Journal of Electronics and Information Science (2023)
Clausius Scientific Press, Canada

DOI: 10.23977/jeis.2023.080603
ISSN 2371-9524 Vol. 8 Num. 6

Research on the Application of Computer Control Technology in Electronic Circuits

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Keywords: Electronic circuits; Computer control technology; Principle; Application

Abstract: This article mainly studies the application of computer control technology in electronic circuits, analyzes the work efficiency of computer control technology from the actual situation, and attempts to find the entry points for upgrading computer control technology. This is of great significance for improving the performance and reliability of electronic circuits, achieving automation and intelligent control, improving work efficiency and product quality, and other aspects. Through research, it has been found that computer control technologies supported by different core technologies have different applicable ranges and functional advantages. For example, computer control technology based on microcontroller regulation has advantages such as high integration, small size, low power consumption, high reliability, and strong programmability. However, system design and debugging are difficult, computing power is limited, and scalability is limited. It is mainly suitable for industrial control, computer networks, and communication fields.

1. Introduction

The Chinese Academy of Engineering has released the "14th Major Technical Challenges for the Development of Electronic Information Engineering Technology in China (2023)", aiming to provide accurate and powerful support for strengthening core and key technology research and accelerating the construction of an innovative country. Among them, it includes the field of "control". Computer control technology is an important branch of electronic information engineering. Electronic circuits are the foundation of computer control technology and electronic information engineering, mainly referring to circuits composed of electronic devices and related radio components. Computer control technology refers to the technology of processing various information based on computer equipment, and then issuing control instructions to achieve control objectives. It is generally used for signal processing and control in electronic circuits. The application and development of computer control technology can provide more efficient and precise control methods for electronic circuits, while also promoting the development and progress of electronic information engineering. Based on the core demand of the "14th National Technical Challenge", the current "control" field needs to grasp application innovation and technological upgrading. In order to clarify the specific direction of computer control technology application innovation, this article intends to analyze the advantages and disadvantages of various control technologies from the perspective of the application scope of computer control technology in electronic circuits.[1]

2. The working principle of computer control technology in electronic circuits

2.1. Data processing system

The main functions of a data processing system include: data collection, data and signal conversion, data storage, data processing and analysis, and data visualization. The working principle of a data processing system is to collect raw data from various data sources (such as sensors, monitoring devices, networks, etc.), and then use computer control technology to convert raw data and signals, as well as data processing and analysis. The final results can provide support for decision-making, and the sorted and analyzed data itself has high value. This process usually converts analog signals into digital signals through analog-to-digital converters (ADCs), or directly inputs digital signals into computer systems through various interface devices. Then, the processing stage will perform various calculations, judgments, and logical operations on the input data. In this stage, the computer system can perform operations such as filtering, smoothing, zooming in and out on input data, as well as arithmetic and logical operations on input data. According to the preset control algorithm and target values, the processed data is output to the control system to achieve control over the system. On the basis of data processing, data processing systems can conduct more in-depth data analysis. This includes statistical analysis of data, trend analysis, spectral analysis, correlation analysis, etc., in order to obtain useful information and conclusions from the data. From the perspective of data processing system applications, computer control technology is mainly responsible for controlling the processing flow and operation of data. Generally, it mainly manifests in basic operations such as data retrieval, insertion, modification, and deletion, as well as various calculations, analysis, and visualization processing of data. Computer control technology can achieve fast, accurate, and efficient processing of data to meet the needs of different applications.[2]

2.2. DDC system

Direct Digital Control (DDC) system is a system that, after digital upgrading based on traditional electrical control technology, is guided by computer control technology to achieve control functions and objectives. In the application of electronic circuits, DDC systems can achieve efficient and accurate control, improve production efficiency and quality. The working principle of DDC system mainly includes: firstly, data acquisition and processing. Based on sensors and other devices, various parameters (such as voltage, current, temperature, etc.) in electronic circuits are collected, and the collected data is converted and filtered to obtain "digital data" [1]. Secondly, based on the analysis results, a control signal is issued. After receiving the digital data, the DDC system can process it according to the preset control algorithm and target value to calculate the control signal. Thirdly, control signal output and target realization. The DDC system will output control signals to devices such as actuators, thereby controlling electronic circuits. The DDC system also includes real-time control, fault diagnosis and alarm, data storage and analysis, etc.[3]

2.3. SCC system

Supervisory Control System (SCC system) is a working system based on computer control technology, with supervision as the main function. The application of SCC system in electronic circuits is mainly to achieve efficient and accurate supervision and control. The working principle of SCC system is also based on sensors collecting various parameters in electronic circuits, and then converting and analyzing the data to form digital data. However, the SCC system will process the digital data based on the preset control model and target values, calculate the control signal, and then output it to the executing device to achieve control of the electronic circuit. The SCC system

also supports human-computer interaction. SCC can provide users with real-time data display, alarm information printing, and other functions through computer displays, printers, and other devices, so that users can monitor and adjust the operation status of the circuit. In the operation of the circuit, the SCC system can also achieve real-time supervision and diagnosis: through preset indicators or fault diagnosis algorithms, monitor and detect parameters such as temperature, pressure, and current in the lower control system, and timely diagnose abnormal situations and faults in the lower control system. Based on this, designers can achieve automatic coordination and scheduling of the system by optimizing algorithms and decision models.[4]

