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Application of AT89S52 microcontroller network design and manufacture traffic light system model

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ABSTRACT: Traffic signals are an essential part of the urban traffic management system, helping to coordinate and control traffic flow, while improving safety for road users.To ensure effective operation of the signal system, a traffic light controller with time management features and flexible response to traffic situations is required[1,2,3], good integration with other systems, and remote monitoring capabilities are essential.

This article presents the application of AT89S52 microcontroller networks to design and manufacture traffic signal system models. In the system model, the authors use the AT89S52 microcontroller as the central controller (Master), Secondary AT89S52 microcontroller (Slave) as a controller to display time and traffic signals at intersections. The microcontroller network uses the RS-485 communication standard to ensure stable and accurate communication between system components.

KEYWORDS: AT89S52 microcontroller network, Traffic light system control,

I. INTRODUCTION

Traffic light systems play an important role in traffic management and coordination at intersections [4,5]. Currently, there are many articles about this controller, but they only stop at software simulation [6,7,8] or on models using a single microcontroller chip [9,10].Therefore, the authors used the AT89S52 microcontroller in real system design to help optimize the cost and flexibility of the system [11]. The RS-485 communication standard was chosen because of its long-distance and stable communication capabilities, especially in applications that need to connect many microcontrollers such as in traffic signal systems [12].

The solution of using the AT89S52 microcontroller network as a traffic light system controller is one of the highly effective solutions. This solution has not been used much and synchronously in practice.

When completed, the author's team's product brings important value in the field of traffic management and coordination, the applicability of the AT89S52 microcontroller network and multiprocessor communication: Improves traffic control efficiency. communications, applying the RS-485 standard to enhance communication capabilities, enhance maintenance and expansion capabilities, remote monitoring and control capabilities, and provide a foundation for learning, research and development.

The article has five main contents throughout: After the introduction, there is an overview of the research content, presentation of the traffic signal system, AT89S52 microcontroller network; Part 2 proposes the system diagram, proceeding to design the circuit diagram and PCB circuit for the Master and Slave controller; Part 3 assembles components into the PCB circuit, makes models and programs the control of the traffic signal system; Part 4 presents the results and analyzes and evaluates the products of the project, and finally part 5 concludes.

II. SYSTEM DESIGN

The traffic light system model in Figure 1 is a traffic control system to ensure safety and efficiency in coordinating traffic flow at intersections.

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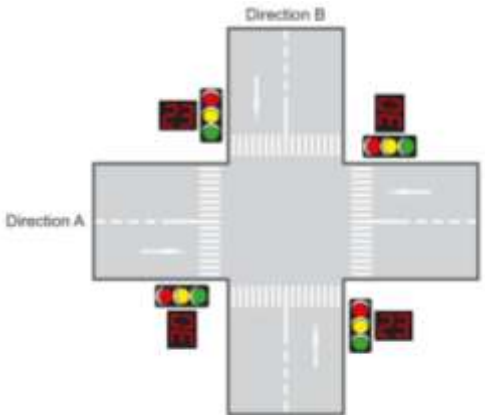

Figure 1: Model of intersection traffic light system

The system includes a central microcontroller chip AT89S52 (Master) and four sub-microcontroller chips AT89S52 as controllers to display traffic lights and the remaining time of traffic lights (Slave), each microcontroller Secondary controls are placed at intersection corners to control traffic signals as shown in Figure 2.

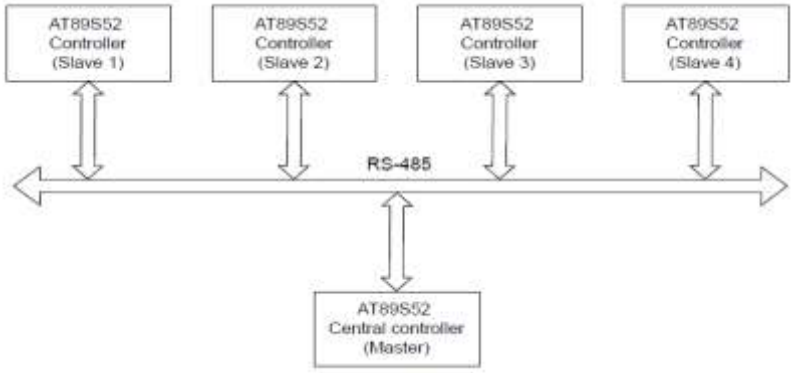

Figure 2: Block diagram of the intersection traffic signal control system

a.Central controller uses microcontroller AT89S52(Master)

Microcontroller AT89S52 (Master) takes on the role of coordinating the entire system, sending control signals and receiving data from sub-microcontrollers. The Master microcontroller adjusts the time and status of traffic lights based on data from sensors or pre-installed on the central microcontroller to the slave microcontroller via RS-485 communication network.

