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Original Article

Designing 2-Wings Gate Controller Use Atmega 2560-Au Microcontroller

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Abstract *- This article describes the design and construction of a gate controller using the Atmega 2560-AU microcontroller. The controller controls the gate type, which has 2 wings, using the swingarm. In addition to managing the gate's door with the remote controller, the device allows phone control via message and gate latch. Atmega 2560-AU microcontroller, 800L sim module, Relay, LCD screen, and other components to complete the product. Proteus software is used for simulation and calculation, and Altium Design software is used to design printed circuit boards. Through the testing process, the system has met the requirements of the problem, easy to install and use.*

Keywords *- A gate controller, Atmega 2560-AU microcontroller, LCD screen, 800L sim module.*

1. Introduction

In modern life, many automatic doors open and close in public places and households. Using automatic doors will help the buildings add elegance and modernity, saving time and bringing convenience to users. Therefore, since its inception, automatic doors have been constantly improved in terms of features and designs to meet users' needs.

In Vietnam, most households still use a two-wings gate, with hinges on both sides, to close and open the gate. For families that build a new gate, the choice of gate design is very diverse such as automatic rolling gate, automatic sliding gate, or automatic folding gate. However, many households that have installed 2-leaf gates still want to install an automatic controller, with the desire to easily open and close the door, especially when it rains or storms.

Many studies have been designing controllers for gates. Some researches focus on controller design using 80C051 family microcontroller[1] or using PLC[2] with higher cost, and some other researches focus on design using RFID technology [3],[4]. In this article, we propose a design option using an Atmega 2560-AU microcontroller and sim800L module to design the control circuit, and it also allows remote gate control by message. The article is divided into 5 parts: (1) Introduction; (2) Design solutions; (3) Hardware and software design; (4) Experiments and results; (5) Conclusion.

2. Design Solution

2.1. Design Options

To meet most of the conditions of families in Viet Nam that have been using 2-wing gate doors, the authors choose a swingarm motor to install in each wing of the gate. The advantage of this method: It is easy to install and suitable for many types of wing gates with different designs.

This method simulates the opening and closing of the gate's wings like a human arm pulling and pushing the gate. Inside the swingarm is a motor. If we want to control the gate, we only need to control the motor to rotate forward and reverse.

Through the process of researching the gate controller market, the authors found that the gate's wing controllers stop at the basic functions:

- Control opening and closing by the remote control key
- Open and close when there is an obstacle by overcurrent measurement method

However, during the working process, some problems occurred, such as the owner forgetting the controller so he could not enter the house and relatives visiting the house. Still, the homeowner was far away. The controller only opened and closed but could not latch the door so thieves could break into the house.

Fig. 1 Automatic gate installation type swingarm

To overcome some disadvantages of existing controllers on the market, the research team designed a 2-wing gate controller with the following features:

- Automatic gate control by fingerprint as608, remote RF433, module sim800L
- Control the opening and closing of the door via text message, allowing only phone numbers (fixed and stored in the code) and the correct opening and closing syntax, and the door will work.
- The circuit stops working when the current increases suddenly.
- Magnetic sensor to recognize the gate state is closed to latch the gate.
- The sensor detects someone passing through the gate, but the gate stops working.

2.2. Block Diagram

From the design solution to the problem, we build the block diagram of the 2-wings gate controller, as shown in Figure 2. In this block diagram, the limit switch block is used to determine whether the gate is entirely closed or not as a condition for locking the gate latch. Motion sensor block is used to determine the condition to stop opening/closing when people pass through the gate, especially children, to increase safety during use. The current sensor block is also a stop/close condition when obstacles such as cars, bricks, and stones exist. RF controller is used to controlling the opening/closing of the gate remotely by the control key or fixed control by the fingerprint sensor. Modules are used to control the opening/closing of the gate remotely, which is extremely important in case the homeowner is not at home. The buttons are used to set working parameters for the controller. LCD display block is used to display the working parameters of the controller. Isolation block: used to isolate the control circuit with the relay and the motor, ensuring the safe working of the system. The relay block controls the forward and reverses the rotation of the motor when opening and closing the gate. The central processor receives control input signals (sensors, modules, RF remote control) and processes these input signals to control the gate opening/closing state and gate latching.

