DESIGN AND IMPLEMENTATION OF A LOW-COST AND VERSATILE ELECTRIC FILE CABINET SYSTEM

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ABSTRACT

In this paper, the driving system of a kind of multi-functional electric file cabinet gets constructed. Its hardware system, running platform for the file cabinet system and software system all get developed, and keyboard input, infrared remote controlling and computer accessing for the multi-functional electric file cabinet system are achieved. The system can control up to 12 suits of file cabinets with very low demand of cost. The work is derived from the problem that the high cost of the current products on market made it against being produced in quantity.

Keywords: *Control, File Cabinet, Security*

1. INTRODUCTION

There appear electric filing cabinets on the market, but they are often with less function, homogeneous control mode and higher cost in particular. To solve the problem that the current products on market was too expensive to produce in quantity, we designed a versatile low-cost electric filing cabinet system. With single chip as the core, the system can be handled with keyboard control, remote operation and computer control. Each set can automatically control 12 filing cabinets with very low cost, so it changes the current situation of the electric file cabinet system.

2. SYSTEM DESIGN

To solve such problems of the current electric filing cabinet system as single function and high cost, this paper constructs a system of mechanical and electrical drive. AT89C51 single chip is employed as the core to develop embedded system to be the electric control system of the filing cabinet. Software system is developed for drive control, and to respond to user's input request, so that the user's needs for the file cabinets can be fulfilled. The software system realizes the control of the file cabinet with keyboard, remote control or computer. The electric-control file cabinet does not rule out the manual control.

2.1 Structure of the Driving System

Driving system is also the action system of a filing cabinet. To use electricity to motivate a heavy file cabinet, a larger torque motor is indispensable. This motor should be installed in all filing cabinets except the last set. That is, among all filing cabinets, there is a set which needn't to move. It is the last set, or the first set if counted from the other end.

Therefore, the motor of the driving system is installed in all cabinets but the last set. Each set of filing cabinets has to be equipped with moving wheels, which are driven by built-in gears. This built-in gear joggles with the motor gear through the clutch. The two gears are joggled only when the control system controls the files and the clutch closes. They are isolated from each other in the rest of the time. Such a design, on the one hand, enables cabinets to be moved by hand in the case of non-electric control or power outage so that electric control and manual operation are both realized. On the other hand, during the electric control, all the cabinet built-in gears joggle with the motor gears. The larger motor torque ensures that the moving filing cabinets will not push away those needn't moving.

2.2 Structure of Hardware System

The functional requirements of this electric cabinet determine the hardware system structure as shown in Figure 1. The interface board is responsible for the man- machine interface control besides computer control, including remote control input and keyboard input control, and converses input control into instructions towards the system. Through serial interface, the instructions are sent to

the communication board, which receives the instruction and displays the status of the system as well. In addition, the wireless remote communication is accomplished by using infrared means.
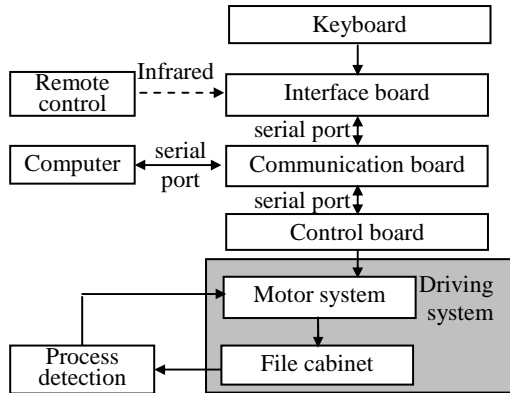

Figure 1 Structure Of Hardware System

As the core of the control system, the control board is expected to complete driving controls to those motors in all filing cabinets. It should steer the running direction of each motor, the direction that filing cabinets move to. It also control the closure and separation of the clutch in each set, checking their location, so that dynamically control the moving or halt of them. The control board also uploads the real-time running status of each set to the interface board or computer through serial port, thus system running can be displayed.