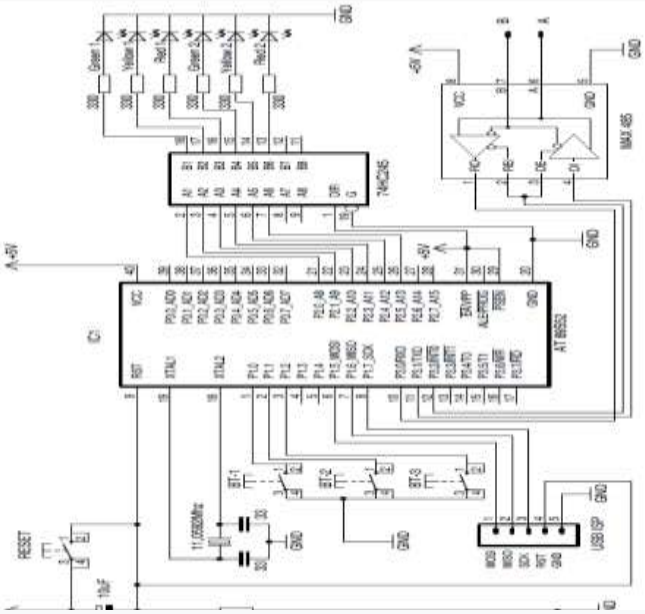

Figure 3: Master circuit principle diagram

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The AT89S52 microcontroller in figure 3 is used as the Master controller and it performs the following important functions:

- Traffic light signal control:
+ Signal cycle management: AT89S52 controls the operating cycle of traffic lights (red, yellow, green, and displays the remaining time of the signal lights). The microcontroller can be programmed to adjust the timing of each signal according to a fixed period or according to actual requirements.
+ Signal conversion: The microcontroller decides when to switch from green light to yellow light and then to red light, and manages the waiting time between transitions.
- Communicate with other devices:
AT89S52 can communicate with other Slave microcontrollers in the system via serial communication protocol using RS-485 standard to receive or send data related to traffic light control.

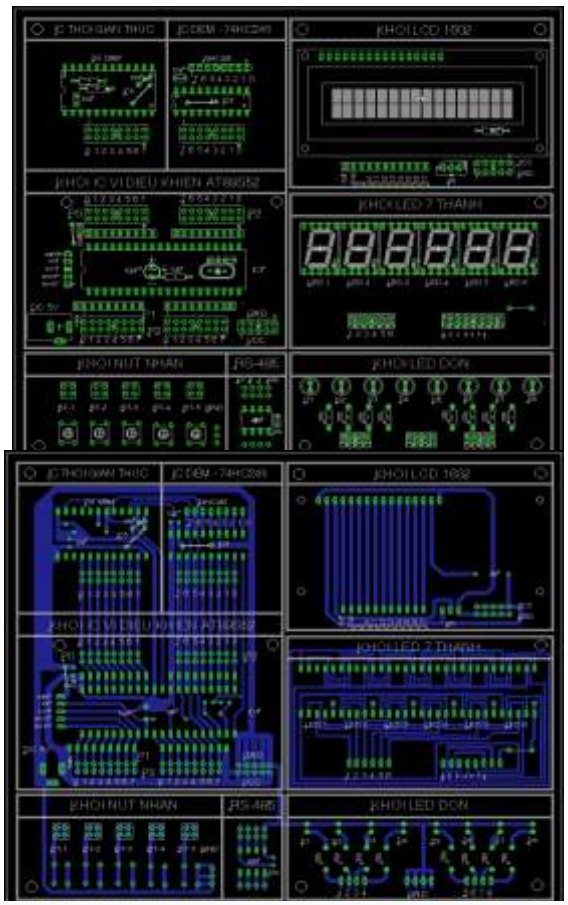

Figure 4: Component layout and PCB wiring diagram of the AT89S52 Master microcontroller circuit

From the principle diagram in Figure 3 of the Master microcontroller circuit combined with a number of communication requirements with other peripheral devices, the authors have designed an electronic circuit board, the components are arranged and configured. Design the PCB wiring as shown in Figure 4.

b. Secondary controller at intersection corners uses microcontroller AT89S52(Slave)

Slave microcontroller: Placed at intersection corners, receiving control signals from the Master microcontroller and adjusting traffic lights in specific areas. The slave microcontrollers send feedback about traffic conditions at intersection corners to the Master microcontroller via RS-485 protocol.

