

Design and Implementation of Elevator Control System by Arduino Microcontroller

May Thu Win, Than Nwe, Nay Win Zaw

Abstract - This paper describes the design and implementation of elevator control system. The elevator control system is one of the important aspects in electronics control module in automotive application. The main aim is to achieve the output PWM value for the DC motor via the H-Bridge driver circuit to drive the elevator with good performance, stable, smooth condition. In this system, Proteus ISIS is also used for testing the code of this project before implementing on hardware.

Index Terms— Arduino Uno, H-Bridge driver, gear DC motor, LCD, Magnetic Contact Sensor, push buttons, Proteus ISIS.

1) INTRODUCTION

An elevator (a lift in British English) is a type of vertical transportation that moves people or good between floors, levels or decks of a buildings, vessels or other structures. In this system, elevator has four stations and the cabin speed depends on difference between current position and position where cabin needs to go. It has four switches for four floors. Magnetic Contact Sensors are used as position sensors for detecting current elevator cabin position and stop the DC motor at reaching the user desire floor.

Based on the switch pressed and sensor, the elevator cabin can move either in upward or downward direction. H-bridge driver is used to control direction and speed of DC motor. Inputs of H-bridge are connected to Arduino Uno which controls direction and PWM duty-cycle. Output of an H-bridge is a voltage between 0 V and 12 V, and which depends on input's duty-cycle. It is connected to a DC motor armature. When the user desired floor and current reaching floor are equal stops the D.C. Motor.

This journal is organized as follows; at first in Section (I), it presents the introduction of the system. The rest of journal is presented as Section (II) describes the background theory and Section (III) presents the flowchart of the system. After that Section (IV) discusses hardware configuration and Section (V) is simulation and test results. The last section shows conclusion for this paper.

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2) BACKGROUND THEORY

In this control system, push buttons (call button) and Magnetic Contact Sensors are input part of the Microcontroller. LCD display unit and H-Bridge driver circuit are output output part of the microcontroller. LCD displays the real time information of elevator moving system. The block diagram of elevator control system is shown in figure 1.

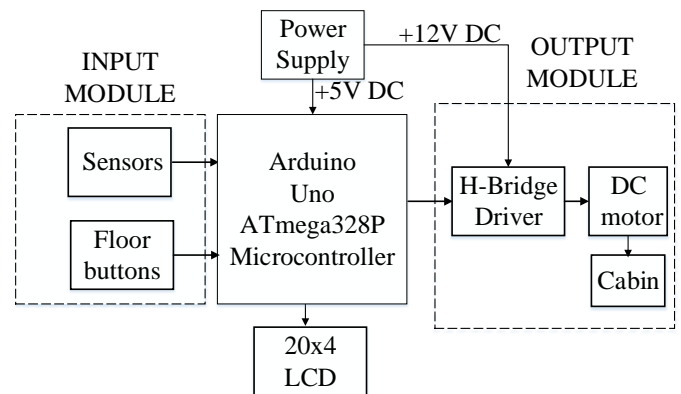


Fig 1. Overall Block Diagram of the Elevator Control System

1) Microcontroller

Arduino Uno microcontroller is the heart of elevator control system. This is ATmega328P 8-bit AVR family microcontroller [1]. Arduino is an open source electronics platform or board which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. The Arduino IDE provides a simplified integrated platform which can run on regular personal computers and allows users to write programs for Arduino using C or C++. It has 14 digital input/output pins (of which 6 pin provide PWM output) and 6 analog input pins, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

. These devices have integrated features to reduce external components, thus reducing system cost, enhancing system reliability and reducing power consumption [2].

In Figure 2, digital pins 2, 3, 4 and 5 are connected with push button input. digital pins 6, 7, 8 and 11 are used for magnetic contact sensor. Pins 9 and 10 are used for data output pin to control the H-Bridge driver circuit to drive the DC motor. SDA, SCL, +5V and GND are connected to the

LCD via the I2C Bus. The power supply of this microcontroller is +5V DC and connected with +5V power supply circuit.

