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SOC chip based smart window curtain design

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Abstract. Relying on the rapid development of embedded systems, it becomes possible to integrate the system hardware into the same chip, and the system on chip SOC (System on Chips) is therefore birthed. This paper will be based on the SOC hardware and software co-design and verification, through the design of intelligent curtains for the specific implementation design of a kind of application in the al-in-one multi-functional machine motherboard design, the motherboard control core using SOC chip, integrated two MCU units, through the main control screen to display the control information to achieve the intelligent window switching conversion switching through the key such as manual mode, timer mode, light control mode. This design uses Keil as the software writing platform to realize the SOC master control system based on the on-chip bus interconnection. As well as this design can effectively reduce the degree of system cumbersomeness and provide smart window design ideas.

Keywords: SOC, Keil, Smart Curtains.

1. Introduction

The development of SOC makes the size of the system hardware greatly reduced, and the delay between the hardware can be reduced, substantially improving the performance of the system, at the same time, SOC has a targeted, in the face of different research and development needs, SOC can give the most streamlined design solutions, and abandoned the previous need for multiple circuit boards to realize the system [1]. However, the technology used for SOC still faces a series of challenges, In summary, SOC hardware and software co-design is the inevitable trend in the development of integrated circuits at present and is also an important development direction for the future of electronic information technology.

For the control methods of intelligent curtains, they can be roughly divided into light control. clock control, sound control, and infrared remote control. What needs to mention is that in people' daily lives, sound control is often affected by noise and is difficult to implement. Therefore, sound control will not be applied in the design of intelligent curtains. If the design of an inexpensive, clear structure, high sensitivity, and the combination of remote control, time control, light control of the intelligent curtain

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system will have a better development prospect, the existence of intelligent curtains can also bring more convenience to human lives.

2. Hardware system overall design

This research system has the most basic function of a general curtain control system, opening and closing curtains by means of motorized buttons. On the premise of this basic function, this design is also designed according to the demand and can automatically open and close the curtains according to the light intensity and set time. In terms of selecting design options and using components, the system is based on the idea of being simple, practical, and economical. Trying to simplify the circuit design, using the simplest circuit wiring, and choosing the most economical and practical devices to achieve the design requirements [2]. As shown in Figure 1.

