Design of Human-computer Interface for Laser Cutting Machine

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Abstract: A design method based on information fusion is proposed regarding the problem of poor integration and intelligence of human-computer interface for current laser cutting machine. The designed human-computer interaction information system of laser cutting machine is divided into laser cutting parameter calculation module, MVB integrated control module, bus control module and information interface interaction module. Embedded ARM and extended bus technology are adopted to carry out human-computer interaction information transmission and resource scheduling of laser cutting machine under the Internet of Things environment, and a human-computer interaction information database is constructed. GUI rendering technology is adopted to design the human-computer interaction information interface. RTCP control structure word of service quality monitoring is combined to carry out information fusion processing of the human-computer interaction information system of laser cutting machine, and centralized control method is adopted to design the human-computer interaction interface of the machine. Simulation results show that the visual effect of using this method to design the human-computer interaction information interface of laser cutting machine is better, and the precision and human-computer interaction of laser cutting are improved.

Keywords: Laser cutting machine; Human-computer interaction; Information interface

1. Introduction

With the development of laser cutting technology, it is used for mechanical processing design to improve the accuracy of mechanical processing. The composition and structure of machined workpieces are becoming increasingly complex, which puts forward higher requirements for the artificial intelligence and information interaction of laser cutting machine. The visualization effect in laser cutting process is improved through the design of human-computer interface of laser cutting machine[1]. Therefore, the research on the optimization design method of the human-computer interaction information interface of the laser cutting machine, combined with embedded bus control and human-computer interaction design, realizes the information perception and interaction in the cutting process of the machine, and further realizes the online real-time monitoring of the laser cutting. The research on the interface design technology of the laser cutting machine, combined with the multi-mode digital processing technology, carries out the human-computer interaction and information online monitoring of the laser cutting, and improves the precision of the laser cutting. The research on the related human-computer interaction information interface design method of the machine has been paid great attention.

In the traditional method, the design and processing control technology of the man-machine interactive information interface of the laser cutting machine mainly adopts a multi-axis joint processing control method and adopts an adaptive information fusion technology to realize the design of the interface of laser cutting machine and promote the intelligence improvement of the laser cutting processing technology. A design method of human-computer interaction information interface of laser cutting machine based on fatigue damage control is proposed in the literature. NET Framework application program is used to design the user interaction experience of the system, which improves the

scene interaction and perception ability of the system. However, it has poor adaptive follow-up control performance when designing the man-machine interaction information interface. In the literature, a human-computer interaction experience design method of laser cutting machine based on laser sensing information fusion tracking is proposed. Laser sensing technology is used for information interaction design and tracking control of the cutting machine to improve control accuracy. However, this method is affected by parameter sensitivity, resulting in poor real-time information interface interaction. To solve the above problems, this paper proposes a design method based on information fusion. The designed system is divided into laser cutting parameter calculation module, MVB integrated control module, user information interaction module and information interface interaction module. The human-computer interaction information database is constructed. GUI rendering technology is adopted to design the man-machine interaction information interface, and centralized control method is adopted to design the interface of laser cutting machine. What's more, performance tests are carried out through simulation experiments to demonstrate the superior performance of the method in improving the human-computer interaction and information perception ability of laser cutting machine.