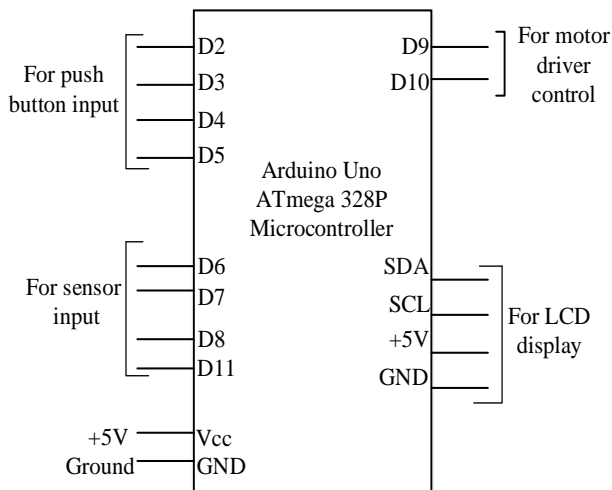


Fig 2. Arduino Uno microcontroller pins assign

2) *H-Bridge Driver*

This H-Bridge driver circuit include four MOSFET (two P-Channel MOSFET and two N-Channel MOSFET) and two NPN transistor. Four MOSFET operate as switches [3]. Four switching elements, MOSFETs, with the motor at the center forming an H-like configuration. H-Bridge driver circuit can drive the motor which can be controlled in both clockwise and counter clockwise direction. When Q1 and Q4 are switching ON, H-Bridge drive the DC motor in one direction and when Q2 and Q3 are switching ON, H-Bridge drive the DC motor in other direction.

The advantages of MOSFET used H-Bridge driver circuit is it can drive the DC motor with high current. In this paper, the H-Bridge motor driver is connected with Arduino Uno microcontroller pin D9 and D10.

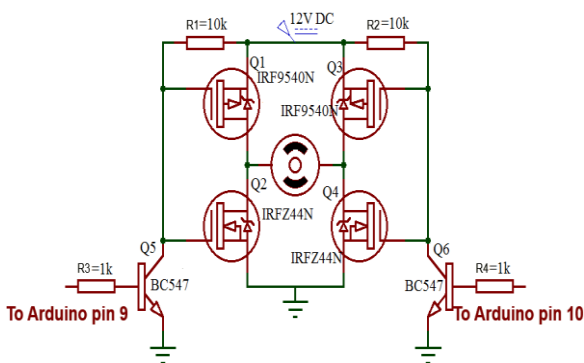


Fig 3. H-Bridge motor driver circuit diagram

3) *Gear DC Motor*

Geared DC motors can be defined as an extension of DC motor which already had its Insight details demystified. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. DC motors are used in elevators because they are controllable and spend

high quantities of energy no matter what the amount of load they are going to carry is. Therefore, they constantly draw high amounts of current [4]. The only known data about the motor armature voltage which is 12 V.

4) *LCD Unit*

The 20 x 4 LCD display is capable of displaying different characters and symbols. It is used to display the real time information of elevator system such as desired floor level, current floor level, floor direction (up / down) and DC motor driving PWM value.

5) *Push Button*

Four buttons are connected to digital inputs of microcontroller shown in figure 4. Algorithm in microcontroller save every button call and send cabin to the first saved value. When the pushbutton is open i.e. not pressed there is no connection between the two legs of the pushbutton, so the pin is connected to ground (through the pull-down resistor) and we read a LOW. When the button is closed (pressed), it makes a connection between its two legs, connecting the pin to 5V, so that we read a HIGH [5].

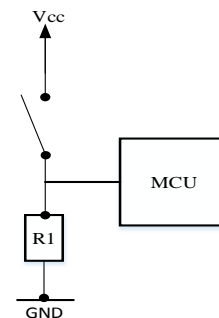


Fig 4. Electrical scheme of a call button with pull down resistor connection

6) *Position Sensor*

In this system, magnetic contact sensors are used as a elevator cabin position sensor. It is mounted on every floor of elevator. On magnet is mounted on the elevator cabin. When the elevator cabin move along the floors, the magnetic sensor of the floor level pass through the elevator cabin is HIGH [6]. Because magnet at elevator cabin meet magnetic contact sensor at elevator floor and produce HIGH voltage. In this way, microcontroller recognized the current reaching floor level (cabin position).



