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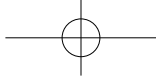
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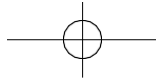
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Table of Contents

1	Analysis on the Development of Cigarette Packaging in the Era of Intelligence <i>Xiang Liu</i>
7	Application Strategy of PLC Technology in Energy-Saving Control of Tunnel Lighting <i>Yuling Zhang</i>
13	Analysis of Potential Causes of Safety Failure of New Energy Vehicle Power Batteries <i>Shaoqing Xiang</i>
20	New-Energy Vehicle Transmission System Optimization and Design <i>Wenjie Zai</i>
27	Research on the Construction of Computer Network Security System in Middle School Campus Network <i>Haijing Xing</i>



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Journal of Electronic Research and Application

Analysis on the Development of Cigarette Packaging in the Era of Intelligence

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Abstract: China is one of the biggest countries in cigarette production and sales, therefore it is important to improve the quality and efficiency of cigarette production. As cigarette packaging is an important part in cigarette production, therefore, it is important to strengthen research on improving the quality of cigarette packaging. This article summarizes the development process of cigarette packaging in China, introduces the development of printing technology in the era of intelligence, summarizes the application of printing technology in cigarette packaging, analyzes and explores the development trend of cigarette packaging in the era of intelligence, with the hope to provide reference for practitioners.

Keywords: Intelligence era; Cigarette packaging; Printing technology; Development trend

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1. Introduction

In recent years, with the advancement of science and technology, China has entered the era of intelligence. In this context, printing and intelligent technology are deeply integrated, various advanced cigarette printing processes are widely used, and the cigarette packaging industry has achieved great development. At present, the scale of China's cigarette packaging enterprises continues to expand, and cigarette packaging products are developing in the direction of functionalization, diversification, and individualization. Therefore, in the era of intelligence, cigarette packaging could achieve greater development.

2. Development course of Chinese cigarette packaging

Cigarette is a special product with certain controversy. The main function of cigarette packaging is to protect internal products and promote sales, and it also has the function of spreading regional cultural characteristics. China's cigarette packaging has a long development history. After years of development, the quality of packaging and printing and the cultural connotation of packaging have been significantly improved. According to research data, British American Tobacco established a cigarette factory in Shanghai in 1902, and successively launched cigarette brands such as Sanpaotai, Daqianmen, Hardemen, and Laodao with the unique, novel, and cultural cigarette package with the market share exceeds 50%. In response to the impact of foreign brands on China's cigarette market, the Nanyang Brothers Tobacco Company was established in Hong Kong in 1906 and launched cigarette brands such as Magpie, Great Wall, and Double Happiness, but the overall market feedback was not good. To a certain extent, the packaging design of domestic cigarettes in China is influenced by cigarette packaging of foreign brands. The brand name and packaging style are similar to those of foreign brands, resulting in a low market share of domestic cigarette brands^[1]. After the founding of New China, China's Tobacco has made great progress and has

become the largest cigarette manufacturer in the world. Cigarette packaging has also resisted cheap development and developed into a packaging model that integrates new materials, high technology, and anti-counterfeiting measures. The printing method of the cigarette packaging is hand-drawn, and it has gradually transformed into advanced surface treatment solutions such as silk screen printing, offset printing, and bronzing ^[2]. Entering the era of intelligence, China's cigarette packaging industry has vigorously strengthened technology research and development, and actively applied intelligent technology in the fields of cigarette packaging structure design and information integration. The functions of cigarette packaging have gradually expanded its promotion and protection to customer service, product protection, and information data integration and other functions.

3. Development of printing technology in the era of intelligence

Currently, information Internet and digital technology are becoming more mature and perfect, and smart phones become popular, impacting the printing industry to a certain extent, and the business volume of some enterprises has dropped significantly. Therefore, packaging printing technology has gradually established a new development channel through the integration of intelligent technology and process innovation. Additionally, it is also essential to realize the needs of consumers, who are increasingly diversified and personalized. Therefore, cigarette packaging should not be limited to the cigarette product itself, but also should provide customers with personalized services, improves their consumption experience, and complete the packaging through packaging. The collection of product-related data enables product traceability, improves the anti-counterfeiting function of products, and makes packaging more environmentally friendly ^[3].

4. Application of printing technology in cigarette packaging

Different from other product packaging, cigarette packaging needs to comprehensively use information technology, high-tech materials, packaging design technology, printing technology, and other high-tech technologies to improve the quality and delicacy of packaging. The printing process is the core process of cigarette packaging. The traditional cigarette packaging printing process mainly includes pre-printing graphic processing, plate making, printing, post-printing processing, die-cutting finished products, etc. Entering the era of intelligence, the printing technology of cigarette packaging is gradually updated and perfected, the digital workflow is integrated into the pre-printing graphic processing, and advanced technologies such as color management technology, sensing technology, and automatic control technology are added to printing system-level related equipment, and gradually formed an industrial system composed of flexo, offset, gravure, screen, digital printing, etc., and the overall level of cigarette packaging printing has been significantly improved.

4.1. Offset printing

Offset printing is widely used in cigarette packaging printing. Its main feature is to use the basic principle, which is water and oil cannot be mixed. The graphic information on the offset printing is transferred to the top of the substrate using a blanket to achieve a good printing effect. In the offset printing mode, the graphical information is lipophilic, other parts are hydrophilic, and the layout is flat. Applying it to cigarette packaging printing can ensure the printing quality, enrich the packaging color, and allow the packaging image to look more layered. It has a higher printing efficiency, and helps to increase the overall sales of cigarettes ^[4].

4.2. Gravure printing

The main feature of gravure printing is that the ink is placed inside the graphic printing plate with a concave

surface, and the content of the relevant printing plate is printed on the substrate by embossing. In the gravure printing process, the depth of the depression of the printing plate can affect the thickness and layering of the printing. If the depression of the printing plate is shallow, the printing result will have a shallow ink layer, otherwise deep ink layer can be achieved ^[5]. Gravure printing ink has a high degree of running-in, bright colors, good layering, relatively stable printing quality, high printing efficiency, and durable printing plates. It is suitable for packaging and printing of cigarette products with large sales volume.

4.3. Flexographic printing

A flexible resin photosensitive plate is required for the flexographic printing process. The operator uses an anilox roller to transfer ink to complete the printing, but a printing plate with protruding graphic information is used during printing, so it can also be regarded as letterpress printing. Flexographic printing uses a flexible resin photosensitive plate with a thickness of 1-5mm. The ink layer formed after printing is thicker, but the color is relatively stable, and the ink used is green and environmentally friendly. The overall printing efficiency is high. It is widely used in packaging, and the tobacco industry mostly uses flexographic printing solutions in carton printing ^[6].

4.4. Screen printing

Screen printing mainly uses a screen-printing plate to complete related operations. The ink can pass through the mesh of the graphic part of the printing plate, and the graphic and text can be printed on the substrate through a semi-automatic scraper or manual operation. The thickness of the screen-printing ink layer is about 30-100 μm , which is obviously higher than other printing schemes. The printing effect has a strong three-dimensional and tactile effect, and can present the surrounding and ice effects, which can be significantly improved the grade of the product when it is applied to cigarette packaging printing.

4.5. Digital printing

Digital printing is a relatively advanced printing method. During the printing process, the graphic information which is stored in the computer needs to be converted into data, and the printing equipment can complete the printing after receiving the data. Compared with other printing methods, digital printing integrates advanced technologies such as electronic technology, computer technology, network communication technology, and printing technology. In this printing method, printing plates are not required during the printing process, and can dynamically adjust relevant data, and complete the printing of full-color images at one time. At present, the digital printing technology is immature, its stability is low, and its production efficiency needs to be improved. The main application of this printing method is in the printing of small batches of cigarette packaging and the printing of cigarette packaging samples. However, this technology can significantly shorten the time-consuming research and development of cigarette packaging, therefore it has good application prospects ^[7].

4.6. Post-printing treatment

After cigarette package is printed, it is essential to implement processes such as varnish, bronzing, die-cutting, and embossing treatment. Through the above-mentioned processes, the quality of the cigarette package can be improved, the package can have anti-counterfeiting functions, and the added value of the cigarette can be increased. In the era of intelligence, cigarette packaging printing technology and the post-printing process gradually becoming matured and perfect. For example, traditional varnish process has been developed into a reverse glazing process, and the bronzing process has been developed into cold stamping, cat's eye bronzing, laser micro-engraving bronzing, holographic anti-counterfeiting bronzing, etc. No matter what kind of post-printing treatment process is used, the purpose is to improve the quality and

aesthetics of the packaging. Overly complicated post-printing treatment process will lead to longer packaging time, higher packaging costs, and increased waste rate of cigarette products. Therefore, it is recommended to use relatively complicated post-printing processing technology to medium and high-end cigarette products, and to adopt conventional technology for ordinary cigarette products.