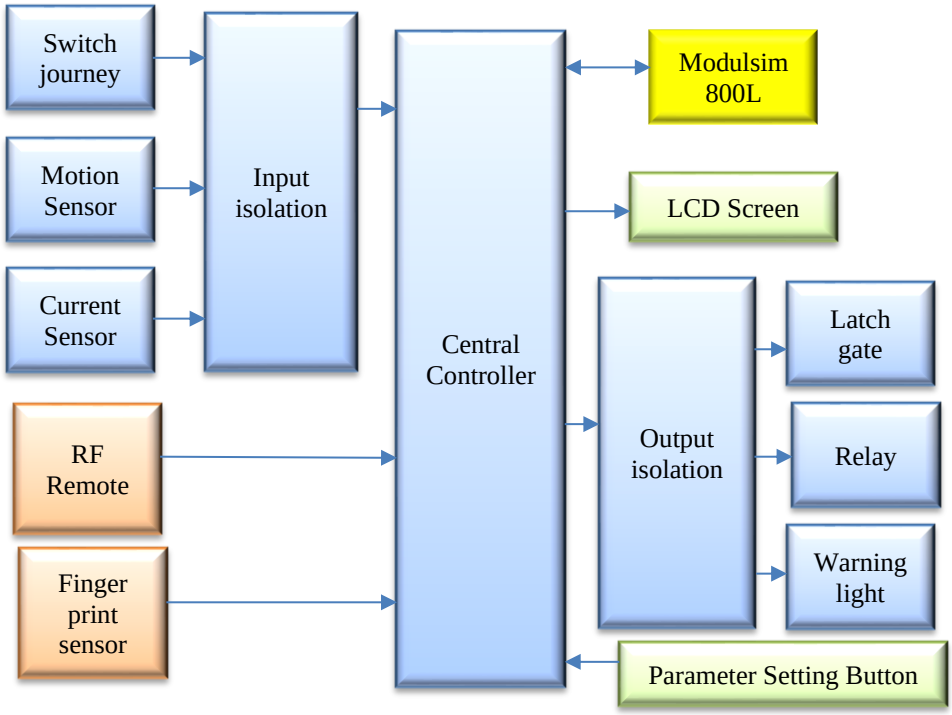


Fig. 2 The diagram of the equipment

3. Designing Hardware and Software

3.1. Designing Hardware

3.1.1. Input Isolation Circuit

This circuit uses IC PS2801, a photocoupler used to isolate the input sensors from the central processor to ensure the safety of the central processor.

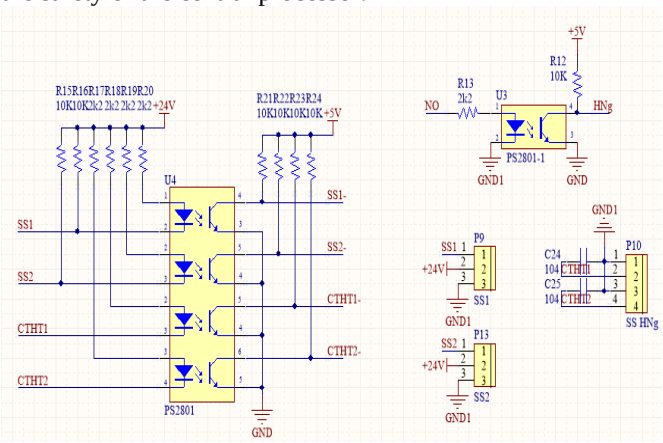


Fig. 3 Input isolation block circuit diagram

3.1.2. Shunt Current Sensor Block

During the operation of the gate, if for some reason the gate's wings are stuck like obstacles, we use the sensors' current transformer to prevent the phenomenon that the controller continues to command the circuit to continue working. The measured current signal from the current sensor will be converted to voltage and compared with the preset value (9.1V) through a comparator using IC LM358. If the current value exceeds the allowable level, this circuit will send a signal to the central processor to command the motor to stop working.