Fig 5. Magnetic contact sensor diagram

3) SYSTEM FLOWCHART

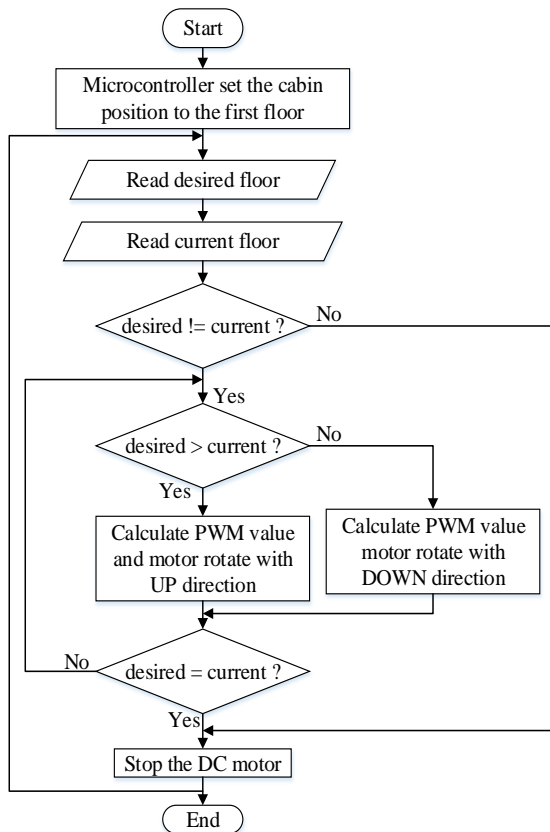


Fig 6. Flowchart of the software system

4) HARDWARE CONFIGURATION

The elevator control system has four press button which is first floor, second floor, third floor and fourth floor. It also has four magnetic contact sensor for detecting elevator cabin current reaching floor. Moreover, it consists of (20x4) LCD which is used for display user's desired floor and real time information of elevator system such as elevator moving direction (up / down) and moving speed (PWM value). A 12V DC power supply board is used to supply the power to the whole circuit.

H-Bridge driver circuit is mainly used to command the gear DC motor by PWM value. H-Bridge driver circuit drive the gear DC motor with forward and backward direction. This driver circuit take input from microcontroller and produce output PWM value and direction to the gear DC motor. This gear DC motor lift (up / down) the elevator cabin with specific PWM value to the user desired floor.

The voltage Regulator LM7805 is used to supply power the microcontroller. For Arduino Uno microcontroller, LM7805 regulator is suitable to control the incoming voltage stable. LM7805 regulator is used not only to be stable the voltage but also the voltage to be 5. LM7805 regulator is connected with 12V dc power supply board given to the H-Bridge driver circuit. The 5V regulator supplies power to the four push button, four sensor and the Arduino Uno microcontroller respectively. The microcontroller records the user command and then calculate the PWM value and direction. The microcontroller sends these data to the H-Bridge driver circuit to drive the DC motor. The whole elevator controller circuit is composed as in figure 7.