5. Development trend of cigarette packaging in the era of intelligence

5.1. Application of digital anti-counterfeiting technology in cigarette packaging

Cigarette packaging contains many functions, among which anti-counterfeiting is one of the important functions. The main purpose of cigarette manufacturers applying various new technologies and processes to cigarette packaging is to improve the technical content of packaging so that other cigarette manufacturers are not easy to imitate, and then realize the effective protection of the brand of cigarette products. At present, the anti-counterfeiting technologies commonly used in cigarette packaging mainly include process anti-counterfeiting technology, material anti-counterfeiting technology, digital anti-counterfeiting technology, etc. In the era of intelligence, the application of network technology and computer technology provides a new development direction for cigarette packaging anti-counterfeiting technology. First, radio frequency identification (RFID) technology. RFID technology is radio frequency identification technology, which uses microwave or electromagnetic waves as the medium, and completes the automatic identification through interconnection and communication in a non-contact state. Some unscrupulous merchants sell counterfeit tobacco products in order to seek profits. Consumers could not completely identify genuine or fake products simply by observing the outer packaging. Adding RFID technology to cigarette packaging can identify effectively the tobacco products, thereby protecting enterprises and consumer interests. The introduction of RFID technology in cigarette packaging can track and record the production, storage, logistics, and sales process of cigarette products in all-way round, and can assist in the establishment of a product traceability system, and reduce the flow of counterfeit products into the market ^[8]. Second, the implementation of unique anti-counterfeiting code technology in the cigarette packaging production. The main feature of the unique anti-counterfeiting code technology is that it converts cigarette-related information into a two-dimensional code with digital printing technology, and sprays it on the top of the cigarette package. This two-dimensional code is a unique identity of the cigarette product, which allow product traceability with anti-counterfeiting functions. The unique anti-counterfeiting code technology adopted by cigarette manufacturers can realize the tracking management of the whole process of product production and marketing, which can ensure product quality and avoid counterfeit products. At present, this technology has been applied in many tobacco manufacturers and has achieved good application results.

5.2. Intelligent interactive printing of cigarette packaging

At present, China has entered the era of intelligence. Consumers generally tend to obtain the information that they need through video, live broadcast, electronic information, etc. The development of intelligent technologies such as virtual reality (VR), augmented reality (AR), and Mixed Reality (MR) has made the cigarette packaging industry present the development trend of intelligent mobile printing. Firstly, VR is a collection of advanced technologies such as multimedia technology, simulation technology, computer graphics technology, and sensing technology allowing people to receive an immersive experience. Secondly, AR which use smartphone's camera to scan the item, and use image recognition technology to obtain the dynamic image and three-dimensional structure model of the item. Through the common fusion of virtual and reality, it can provide consumers with rich product information, thereby satisfying the diversification of consumers needs ^[9]. Thirdly, MR is an interactive technology that integrates virtual scenes and reality. Consumers can enter the connection point through MR equipment and freely adjust the virtual and real states. In the era of intelligence, the above-mentioned technologies need to be reasonably integrated into

cigarette packaging, thereby consumers can obtain a good visual experience and fully understand product information.

5.3. Cigarette packaging green printing

Green printing is a brand-new cigarette packaging printing concept, not just a certain printing technology, its main feature that it involved in the whole process of cigarette packaging printing, including raw materials, growth and processing, sales, recycling, etc., follows the concept of green environmental protection, save resources, and reduce the impact on the ecological environment. The author believes that the development trend of green printing on cigarette packaging mainly includes the following two aspects. Firstly, environmentally friendly injection molded parts are used in cigarette packaging boxes. Adding environmentally friendly injection molding parts to cigarette packaging can improve the forming effect, increase the stiffness of the package, and avoid environmental pollution caused by traditional cardboard packaging. At this stage, the packaging of high-end cigarette products such as Double Happiness Jin Guoxi and Nanjing Jiuwu Zhizun are all added with environmentally friendly injection molded parts. Among them, Nanjing Jiuwu Zhizun uses 0.9mm open-molded environmentally friendly injection molded parts to replace white cardboard and wrap the facial tissue over the environmentally friendly injection molded parts, and set the butter paper as the surrounding bar. The stiffness and flatness of the package are much better than the traditional package, and it can also save paper and reduce the pollution to the ecological environment^[10]. Secondly, cigarette packaging is printed without ink. Inkless printing of cigarette packaging mainly adopts advanced technologies such as laser writing, electron beam, electrochemistry, holographic technology, and precision numerical control processing, so that the nanostructure formed by digital weaving is presented on the surface of the substrate, and light such as reflection, scattering, and diffraction can be generated after printing to change the color rendering effect. Inkless printing does not need to use ink and paper, and uses electronic technology and laser technology to complete a specific printing. Some cigarette companies have applied this technology to design product packaging and other fields, and achieved good results. In the future, this technology can also be applied to a large-volume cigarette packaging printing.

5.4. Rationalized and personalized packaging

In the era of intelligence, people's consumption concepts have changed significantly, and rationalization has become a new demand for consumer. Therefore, cigarette packaging companies need to change their concepts, clarify the relationship between cigarette packaging costs and product quality, appropriately simplify packaging and printing solutions, and choose more cost-effective products. Printing materials can reduce the cost of cigarette packaging and improve the environmental protection of cigarette products. At the same time, it is also necessary to pay attention to the individual needs of consumers in the printing of cigarette packaging, develop packaging according to the characteristics of consumer groups, improve the visual impact, and individual characteristics of products, to fully stimulate consumers' desire to buy the product and eventually increase the product sales.

6. Conclusion

In the era of intelligence, technologies such as the Internet, cloud computing, and the Internet of Things are increasingly widely used, and the pace of technological change is accelerating under the leadership of emerging electronic technologies. Facing the new social development situation, cigarette packaging companies have changed their development concepts, strengthened technology research and development, integrated digital anti-counterfeiting technology, intelligent interactive technology, and green printing technology into cigarette packaging, and paid attention to the rationalization and personalization of cigarette packaging to meet the diverse needs of consumers and promote their own stable and healthy development.

Disclosure statement

The author declares no conflict of interest.

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Application Strategy of PLC Technology in Energy-Saving Control of Tunnel Lighting

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Abstract: In this study, we investigated on the application of planar lightwave circuit (PLC) technology in energy-saving control of tunnel lighting. The application status of PLC in the field of energy saving followed by the necessity of energy saving in tunnel lighting was analyzed. Finally, the application of PLC in tunnel lighting energy-saving control around the three dimensions of system overall architecture design, control scheme, and program control process was investigated. The results showed that the system meets the requirements of control effect, robustness, and visual effect after trial operation, and is suitable for practical applications.

Keywords: Energy-saving tunnel lighting; PLC technology; Control scheme; Program control

Online publication: July 21, 2023

1. Introduction

Tunnel lighting plays an important role in the transportation system, but traditional tunnel lighting equipment like high-pressure mercury lamps has high energy consumption. This is traditional lighting uses electrical energy, and tunnel lighting works for long periods, and the energy consumption is much higher especially at night. At the same time, traditional lighting equipment is not controllable or intelligent, so the lamps cannot be controlled according to lighting requirements. In addition, traditional lighting equipment also has defects such as short service life, low color rendering index, and susceptibility to temperature changes, which requires continuous replacement and maintenance, which is also an important factor of energy waste. These problems lead to high energy consumption of tunnel lighting, difficulty in automatic and effective control, and high operation and maintenance costs. Therefore, exploring how to realize tunnel lighting energy saving based on PLC has important research value for promoting the sustainable development of tunnel lighting system.

2. Application status of PLC in the field of energy conservation

Planar lightwave circuit (PLC) is a programmable logic controller, which is a computerized control system specially used for automation and control of industrial machinery. PLC is widely used in the field of energy saving. For example, PLC can be used to control air conditioners and lights, cleaning systems according to environmental conditions, compressors, and conveyor belts, etc., so as to achieve the goal of energy saving and emission reduction.

In the automation and control of industrial machinery, the PLC system can be integrated with other systems through the network to realize data sharing and remote control. Through the data collection and analysis by the PLC system, enterprises can realize automatic control, optimize energy use, reduce

production costs, etc. PLC is widely used in the manufacturing industry, which promotes the development of the manufacturing industry. For example, in the automotive industry, the PLC system can achieve a uniform production speed by controlling the machinery, thereby avoiding wastage. In the textile industry, PLC systems can reduce energy consumption and material waste by controlling the speed of machines. In the metalworking industry, energy consumption and material loss during cutting can be reduced by controlling the speed and temperature of machine tools. In addition, the PLC system also widely applied in the fields of ships and buildings. For example, in the shipping industry, the PLC system can measure multiple parameters such as the wind speed, the depth of the waters, and the ship's center of gravity, and control parameters such as direction and speed of the ship accordingly to achieve efficient use of ship fuel. In the field of construction, the PLC system controls the heating, ventilation, and air conditioning, and other systems in the building to achieve the goal of saving energy, protecting the environment, and reducing the energy consumption of enterprises ^[1].

The application of PLC in the field of energy-saving is constantly growing, which provides strong support for enterprises to save resources, reduce environmental pollution, and improve economic benefits.

3. Necessity of saving energy in tunnel lighting

Energy consumption figures for tunnel lighting vary depending on different factors such as tunnel length, type of tunnel lighting fixtures, and operating hours of tunnel lighting. Generally speaking, the power of traditional tunnel lighting equipment such as high-pressure mercury lamps is generally between 250 W and 400 W. When the equipment works all night, the energy consumption of a tunnel will reach more than several thousand kWh. For example, a tunnel with a nominal length of 4.5 kilometers is illuminated by high-pressure sodium lamps with a power of 275 W. The tunnel works 18 hours a day and consumes 2,308,457.8 kWh of electricity per year. This shows that the energy consumption of tunnel lighting is massive in the urban traffic system.

Therefore, research was carried out on energy-saving measures for tunnel lighting. In view of globalization, the imbalance between supply and demand of energy resources is becoming increasingly prominent. Energy conservation and consumption reduction are important measures to overcome energy depletion, ensure energy security, and stabilize economic and social development. Energy conservation through tunnel lighting can contribute to alleviating energy pressure. Secondly, energy-saving tunnel lighting technology can reduce the cost of tunnel operating enterprises. If new energy-saving tunnel lighting equipment is used, the cost of enterprises can be reduced and the competitiveness of enterprises can be enhanced. Thirdly, tunnel lighting technology helps to promote environmental protection. Research and promotion of tunnel lighting energy-saving technology can reduce energy waste, carbon emissions, environmental pollution, and ecological damage, promote environmental protection, and achieve harmony between man and nature ^[2].