2. The Overall Design Framework and Development Environment Description of the System

2.1 Overall system design framework

The man-machine interaction information interface of laser cutting machine is an important part of mechanical processing and laser cutting systems. The man-machine interaction level of laser cutting machine is improved through the design of information interaction interface. In order to improve the human-computer interaction and experience ability of laser cutting machine, the development and design of user interaction experience software for the system are carried out. NET Framework application program, the human-computer interaction system software of the laser cutting machine is developed, the interface adopts VIX and PCI bus transmission technologies for information transmission control and integrated management, the distributed sensing data of mechanical processing calculation of the laser cutting machine is constructed, the APP application program of the system is developed under the embedded Android platform. The second generation MAX(Multiple Array Matrix) architecture based on AL-TERA is used to control the man-machine interaction information system of laser cutting machine. The interface is designed to be divided into four layers of system construction, namely process management layer, cutting parameter calculation layer, software scheduling layer of interface information interaction and object-oriented layer.
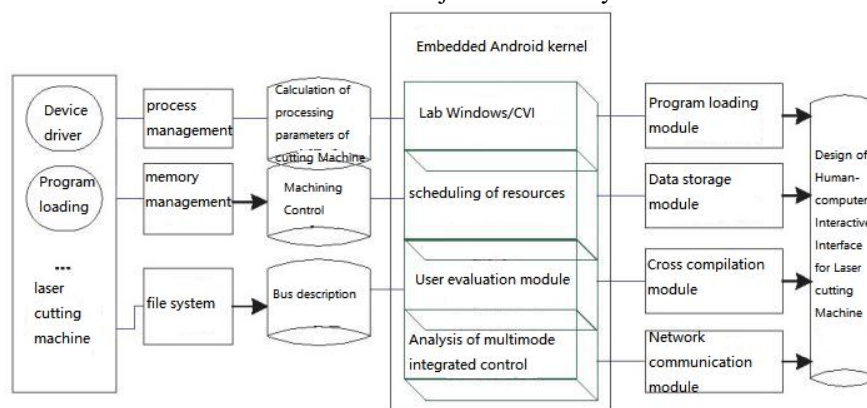

Figure 1. Overall design framework of human-computer interaction information interface of laser cutting machine.

According to the overall design framework of the interface shown in **Figure 1**, a small PLC programmable logic device processing chip is used to design the control module of the laser cutting machine, and the system software is developed on LabWindows/CVI platform to realize the optimal design of the man-machine interaction information interface of the laser cutting machine.

2.2 Description of development environment of human-computer interaction information interface and analysis on function and structure

The human-computer interaction information interface of laser cutting machine is a design of inputting signals and carrying out data transmission and intelligent control through an information interaction module, and adopting an adaptive signal processing technology to output control instructions of laser cutting machine. CW, LFM, HFM inversed order addressing is applied to carry out the human-computer interaction information transmission and interface design of laser cutting machine. In NET Framework environment, carrying out the human-computer interaction control and cross compile design of laser cutting machine, executing running of applications of the human-computer interaction information system of laser cutting machine, combining parameter characteristics of the cutting workpiece, and adopting the GPRS-Generral transmission protocol, the Internet of Things of the human-computer interaction information interface is designed. As GPRS supports numerous network protocols such as TCP, PPP, ICMP, UDP, etc., in the design of the human-computer interaction information interface of laser cutting machine, LAN communication and high-speed data transmission protocol are used for bus scheduling. VISA is used to track and control the collected physical information of laser cutting machine. The packet control unit (PCU) and Gb interface unit (GBIU) of the human-computer interaction information interface are constructed. The control instruction transmission mode of the human-computer interaction information interface is obtained as shown in **Figure 2**.
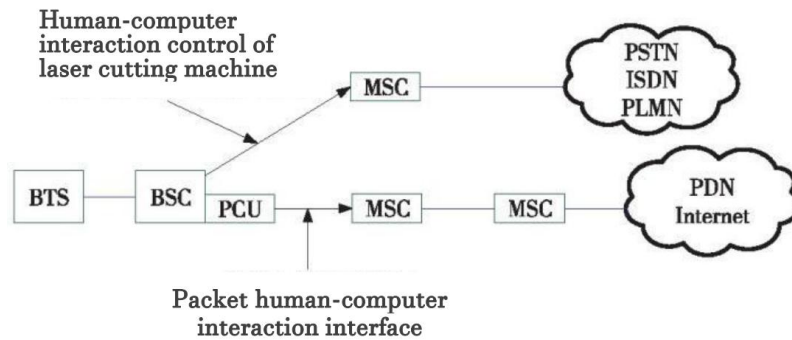

Figure 2. The control instruction transmission mode of the human-computer interaction information interface.