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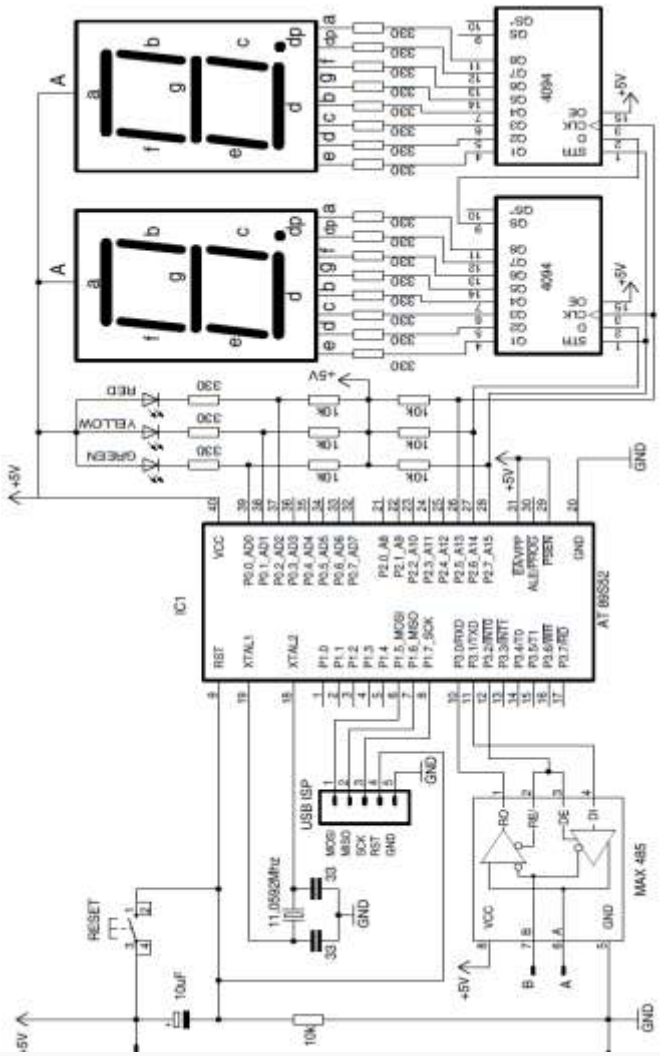

Figure 5: Slave circuit principle diagram

The AT89S52 microcontroller in Figure 5 is used as a slave controller in a traffic light control application. Its role and function is mainly to communicate with the master microcontroller and display time and traffic light signals. pine. Below are the main functions of the AT89S52 microcontroller when operating in Slave mode in this application:

- Receive data and commands from Master:

+ Receive control commands: AT89S52 slave receives commands from the master microcontroller to control traffic light states. This command can include changing light modes, light operating times, or special requests such as priority for emergency vehicles.

+ Receive configuration and information: The slave microcontroller can receive configuration information such as traffic light cycle times, special operating modes, or other configuration parameters from the master.

- Control outputs:

+ Traffic light management: Based on the command from the master, the AT89S52 slave controls the output pins to turn on or off traffic lights (red, yellow, green lights, seconds display lights). This is usually done through the microcontroller's I/O pins.

+ Control auxiliary devices: In addition to controlling traffic lights, the Slave microcontroller can manage other auxiliary devices such as sirens, display screens, or flashing warning lights.

- Send status data and responses:

+ Status transmission: AT89S52 slave sends status information about traffic lights, sensors, or auxiliary devices to the master. This helps the master have an overview of the system's operating status.

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+ Send command response: After receiving the command from the master, the slave microcontroller sends a response confirming the execution of the command or an error message if there is a problem.

For convenience in model building, each quadrant of the traffic light system will use an AT89S52 microcontroller IC as a Slave. Each Slave circuit controls 3 red, yellow, green LEDs to indicate traffic light signals and 2 7-segment LEDs to display the remaining time of the signal light.