4. Application strategy of PLC technology in tunnel lighting energy-saving control system

4.1. Construction of a PLC-based tunnel lighting energy-saving control system

A PLC-based tunnel lighting control system uses PLC as an actuator to control the brightness of the lamps in the tunnel, which achieves intelligent control of the tunnel lighting equipment.

First, data in the tunnel will be collected by sensors. In the PLC-based tunnel lighting energy-saving control system, multiple sensors will be installed in the tunnel during the layout stage to collect real-time data of the environment in the tunnel, such as illuminance and vehicle information. The collected data will then be transmitted to the central processor through the signal transmitter for processing ^[3]. The central processor processes the data according to preset rules and parameters, and performs real-time monitoring and control according to the traffic flow and brightness in the tunnel. Then, the PLC will automatically

control the brightness and number of lamps in the tunnel accordingly in real time, which ensures the brightness and flexibility of tunnel lighting. **Figure 1** shows the architecture of this PLC-based tunnel lighting energy-saving control system.

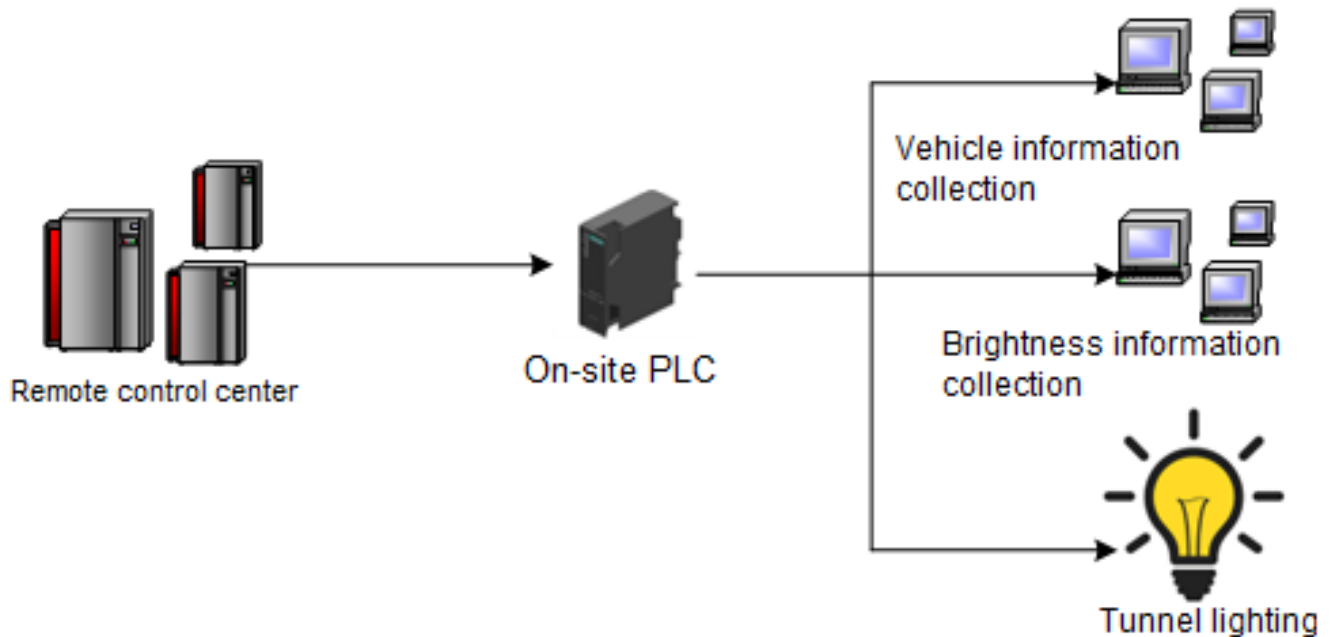


Figure 1. PLC-based tunnel lighting energy-saving control system architecture

During the signal output, the PLC central processor will output the corresponding signal after processing the sensor data to control the brightness of the lamp. The remote-control center acts as the host to collect various data instructions from the PLC control system in the tunnel, analyze and process them, and send instructions to the PLC control system in the tunnel remotely through the network.

4.2. Control plan

4.2.1. System control

In the PLC-based tunnel lighting energy-saving control system, vehicle information will first be collected from the sensors installed in the tunnel that will detect the number of vehicles passing through. After collecting vehicle information, the lighting will automatically adjust by a central processor. Besides, this system also includes detectors to detect the illuminance and brightness of the tunnel lighting at all times. The collected data is transmitted to the PLC central processing system for processing, and the brightness and number of lamps in the tunnel will then be automatically adjusted according to preset rules and parameters, so as to achieve the optimum brightness, energy consumption, and reliability of the tunnel lighting system. In terms of energy-saving, the PLC central processor automatically controls the number of lamps in the tunnel that should be turned on with high brightness, low brightness, or turned off according to the collected data. The signal will then be transmitted to the lamp controller to drive the brightness and color temperature of the lamps to ensure optimum brightness and color temperature of the lamps, so as to visual comfort and energy efficiency ^[4].

The PLC-based tunnel lighting energy-saving control system involves three layers of software. The first layer is the main control program layer, which is responsible for executing the main loop program and controlling the entry 41 and start flag of the subroutine. The second layer is the “common control mode” layer, which is responsible for executing the tasks required by the PLC system under normal circumstances,

including information transmission under normal conditions, on-site lamp communication, etc. The third layer is the “special control mode” layer, which allows PLC to communicate with other devices under special circumstances.

4.2.2. System control logic

This PLC-based tunnel lighting energy-saving control system is designed to adjust the lighting in the tunnel as a normal control mode and a special control mode.

The ordinary control mode involves conventional lighting control on the tunnel lamps, the weather and traffic conditions will be monitored in real time. Besides, the temperature, humidity, rain, snow, and other weather factors inside and outside the tunnel, and the traffic flow in the tunnel can also be monitored in real time using sensors or other equipment. The light intensity will be adjusted based on weather and traffic conditions^[5]. For example, the light brightness can be lowered in sunny day at night and when there are few vehicles to save energy; in rainy and snowy weather or nights when there are many vehicles, the brightness of the light can be increased to improve traffic safety.

In addition to adjusting the brightness of the light according to the weather and traffic conditions, it is also possible to turn the lights on and off through the PLC system. For example, turning on high-brightness lighting during morning and evening peak hours and late evening hours, and using low-brightness lighting at ordinary times. In addition, the system has a fault alarm function in normal mode. When a lamp or controller fails, a fault alarm signal will be sent by the system for timely maintenance and repair.

The special control is mainly designed for emergencies where the host computer disconnects from the PLC, and the lighting equipment in the tunnel will be controlled according to the preset program^[6]. There are four steps involved in the special control mode. (i) When the host computer disconnects from the PLC, the personnel at the workstation manually check whether there is a physical connection failure between the PLC and the computer. If a physical connection failure is detected, the connection failure shall be repaired as soon as possible. If no physical connection fault is detected, Step 2 is applied. (2) The system will send a query command after a set period of time, and then wait for a reply. If a reply message is received, it means that the communication between the computer and the PLC is normal, and lighting control can be continued; if no reply message is received, Step 3 is applied. (3) The system will send a second query command after a set period of time, and then wait for the reply message. If a reply message is received, it means that the communication between the computer and the PLC has returned to normal, and the lighting control can be continued. If there is still no reply message, Step 4 is applied. (4) At this moment, the PLC will judge that the computer has been disconnected and perform, automatic lighting control on different sections of the tunnel according to the preset program.

Through the implementation of the steps above, the normal operation of the PLC-based tunnel lighting energy-saving control system can be guaranteed even when the computer is disconnected from the PLC. At the same time, in terms of energy-saving control, the lighting control strategy should be evaluated even after it is put into use, so as to improve energy efficiency and save resources.

4.2.3. Program control process

Based on the functions and working principle this tunnel lighting energy-saving control system design, the specific program control process is designed into nine modules, as shown in **Figure 2**.