3. The application scope of computer control technology in electronic circuits

3.1. Based on microcontroller control

The computer control technology based on microcontroller regulation is a technology that uses the microcontroller as the control center to achieve automatic control of external electronic circuits. The basic principle of this technology is to implement computer control algorithms through programming languages, based on the input and output interfaces of microcontrollers and analog circuit interfaces, connect external circuits to complete data reading and writing, signal processing, analog acquisition and control. Computer control technology based on microcontroller regulation has advantages such as high integration, small size, low power consumption, high reliability, strong programmability, high-speed processing ability, and various peripheral interfaces. It is suitable for various application scenarios that require high volume and power consumption, and can achieve various control and data processing tasks. However, the design and development of computer control systems based on microcontroller regulation are relatively difficult. Moreover, the compatibility of the system is not awesome enough. Once the system functions need to be expanded, the chip needs to be replaced or the system needs to be redesigned, which is poor in scalability. Due to the hardware performance limitations of microcontrollers, the real-time and stability of the system cannot meet some high demand applications. Moreover, the programming difficulty of computer control systems based on microcontroller regulation is relatively high, requiring a large amount of code to implement control and data processing tasks. From the perspective of practical application scope, it is currently mainly applied in industrial control, household appliances, computer networks and communication fields, medical equipment fields, and other fields, such as intelligent management of factory assembly lines, intelligent control of elevators, and various alarm systems; Applications in washing machines, refrigerators, air conditioners, color televisions, etc; Applications in mobile phones, small program-controlled switches, building automatic communication call systems, train wireless communication, etc; The application of medical ventilators, various analyzers, monitors, ultrasound diagnostic equipment, and hospital bed call systems.[5]

3.2. Based on DSP regulation

Computer control technology based on DSP regulation is a method of using a digital signal processor (DSP) for control. DSP is a chip specifically designed for processing digital signals, which can perform fast and accurate digital signal processing, and is therefore widely used in various control systems. Computer control technology based on DSP regulation has advantages such as high-precision digital signal processing and control, high-speed processing, strong programmability, strong reliability, and stability. DSP is suitable for more complex multi algorithm tasks because it has a dedicated microprocessor that can better process and control various algorithms. However, DSP chips are usually more expensive than general-purpose microprocessors,

which may increase the cost of the entire system. Moreover, DSP technology is relatively new, and technicians need to accumulate some experience to master it. In addition, DSP cannot replace the functions of all chips and needs to be used in conjunction with other devices to complete more complex tasks. DSP also has relatively high quality requirements for power supplies. From the perspective of practical application scope, current computer control technology based on DSP regulation is mainly applied in various scenarios that require high-precision and high-speed digital signal processing. For example, it is used to achieve real-time monitoring and regulation of power systems, as well as high-precision motion control and data acquisition in motor control; Used for the control of medical equipment, achieving the collection and processing of various physiological signals, and completing the detection of electrocardiograms, electroencephalograms, and other aspects; Used to achieve tasks such as modulation and demodulation, encoding and decoding of digital signals, including wireless communication, fiber optic communication, and other fields. It should be noted that different DSPs have different characteristics and functions, so designers need to choose appropriate DSP models and application solutions based on specific application scenarios and requirements. At the same time, it is necessary to continuously conduct on-site debugging on the designed system to ensure its stability and reliability.[6]

3.3. FPGA Application

Computer control technology based on FPGA (Field Programmable Gate Array) is a hardware logic based computer control scheme. FPGA is a programmable digital circuit device that can be reconfigured according to the needs of designers to achieve circuit designs with different functions. In the field of computer control, FPGA can be used to achieve highly customizable control logic and data processing functions [5]. FPGA has the characteristics of strong programmability, flexible adjustment, personalized customization, high-speed performance, easy maintenance and upgrading, and strong timeliness, making it very suitable for work scenarios that require real-time processing. Moreover, the circuit structure of FPGA adopts some low-power design techniques, such as dynamic power management, clock gating, etc., which can achieve low-power digital circuit design, which is conducive to ensuring cost control and safe working environment. FPGA based computer control technology is suitable for various scenarios that require highly customized and high-performance digital signal processing in electronic circuits. For example, in the field of communication, it is responsible for implementing packet processing and data flow control functions for communication equipment such as routers, switches, and fiber optic communication, as well as compatibility with various communication protocols; In scientific instruments, responsible for achieving high-speed data acquisition and real-time processing capabilities of scientific instruments such as spectrometers, mass spectrometers, and particle accelerators; Embedded systems based on applications such as automotive electronics, aerospace, industrial automation, etc. are mainly responsible for implementing control and data processing functions with low latency and highly customized characteristics.[7]

4. Application Strategies of Computer Control Technology in 3 Electronic Circuits

The application of computer control technology in electronic circuits is very extensive and applicable in many fields. This article chooses to analyze the upgrading and application strategies of computer control technology from the perspective of industrial automation.