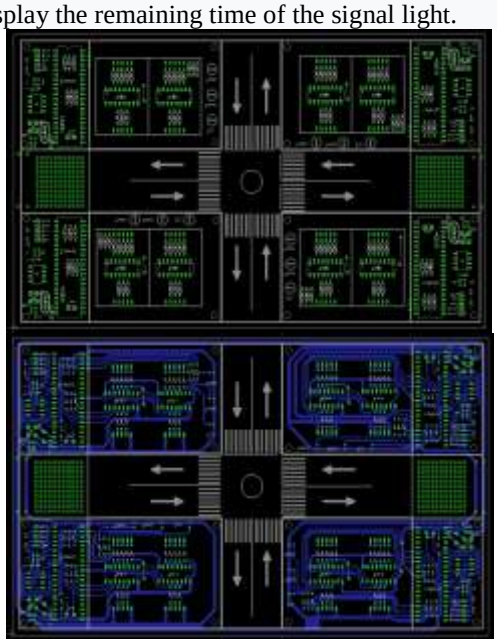

Figure 6: Component layout and PCB wiring diagram of the Slave microcontroller circuit

From the principle diagram in Figure 5 of the Slave microcontroller circuit, the authors have designed an electronic circuit board, the components are arranged and the PCB wiring is designed as shown in Figure 6.

c. RS-485 communication standard

The RS-485 standard is used to connect microcontrollers in a network, providing stable communication and long-distance transmission capabilities. RS-485 supports connecting multiple devices on the same communication bus, which is especially important in applications with multiple microcontrollers such as traffic light systems.

In this application, the RS-485 network connects between the Master microcontroller and the Slave microcontrollers through twisted pair cables to increase noise immunity, the communication speed configured in this application is 9600 baud, This transmission speed allows the communication system to be stable and receive farther.

The communication protocol between the Master microcontroller and the Slave microcontrollers is the Modbus RTU communication protocol, the Modbus RTU communication frame structure includes 1 address byte, 1 command byte, 2 data length bytes, then are the data bytes and the last are also 2 error checking bytes during data transmission.

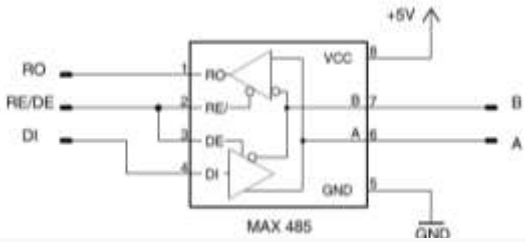

Figure 7: RS-485 block circuit diagram

Figure 7 shows the connection diagram of the RS-485 block, the pins connected to the microcontroller are left on hold, the arrangement of components and the wiring of the pins on the PCB circuit are as shown in Figure 8.

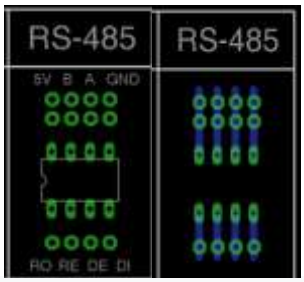

Figure 8: Diagram of component layout and PCB wiring on the RS-485 block

III. MODEL MAKING

Traffic light system model is built with AT89S52 Master microcontroller and AT89S52 Slave microcontrollers. The manufacturing process includes hardware assembly, software programming for microcontrollers, and functional testing of the entire system.

a. Hardware assembly

Assembling components onto printed circuit boards (PCBs) to form electronic circuit boards in Figure 11 and Figure 12 is an important process in electronic device manufacturing. Below are the detailed steps that the authors perform in assembling components onto printed circuit boards (PCBs).

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Check that the PCB design in Figure 9 is correct with parameters such as: size, distance and component location are correct.

Figure 9: Checking the PCB circuit before assembly

Components are fully prepared according to the design in the circuit diagram. Before installing components on the PCB circuit in Figure 10, the components need to be inspected and classified.

Tools and materials such as clean work benches, tweezers, soldering tools, soldering test equipment, and materials such as soldering iron.

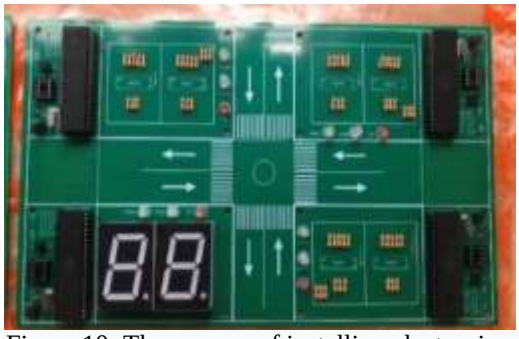

Figure 10: The process of installing electronic components into the PCB circuit

Figure 11: Complete electronic circuit for the Master controller and Slaves

Figure 12: Complete model fabrication of Traffic light signal system using Master and 4 Slave microcontroller network

b. Software programming

Programming a traffic light system using a microcontroller is a job that requires precision in programming and timing as well as the traffic signal control process.