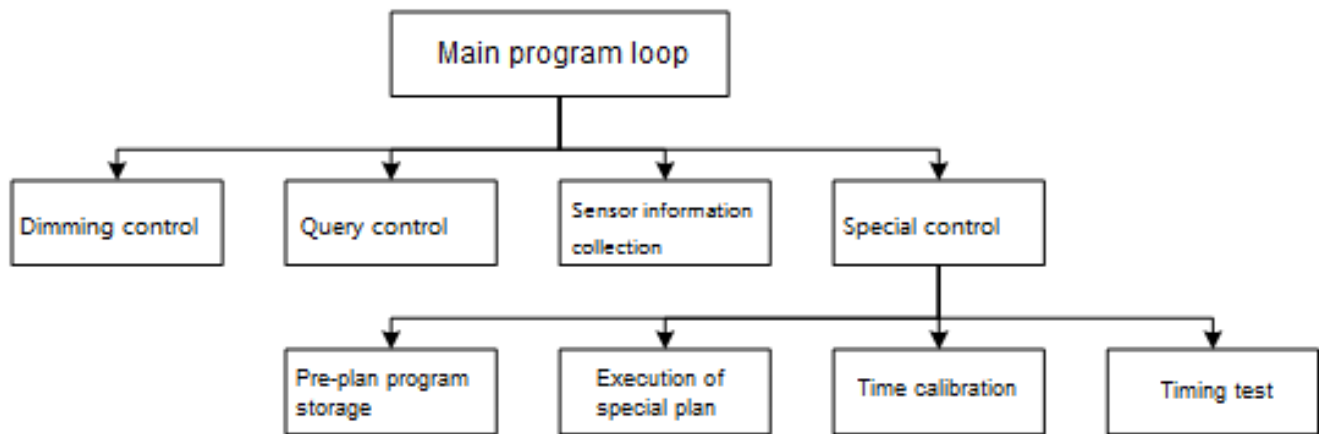


Figure 2. Program control flow

As shown in **Figure 2**, the main program loop is the most basic program in the PLC, and it is also the core of the control program, which is mainly responsible for the overall control of the tunnel lighting. This program includes basic functions such as adjusting the brightness of the tunnel lights and detecting faults through continuous loop operation ^[6]. Secondly, in terms of the dimming function, the brightness of the lights needs to be controlled according to different situations to achieve the purpose of saving energy and reducing consumption. The dimming control program adjusts the brightness of the lights in real time according to the information obtained by the main program loop. Third, the sensor information acquisition program is responsible for obtaining real-time data such as weather, traffic flow, and brightness from the sensor, processing it through the main program loop, and transmitting it to the dimming control program, which plays an important role in real-time adjustment of the lighting brightness in the tunnel ^[7]. Fourthly, the timing test program can detect the fault points in time when the PLC experiences failures by testing and checking the internal hardware and software systems, which will reduce the duration of system failure and ensure the safe and stable operation of the system. Fifth, under the special control program, when the PLC core controller receives the special case keyword, it will automatically activate the special control program stored in the system table and enter the third-level program under the control flow ^[8]. Sixthly, the query control program is used to query the status of various equipment and sensors. In the query control program, the status of the dimming controller or other equipment status will be monitored. This method can not only monitor the working status of each device in real time, but also provide real-time data for use by other control programs. For example, whether the brightness value of the lighting component has reached the preset value; if not, one of the subsequent control programs will control the lamps accordingly ^[9]. Seventh, the function of the time calibration program is mainly to send an instruction to calibrate the time to the clock controller in the PLC. The time calibration program can ensure the accuracy of the internal time of the PLC system by sending time correction instructions to the PLC regularly. At the same time, the time calibration program can also automatically correct the timing inside the PLC system to avoid the impact of some unexpected conditions on the system's timing, such as power failure.

5. Conclusion

After the design is completed, this set of PLC-based tunnel lighting energy-saving control system can be applied to a completed and open-to-traffic tunnel. In terms of lighting control, the system can control the brightness of the lighting equipment in the tunnel in real time according to the weather and the traffic flow in the tunnel. In terms of robustness, the system can still operate normally under severe weather conditions, which makes it highly reliable. In terms of visual effects, the lighting in the tunnel will have a good visual

effect under the control of this system, which ensures the visual comfort of drivers. Therefore, it can be concluded that this system can operate efficiently and stably, can meet the energy-saving control requirements of tunnel lighting, and has practical application value.

Disclosure statement

The author declares no conflict of interest.

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Analysis of Potential Causes of Safety Failure of New Energy Vehicle Power Batteries

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Abstract: The aim of this paper is to analyze the potential reasons for the safety failure of batteries for new-energy vehicles. Firstly, the importance and popularization of new energy batteries are introduced, and the importance of safety failure issues is drawn out. Then, the composition and working principle of the battery is explained in detail, which provides the basis for the subsequent analysis. Then, the potential impacts of factors such as overcharge and over-discharge, high and low temperature environments, internal faults, and external shocks and vibrations on the safety of the batteries are analyzed. Finally, some common safety measures and solutions are proposed to improve the safety of new energy batteries, in hopes of improving the safety of batteries for new-energy vehicle.

Keywords: New-energy vehicle; Power battery; Safety failure; Potential cause; Analysis and research

Online publication: July 21, 2023

1. Introduction

As the world pays more and more attention to environmental issues, new energy vehicles, as an environmentally friendly and sustainable means of transportation, are gradually replacing traditional fuel vehicles. The battery as one of the core components of new energy vehicles has become particularly important for the safety of the vehicle. However, safety accidents have occurred in recent years and have raise concerns about the safety of new energy vehicles. Therefore, an in-depth analysis of the potential reasons for the safety failure of new energy vehicle power batteries is of great significance to ensure the safety of new energy vehicles. This article will start with the composition and working principle of the power battery, followed by exploring the potential causes of safety failures of the power battery. Specifically, we, the impact of factors such as overcharging and over-discharging, high and low temperature environments, internal failures, and external shock and vibration on the safety of power batteries are analyzed. Subsequently, some common safety measures and solutions are proposed to improve the safety of batteries for new-energy vehicles. We hope to provide some guidance and reference for the safety of new energy vehicle power batteries and promote the sustainable development of the new energy vehicle industry through this paper.

2. The importance of batteries for new energy vehicles

First of all, the battery is the main source of energy of new energy vehicles. Electrical energy is stored and released by the battery when needed to power electric vehicles. Compared to traditional fuel vehicles, new-energy vehicle batteries can convert energy more efficiently and provide a greater power output. The battery of a new energy vehicle uses electric energy; thus, it does not produce exhaust emissions and achieves zero-

emission driving. This is of great significance for reducing air pollution and improving environmental quality, and helps in dealing with climate change and other environmental issues. Thirdly, compared to traditional fuel vehicles, the energy utilization efficiency of new energy vehicle batteries is higher. Batteries for new energy vehicles can store electrical energy and release energy when needed, thus reducing energy waste. This helps to reduce dependence on non-renewable energy and improve energy efficiency ^[1]. The electric energy used by the batteries of the fourth-generation electric vehicles can be charged by renewable energy, such as solar energy and wind energy. The use of renewable energy helps reduce dependence on traditional energy sources and promote sustainable development. Besides, the recycling and reuse of batteries also help reduce resource consumption and environmental impact. The development of the fifth-generation new energy vehicle batteries has promoted the innovation and progress of battery technology. Scientists and engineers have been conducting research and development to improve the performance, safety, and life of the batteries, which promotes the advancement of battery technology ^[2]. This technological innovation also helps drive the development of the entire new energy vehicle industry.

3. Composition and working principle of power battery

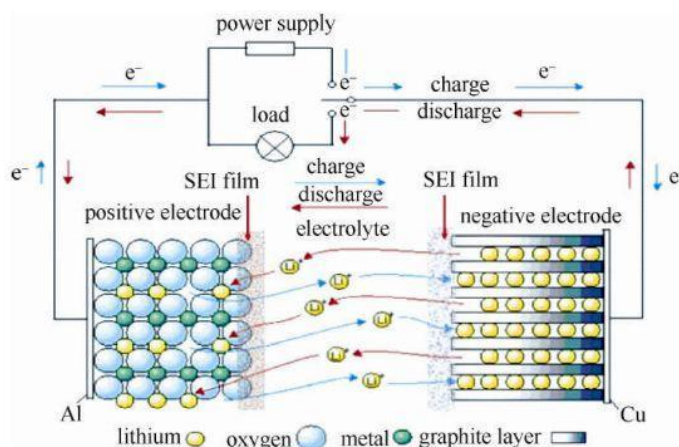
3.1. Basic components of a battery for new energy vehicles

- (i) Positive electrode
The positive electrode of the battery is usually made of a lithium compound, such as lithium iron phosphate lithium (LiFePO_4) or lithium nickel manganese cobalt oxide (NMC). The positive electrode is responsible for storing and releasing ions.
- (ii) Negative electrode
The negative electrode of the battery is usually made of carbon, such as graphite. The negative electrode is responsible for storing and releasing negative ions ^[3].
- (iii) Electrolyte
The electrolyte of the power battery is usually a liquid or solid conductive medium, which is used for ion conduction between the positive and negative electrodes.
- (iv) Diaphragm
The diaphragm of the battery is located between the positive and negative electrodes, and it prevents the electrolyte from mixing while allowing the conduction of ions.
- (v) Housing and connectors
The housing and connectors of the battery serve to protect the internal components of the battery and provide connection and installation of the battery.

3.2. Working principle of the battery

The working principle of the battery is based on the movement and chemical reaction of ions between the positive and negative electrodes. The basic steps of how a power battery works is described below (**Figure 1**).

- (i) Charging process
During the charging process, electrical energy is supplied by an external source to move the lithium ions (Li^+) from the positive electrode material to the negative electrode material through the electrolyte. At the same time, the carbon in the negative electrode material will absorb and store lithium ions ^[4].
- (ii) Discharging process
During the discharging process, when energy is released from the battery, the stored lithium ions in the negative electrode will move to the positive electrode through the electrolyte. At the same time, the lithium ions in the positive electrode material will react with the oxide layer, releasing electrons and oxygen.



Positive pole: $\text{LiMO}_2 \rightleftharpoons \text{Li}_{1-x}\text{MO}_2 + x\text{Li}^+ + xe^-$

Negative pole: $6\text{C} + x\text{Li}^+ + xe^- \rightleftharpoons \text{Li}_x\text{C}_6$

Battery reaction: $6\text{C} + \text{LiMO}_2 \rightleftharpoons \text{Li}_{1-x}\text{MO}_2 + \text{Li}_x\text{C}_6$

Figure 1. Schematic diagram of the working principle of lithium-ion batteries

3.3. Flow of electrons

During discharge, the released electrons flow through an external circuit, providing power to the external device. While charging, electrical energy from an external source causes electrons to flow back into the battery to store electrical energy.

Charging and discharging are achieved through the movements and chemical reactions of ions between the positive and negative electrodes, thereby generating electrical energy to move the vehicle. This working principle makes the battery a key energy storage and release device for new energy vehicles.