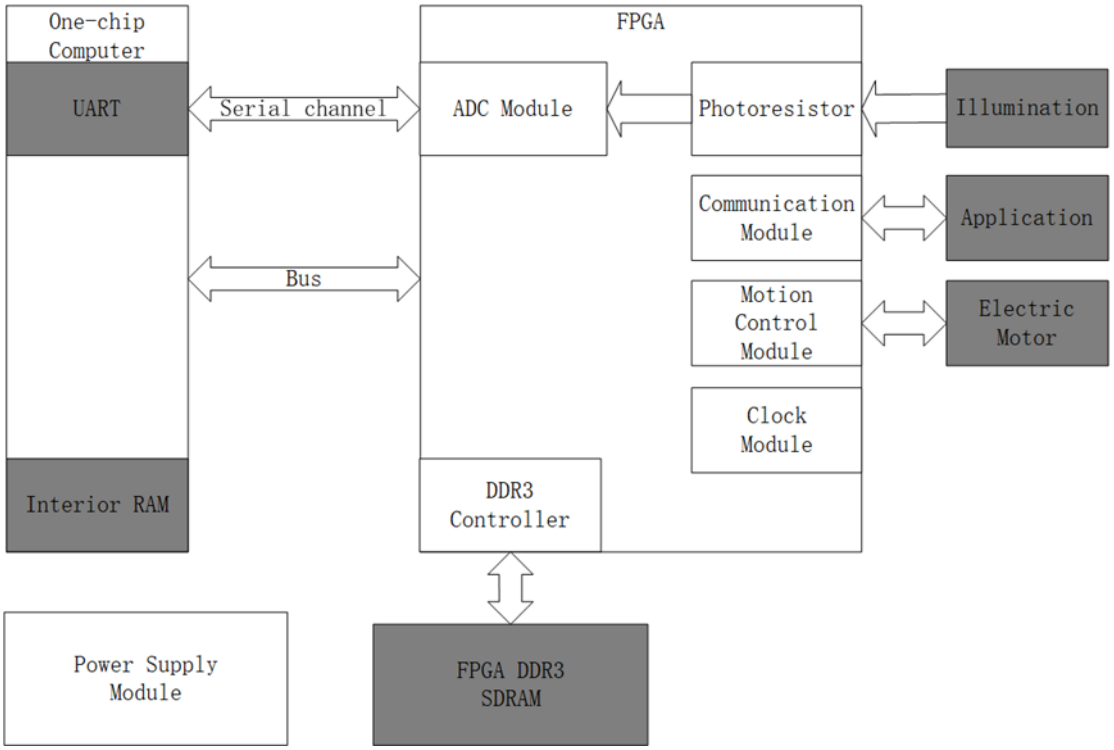

Figure 1. SOC design architecture diagram.

The system uses an FPGA chip to realize the functions of the motor module, light source signal module, and time display. Meanwhile, it realizes high-speed and stable data transmission with the help of a high-speed bus; the microcontroller is responsible for the operation and control of the system.

The automatic curtain control system has the basic functions of manual control, light automatic control, and time control [3]. The manual function is according to the user's needs through the key for the curtain switch, which can make the curtain open and close in any kind of state. The light automatic control function system can be set according to the user's light intensity value through the photocell to collect light automatically open and light curtains. The time control function is according to the user-set time one-time switch curtains. ln addition, the user can press the button is the above three control modes cycle switching.

Adopt a microcontroller as the system controller. Microcontroller has the advantages of strong reliability, cost-effective engagement, low voltage, and low power consumption, and other advantages have been rapid development and wide range of promotion. Microcontroller also has arithmetic function, software programming flexibility, freedom, and available software programming to achieve a variety of

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logic functions. With its own timer, counter can be used for timing and counting. At same time, it is low power consumption, small size, counting the advantages of maturity and low cost [4].

2.1. Clock module and motor control module

DS1302 clock chip is used to realize the clock, DS1302 is a high-performance, low-power, real-time clock circuit with RAM introduced by the American DALLAS company. It can be used to time the year, month, day, Sunday, hour, minute, and second, with an operating voltage of 2.5V to 5.5V, as shown in Figure 2. It uses a three-wire interface for synchronous communication with the CPU and can transmit multiple bytes of clock signals or RAM data at a time in burst mode. The DS1302 has an internal 31 8 RAM register for temporary data storage [5].

The motor control module of the motherboard can be divided into two kinds of stepper motor control and DC motor control, this design uses a stepper motor as an actuator to drive the curtain movement to realize opening and closing. The advantage of this program is that after giving a stop signal, it will stop immediately and will not cause damage to the curtain frame. What's more its torque is larger than the DC motor, which makes it easy to drive the curtain movement, but its disadvantage is that the price is slightly more expensive than the DC motor.

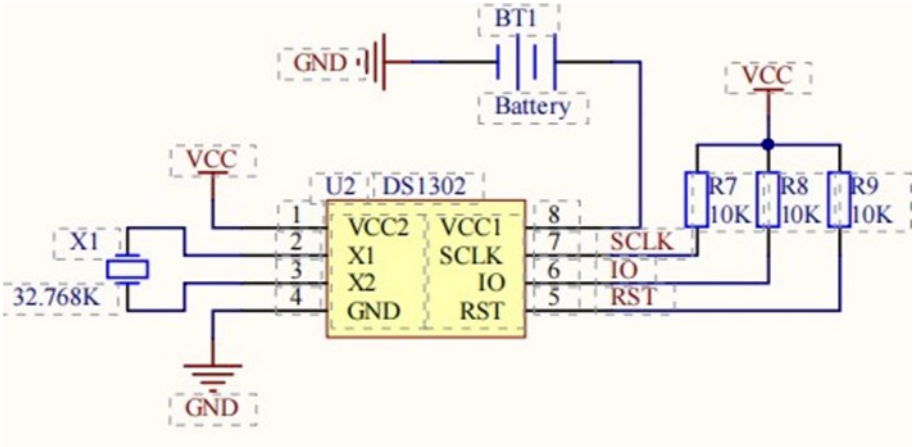

Figure 2. Clock module circuit [5].