4.1. Project Quality Management

There are many types of technical designs that use computer control technology to ensure project

quality management. This article attempts to propose a conjecture about achieving a "visual industrial automation control system" from the perspective of the organic combination of computer control technology and Unity3D technology. This design aims to achieve more efficient, precise, and reliable production process control, thereby improving production efficiency and product quality. By combining large computer control technology with Unity3D technology, real-time monitoring and automated adjustment of the entire production process are carried out, thereby improving the stability of the production process and product quality. Designers first need to design the overall architecture of the system and the functions of each module based on the requirements analysis results, and then choose to use Unity3D technology to build a realistic production scene model, realizing the visualization of the production process. At the same time, based on the interaction function of Unity3D, improve the computer control panel design, and ensure that it can support operators to intervene and adjust the production process in real time. Firstly, designers need to clarify the project requirements, including the practical needs of monitoring, adjusting, and visualizing the production process. Secondly, designers need to design the overall architecture of the system and the functions of each module based on the requirements analysis results. Then, the designer needs to select appropriate hardware devices, including sensors, actuators, etc., and build a stable hardware platform. Next, designers need to do a good job in software programming, using computer control technology and Unity3D technology to develop software systems, achieving real-time monitoring and adjustment of the production process, as well as visualization. Finally, the designer needs to conduct operational testing and on-site debugging of the entire system, deploy the system to the actual production site for debugging, and further optimize the performance of the system.[8]

4.2. Project Cost Management

Based on the field of industrial automation, analyze the possibility of applying computer control technology combined with artificial intelligence technology from the perspective of project cost management. Designers can try to build a real-time and intelligent industrial automation control system. By utilizing artificial intelligence technology to model and analyze production data, intelligent control of the production process is achieved. At the same time, based on the prediction function of artificial intelligence technology, the production process is predicted and optimized, thereby improving production efficiency and reducing costs. For example, based on the combination of computer control technology and artificial intelligence technology for data collection and analysis, various data on the production line are collected and recorded in real-time, including equipment status, production efficiency, material consumption, etc., and automatically transferred from the background to the artificial intelligence data analysis function module. Through deep learning and analysis, potential production problems and cost risks are identified, providing early warning and decision support for management decision-making. The combination of two technologies to optimize project cost management can also be achieved through resource scheduling optimization. Based on real-time collection and analysis of data information, intelligent resource scheduling can be achieved, such as rational arrangement of production equipment usage sequence and optimization of material distribution path. This can reduce idle time and energy consumption in the production process, thereby improving production efficiency and reducing costs.

4.3. Project Progress Management

Based on the complete system upgrade needs in the field of industrial automation, optimizing computer control technology design to promote automation system upgrade can further achieve fast,

stable, and efficient operation of the automation system, comprehensively improve the work efficiency of various links in the production line, and ensure the smooth completion of project progress and meet production needs. The designer first needs to analyze the existing automation system, focusing on refining the requirements analysis and technical evaluation from the aspects of production needs and system performance upgrades, determining specific implementation goals and design plans, including hardware equipment upgrades, software program optimization, and system function expansion. Then, the designer should gradually upgrade the hardware equipment and software programs while ensuring system stability and reliability, and complete the testing and verification of the upgraded system. If the preliminary design scheme cannot guarantee that the system performance meets the expected goals, the designer needs to analyze the specific reasons, determine which link and step there is a problem, whether optimization can be carried out on the original basis, or whether a new system upgrade scheme needs to be designed directly. On this basis, from the perspective of ensuring project schedule management, designers should focus on the following aspects: firstly, upgrading the risk analysis and evaluation function. While formulating the automation system upgrade plan, designers should also analyze and evaluate potential risks and develop response measures to avoid the impact of risks on project schedule. Secondly, the upgrade of the supervision function module requires the designer to improve the system upgrade plan from the perspective of visual supervision of the production line, and also consider the coherence between data collection, progress analysis, and automation control, ensuring that the automation system based on the technology designed can timely and independently detect problems, and take measures according to the instructions set to ensure the progress of the entire project.

5. Conclusions

In summary, the application of computer control technology in electronic circuits can achieve high-precision control of circuits, automatic fault detection and elimination, real-time monitoring and processing of data, and optimized management of the entire system. Computer control technology can not only effectively improve production efficiency and ensure product quality, but also provide assistance for scientific decision-making in enterprises. The application prospects of computer control technology in electronic circuits are extensive. Designers should optimize it appropriately based on actual needs to ensure that the practical needs of modern industrial automation and intelligent development are met.

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