Research on Human-Computer Interaction System Based on C8051F040

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Abstract: In recent years, many new technologies have appeared in the field of construction machinery control, such as condition monitoring, fault diagnosis, intelligent engine control, and human-computer interaction intelligence. This topic has developed a control system suitable for various construction machinery control platform, only need to modify the corresponding application software according to the application requirements to realize the application on different construction machinery. The platform consists of two parts: human-computer interaction module and monitoring module, the former realizes the information interaction between the operator and the monitoring module. The latter completes the machine's motion control and monitoring of the running state. The human-computer interface uses a cost-effective monochrome large-screen LCD for graphical display, and the menu structure and graphics of the interactive interface are visually designed for the operator.

1. Introduction

With the more complicated working conditions of construction machinery, the market competition is becoming more and more fierce, and the control accuracy and intelligent requirements of construction machinery for control systems are constantly improving [1]. Construction machinery controllers are a type of motion controllers, and motion controllers have experienced separation [2]. Electronic devices, integrated circuits and the current era of microcontrollers [3]. The emergence of microcontrollers has led to the rapid development of motion controllers, and also entered the era of digital control of motion control systems [4]. Foreign countries have done a lot of research in the field of construction machinery control. For example, research in condition monitoring, fault diagnosis, engine control, human-computer interaction intelligence, etc.; and developed a variety of intelligent construction machinery controllers, such as series controllers from Rexroth of Germany, series controllers from Siemens of Germany, Finland Series controller etc [5].

In recent years, the country has continuously increased investment in infrastructure such as transportation, and the construction machinery industry has developed rapidly, and its electrical control system is developing in the direction of high intelligence, high reliability, and low cost [6]. The important components of the system are meeting various challenges, such as the more complex control systems, the increasing amount of human-computer interaction data, the higher real-time requirements, and the more complex electromagnetic environment [7]. Judging from the current construction machinery man-machine interaction platform, they have the following disadvantages: the degree of intelligence is not high; the man-machine interaction interface cannot be seen clearly under strong light and high temperature; it does not have bus communication function or the communication speed is slow, the communication is unstable, real-time poor performance, etc [8]. Therefore, this article designed a human-computer interaction system based on C8051F040 to meet the needs of the field of construction machinery.

2. Design Task

This topic designs a C8051F040 human-machine interactive control platform dedicated to construction machinery, which can not only improve the processing capacity of the control platform, but also make the control platform have good scalability [9]. The human-machine interactive platform realizes the information of the operator and the monitoring module. The interaction and monitoring module realizes the motion control and running status monitoring of the machine [10]. It can be applied to different types of construction machinery by modifying the application program on the operating system, which will have a certain impact on the improvement of China's construction machinery intelligence and will also be enterprises bring great economic benefits.

3. System Design

3.1. Human-computer Interaction Module

The task of the human-machine interaction platform of the construction machinery control system is to realize the information interaction between the operator and the construction machinery control system. The bus-based intelligent control system human-computer interaction system designed in this paper improves the scalability, reliability and convenient debugging of the system. The hardware design of the human-computer interaction platform adopts a modular design method. As shown in the figure, the system consists of ten modules, namely: microcontroller, liquid crystal display module, communication module, signal collection module, clock module, alarm module, memory module, button module, watchdog reset module and power module. Take C8051F040 as the central processor, use the popular CAN bus in the industrial field to communicate with the control node, and apply LCD graphic display technology to display the status of the monitoring system in real time. And designed a can communication protocol with strong practicability.

(1) Micro control module. Considering that it mainly realizes the display and communication functions of the man-machine interface, no complicated data processing and control functions are needed, so the C8051F040 chip is used. It is a mixed signal processor with CIP-51 as the core, its internal resources are rich, there are 8 sets of IO ports (64), integrated a CAN 2.0b controller, only need to add a CAN transceiver device to connect to the can network, a SPI serial peripheral interface controller and a compatible I2C. The bus's SMBUS bus controller not only simplifies the peripheral circuit and reduces the cost, but also improves the stability of the system. The maximum working rate of C8051F040 can reach 25 MIPS, which is enough to meet the real-time data update and page switching, and integrates 64KB Internal ROM, 4.2KB internal RAM.