4. Overcharge and over-discharge

4.1. Concepts of overcharge and overdischarge

Overcharge and overdischarge refers to the situation where the battery voltage or power exceeds the designed range during the charging or discharging process. Overcharge is when the battery is charged beyond its designed voltage or capacity. Overcharge occurs when a battery continues to receive power even when the voltage or charge exceeds its designed range^[5]. Overcharge will cause the internal reaction of the battery to run out of control, causing abnormal chemical reactions inside the battery, which may lead to safety problems such as heating, gas release, and electrolyte leakage. Over-discharge is when the battery is discharged beyond its design voltage or capacity. Excessive discharge will lead to incomplete internal chemical reaction of the battery, reduction of the performance and lifespan of the battery, and may cause safety problems such as damage of the internal structure of the battery and low battery voltage. Both overcharge and over-discharge will have a negative impact on the safety of the battery. Therefore, it is very important to control the charging and discharging process to ensure that the voltage and power of the battery work within the designed range to ensure the safety and performance of the battery.

4.2. Analysis of the impact of overcharge and overdischarge on the safety of power batteries

The potential causes of safety failure of new energy vehicle power batteries is summarized in **Figure 2**.

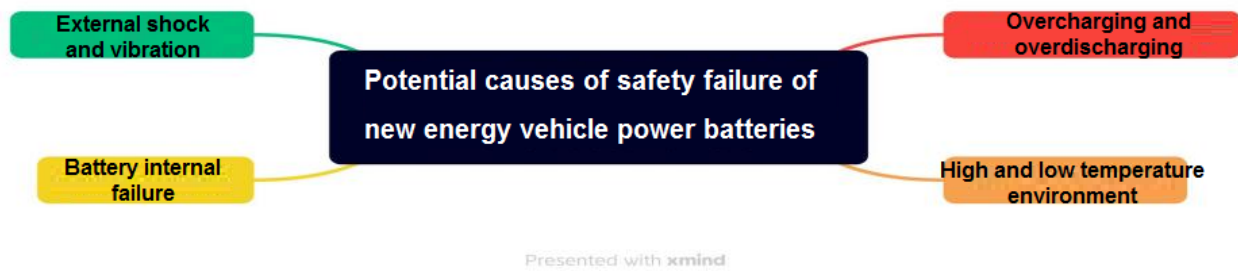


Figure 2. Potential causes of safety failure of new energy vehicle power batteries

(i) Overcharge

When the battery is overcharged, the chemical reaction inside the battery will become unstable, causing its internal temperature to rise. This can trigger a thermal runaway, causing the battery to overheat, burn, and even explode. Overcharging may also lead to the precipitation of lithium metal inside the battery, forming lithium dendrites, increasing the risk of short circuit and further exacerbating potential safety hazards.

(ii) Overdischarge

When the battery is overdischarged, the voltage of the battery will drop to a low level, which may cause the battery to not work properly. Excessive discharge will cause the chemical reaction inside the battery to be unstable, which may trigger a thermal runaway inside the battery, causing the battery to overheat, burn, or even explode. In addition, excessive discharge may also cause damage to the lithium ions inside the battery, reducing the capacity and performance of the battery ^[6].

5. Safety failures caused by low or high temperature environments

5.1. Potential risks of high temperature environments

A high temperature environment will cause the internal temperature of the battery to rise, which may cause overheating and thermal runaway, increasing the risk burning and explosion. High temperatures speed up the rate of chemical reactions inside the battery, resulting in shorter battery life, which means less battery capacity. Under a high temperature environment, the lithium metal inside the battery may precipitate and form lithium dendrites, which increases the risk of short circuit and further aggravates the potential safety hazard.

5.2. Potential risks of low temperature environment

Low temperatures cause the chemical reactions inside the battery to slow down, reducing the battery's discharge capacity and power output. This will result in reduced battery life and battery capacity. In a low temperature environment, the charging speed of the battery may be limited, because the internal chemical reaction of the battery will slow down at a low temperature, and the charging current cannot be absorbed effectively. In a low temperature environment, the internal resistance of the battery will increase, resulting in a decrease in the output power of the battery, which may cause difficulty in starting the engine if the vehicle or malfunction ^[7].

These potential risks may lead to reduced performance, shortened battery life, and reduced safety of batteries. To reduce these risks, manufacturers take measures to manage the environment temperature, such as temperature sensors and cooling or heating systems. In addition, users should also follow relevant usage guidelines when using electric vehicles and avoid using or storing electric vehicles under extreme temperature conditions to reduce safety risks.

6. Internal battery failure and external shock and vibration

6.1. Internal failure

(i) Thermal runaway and overheating

Internal battery failures may cause thermal runaway of the battery, increasing its internal temperature. Overly high temperatures will accelerate the chemical reaction inside the battery, further increasing the battery temperature, forming a vicious circle. This may cause the battery to overheat, burn, or even explode, posing a serious threat to the vehicle and passengers ^[8].

(ii) Short circuit and fire

Internal failure of the battery may lead to the precipitation of metallic lithium inside the battery, forming lithium dendrites. These lithium dendrites can penetrate the separator and cause short circuit, which causes the battery to overheat, burn, or explode. A short circuit could also start a fire inside the battery, further compounding the safety risk.

(iii) Decrease in capacity and performance

Internal battery failures may lead to damage and aging of battery materials, which in turn lead to battery capacity fading and performance degradation. This will affect the cruising range and performance of the electric vehicle, and reduce the reliability and experience of the vehicle.

(iv) Shortened battery life

Internal battery failures may accelerate the aging process of the battery, resulting in shortened battery life. This means batteries need to be replaced more frequently, increasing maintenance costs and inconvenience.

(v) Radiation of safety hazards

An internal failure of the battery may cause damage to one unit of the battery module or battery pack, which in turn causes failure of adjacent units, forming a chain reaction. This may affect the safety of the entire battery pack, increasing the risk of accidents ^[9].

The internal failure of the battery has a serious impact on the safety of the battery. To reduce these risks, manufacturers usually implement strict quality control measures to ensure the quality and reliability of the manufacturing process. In addition, the use of battery management system (BMS) can also monitor and control the working status of the battery and identify and deal with potential failures in time ^[10]. Users should follow the usage guidelines when using electric vehicles, regularly service the battery, and avoid excessive charging and discharging and physical damage to reduce the risk of internal battery failure.

6.2. External shock and vibration

(i) Risk of fire and explosion

External shocks and vibrations may cause a short circuit or damage inside the battery, causing overheating of the battery, rapid release of electrical energy, or uncontrolled chemical reactions inside the battery, resulting in fire or explosion.

(ii) Degradation of battery performance

External shocks and vibrations may cause damage to the battery casing or internal components, thereby reducing the performance and lifespan of the battery. This can lead to reduced battery capacity and energy density and slower charging and discharging rates ^[11].

(iii) Battery failure

External shocks and vibrations can damage the components in the battery or cause the internal connections to loosen, resulting in the battery not functioning properly or failing completely. This will affect the vehicle's power output and range.

(iv) Safety hazard

External shocks and vibrations may damage the battery case, exposing the chemicals and electrolyte inside the battery. This can be dangerous to personnel and the environment as the electrolyte is corrosive and toxic ^[12].

(v) The effect on vehicle stability

External shocks and vibrations may lead to loose battery connections or deformation of the battery structure, thereby affecting vehicle stability and performance ^[13].

To reduce these potential risks, manufacturers have taken various measures, such as using strong battery casings, designing shock-absorbing structures, optimizing the layout and connection methods of battery internal components, and implementing strict safety testing and certification standards ^[14]. In addition, the impact of external shock and vibration should also be considered in the design and manufacture of vehicles to ensure the safety performance and reliability of the battery ^[15].

7. Conclusion

The safety of power batteries is an important issue in the development of new energy vehicles. External shock and vibration are considered to be an important factor in the analysis of potential causes of safety failure of new energy vehicle batteries. External shocks and vibrations may cause battery damage, internal short circuits, loose connections, structural deformation, etc., resulting in potential risks such as fire, explosion, battery performance degradation, safety hazards, and reduced vehicle stability. In order to ensure the safety of the batteries, manufacturers have taken various measures, such as designing strong battery cases using shock-absorbing materials, optimizing the internal structure, and implementing strict safety testing and certification. In addition, the impact of external shock and vibration should be considered in the design and manufacture of the vehicle to ensure the safety performance and reliability of the battery. Although external shocks and vibrations may pose potential risks to the safety of power batteries, these risks can be minimized through proper design, manufacture, and use. Continuous research and technological innovation will be needed to further improve the safety of batteries and promote the sustainable development of the new energy vehicle industry.

Disclosure statement

The author declares no conflict of interest.

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New-Energy Vehicle Transmission System Optimization and Design

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Abstract: This paper discusses the optimization and design of the new-energy vehicle transmission systems. Traditional automatic transmission systems suffer from fuel consumption and emissions issues, as well as limitations in the efficiency of mechanical transmission systems. In order to solve these problems, different types of transmission systems are used in new-energy vehicles, including battery electric vehicles (BEV), hybrid electric vehicles (HEV), and fuel cell electric vehicles (FCEV). The key factors for optimizing the transmission systems of new-energy vehicles include battery technology and energy management system, electric motor and electronic control system, energy recovery and reuse technology, and lightweight and aerodynamic design of the vehicle. This paper also introduces methods and tools for designing new-energy vehicle transmission systems, including simulation tools, optimization algorithms and data analysis, as well as experimental verification and testing methods. Besides, new-energy vehicle transmission system designs are proposed, and future challenges and development directions are discussed through case studies.

Keywords: New-energy vehicle; Transmission system; Optimization; Design; Strategy research

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1. Introduction

With the increasing global concern for environmental protection and sustainable development, the demand for new-energy vehicles is also increasing. The optimization and design of new-energy vehicle transmission systems has become a popular research topic. There are fuel consumption and emission problems in traditional automatic transmission systems, as well as limitations in the efficiency of mechanical transmission systems. These problems need to be solved through new technologies and design methods. New-energy vehicles adopt different types of transmission systems, such as battery electric vehicles (BEV), hybrid electric vehicles (HEV), and fuel cell electric vehicles (FCEV), to reduce dependence on fossil fuels and reduce emissions. The key factors for optimizing the transmission system of new-energy vehicles include battery technology and energy management system, electric motor and electronic control system, energy recovery and reuse technology, and lightweight and aerodynamic design of the vehicle. This paper aims to discuss the optimization and design of new-energy vehicle transmission systems, and successful designs are presented through case studies. At the same time, this paper will also discuss future challenges and development directions to promote further improvements and innovations in new-energy vehicle transmission systems.