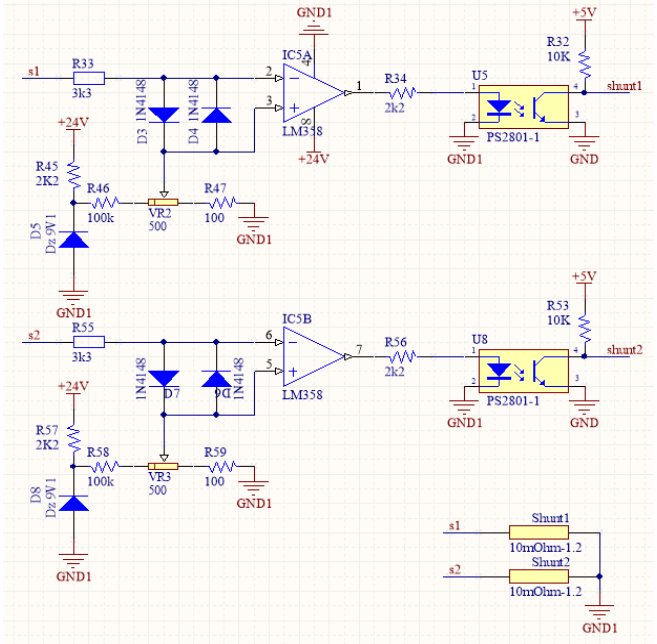


Fig. 4 Circuit diagram of the shunt current sensor block

3.1.3. The Central Processor

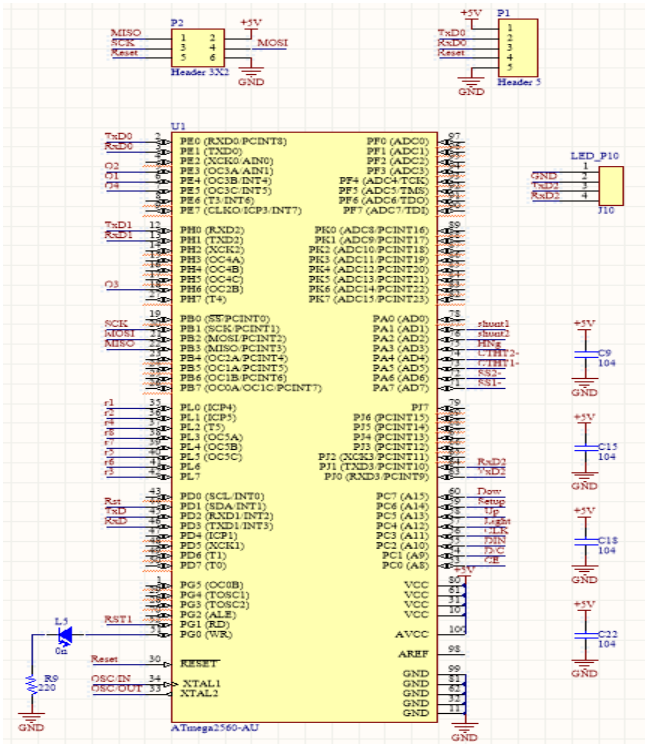


Fig. 5 Central processing circuit diagram

After receiving signals from the gate open/close command circuits such as RF, fingerprint sensor, sim module, or commands from input sensors such as motion sensor, current sensor, or limit sensor, Atmega 2560- AU microcontroller will process commands based on previously installed programs to send commands to open/close the gate or close the gate latch. In addition, it also gives commands to control the lights and LCD to display the working status of the controller.

3.1.4. Output Isolation Circuit

The microcontroller's output signal to control the motor's speed and direction is very small, and the possibility of noise is high, so it is necessary to isolate the noise to get a stable control signal. In the circuit, we use 2 photocouplers, IC, LN2803, and PPS2801, to isolate the control signal.

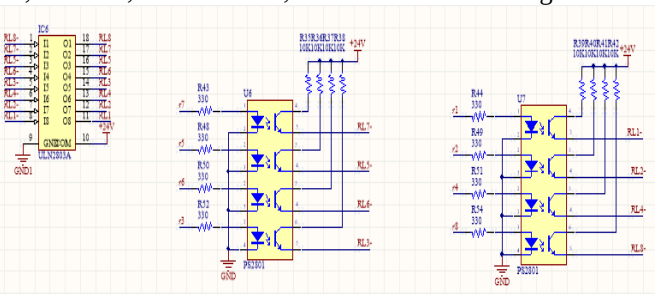


Fig. 6 Output isolation circuit diagram

In this diagram, the microcontroller analyzes the input commands to decide whether to open/close or latch the gate. This command will be sent to the output pin (r1- r8), through

the isolation circuit (here using a photocoupler), and to the output (RL1- RL8) to control the on/off relay.