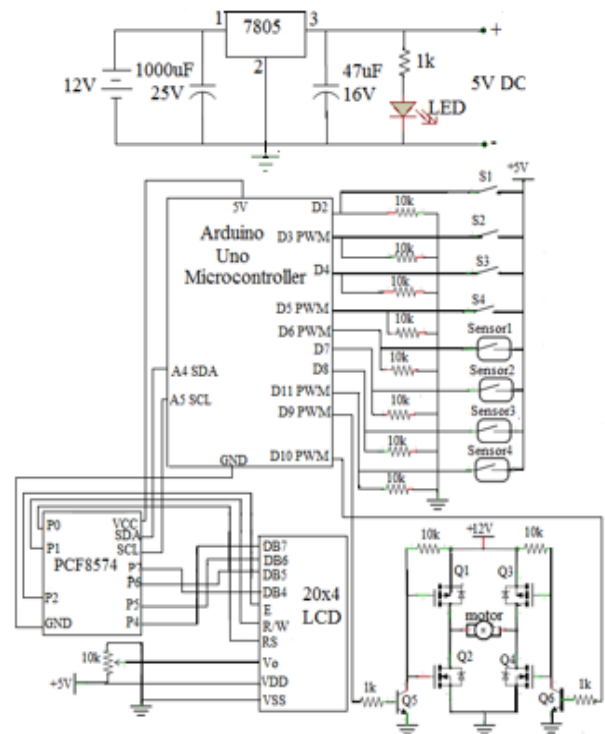


Fig 7. Circuit Diagram of the Elevator Control System

5) SIMULATION AND TEST RESULT

For this system, the simulation result is done by using Proteus professional schematic software [7]. After the program is compiled as hex files, the compiled code sent to a Arduino Uno microcontroller to load the microcontrollers with no errors. The program has successful complication and then the circuit is tested using the proteus software as shown in figure 8 & 9. This control system is completely tested and can be used in real time. Proteus is very handy software and is used for circuit and PCB designing. It is also used for circuit and programming testing. Note that the same Arduino code used in Proteus is used in the experiment.

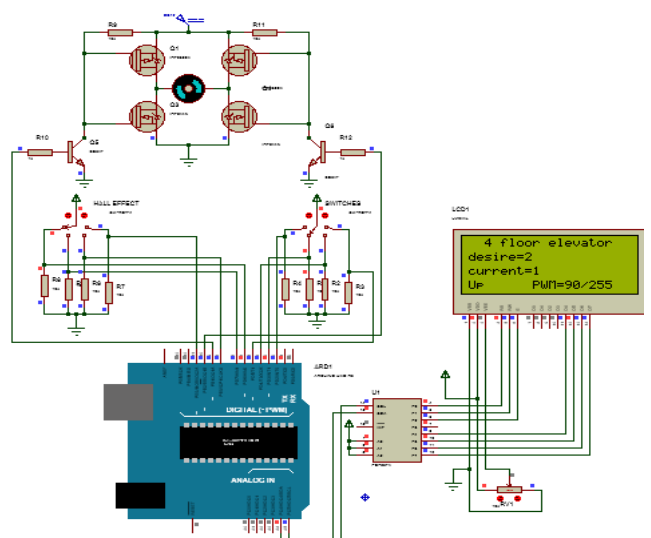


Fig 8. Simulation Result of Elevator Control System when desired floor is two and current floor is one

The figure 8 is the simulation of elevator control system when the user desired floor level is two and current reaching floor level is one. In this situation, the calculated PWM value is 90 pwm. This pwm value drive the DC motor through the H-Bridge driver with medium speed. So, the DC motor rotate and the elevator cabin move to the floor level two with up direction. Because of user desired floor is greater than the current reaching floor.

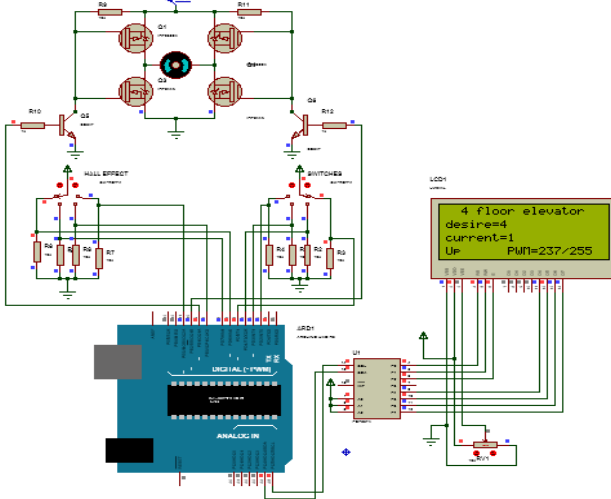


Fig 9. Simulation Result of Elevator Control System when desired floor is four and current floor is one