2. The importance of new-energy vehicle transmission system optimization

The transmission system of traditional fuel vehicles has some limitations in terms of energy loss and

efficiency, resulting in increased fuel consumption and emissions. By optimizing the transmission system, the efficiency of energy utilization can be improved and energy loss can be reduced, thereby reducing fuel consumption and emissions ^[1]. Second, traditional fuel vehicles are one of the main sources of greenhouse gas emissions, which have a negative impact on climate change and air quality. Optimizing energy vehicle transmission systems can reduce dependence on fossil fuels, lower greenhouse gas emissions, and improve environmental quality. The fourth-generation optimized transmission system provides smoother and more efficient power output, which enhance the driving experience ^[2]. The electric transmission system of new-energy vehicles has high torque and quick response, making acceleration faster and driving more comfortable. The optimization of the transmission systems of the fifth-generation new-energy vehicles can reduce operating costs. The transmission system of an electric vehicle is relatively simple, reducing the need for maintenance and upkeep. In addition, through energy recovery and reuse technology, the battery life can be extended, which reduces costs of replacement and repair. The optimization of the sixth-generation new-energy vehicle transmission system requires technological innovations in multiple fields, such as battery technology, motor control, energy management, etc. This has promoted the development of related industries and promoted the progress and innovation of new-energy vehicle technology ^[3].

3. Limitations of traditional automatic transmission system

3.1. Fuel consumption and emission issues

There are some limitations in terms of fuel consumption and emissions in the traditional vehicle transmission system, these problems need to be solved through the optimization of the new-energy vehicle transmission system. In response to these limitations, different types of transmission systems have been designed for new-energy vehicles, such as BEV, HEV, and FCEV, to reduce dependence on fossil fuels and reduce fuel consumption and emissions. The optimization of these new-energy vehicle transmission systems can effectively solve the problems of traditional vehicle transmission systems in terms of fuel consumption and emissions. The limitations of conventional automatic transmission systems in terms of fuel consumption and emissions are described below ^[4].

3.1.1. Fuel consumption

Traditional cars are powered by the combustion of fossil fuel by an internal combustion engine. However, the thermal efficiency of an internal combustion engine is limited, most of the energy generated by the fuel is lost in the form of heat, and only some can be converted into effective power output. This leads to a relatively high fuel consumption of conventional cars.

3.1.2. Carbon emissions

Emissions of greenhouse gases such as carbon dioxide (CO₂) produced when internal combustion engines burn fossil fuels. These greenhouse gases are one of the main causes of climate change ^[5]. The large-scale use of traditional cars has resulted in a large amount of carbon emissions, which has a negative impact on climate change.

3.1.3. Pollutant emissions

In addition to carbon dioxide, the internal combustion engine of a traditional car also emits a series of pollutants, such as carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM). These pollutants are harmful to air quality and human health, especially in the case of urban traffic congestion ^[6].

3.1.4. Energy dependency

The transmission system of a conventional car relies on non-renewable energy such as fossil fuel. With the

depletion of global oil reserves and the issue of energy security, the energy dependence of conventional vehicles becomes a major challenge.

3.2. Efficiency limitation of mechanical transmission system

Mechanical transmission systems in conventional automatic transmission systems have limited energy efficiency, which will affect their drivability. In order to increase the efficiency of mechanical transmission systems, new-energy vehicles adopt electric transmission systems, in which the electric motor directly drives the wheels, avoiding the transmission losses in and increasing the efficiency of multi-speed transmissions ^[7]. The electric transmission system has high efficiency, high responsiveness, and a more simplified structure, resulting in better energy efficiency and drivability. The following are limitations of mechanical transmission systems in terms of efficiency.

3.2.1. Transmission loss

Various transmission elements (such as gears, bearings, transmission belts, etc.) in the mechanical transmission system will generate friction and mechanical loss when transmitting power. These transmission losses result in wasted energy and reduced efficiency. Especially under long-term running and high-load conditions, the transmission loss will be more significant.

3.2.2. Efficiency loss of multi-speed transmission

Conventional cars are usually equipped with multi-speed transmissions to provide suitable torque and power output in different speed ranges. However, the switching and gear matching process of the multi-speed transmission will cause energy loss and decrease in efficiency. In addition, the weight and complexity of the multi-speed transmission will also affect the efficiency of the entire transmission system ^[8].

3.2.3. Limitations of power transmission path

The mechanical transmission system of a traditional car transmits power from the engine to the wheels through the drive shaft. However, the length and angle of the transmission shaft have a certain effect on the transmission efficiency. Long drive shafts increase transmission losses, while steeply angled drive shafts cause vibration and energy loss.

3.2.4. Responsiveness of power output

The responsiveness of mechanical transmission systems are affected by the inertia of the transmission components and the delay of the transmission process. This can lead to lag and instability in power delivery, affecting the driving experience and vehicle performance.

4. Types of new-energy vehicle transmission systems

4.1. BEV transmission systems

In BEVs, the battery pack is the only energy storage device, and the electric motor directly drives the wheels to generate power. The battery pack is responsible for storing and releasing electrical energy, and the electric motor converts electric energy into mechanical energy to drive the vehicle. The BEV transmission system does not require traditional engines and fuel systems, and has a simplified structure and high energy efficiency. Charging is a key link in the BEV transmission system, and proper charging infrastructure needs to be established to support long-distance travel and daily use ^[9].

4.2. HEV transmission system

HEVs are powered by a combination of an internal combustion engine and an electric motor (**Figure 1**).

The internal combustion engine can drive the wheels directly and charge the electric motor via a generator simultaneously. The electric motor can provide additional power, and the braking energy is converted into electrical energy and stored and through an energy recovery system. HEV transmission systems have high energy efficiency and long cruising range and are less dependent on charging infrastructure [10].

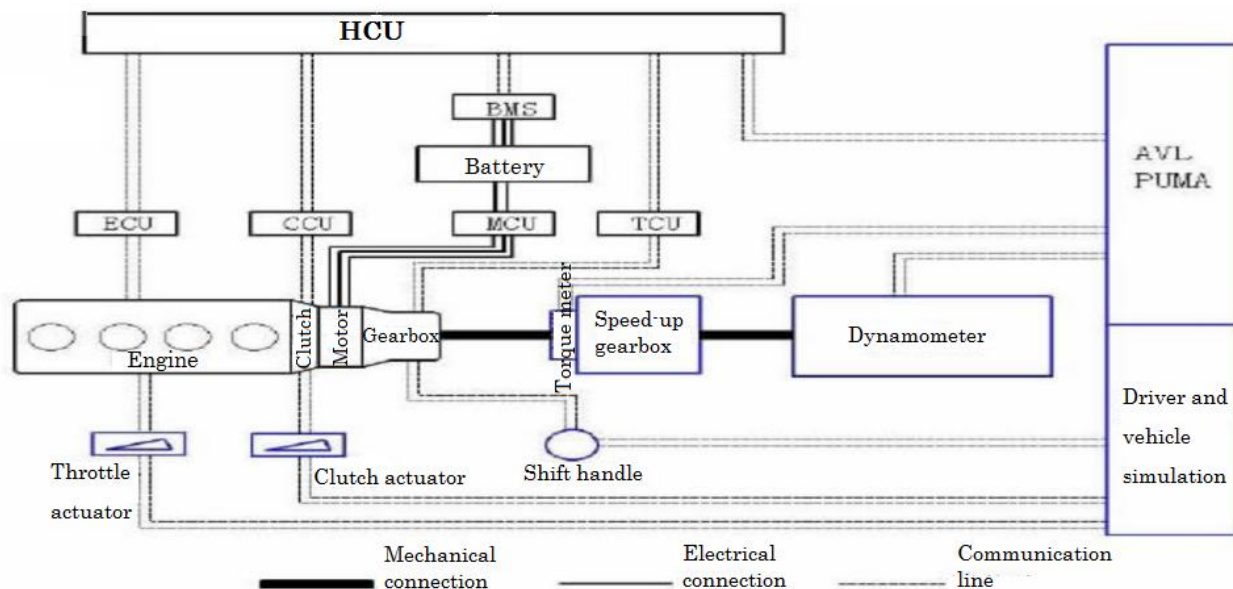


Figure 1. HEV transmission system

4.3. FCEV transmission system

FCEV use hydrogen as fuel, and the hydrogen reacts with oxygen through fuel cells to generate electricity that powers the electric motor. The emission of fuel cell vehicles is only water vapor, which achieves zero emission. FCEVs has the advantages of fast hydrogen refueling and long cruising range, but there are still some challenges in the construction of hydrogen infrastructure.

5. Key measures to optimize the transmission system of new-energy vehicles

The key measures to optimize the transmission systems of new-energy vehicles are described in **Figure 2**.

