Design of the LCD display system for elevator based on Embedded STM8S

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Abstract. Design of the LCD display system used for elevators based on Embedded STM8S was put forward, and design plan of the hardware and the workflow of the software were given at the same time, aiming at the defects of traditional elevator display system. This design scheme has high display precision, rich display function, good anti-interference performance and simple structure. It meets the requirements of real-time display when modern intelligent elevators working.

1. Preface
The application of Liquid Crystal Display (LCD) screen for modern elevator control system improves the control on intelligence and humanization. A friendly Human-Machine-Interface (HMI) is able to monitor the real-time operation statue and system safety, and furthermore, it brings the convenience for installation, commissioning and maintenance. The traditional elevator screen has the disadvantages of single display, numerous components, low resolution, bad functional expansion and etc. In order to solve these problems, a LCD screen system for elevators based on STM8S was designed in this paper. This system not only enables to display the information of floors, overload, full, fire alarm, overhaul and etc., but also is connected to the control system to realize the integration control of elevator.

2. System Design
This LCD screen system is a combination of modern elevator system and embedded technology, using 8-bits kernel processor chip from ST-Microelectronics as the core of the system. A design scheme based on STM8S chip and a LCD screen system which is composed of data transceiver circuit and driver interface is proposed. In this system, STM8S chip collects the button signals, processes in real-time and displays information on LCD screen. The system architecture is shown in Figure 1 as below.

The working processes of this system area follows:

- Microprocessor STM8S gathers the signals from the outbound buttons;
- Data transceiver circuit send the data from STM8S to CPU ARM9 (Chip of AT91SAM9263) through ModBus;
- CPU goes through acknowledge and execution judgment, and then sends instructions back to STM8S;
- LCD receives the information through driver interface circuit and displays the elevator operation information on screen.
Elevator system requests real-time monitor and control during the whole operation process, and ModBus protocol provides the real-time communication between the STM8S and CPU of ARM9 to transfer the information of outbound, floors, overload, full load and so on.

![Block diagram of system structure](image)

**Figure 1. Block diagram of system structure**

### 3. Hardware System Design

This system uses 8-bits microprocessor STM8S103K3 from ST company as master control chip. This microprocessor has advanced STM8 core with Harvard structure of three-stage pipeline and extended instruction set. Its flexible static memory controller provides the convenient connection to memories and peripheral, meanwhile, the existing peripheral on the STM8S enables the circuit design much easier. Hardware circuit consists of data transceiver circuit - the core of the system, STM8S master control circuit and LCD driver interface circuit.

#### 3.1. STM8S Main Control Circuit

The main control circuit uses STM8S103K3 microprocessor as the core chip, other connected circuits include clock circuit, reset circuit, floor button circuit, data transceiver circuit and LCD interface driver circuit. The circuit diagram is illustrated in Figure 2.

![Main control circuit diagram of STM8S103K3](image)

**Figure 2. Main control circuit diagram of STM8S103K3**
3.2. Transceiver Circuit
As an important part of the LCD screen system, data transceiver circuit is the data channel between the LCD screen and operation control system. In this system, ADM487 based on RS485/422 from Analog Devices is used as the data transceiver since its transmission speed reached to 250kbps. The wiring diagram is shown in Figure 3. Pins A and B of ADM487 are connected to the CPU of ARM9. ADM487 sends the receives operation instructions by ModBus protocol to transfer the data between display system and elevator control board. Pin RO and DI are connected to the sending end and receiving end of the STM8S, and UART protocol is applied for data transmission. Considering the stability and interference immunity, impedance circuit, inductive circuit and voltage stabilizing circuit are added in detail design.

3.3. CD driver interface circuit
The component is HT1621 LCD driver from Holtek Semiconductor, its wire connection is shown in Figure 4. The functions of this part are reading, writing and erasing system data, controlling data generation and transmission, display brightness adjustment and etc.

4. Software System Design
Software system mainly consists of three parts to control the LCD screen: data sending and receiving software, STM8S control software and LCD driver software.
4.1. Data Sending and Receiving Software

The software design for data sending and receiving contains two sections:

- driver program design of UART serial interface for STM8S and ADM487;
- The ModBus communication program design for STM8S and ARM9.

In which, the processes of the UART driver program are the reading and writing of buffer data and data sending and receiving, the detail procedure is shown in Figure 5.

![Figure 5. UART data transceiver drive process](image)

In contrast, the ModBus communication program design is more complicated and it is the difficulty of the whole design. Aim at the hardware situation of the STM8S and ARM9, firstly the system has to be initialized and open the interrupt. Secondly, to initial the serial interface, timer and variables. Thirdly, if the receiving interrupt is obtained and the receiving flag is 1, this program will start to receive the ModBus data frames; when the system gets the flag of receiving finished, program moves to the process module for ModBus frames, which unpacks, analyse and packs the data. Finally, system sends the response frame to mainframe. Processing chart is illustrated as below (Figure 6).

![Figure 6. ModBus frame transmission flow chart](image)
4.2. **STM8S Control Software Design**

STM8S microprocessor has the function of scheduling for whole system, and it controls the working states of all functional modules. This control software contains outbound button request, button signal transfer, control signal processing, algorithm design for display mode, LCD driver setting and etc. The flow chart is shown Figure 7.

![Flow Chart](image)

Figure 7. STM8S control software flow chart

4.3. **LCD Driver Software**

The LCD driver software drives the output interface, reconfigures the image data which means transfer the data into “0” and “1” codes serials that LCD can directly scan them, and display the information on screen based on the time sequence of display driver chip HT1621. This program is comprised of function definition of LCD initialization, control clock and registers configuration, data buffer frame configuration, coded signal and time sequence processing, resolution and pixels parameter setting and so on.

5. **Performance Analysis**

This elevator screen system based on STM8S is the combination of software and hardware. Program downloads to screen system by IAR software and system display results are shown in Figure 8. In this figure, it shows the information of arrows, overload, breakdown and overhaul of the elevator system, which meets the modern control requirements of elevators.

![Display Test Results](image)

(a) Floor arrow shows (b) Overload display (c) Fault display (d) Maintenance display

Figure 8. Display test results
6. Conclusion
This article proposed a design method of elevator display system based on STM8S on the basis of analyzing the present research status of elevator display system. This system adopts STM8S103K3 microprocessor as hardware, and display mode algorithm in software design to present the information of floor number, overload, full load, fire alarm, overhaul and so on. This system has the merits of high display resolution, abundant display functions, high integration, high stability, low consumption, low cost and small size. It is suitable for the environment of elevator-car and corridor and meets the design requirements of real-time display for intelligent elevator.

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