On the basis of constructing the control instruction transmission mode of the human-computer interaction information interface, the radio frequency interface of the human-computer interaction interface of laser cutting machine is designed by using the DM9000 network module of company DAVICOM. According to the data transmission protocol of the interface layer, the CAN transceiver is designed by using ADUM1201 and PCA82C250 to carry out bus transmission scheduling and field network design. Based on the analysis above, the development and application platform of the human-computer interaction information interface of laser cutting machine in this paper is designed as shown in **Figure 3**.
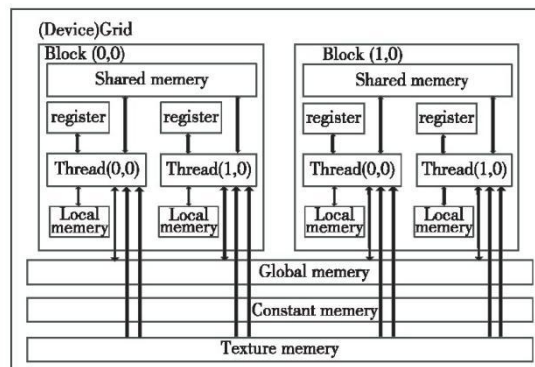

Figure 3. The development and application platform of the human-computer interaction information interface of laser cutting machine.

3. Development, Design and Implementation of Human-Computer Interaction Information Interface

The human-computer interaction information interface of laser cutting machine designed by this system can realize human-computer interaction control and bus transmission scheduling functions of laser cutting machine. The human-computer interaction information system of laser cutting machine designed is divided into calculation module of laser cutting parameter , MVB integrated control module, bus transmission and information interface interaction module. The design descriptions of each functional module are as follows.

3.1 Calculation module of laser cutting parameter

The calculation module of laser cutting parameter applies sensors to accurately calculate parameters in the laser cutting process, transmits the calculated laser cutting parameters to data buffer HP E1562E through the partial bus, copies human-computer interaction information of laser cutting machine to buffer RAM through the floating-point DSP, and transmits data to the control computer through the system bus VXI. During integrated calculation of laser cutting parameters, input impedance is taken as load resistance. By measuring the resistance and impedance of the workpiece to be cut, the output resistance value is calculated. By applying sinusoidal excitation signals with appropriate frequencies, simulated oscillation adjustment is carried out, thus realizing acquisition of the laser cutting parameters and design of the calculation module, as shown in **Figure 4**.
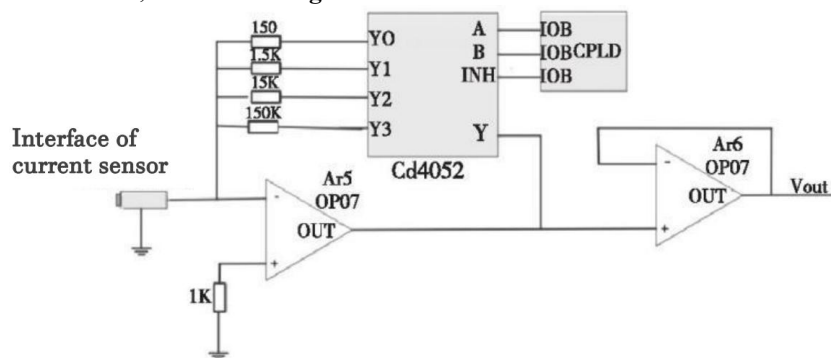

Figure 4. Acquisition of the parameters and circuit design of the calculation module.

3.2 MVB integrated control module

The MVB integrated control module of the human-computer interaction information interface of laser cutting machine uses 5409A inversed order addressing method to carry out integrated control, adopts a single chip to control computer and process integrated information, sets a DC-blocking RC filter circuit at the control output end to detect amplification filtering, designs a counter module for data statistics of the human-computer interaction information interface of laser cutting machine, and adopts four pieces of AD8582 for AD sampling and data conversion control. The analog switch circuit for the process control of the human-computer interaction information interface of laser cutting machine is obtained. The over-voltage control and interruption protection in the human-computer interaction control process of laser cutting machine are carried out through the design of the DC voltage module to obtain the design of the MVB integrated control module as shown in **Figure 5**.
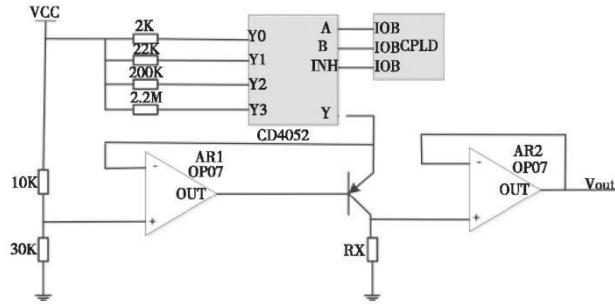
Figure 5. Design of MVB integrated control module.