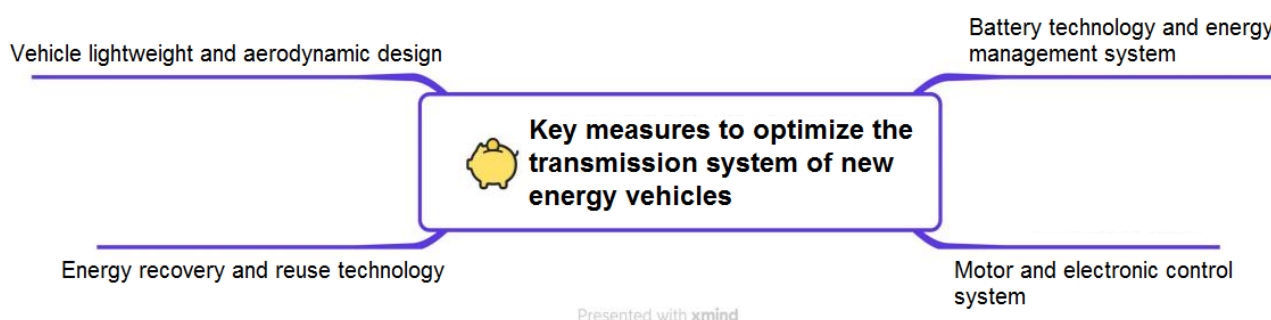


Figure 2. Key measures to optimize the transmission system of new-energy vehicles

5.1. Battery technology and energy management system

One of the key measures to optimize the transmission systems of new-energy vehicles is to improve battery technology and the energy management system. These measures can improve the performance and life of the battery while maximizing the utilization of energy of the battery. In terms of battery technology,

researchers can work on developing batteries with higher energy density and higher power output. Batteries with high energy density can provide longer cruising range, while batteries with high power output can provide better acceleration performance ^[11]. In addition, it is also important to improve the cycle life and charging speed of batteries.

Optimization of energy management systems can be achieved through several ways. First, the development of intelligent energy management algorithms control the charging and discharging process of the battery more effectively to maximize the battery life. Second, adopting advanced energy recovery technologies, such as braking energy recovery and kinetic energy recovery systems can convert the energy generated while the vehicle is driven into electrical energy and store it in the battery. In addition, optimizing the vehicle's overall energy system including electric motors and electronic control units can improve energy efficiency. In addition to technical improvements, the government and related agencies can also take measures to promote the development of new-energy vehicles. For example, providing financial support and tax incentives to encourage the R&D and production of key technologies for new-energy vehicles. In addition, establishing a charging infrastructure network that is more complete is also an important measure to promote new-energy vehicles.

5.2. Motor and electric control system

Another key measure to optimize the transmission system of new-energy vehicles is to improve the motor and electronic control system. These measures can improve the efficiency and performance of the motor ^[12]. Researchers can work on improving the power density and efficiency of electric motors. Increasing the power density can enable the electric motor to provide greater output power under the same volume or weight, thereby improving the acceleration performance of the vehicle. Improving efficiency can reduce the energy loss of the electric motor and improve the energy efficiency of the transmission system.

In addition, it is also important to the thermal management system of the motor because a lot of heat is generated during the operation of the motor. If the heat generated cannot be dissipated properly, the motor will overheat, and its performance and lifespan will be affected. Therefore, the heat dissipation system should be optimized with efficient cooling techniques and materials, which will improve the reliability and durability of the electric motor.

In terms of electronic control systems, researchers can work on developing more advanced electronic control algorithms and strategies. These algorithms and strategies can achieve precise control of the motor even under different driving conditions ^[13]. For example, the output power and torque of the electric motor are dynamically adjusted according to factors such as vehicle speed, load and driving mode, so as to provide the best driving experience and energy efficiency. In addition, improving the reliability and safety of electronic control systems is also an important goal. The electronic control system of electric vehicles needs to be able to detect and respond to faults in time to ensure the safety and reliability of the vehicle. Therefore, it is necessary to adopt advanced fault diagnosis technology and safety protection measures.

5.3. Energy recovery and reuse technology

Another key measure to optimize the transmission systems of new-energy vehicles is to adopt energy recovery and reuse technology, in which the energy generated during the driving of the vehicle is recovered and reused to improve energy efficiency. A common energy recovery technology is braking energy recovery system, also known as regenerative braking system. When the vehicle brakes, the energy generated by braking is lost as heat energy. With regenerative braking, braking energy is converted into electricity and stored in the battery for later use. This can reduce energy waste and increase the cruising range of the vehicle ^[14]. In addition to braking energy recovery, there are other energy recovery technologies that can be applied to new-energy vehicles. For example, a kinetic energy recovery system can convert the

inertial energy generated when a vehicle is moving into electrical energy and store it. With this technology, energy can be generated when the vehicle is decelerating or moving, further improving energy efficiency. In addition, solar charging technology can also be used in new-energy vehicles. By installing solar panels on the vehicle, solar energy can be converted into electricity that can be used to recharge or power the vehicle's auxiliary systems. This technology reduces dependence on the grid and increases the vehicle's self-sufficiency. In addition to energy recovery technology, energy reuse is also one of the key measures to optimize the transmission systems of new-energy vehicles. For example, using the energy stored in the battery to power or drive the vehicle's auxiliary systems can reduce the load on the engine and improve the efficiency of the entire transmission system.

5.4. Lightweight and aerodynamic design of the vehicle

Another key measure to optimize the transmission systems of new-energy vehicles is the lightweight and aerodynamic design. A lightweight and aerodynamic design reduces the vehicle's weight and air resistance, thereby improving energy efficiency and driving performance. The vehicle's weight can be reduced through the use of lightweight materials and an optimized design. Common lightweight materials include high-strength steel, aluminum alloy, carbon fiber composite materials, etc. These materials have high strength and rigidity, which can reduce weight while ensuring the safety of vehicle structure. In addition, the weight of the vehicle can also be reduced by optimizing the vehicle's structural design and component layout, such as reducing unnecessary parts and using a compact structure.

An aerodynamic design reduces air resistance by optimizing the shape and hydrodynamic characteristics of the vehicle. Reducing air resistance can reduce the energy required to drive the vehicle, thereby improving cruising range and driving efficiency. The air resistance of the vehicle can be reduced by improving body lines, reducing protruding parts, and optimizing the design of the vehicle floor. In addition, other measures can be adopted to further reduce the weight of the vehicle while having an aerodynamic design ^[15]. For example, advanced manufacturing processes and technologies such as 3D printing and simulation optimization can be used to increase the accuracy and efficiency of component manufacturing and design. Additionally, the vehicle's aerodynamic performance can be evaluated and improved using advanced computational fluid dynamics (CFD) simulations and wind tunnel testing.

6. Conclusion

There are several key measures that can be taken in optimizing and designing energy vehicle transmission systems, such as improving battery technology and energy management systems, optimizing electric motors and electronic control systems, adopting energy recovery and reuse technologies, and lightweight and aerodynamics design. These measures are taken to increase energy efficiency and cruising range, improve drivability, and reduce environmental impact. Through these optimization and design measures, we can produce transmission systems that are more efficient and greener. This not only helps to reduce dependence on traditional petroleum energy and reduce greenhouse gas emissions, but also improves driving experience and reduces operating costs. Besides, these measures can also promote the development and innovation of new-energy vehicle technology and the realization of sustainable transportation. However, the joint efforts of all parties such as the government, research institutions, automakers, and consumers are needed to realize the optimization and design of transmission systems. Only through continuous innovation, technological advancement, and policy support can we achieve a more sustainable and environmentally friendly transportation future. In the future, we can look forward to the continuous development and improvement of energy vehicle transmission systems to meet people's needs for more efficient and environmentally friendly modes of transportation. Through continuous research, we can develop transmission systems that are more intelligent, efficient, and sustainable, which will benefit our society and environment.

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Disclosure statement

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Research on the Construction of Computer Network Security System in Middle School Campus Network

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Abstract: In order to improve the security of high school campus networks, this paper introduces the goal, system composition, and function of the network security of high school campus networks, and puts forward a series of strategies, including the establishment of network security protection system, data backup and recovery mechanism, and strengthening network security management and training. Through these strategies, the safety and stable operation of the campus network can be ensured, the quality of education can be improved, and school's development can be promoted.

Keywords: Network security; Physical security; Software security

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1. Introduction

The requirements for network security have been increasing with the continuous development of computer technology. Various factors need to be considered in the process of building a high school campus network, such as the scale of the school network, the level of school development, and the impact on students and teachers [1-4]. In the process of campus network construction in middle schools, it is necessary to focus on the overall planning of the campus network, and the specific needs and functions of the network system. Besides, factors like security awareness, security system, network environment, and network management should also be considered. Moreover, it is also necessary to pay attention to the cultivation of information protection awareness and fully consider the needs of students and teachers as well as the campus network environment [5]. In addition, it is necessary to formulate corresponding security measures and management systems according to relevant regulations and standards and improve the security of the school network system. The information security of students and teachers and the stability of the network environment can only be ensured with a proper network security system.

2. Construction of computer network security system for middle school campus network

2.1. Purpose of constructing a network safety system

The goal of constructing a campus network security system is to ensure the safe and stable operation of the campus network [6-8], which includes the following aspects: preventing unauthorized access and attacks, ensuring network security and stability, preventing viruses and dissemination of malware, safeguarding important data.

2.2. System framework

The computer network security system of the high school campus network consists of four parts, specifically the security management platform + security operation and maintenance platform, organization chart, security management, and technical support (**Figure 1**).



Figure 1. Composition of the computer network security system of the middle school campus network

2.3. System functions

2.3.1. Intrusion Detection System

The Intrusion Detection System (IDS) is an important part of network security management. With an IDS,

malicious activities can be detected in time, thereby reducing the risk of computer damage. Besides, security risks in the network can also be found and eliminated through an intrusion detection technology. IDS is divided into artificial, automatic, and intelligent. Manual intrusion detection refers to carrying out intrusion detection through a computer system and to check the loopholes and hidden dangers in the information management of computer systems; automated intrusion detection refers to the use of automatic control technology in computer systems for intrusion detection. In order to better apply automatic intrusion detection technology, it is necessary to use artificial intelligence for effective detection, analysis, and control.