The authors use assembly programming language to implement the controller's requirements, and at the same time provide a simple operating procedure for traffic lights at an intersection.

The time of the signal lights at the intersection corner of route A is green light for 35 seconds, yellow light for 3 seconds and red light for 48

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seconds, line B is green for 45 seconds, yellow for 3 seconds and red for 38 seconds. .

The AT89S52 Master central microcontroller is programmed by the authors as shown in the flow chart in Figure 13.

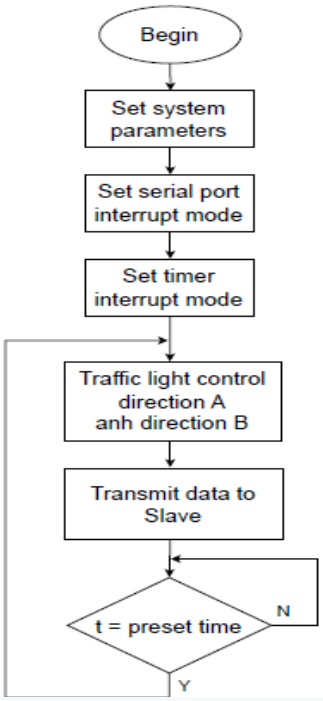

Figure 13: Master programming solution algorithm flow chart

The AT89S52 Master central microcontroller is programmed by the authors as shown in the flow chart in Figure 13.

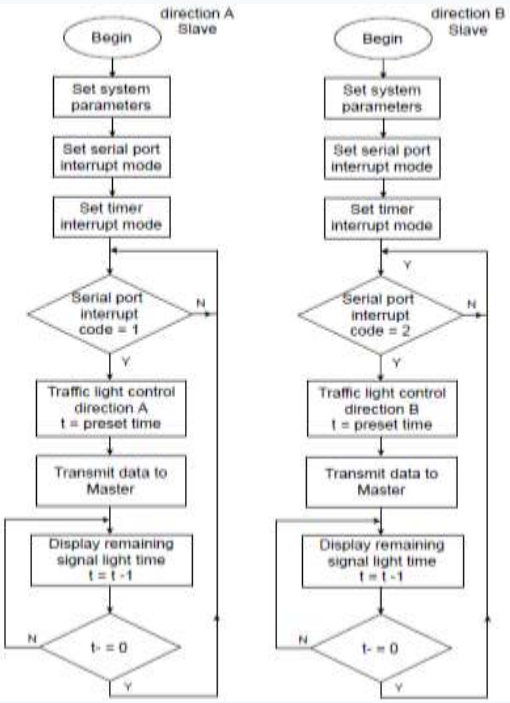

Figure 14: Save the Slave setup algorithm

International Journal of Advances in Engineering and Management (IJAEM)
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IV. RESULTS AND EVALUATION

Test results show that the system operates stably, with the ability to adjust traffic light times accurately and flexibly, as shown in Figures 15, 16, 17,18.

The AT89S52 microcontroller is used as a Master and Slave controller to coordinate effectively via the RS-485 communication network, helping to improve traffic coordination at intersections. At the same time, RS-485 communication ensures stable data transmission even in noisy environments.

The ability to easily expand the system by adding more Slave parts without changing the Master part as well as the current system structure. Maintenance, repair and troubleshooting when the system fails is also more convenient because of the Independent operation of slaves in the system.

The Master and Slave microcontrollers are designed with input and output pins as standby pins, which helps increase flexibility and creativity for teaching and research applications.

Figure 15: Green light direction A and red light direction B

Figure 16: Yellow light direction A and red light direction B

Figure 17: Red light direction A and green light direction B

Figure 18: Red light direction A and yellow light direction B

V. CONCLUSION

Using the AT89S52 microcontroller network and RS-485 communication standard in the traffic light system has proven to be an effective solution for traffic coordination at intersections. This research provides a cost-effective and flexible method, and opens the way for future intelligent transportation systems. The author's team's finished model product is used in learning and teaching as well as in-depth research on the application field of microcontrollers.

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