2.3 Structure of Software System

The hardware system is a system-wide operating platform, while the software system is the key to realize all functions of the system. Its structure is shown in Figure 2. The interface board software illustrated in the system, on the one hand, translates the signals received from the remote control into operating instructions; on the other hand, It changes the user's keyboard input into operating instructions after scanning, and then send through the serial port to the communication board. Computer software, or the PC software, is responsible for sending user's input to the communication board, and receives and displays the system status which comes from the control board and transmitted by the communication board. Communication board software plays a role of communication hub to transmit the instructions and status information from all directions. While the control board, based on user input commands, carries out real-time detection of the state of each file cabinet, and dictates the driving system of the cabinets to move them, freeing up space needed by the user to look up files.

2.4 Performance Design

Safety performance consists of user access security, using safety and operation safety. User access security refers to the case that those unauthorized users use the filing cabinet system to look up files without permission. This problem is solved mainly by taking use of a system key, which controls the system boot, and of computer software encryption. Using safety means that when a user presses the keyboard, remote control or clicks the button for a instruction, he needs to confirm the instruction to avoid mistakes. Operation safety is the possibility that filing cabinets may lose balance or even collapse during running for such reasons as uneven display inside. The tragedy can be avoided by attaching each two adjacent sets at the top center position with hinges. Stroke detecting cable can be embedded in the hinges, addressing both operation safety problem and routing problem.
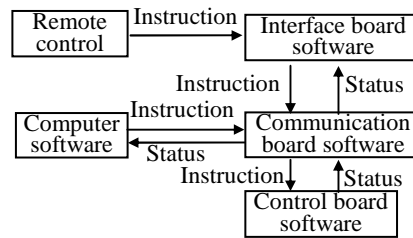

Figure 2 Structure Of Software System

Reliability of the system focuses on abnormal crash during operation, interference, as well as the problem-solving mechanism for filing cabinets running location. As CPU is the control core of the system, the running file cabinets couldn't stop when abnormal crash happens, causing security problem. This can be solved by using a watchdog circuit. As the driving system is often driven by strong electricity while control system is generally powered by weak, the strong power system has quite interference with the weak. In serious situation, the control system even fails. Therefore, appropriate isolation measures must be taken. Each time a set of filing cabinet runs, the user should not consider their location. They should be ready to run or stop so that users can put more energy into the file management. This requires detection technologies to decouple the relativity of the location and the operation.

3. HARDWARE DESIGN

The hardware system is the basis of the system. The operating instructions are received by interface board and then transmit to the control board through communication board. According to user's

commands, the control board, on the basis of real-time detection of file cabinet status, controls the action of each set of filing cabinets, driving the system to run.

3.1 Control Board Design

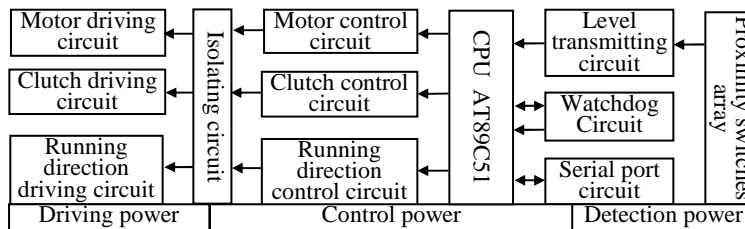The control board is the core of hardware system. Its structure is shown in Figure 3.

Figure 3 Block Diagram Of Control Boar Circuit

CPU is the core of the control board. It tests the status of each set of filing cabinets and directs the driving circuit to move the cabinets according the user's command received by the serial communication circuit. The watchdog circuit is responsible for monitoring CPU operating and control power state to ensure the reliability of the system. The control power should be the control system +5 V power supply. Proximity switch array is the Hall sensor installed in the file cabinets, which checks the location of cabinets[1]. Longer cable will be needed if there are more file cabinets, which results in great attenuation of signals, so +12V detection power supply should be adopted. When a set of running filing cabinets gets close to another, proximity switches send this information to the level conversion after detection. The information is converted to TTL level and input to the CPU for monitor[2]. When the system is running, some filing cabinets will move forward, and some should be moved backward. The running direction control circuit makes polarity control to the driving power supply (+24 V) of the driving motor, in order to achieve this direction control. The clutch control circuit ensures the clutch gets closed during running, and gets separated after operation, to realize the meshing control of the built-in gear and the motor gear. The motor control circuit supplies powers to the motors in cabinets, achieving the mobile control to all of them.