2.2. Photometric and analog-to-digital conversion modules

This design uses a simple photoresistor as a light measurement module, as shown in Figure 3. The important characteristic of the photoresistor is that the size of its resistance changes with the ambient light. When the ambient light is stronger, its resistance decreases, on the contrary when the ambient light is weaker, its resistance increases. This design utilizes the characteristics of the photoresistor to detect the ambient light outside of the window and to realize the automatic opening and closing of the smart curtains in the automatic mode [6]. Analog-to-digital conversion module needs to convert the received analog signal into a digital signal, which will receive the signal photosensitive sensor light intensity signal. The analog signal is converted into a digital signal is transmitted to the LCD screen and display, and at the same time through the bus to the microcontroller and determine whether it meets the conditions for opening the curtains [7].

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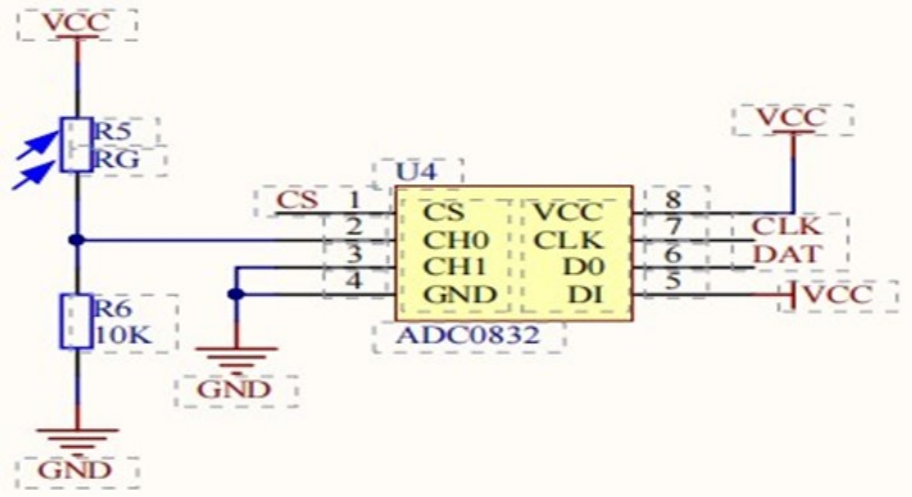

Figure 3. Photoresistor circuit [5].

2.3. Communication interface module and power supply module

The motherboard is equipped with Bluetooth communication and a Wi-Fi communication module to realize the remote control of a cell phone. It also carries three USB ports to realize external data input, which can realize the storage of light data and the expansion of additional functions as Table 1.

ln order to be able to support the development of the upper layer of hardware and software. SOC hardware platform has many interfaces various interfaces require different voltage standards, in order to make the system work properly. This paper designs a set of power supply system to provide the required voltage for each hardware module.

Table 1. Communication interface module.

code	I/O
USB 3.0 Device	This interface is used to connect to a PC for data transfer
USB 3.0 Host	Used to connect to the internal hard disk for light data storage or reading; It can also be operated via the touch screen monitor to locate the target for image storage
USB 2.0 Host	It can be used to connect to an external USB flash drive for image data storage or readout; it can also be operated via the touch screen monitor to find a target for data storage.
Ethernet(10M/100M/100M)	For connecting to a network for data transmission

3. Software design section

In this study, the KEIL software will be used for the design, and the C language will be used to write the main part of the program, which mainly includes the initialization of the device, the conversion of the three modes, and the implementation of the specific control in the three modes. Then the C language program will be converted into binary machine code and burned onto the microcontroller to realize the software design

