THE FIFTH GENERATION MOBILE COMMUNICATIONS TECHNOLOGY

The fifth-generation mobile communication technology. To address the challenges brought by the rapid growth in mobile data traffic and terminal connections, while providing users with higher transmission rates, lower transmission delays, and higher quality of experience services, the industry began studying 5G in 2012 and officially named it IMT-2020 in 2015.5G is different from 2G, 3G, and 4G, as its definition is not limited to a single business capability or a typical technology. 5G network is an intelligent network for user experience and business applications, which can meet a wide range of business needs including data and connectivity[5].

5G will greatly improve the user experience of people-centered mobile Internet business while fully supporting the Internet of Things business centered on things, realizing intelligent interconnection between people, people and things, and things and things. The access network and core network of 5G will further develop towards intelligence and flatness, realizing multi-network integration, effectively supporting the application scenarios of mobile Internet of Things, including low-power consumption and large connectivity in sensor category and low-latency and high-reliability application scenarios in automatic control category. Its high transmission rate and large transmission capacity can provide faster data transmission and processing capability for Internet of Things, reduce the time delay of data transmission and processing, and meet the tolerance of Internet of Things to time delay. In addition, in response to the rapid growth and increasing complexity of Internet of Things devices and data, 5G applies cloud computing and big data technology to provide an intelligent platform for Internet of Things data processing, which can effectively manage the network[6].

The international standards related to 5G are mainly developed by the 3GPP, which are divided into two versions, R15 and R16, to meet all the requirements of the ITUIMT-2020. R15 is the basic version of 5G, which is divided into early, main, and late versions. Currently, the 5G standard based on R15 has been frozen, and the latest version has been ready for commercial use, focusing on meeting the needs of enhanced mobile broadband and basic ultra-reliable low-latency communication applications. R16 mainly meets the needs of massive machine-type communication applications and enhances the application of ultra-reliable low-latency communication, step by step meeting the standards for various business scenarios of 5G. It was frozen in June 2020 and formed a complete 5G standard. As an enhanced version of 5G, R16 further enhances the ability and efficiency of network support for eMBB based on R15, focusing on improving support for vertical industry applications, especially for URLLC and mMTC business. The gradual completion of R16 version enhances 5G network from five dimensions: smarter network, better performance, more flexible deployment, richer supported frequency bands, and wider application, which promotes the focus of 5G applications to control and IoT business[7].

4G changes life, and 5G changes society. 5G has distinctive features of scenario application, which is deployed commercially around people's needs of living, working, leisure, transportation and vertical industries. These scenario needs have a series of characteristics such as ultra-high speed, ultra-large capacity, ultra-reliable low-latency, ultra-high density, ultra-large connection number, and ultra-high mobility. According to the characteristics of business needs and different application scenarios, ITU defined three major application scenarios of 5G in its 5G white paper: enhanced mobile broadband (eMBB), ultra-reliable low-latency communication (URLLC) and massive machine type communication (mMTC).

4. THE SIXTH GENERATION MOBILE COMMUNICATION TECHNOLOGY

So far, the design of 1G to 5G has followed the loose coupling principle between the network side and the user side. Driven by technology, it has to some extent met the basic needs of users and networks, such as latency, energy efficiency, and spectrum efficiency. However, due to technology driven capabilities, the design of 1G to 5G does not involve deeper communication requirements. In the future Sixth Generation Mobile Communication System (6G), the network and users will be regarded as a unified whole, and further exploration and implementation of user needs are needed, which will serve as a benchmark for technical planning and evolutionary layout. The early stage of 6G will be the further expansion and in-depth research of 5G, and the deep integration of intelligent applications and networks will be based on artificial intelligence, edge computing and the Internet of Things. At the same time, compared to 5G, 6G not only pursues higher network performance, but also focuses more on personalized human needs, building more intelligent, secure, and flexible networks[8].

In recent years, more and more institutions or individuals in academia and industry have begun to involve in the concept of 6G, and countries around the world are intensively carrying out related work on 6G. It can be seen that there is a certain consensus in the industry to start 6G related research now. However, there is no definition of 6G yet. All parties have their own visions, and there is no unified and universally recognized definition of 6G[9]. From the work that has been completed, it can be seen that 6G will explore and gather relevant technologies that are missing in 5G,

but it is not just a simple breakthrough in network performance, but also to narrow the digital divide and realize the intelligent connection of all things.

The main body, the new form characteristics, and the key indicator development trends of 6G networks are completely different from those of previous networks, and even have disruptive changes, which will fully meet the various personalized needs of humans in the physical and virtual worlds. The evolution trend of the main body of 6G networks will expand the fourth dimension - "spirit" on the original three dimensions of "human-machine-object". "Spirit" refers to the virtual world space, including virtual physical space and virtual behavior space, referring to all spaces, situations, and even artistic conception that affect human personalized development. Compared with the object-oriented era of 5G, the main body in the era of 6G is more abstract and generalized to any entity in the physical world that can learn and think by itself and can interact with the environment. It is more intelligent and flexible[10]. Therefore, in addition to improving communication performance, 6G will further explore and develop in terms of cognition and experience, so as to achieve intelligent communication, deep cognition, holographic experience, and ubiquitous connectivity, which is also the characteristics of 6G.