The figure 9 is the simulation of elevator control system when the user desired floor level is four and current reaching floor level is one. In this situation, the calculated PWM value is 237 pwm. This pwm value drive the DC motor through the H-Bridge driver with very high speed. So, the DC motor rotate and the elevator cabin move to the floor level three with up direction. Because of user desired floor is greater than the current reaching floor.



Fig 10. Prototype design of Elevator Control System

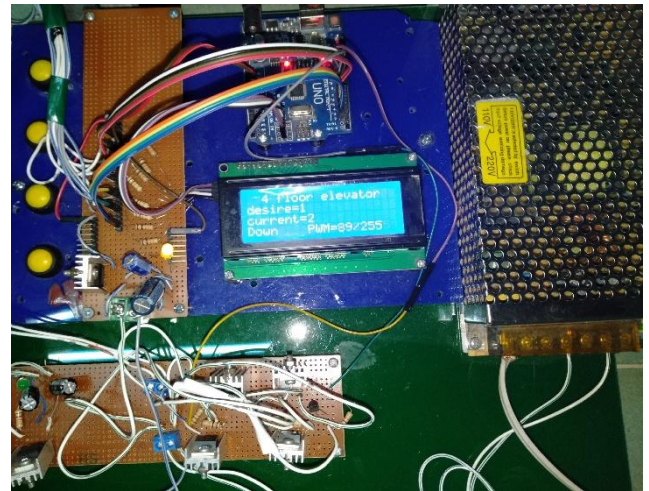


Fig 11. Experimental result of Elevator Control System

Figure 11 is the experimental result of Elevator Control System. When power supply is switching ON, firstly the microcontroller check the current reaching cabin floor position. If the cabin floor position is not in the first position, the microcontroller command the DC motor through the motor driver to move the elevator cabin to the first position. Then the microcontroller checks user desired floor (push buttons) and read the position sensor (current reaching floor). Based on these data, microcontroller calculate suitable PWM value and direction. These output data give to the H-Bridge driver circuit to drive the gear DC motor. In this way, elevator cabin move to the user desire floor.

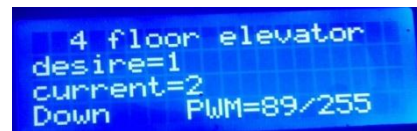


Fig 12. Real time information display on LCD Screen

Figure 12 is the LCD screen shows the real time information of Elevator Control System. Now this LCD display the user desired floor is floor level one, cabin current reaching floor is floor level two and the DC motor drive the 89 PWM value with downward direction.

6) CONCLUSION

Elevator control systems were widely used in most buildings. This thesis was based on design and implementation of arduino microcontroller based elevator control system. The main components were used in this thesis are Arduino microcontroller, push button, magnetic contact sensor, LCD displaying device, I2C bus, H-Bridge driver circuit, gear DC motor, 7805 regulator, 12V DC power supply board, personal computer and USB interfacing device. The Arduino Uno ATmega328P microcontroller was used as the main controller unit to display and control section.

In this work, we have designed and implemented a prototype elevator and its control systems using Arduino microcontroller based circuit. The elevator is operated by using DC motors and gears along with timing belt. Forward and reverse direction of motion of the DC motor is obtained by using a MOSFET H-Bridge. Before implementation of the

system, we have simulated the control circuit. It was found that the simulation results are satisfactory and practical systems work very well.

The signals were sent by the host computer section to the Arduino Uno ATmega328p microcontroller. To accomplish the goal of the thesis, commercially available hardware was used. The Arduino microcontroller, DC motor, H-Bridge motor driver MOSFET used in this thesis are compact, less expensive, very efficient and get in local market. After all, this project has been constructed with low cost, very compact, very low power requirement and high efficiency components.

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