3.1. Programming language and development environment

C language as a computer programming language, compared with assembly, C language in function, structure, readability, and maintainability has obvious advantages, and is easy to learn and use, is the computer as well as electronic information field of important tools. It was introduced by Dennis M. Ritchie in 1972 and has been ported to large, medium, small and micro machines since 1978. C can be

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used as a working system design language to write system applications and as an application programming language. ln the research process, C can efficiently and succinctly present the required design structure as well as ideas and can be converted into binary code and burned into the microcontroller [8]. Due to the need for C programming, this study chose to use Keil for software design, which provides a complete development solution including a C compiler, macro assembler connectors, library management, and a powerful simulation debugger.

3.2. Programming

3.2.1. Main program design flow

The software design flow chart of this system is shown in Figure 4. At the very beginning, the initialization of light information and clock chip is carried out first, after that the date and time data of the clock chip is read first. Then it is displayed on the top of the LCD screen, and then the light intensity is read and displayed. Then it enters a cyclic processing process. Further down is the mode button scanning, if the detection of a change in the mode button is pressed then according to the key set mode, every time you press the button will jump to the next mode to timed - manual - light for the arrangement and cycle. Finally, according to different modes different curtain switch control. If it is manual mode, the curtains will be switched on and of according to the open curtain key and close curtain key. If it is timer mode, the curtains will be controlled according to the set open time and close time. If it is light control mode, it will judge whether the current light is higher than the set control threshold. If it is, the curtains will be closed, on the other hand, the curtains will be opened. When the end of the light curtains will determine whether to receive instructions to change the control mode, if there is a return to the control mode judgment, and vice versa to maintain the status quo until there is a new instruction. This completes the process of a cycle.

3.2.2. Auxiliary programming

The display program is the collection of the operator interface and the display screen, which allows the user to know the situation of the curtains including the time and light intensity. The display also shows the current control mode so that the operator can adjust the control mode [9].

The clock program is used to display the current time, with the help of which the current time can be customized. ln this study, when the user's preset time is reached, the system will turn on and off the motion control module according to the setting. For humanization reasons the clock program can also be equipped with functions such as an alarm clock [9].

3.3. Summary and Future Program Testing.

This study presents the design theory as well as part of the program design, in order to test the correctness of the written program. Keil uvision is not only a software environment for microcontroller development, in which the debugger can help the user to accurately debug the ARM device's on-chip peripheral functions (12C, CAN, UART, SPI, interrupts, l/0 ports, A/D converters, D/A converters and PWM module and other functions). This study piggybacks on the analog-to-digital converter module, three control modules, and motion motor control needs to be debugged through the debugger accurate debugging combinations [10]. ULINK USB-JTAG converter can be used to connect the PC's USB port to the user's target hardware (via JTAG or OCD) so that the user can debug the code on the target hardware. Further testing will piggyback on modules that can use the ULINK USB-JTAG converter. After burning the program to the microcontroller, the binary program on the microcontroller needs to be tested for further verification. By using the Keil uvision debugger and the ULNK USB-JTAG converter, the user can easily edit, and test the embedded program on the actual target hardware.