(2) Liquid crystal display module. In order to adapt to the industrial site environment (reducing the impact of direct sunlight on the visual effect), the LCD monochrome screen-LM2088ECW is used for graphic Chinese character display (practice shows that the color screen can be more powerful than the monochrome screen under strong light (The visibility is poor), and the cost of the monochrome screen is much lower than that of the color screen-LM2088ECW is a monochrome graphics dot matrix LCD screen, size 5.7 inches, inches, pixels 520*240, its advantages are low power consumption and high or low temperature performance is well, relatively good visual effect under strong light, internal control circuit, high cost performance. The display's grayscale and brightness design are manually and automatically adjusted in two compatible modes, the former directly adjusts grayscale and brightness through buttons. The latter is based on the detected environmental variables (temperature) to automatically perform closed-loop control of the grayscale and brightness drive voltages to keep grayscale and brightness within the most suitable visual range for the human eye.

(3) CAN communication module. Realize the communication function between human-computer interaction platform and monitoring module. C8051F040 integrates CAN 2.0B (full-function CAN) controller, compatible with can 2.0A (basic function CAN), so only external CAN Transceivers and isolation devices (high-speed optocouplers) are sufficient.

(4) Signal acquisition module. It includes temperature collection (using DS18B20) and system power supply voltage detection (using internal AD). By collecting on-site ambient temperature, the

brightness and grayscale of the display are compensated to make the display visual the effect remains the best.

(5) Clock module. Use DS1302 to provide time information for the system.

(6) Alarm module. It is mainly used to give an audible alarm to the system alarm information. In order to reduce the system cost, a buzzer is used to give an alarm prompt.

(7) Storage module. It is used to save important information about the operation of the machine (such as the current running time value of the machine, historical fault information, etc.) and some information of the human-computer interaction module itself (grayscale potentiometer value, brightness potentiometer value, Chinese characters and picture information, etc.), considering that the amount of information is not very large, and the requirements for the number of erasures are very high, so the eeprom memory chip (AT24C1024, its storage space is 128KB) is used, its cost is relatively low and the number of erasures can reach hundreds Ten thousand times.

(8) Button module. Its function is to set various parameters of the control system, calibrate various intelligent sensors of the control system, read the parameters of the control module, and change the page of the man-machine interface. The C8051F040 has a total of 64 IO ports, and there are enough ports after other modules are used. therefore, using an independent keyboard can reduce keyboard scanning time.

(9) Watchdog reset module module. The watchdog circuit is mainly used to improve the stability and reliability of the system. When the system enters abnormal operation for various reasons, the watchdog circuit can automatically reset the system and restart normal work.

(10) Power supply module. Provide various dc power supply for the system, the front end uses a wide voltage input isolated power supply module, and the rear stage uses LDO regulated power supply chip.

3.2. CAN Communication Protocol

ID is the identifier of the arbitration field, taking the standard format (length is 11 bits), each node has a unique ID number. Length (4 bits) refers to the data length of the data field, located in the control field. Key (keyword) is the lower four bits of the first byte of the data field, which is used to describe the type of valid information sent (3 represents valid status information, 5 represents request to send status information, 6 represents calibration controller information, 9 represents system alarm information, 10 Indicates that the message was successfully returned, etc.). Index (data index number) is composed of the lower eight bits of the second byte of the data field, and the upper four bits of the first byte constitute the upper four bits of a 12-bit binary number, which refers to the corresponding node. The index number of the status information. All status information of each node has a unique data index number, but different nodes can have the same data index number. Data (effective data) refers to the status information of all nodes. For example: human-computer interaction, the node number is 0*121, the data node number to be updated is 0*181, the data length is 3, and the data index number is 356.The data that human-computer interaction will send is shown in the following table.

Table.1. Human-machine interactive transmission of messages

0*181	0*03	5	356	0*00

After receiving the information, node 0*181 judges that the keyword is 5, indicating that the human-machine interaction request sends status information, and then obtains the corresponding information through the data index number (if it is 0*39) .The data returned to the human-machine interaction is as shown in the following table display.

Table.2. Message returned by human-computer interaction

0*121	0*03	3	356	0*39

After receiving the information, the human-machine interaction returns the successful reception flag information to the node. The data is shown in the following table.

Table.3. Human-computer interaction response message

0*181	0*03	10	356	0*00

After receiving the information in Table 3, node 0*181 stops sending the information in Table 2, otherwise it continues to send until the number of transmissions reaches the set upper limit (20 times).