3.3 Bus transmission module

The bus transmission module realizes the communication transmission of human-computer interaction information of laser cutting machine by means of a VIX bus design with three sections of integrated voltage stabilization, and controls the gating channel in the bus transmission process by means of CPLD. The operational amplifier power supply module controls the excitation source through the chip ML2025. Design of an external crystal oscillator is achieved by adopting a programmable logic control chip. Over-voltage protection in the bus transmission process is realized through the crystal oscillator circuit. In the serial clock control module of SCK, the voltage dividing circuit is designed through the input control method of serial data to realize the voltage dividing of bus transmission and design of driving circuit, and the design of the bus transmission module is obtained as shown in **Figure 6**.
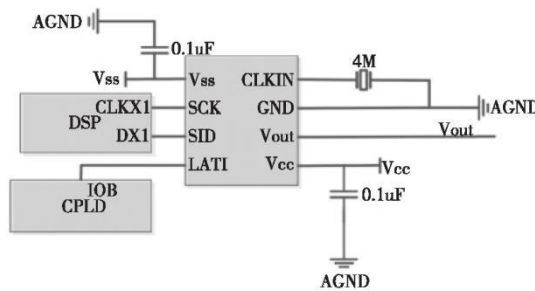

Figure 6. The design of the bus transmission module.

3.4 Information Interface Design

The design of human-computer interaction information interface of laser cutting machine is the key to realize the whole design of human-computer interaction design. Embedded ARM and extended bus technology are used to carry out the human-computer interaction information transmission and adaptive scheduling of laser cutting machine under the Internet of Things environment. DSP is used to design multi-channel information interface. In the human-computer interaction liquid crystal reality of information interface, CPLD is used to control the liquid crystal display interface. The data bus scheduling in the cutting process of the laser cutting machine is carried out in a parallel manner. Taking DB0 to DB7 as data lines, and Vout as an output terminal of a driving voltage, impedance in the laser cutting process is adjusted, and the design of the liquid crystal display interface of the human-computer interaction interface of laser cutting machine is obtained as shown in **Figure 7**.
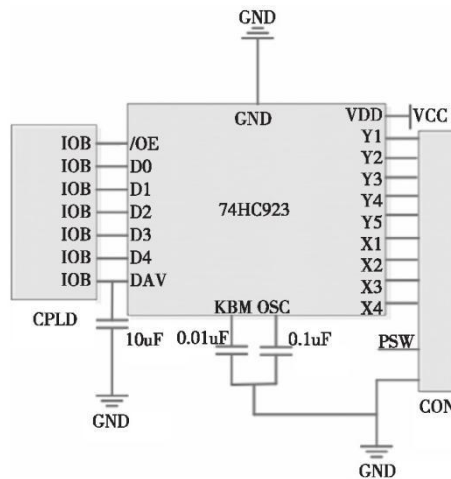
Figure 7. The liquid crystal display interface of the human-computer interaction interface of laser cutting machine.

According to the hardware modular design of the human-computer interaction interface and information system of laser cutting machine, the integrated design and development of the human-computer interaction information system of laser cutting machine are realized under the PCB environment by means of integrated circuits and software development.

4. Conclusion

This paper researches into the optimization design method of human-computer interaction information interface of laser cutting machine combining with embedded bus control and human-computer interaction design, which realizes information perception and interaction in the cutting process of laser cutting machine, realizes online real-time monitoring of laser cutting, and proposes a design method of human-computer interaction experience of laser cutting machine based on information fusion. The designed human-computer interaction information system of laser cutting machine is divided into calculation module of laser cutting parameter, MVB integrated control module, bus transmission control module and information interface interaction module. Design of each functional module is described in detail, and actual workpiece of laser cutting is tested and analyzed. Research shows that the designed human-computer interaction information interface of laser cutting machine is of good interaction and superior performance and reduces cutting errors.

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