3.1.5. Output Isolation Circuit

In this diagram, an 8-pin 24V relay is used. After the isolator (RL1-RL8), the control signal will be sent to the relay block to control the opening/closing of the motor, and the output of the relay block will be sent to the terminals (P5, P6, P8, P11).). These terminals will be connected to the motor, making it easy to connect and repair.

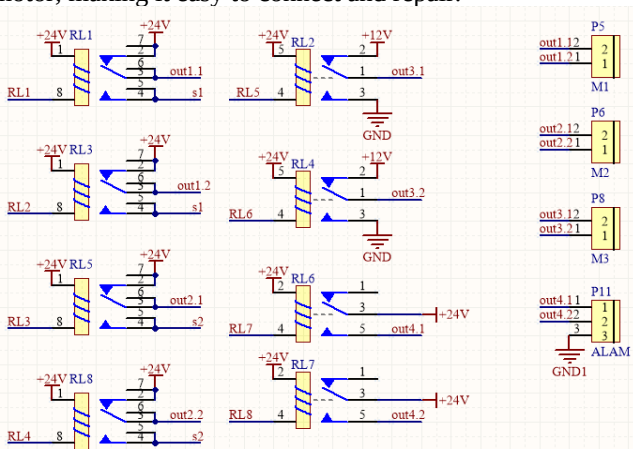


Fig. 7 Relay circuit diagram

In this diagram, the microcontroller analyzes the input commands to decide whether to open/close or latch the gate. This command will be sent to the output pin (r1- r8), through the isolation circuit (here using a photocoupler), and to the output (RL1- RL8) to control the on/off a relay.

3.1.6. Pairing Sim Module Circuit

The input and output signals of the sim module circuit will be directly connected to the pins of the central microcontroller through the pins (Rst, RxD, TxD). When the sim module receives the messages from the controller, it will send the data stream to the microcontroller, and the microcontroller will control the motor to open/close the gate through the relays.

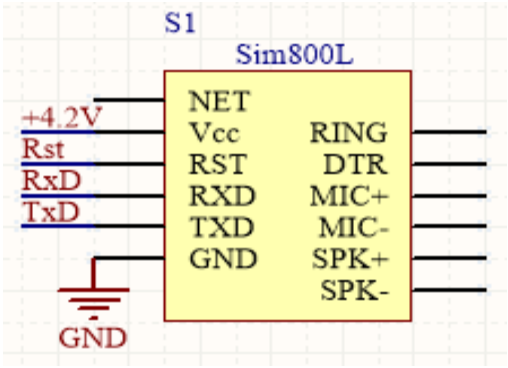


Fig. 8 Pairing sim module circuit diagram

3.1.7. LCD Display Circuit

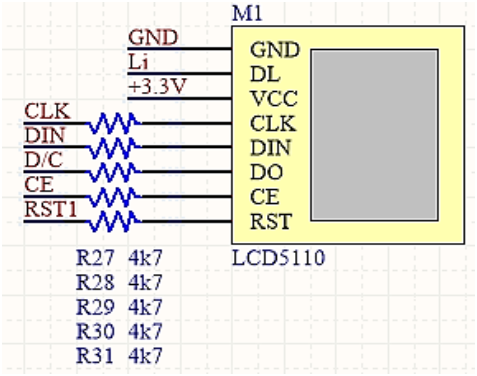


Fig. 9 LCD connection circuit diagram

The signals that need to display the output status will be displayed on the LCD 5110's screen. These signals are taken from the output of the central processor through the output pins Li, CLK, DIN, D/C, CE, and RTS1.