There are several key problems for control board must be solved. first, the drive circuit needs stronger driving power, which demands highly for the circuit board wiring layout and producing techniques; second, the +24 V driving power with its large currents will interfere greatly with the control system, causing the failure of it. An isolation circuit should be adopted to make optical isolation between the driving circuit and control circuit. a watchdog is used for monitor, and plan reasonably in circuit layout and copper covering.

The power should not on the same place. Third, control levels corresponding to each driving circuit should have rational planning. They must be separated from high level region emitted from all ports when the system reset, so that ensure the safety and reliability of the system

3.2 Interface Board Design

The infrared receiving circuit receives from the remote control and infrared signals, and carries out PWM demodulation[3], with its decoding accomplished by the software on CPU. Finally, it transmits user's commands from remote control and keyboard input commands into control commands and then send to the control board.

3.3 Remote Control Design

Using SC9012 controller chip, the remote control insures users' key input operation, and encodes and modulates the scanning keyboard input. The high and low levels control infrared emitting diode turn-on and turn-off, so infrared signal sending is achieved[4]. The software design of each system can make one remote control shared by many systems.

4. SOFTWARE DESIGN

4.1 Control Board Software Design

Control board software receives user's operating instructions, detects the status of the filing cabinets, and plans the mobile programs for filing cabinets. It firstly moves backward the cabinets behind the one the user requires, and then it monitors the real-time status of cabinets during moving, and sends out the running situation. It also makes real-time and dynamic adjustment of moving programs according to the status of each file cabinet. If the cabinets moving backward are in their place, the software moves those in front of the one the user requires.

Similarly, the real-time detection and sending of the cabinet status are needed, so does the

adjustment for the moving program. In the process of moving, the user may suspend at any time, or may change the operational requirements. Therefore, the software must be ready to monitor the user commands, and make a timely response to them. As the system has decoupled the location dependence with user's operational requirements, independence of cabinet location gets realized, so users can to change the operational requirements at any time, causing no troubles in software design. Before the software accomplishes these operations, the system must be initialized. During operations, the software must feed the watchdog in case that the watchdog mistakes an abnormal state of the system and reset it.

4.2 Interface Board Software Design

The interface board software completes the scanning of keyboard input, receives infrared remote control commands and decodes them. it determines the user's operation, and changes the operating requirements into control commands, then sends to the control board. At the same time, it receives status information from the control board for display, so that users can know the operation of the system. Due to safety concerns, when a user makes operation input, he must enter the run key, then input the number of the set within 1 minute. This is treated as valid input, otherwise invalid input, and the system will not respond to.

Infrared decoding process is achieved by interrupting response, calculating the time interval between each input level to determine the infrared remote control operation code.

4.3 Communication Board Software Design

Based on communication board hardware circuit, communication board software makes the modules on the circuit work together, and receives and transmits the operating instructions and state information from other circuit boards. This software must firstly initialize each module and program the timer, so that certain baud rate clock signals can be provided for each serial port expansion module, which joins with the clock signal to complete communication conversion from the parallel port to serial port according to the CPU's control input into its registers.

5. SYSTEM IMPLEMENTATION

The above statement illustrates the driving system of a versatile electric filing cabinet system. the design of its hardware system, the operating platform and its software system make the system achieve keyboard input, infrared remote control

input and computer-controlled access, so that a single system can control up to 12 sets of filing cabinet. During user's operation, the process can stop at any time, or operational instruction can be changed in accordance with requirements without regard to the current location of file cabinets. The simple operation enables file keepers to focus all their energy on the file management, which greatly improves work efficiency. As the system uses MCU, it has the features s of reliable system, high safety performance and low cost, well below high-cost system with PLC the market[5], being the first choice among the versatile electric filing cabinet in low-cost.

6. CONCLUSIONS

The multifunctional low-cost electric filing cabinet system introduced in this paper can be handled with several operating mode like computer control, keyboard control and remote input operation. If on the same place, the remote control can instruct more than one system. However, as the remote control is achieve by using infrared communications, its control distance is shorter, limited to within a room. For enlarging its control distance, the further research is that microwave remote control is added to the remote control means.

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