3.3. Monitoring Module

The monitoring module is the heart of the entire control system, that is, to complete the control of the movement of the machine and the detection of the running state, and at the same time, the machine's control state, running state information and alarm information must be fed back to the human-computer interaction platform in time. The task-level response time is uncertain and relatively long, so it is difficult to meet the real-time requirements of the system. This system uses a real-time operating system (RTOS) with μC/OSⅡ as the core. MC/OSⅡ is a deprivable core as long as the highest priority. Once the task is ready, you can get the right to use it, so the real-time performance is very good.

The timing of the read and write bus of the system is analyzed, and the bus timing is shown in the figure. When reading and writing data, first set /CS to 0, /WR and /RD to 1, and secondly, according to the type of read and write data, it should be judged that 1 should be written to the A0 bit. Or 0, if it is to write command word or read display memory data, read cursor address, write 1 to A0, otherwise write 0. After delay t2, set /WR or /RD to 0 according to the type of read and write, if read, set /RD Is 0, /WR is 1, and vice versa. Then, if the data is written, the data is assigned to the eight-bit data ports DB0 ... DB7, after a delay of t4, /WR is set to 1, and after a delay of t6, /CS is set 1 If you are reading data, you need to delay more than t3+t13+t11, then read the eight-bit data port data, then set /CS to 1, and then delay /6 to set 1.

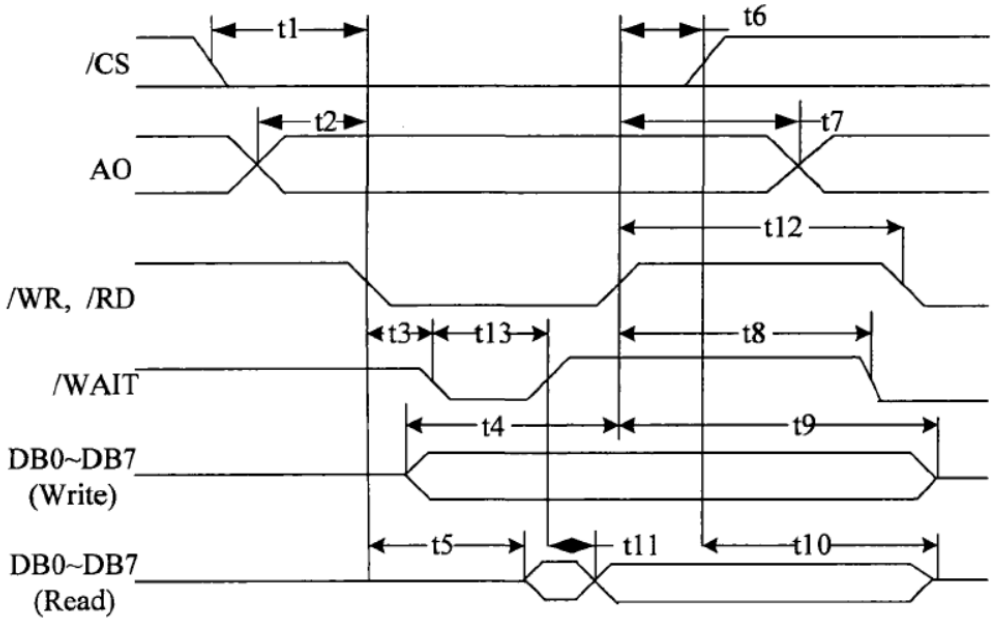

Figure 1. Bus timing

In addition, it is also equipped with data update, key processing, alarm processing module, backlight and grayscale automatic adjustment. Among them, the data update mode is to update the dynamic information of the current interface in real time through communication. The key processing module mainly completes interface switching and system settings, Calibrate the bus node and other functions. The alarm processing module mainly records the alarm information of each time, whether there is any processing situation, and the alarm process is completed in the interruption to achieve the purpose of real-time alarm. The backlight and grayscale automatic adjustment module is mainly. According to the temperature value collected regularly, the backlight and grayscale are automatically adjusted to ensure that the display always maintains the best visual state.

4. Conclusion

This subject designed a manual interaction platform for engineering machinery control, using C8051F040 as a processor, a monochrome screen with control LCD (LM2088ECW) for graphic display, and designed alarm, communication, contrast control and other circuits to achieve human-computer interaction. The hardware design of the platform has the advantages of intelligence and high reliability, and has reference significance.

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