The future 6G network will be a more complex and larger network, and the diversification of terminal devices and services will make the integration of mobile network and artificial intelligence an inevitable trend. The artificial intelligence technology applied in 5G only upgrades the network architecture, while 6G will realize the internal intelligence of communication system through artificial intelligence technology, including the intelligence of network elements and network architecture, the intelligence of connected objects, and the intelligence of information carrying. "Wisdom" will become the inherent characteristic of 6G network and become the support of other three characteristics.

As the types and scenarios of information interaction requirements become more complex, the demand for IoT communication is rapidly increasing, and it has been greatly expanded in terms of spatial scope and information interaction types, including deep expansion of the activity space of connected objects, deepening of perceptual interaction, deep data mining in the physical network world, and deep neural interaction. The 6G access requirement will evolve from deep coverage to "deep cognition".

6G provides high-fidelity AR/VR, holographic communication and other needs. Holographic communication and display can be carried out anytime and anywhere, allowing people to enjoy fully immersive holographic interactive experiences at any time and any place, realizing the vision of "holographic experience"[11].

6G network will achieve widespread communication, aiming to achieve smooth communication at any time, any place, for any person, for any object. Compared with deep cognition, ubiquitous connectivity emphasizes the breadth of communication, forming a three-dimensional coverage connection across all landscapes, spaces, and seas, i.e. an integration of space-time-ground[12].

5. REQUIREMENTS AND CHALLENGES OF 6G NETWORKS

The realization of the beautiful vision of 6G network also faces many technical needs and challenges. The performance indicators of 6G network follow the TRUST principle, and actively explore various other unknown key indicators, which will exceed any previous generation of mobile communication systems. The 6G network will be densified, and the theoretical download speed will reach the order of terabit per second (Tbps), which is 100 times faster than the download speed of 5G. The actual data rate experienced by users will reach 10-11 Gbps; the era of 6G is expected to realize the intelligent connection of all things. The intelligent connection of all things integrates people, artificial intelligence, processes, data, and things together, making network connections more relevant and valuable. 6G will shorten the distance between all things, and conveniently realize the intelligent interconnection between people and all things through seamless integration. At that time, smart cities, smart societies, smart homes, etc. will all be further developed; the era of 6G is expected to provide ATM communication system based on home, satellite-to-satellite direct communication, maritime-to-space communication, provide home automation, smart home/city/village, defense, disaster prevention and other related applications.

REFERENCES

[1]G. A. Akpakwu, B. J. Silva, G. P. Hancke and A. M. Abu-Mahfouz, “A survey on 5G networks for the Internet of Things: communication technologies and challenges,” IEEE Access, 2018, 6: 3619-3647.

[2] H. Tran-Dang, N. Krommenacker, P. Charpentier and D. -S. Kim, “Toward the Internet of Things for physical internet: perspectives and challenges,” IEEE Internet of Things Journal, 2020,7(6): 4711-4736.

[3] Mohr, W, “Development of mobile communications systems beyond third generation,” Wireless Personal Communications, 2001,17:191–207.

[4]. Y. Li and G. Cheng, “Fourth generation wireless communication network,” 2013 3rd International Conference on Consumer Electronics, Communications and Networks, Xianning, China, 2013:312-315.

[5] Al-Dujaili, M., Al-dulaimi, M., “Fifth-Generation telecommunications technologies: features, architecture, challenges and solutions,” Wireless Pers Commun., 2023,128:447–469.

[6] P. Lindgren, “Multi business model innovation in a world of 5G: what will persuasive business models look like in a world of 5G? ” Wireless Pers Commun.,

2016,88:79–84.
[7] P. Qian, V. S. H. Huynh, N. Wang, S. Anmulwar, D. Mi and R. R. Tafazolli, "Remote production for live holographic teleportation applications in 5G networks," IEEE Transactions on Broadcasting, 2022, 68(2): 451-463.
[8] P. Upadhyaya, S. Dutt, Ruchi and S. Upadhyaya, "6G communication: next generation technology for IoT applications," 2021 First International Conference on Advances in Computing and Future Communication Technologies (ICACFCT), Meerut, India, 2021: 23-26.
[9] C. X. Wang et al., "On the road to 6G: visions, requirements, key technologies, and testbeds," IEEE Communications Surveys & Tutorials, 2023,25(2): 905-974.
[10] N. H. Mahmood, G. Berardinelli, E. J. Khatib, R. Hashemi, C. De Lima and M. Latva-aho, "A functional architecture for 6G special-purpose industrial IoT networks," IEEE Transactions on Industrial Informatics, 2023,19(3): 2530-2540.
[11] R. Bolla, R. Bruschi, C. Lombardo and B. Siccardi, "6G enablers for zero-carbon network slices and vertical edge services," IEEE Networking Letters, 2023,5(3): 173-176.
[12] W. Jiang, B. Han, M. A. Habibi and H. D. Schotten, "The road towards 6G: a comprehensive survey," IEEE Open Journal of the Communications Society, 2021,2:334-366.