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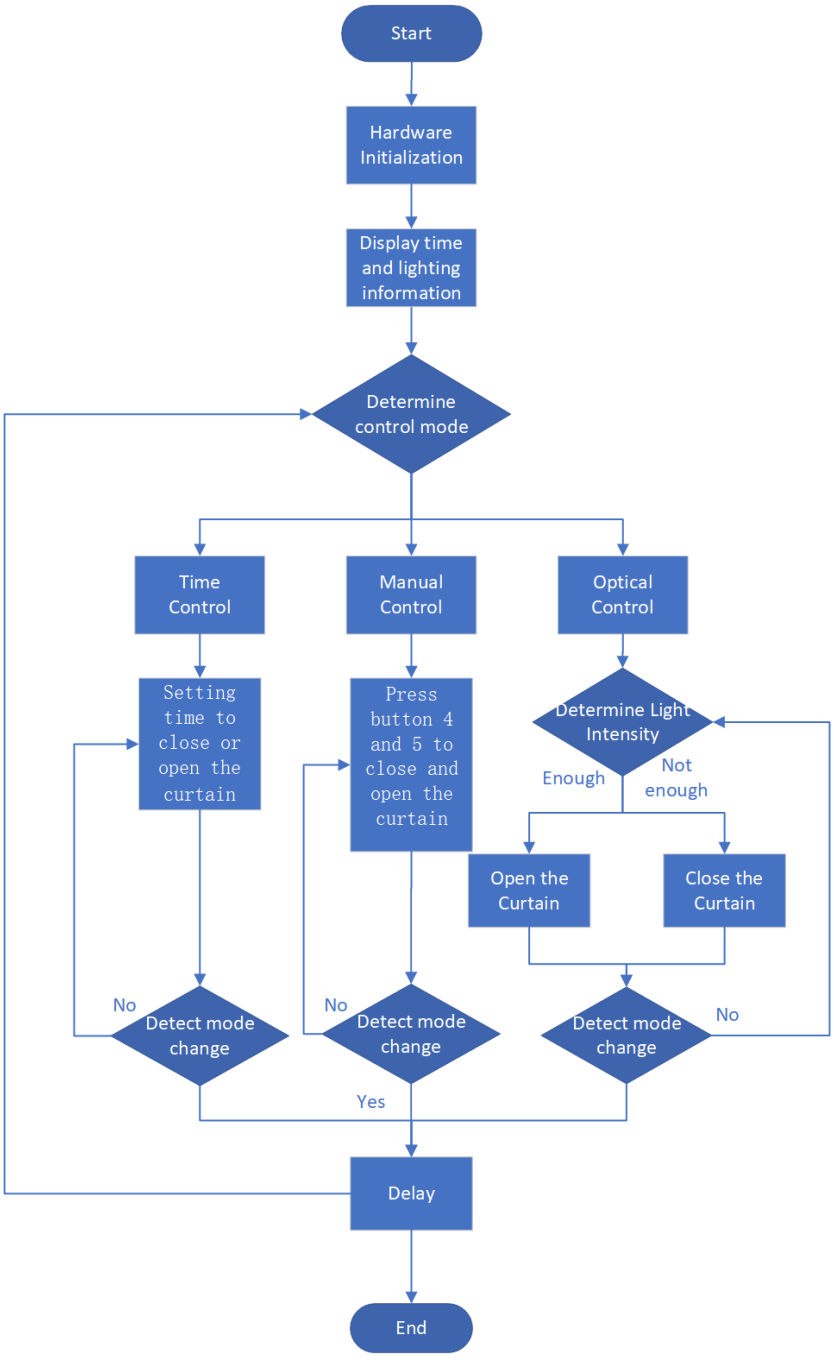

Figure 4. Flowchart of main program.

4. Conclusion

Smart home is an important part of smart life, and smart curtain is a branch of smart home. so it is necessary to study a practical smart curtain. This design is a smart curtain controlled by soc chip. intelligent curtains generally use three different control methods to send data and control the electric motor switch The system is stable, and reliable. real-time, and can centralize the management of software programs. This intelligent curtain method is commonly used in domestic households and is the object of the most frequent user interactive operation, which can realize automatic switching according to light, timed start, and manual control. Stronger ability to process data, analog data can be sent to the microcontroller before the analog data analog-to-digital conversion processing. After the pre-processing

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of the data and transferred to the microcontroller through the ARM, the data bus, which reduces the workload of the SOC FPGA processor and improves the effective utilization of the processor. This system is designed around simple, practical, low-cost design ideas, as much as possible to simplify the circuit part of the design, so that the circuit wiring is relatively simple while choosing more cost-effective and reliable components used to achieve the desired function. This intelligent curtain design makes the curtain automation degree higher, more intelligent, and better meet people's needs for smart homes.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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