2.3.2. System defense

System defense is used to block attacks by preventing access to the computer information systems. Therefore, the application of defense technologies must be strengthened to protect the normal operation of computer information systems. To improve the defense system, the IDS needs to be improved. Analyzing and researching network attacks is a very important prevent and defend against information system security problems. There are a few methods that are used to attack networks: computer worms, remote code execution, and URL encoding. These methods of attacks are usually executed on software. Therefore, it is necessary to strengthen the management of these attack methods and monitor them in real time to ensure the normal operation of the network information system^[9]; secondly, network functions of the computer information system should be important. Only by improving the level of network security management and ensuring the normal operation of the network information system can the security of the computer information system be ensured. Besides, it is necessary to further improve the system functions to enhance the quality of the defense system.

2.3.3. Antivirus detection and management

The management of computer viruses is crucial because computer viruses are concealed to a certain degree, so it is necessary to detect viruses in time when monitoring computer viruses. At present, domestic computer viruses are mainly divided into four categories: Web viruses, e-mail viruses, Trojan horse, and other forms of worms. To deal with these four viruses, a virus control software can be installed in the infected computer. This software should detect the virus in time and eliminate it. The computer systems should be monitored and inspected regularly for such viruses. If a virus is found, the website should not just be deleted, but it is necessary to clean up the system after understanding the characteristics of the virus. The protection technologies used for these four types of viruses are different. Because computer viruses spread easily, it is necessary to adopt special management software and technology to prevent and restrict computer viruses in a timely manner. Besides, it is also necessary to update the software and related rules in time to effectively prevent the spread of viruses^[10].

2.3.4. Network monitoring

Network monitoring mainly refers to the maintenance and detection of computers to ensure network security. However, the monitored object is not limited to the computer itself, but also involves other equipment. Therefore, network monitoring technology requires the integration of information equipment and data and network management. Taking the monitoring of information equipment as an example, the following methods can be used. First, the respective environments and operating conditions of network equipment and computers is analyzed to understand the network operation status. The analysis software can intuitively reflect whether the information equipment in the entire network environment is normal by recording the start-up time and operating status of each network device. If there is an abnormal device or the system needs to be adjusted, it needs to be monitored in real time through network monitoring

technology, and the fault should be dealt with in time. Secondly, use the automatic control system to intelligently monitor the network system, which can effectively ensure the safe operation of the computer system and record network operation data and status. Lastly, network data security inspections and security assessments should be conducted regularly to ensure the scientificity, rationality, and effectiveness of the risk control and monitoring methods.

3. Security policy of campus network system

In the process of campus network construction, it is necessary to formulate corresponding security policies, including physical security, information security, system security, data security, etc. It is also necessary to plan the campus network system so as to optimize the entire campus network system. When formulating a network system security plan, it is necessary to consider all aspects of the campus network system and formulate corresponding protection measures. Besides, it is necessary to focus on the security of information, so as to ensure the smooth operation of the network system. At the same time, it is also necessary to pay attention to the maintenance of the campus network system, especially the maintenance of the operating system and software. Only in this way can the computer network system be more stable and secure.

3.1. Physical security

During the construction of the campus network, the physical security of the campus network system needs to be considered, and certain principles must be followed throughout the construction process. The campus network system mainly consists of computer systems, switches, routers and other equipment. When designing a computer, it is necessary to ensure that these devices can operate normally and can be monitored and maintained at any time to avoid problems. When in use, two aspects of the network system need to be considered, which is the hardware and software. The hardware aspect mainly includes the computer room, the facilities in the computer room, and the placement of equipment. Through reasonable planning and design of these factors, the stability of the entire campus network system can be ensured. When planning the installation of hardware, it is necessary to ensure that the devices can work in coordination with each other. Only in this way can the safe and stable operation of the entire campus network system be ensured. The software mainly includes virus removal, data backup, and access control. Through the reasonable planning and design of software, the destructive effect of various viruses on computer network systems can be reduced. In addition, it is necessary to maintain, manage, and improve the quality of the computer network environment by controlling the temperature, humidity, and lighting in the computer room. Only in this way can the entire computer room and the computer network environment be more secure and stable.

3.2. Software security

In the process of building a high school campus network, software security is a very important aspect. When designing software security, it is necessary to fully consider its security and integrity. First of all, it is necessary to use data encryption to better protect the users' data; secondly, it is necessary to strengthen the authentication technology so that users can log in to the software through effective identity authentication methods. In addition, there is a need to strengthen the use of ports in terms of network connection and access. Effective use of ports can effectively prevent hackers and viruses from damaging the system. When designing system software, it is necessary to determine the corresponding security strategy based on specific requirements. In terms of network connection and access, it is necessary to make full use of software security mechanisms to ensure that both connection and access are safe and reliable.

3.3. Network security preventive measures

In the process of campus network construction in middle schools, it is necessary to focus on preventive measures and continuously improve the network security management system. By formulating a sound network security management system, the normal operation of the computer network security system can be ensured. Besides, it is necessary to continuously upgrade the software of the to ensure network security. In addition, during the construction of the campus network, it is necessary to strengthen the maintenance of the computer network system, so problems can be detected and resolved in time, and security problems can be avoided. In addition, it is also necessary to continuously improve the information protection awareness of the staff, so that they strictly abide by relevant laws, regulations, and operating norms. Moreover, it is necessary to pay attention to the cultivation of information protection awareness of students and teachers, so that the information protection and information security of students and teachers can be improved. In addition, it is necessary to continuously strengthen the security management of the campus network to improve the quality of the campus network.

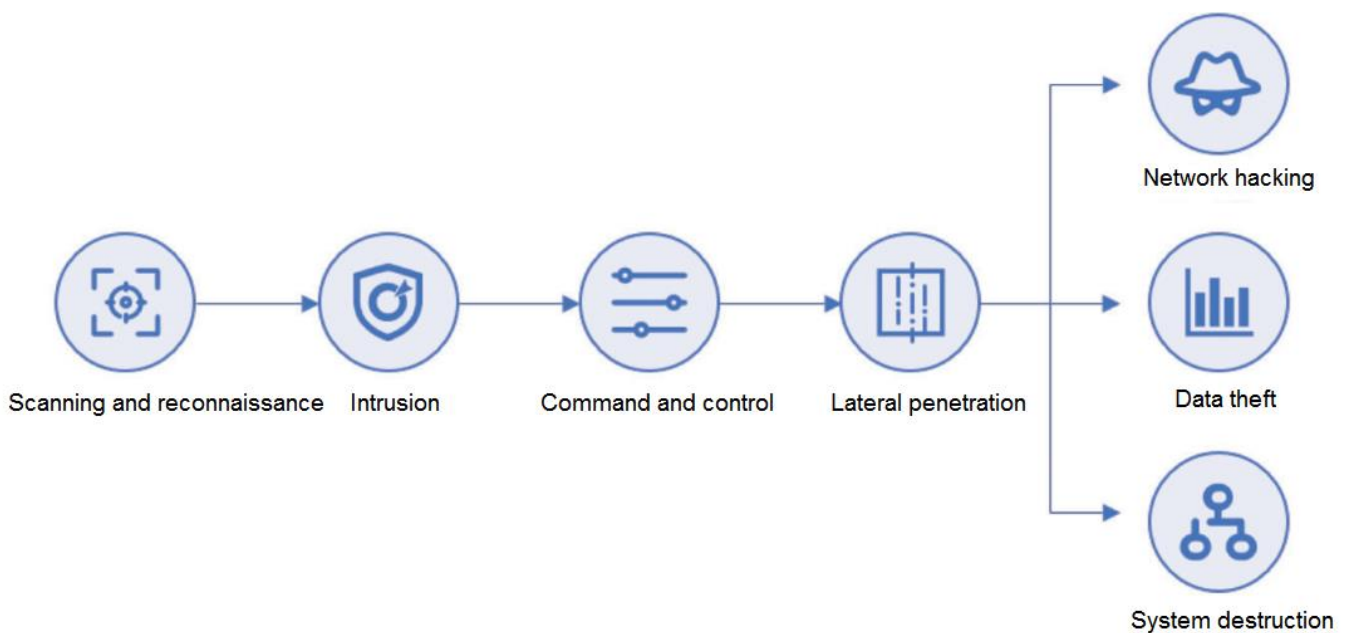


Figure 2. Network security technology protection system

3.4. Improving users' information security awareness

In the process of campus network construction, it is necessary to improve network security awareness and implement security precautions. Only in this way can users' awareness towards information security can be improved, and users will know how to use computer network systems correctly. Thematic activities can be carried out to cultivate the students' and teachers' awareness towards information security, so that students and teachers can understand the importance of network security and learn to use computer network systems correctly. In addition, it is necessary to pay attention to the prevention of network viruses during the construction of the middle school campus network. Computer viruses can be prevented by strengthening the construction of network security system like establishing firewalls and installing anti-virus software.

4. Conclusion

The construction of computer network security systems in middle school campus network is one of the important tasks informationization of schools. During the construction process, we need to focus on

preventing and responding to various network security threats, establish a comprehensive network security protection system, strengthen data backup and recovery mechanisms, and at the same time strengthen network security management and training and improve the network security awareness of teachers and students. Only in this way can we guarantee the safe and stable operation of the campus network and provide strong support for the school's education and management.

Disclosure statement

The author declares no conflict of interest.

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Note: When referencing an entry from a dictionary or an encyclopedia with no author there is no requirement to include the source in the reference list. In these cases, only cite the title and year of the source in-text. For an authored dictionary/encyclopedia, treat the source as an authored book.

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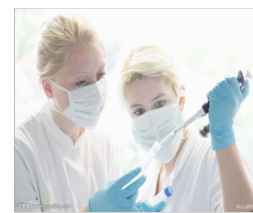
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