3.2. Designing the Software

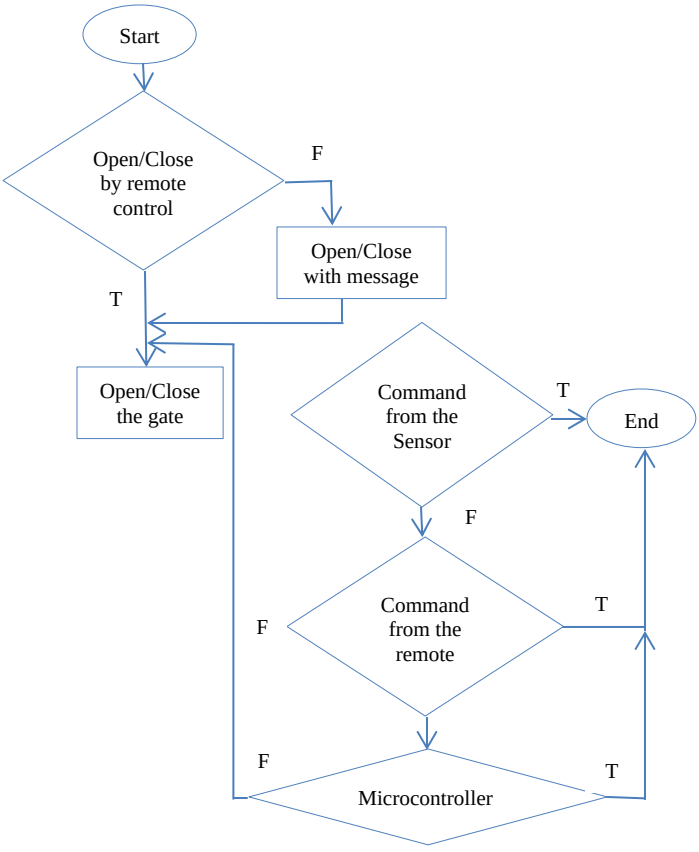
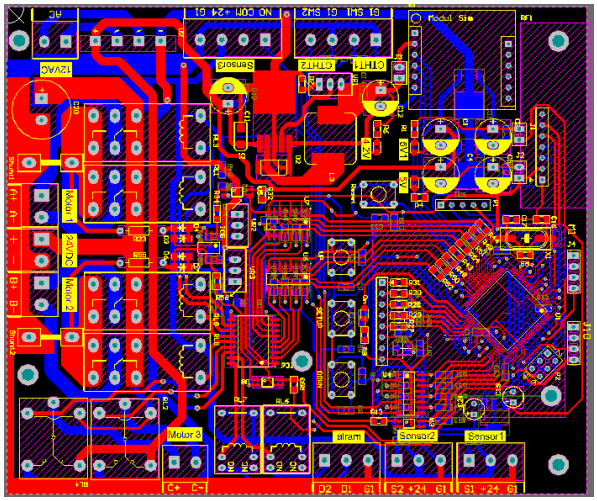


Fig. 10 The system flowchart of the main program

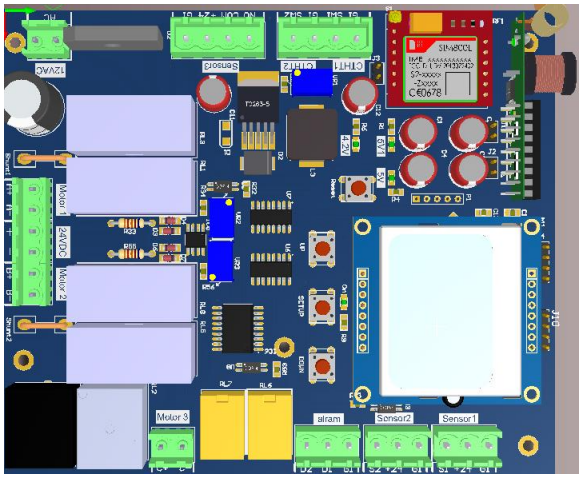
The authors write a software program in C language from the above algorithm flowchart for the central controller. Using Arduino Nano microcontroller to program through Arduino IDE software.

4. Experiment and Result

To design printed circuit boards, the team used Altium Designer software. Figure 11(a) is a 2D diagram, and figure 11(b) is a 3D diagram of a 2-wings gate controller circuit.



(a)



(b)

Fig. 11 The general principle diagram of equipment

Figure 12 is a photo of the complete installation of the gate controller on the 2 gate's wings. After installation, check and adjust the working parameters of the controller according to reality. Figure 13 is a photo that checks the gate's features.

Fig. 12 Complete installation of the gate controller

Fig. 13 Check the operation of the controller

5. Conclusion

The solution to design a 2-wing gate controller using an Atmega 2560-AU microcontroller and Sim800L module is effective, meeting the problem's requirements, affordable, and easy to install. In this paper, the authors have surveyed the needs of families wishing to install automatic gate controllers, proposed solutions, and built a test system in the laboratory of Electronic Engineering major, Faculty of Electronic Engineering, Thai Nguyen University of Technology, and practical installation at home. The results show that the device works well and meets the requirements of the problem.

Acknowledgment

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