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MICROCONTROLLER BASED INDUSTRIAL ELEVATOR WITH EARTHQUAKE SAFETY

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Abstract- *In industries some tasks that are beyond human capabilities, such as handling of too heavy loads, too large objects etc., are generally being carried by the elevator. Generally in industries or high rise buildings, all commercial elevators operate automatically. The computer age has brought the microchip –based capability to operate vast numbers of elevators. The geometrical position of Bangladesh is lies on the earthquake zone. Due to increase of environmental disasters, earthquake safety is necessary for industrial elevator. In this paper a small model elevator is developed with an earthquake safety system which is being controlled by microcontroller system. Stepper motor is used to carry the demo elevator.*

Keywords: Earthquake, Elevator, Microcontroller, Stepper motor, Voltage comparator (LM339).

1. INTRODUCTION

A lift known throughout the world is known as an elevator in the United States. An elevator or lift is a transport device used to move goods or people vertically, from one floor to another. The elevator turns electrical power into mechanical (rotational) power. There are many type of elevator or lift depending on the uses of it but they all work in the same way. These are passenger elevator, freight elevator, vehicle elevator, boat elevator, aircraft elevator, dumbwaiter, paternoster and others. A lift/elevator is made up of 4 major components: The lift/elevator cab or platform, the shaft or hoist way, the drive system and the counterweight.

Automation plays an increasingly important role in enhancing the betterment of daily experience as well as the global economy [1]. Figure 1 shows an architecture model of industrial automation system. We can easily control any automation system by the help of this architecture.

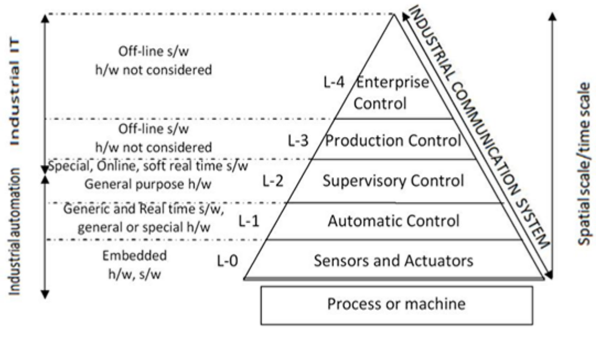

Fig.1: Architecture of Industrial Automation System [2].

At present, the purpose of automation has shifted from growing productivity and reducing costs to broader issues; for example, in increasing quality and flexibility in engineering processes. Any modern industry which wants to face the challenges of increasing globalization and competitiveness in the production processes of their business successfully, should take into account the latest advances on automation as because they become a factor that spread through the more advanced companies and differentiate them from the rest.

Tectonic frame work of Bangladesh and adjoining areas indicate that Bangladesh is suited adjacent to the plate margins of India and Eurasia where devastating earthquakes have occurred in the past. During the last 150 years, seven major earthquakes (with M>7) have affected Bangladesh. Table 1 shows the date, magnitude for each earthquake. Out of the seven only two had their epicenters within Bangladesh [3].

Table 1: Major earthquakes in Bangladesh during the last 150 years[3].

Date	Name of earthquake	Magnitude (Richter scale)
10 January, 1869	Cachar Earthquake	7.5
14 July, 1885	Bengal Earthquake	7.0
12 June, 1897	Great Indian Earthquake	8.7
8 July, 1918	Srimongol Earthquake	7.3
2 July, 1930	Dhurbi Earthquake	7.1
15 January, 1934	Bihar-Nepal Earthquake	7.0
15 August, 1950	Assam Earthquake	8.5

So it is necessary to use technology or automation system guarding against disasters. For that reason, industrial elevator with earthquake safety is more preferable for saving human life in a country like Bangladesh. This paper deals with a small model elevator which is developed with an earthquake safety which is controlled by microcontroller system.

2.EQUIPMENTS DESCRIPTION

2.1 PIC16f73 microcontroller [4]

- High performance RISC CPU.
- Only 35 simple word instructions.
- Operating speed: clock input (200MHz), instruction cycle (200nS).
- 10bit, up to 8 channel A/D converter.
- Data memory (bytes) is 368.
- Up to 368×8bit of RAM (data memory), 256×8 of EEPROM (data memory), 8k×14 of flash memory.
- Maximum operating frequency is 20MHz.
- Programmable code protection.
- Power saving sleep modes.
- Selectable oscillator options.

2.2 Unipolar Stepper motor (12 v)

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequences. The motors rotation has several direct relationships to these applied input pulses. Each stator coil features a centre tap with a fixed connection to the supply voltage. The current flows through the phase windings in only one direction, since each phase is wound in parallel with two wires. The current direction of the stator coil depends on which coil end is connected to earth. This configuration results in savings in the control electronics.

2.3 Motor driver circuit

Motor driver circuit used to drive the stepper motor. Here the ULN2003 motor driver was used.

2.4 Voltage comparator (LM339)

In electronics, a comparator is a device that compares two voltages or currents and outputs a digital signal indicating which is larger. It has two analog inputs V+ and V- and one binary digital output V_0.

2.5 Variable resister

A variable resistor works by adjusting the path that current has to flow. Inside the resistor is a strip of metal or conducting ceramic which is connected to one part of the circuit.

2.6 Capacitor

In a way, a capacitor is a little like a battery. Although they work in completely different ways, capacitors and batteries both store electrical energy. 100µF, 10µF and 22PF capacitor are used here.

2.7 Crystal 20MHz

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency .

2.8 Resister

Resister introduces resistance to the free flow of electricity. Here three resisters of 100Ω, 1kΩ and 10kΩ have been employed.

2.9 SPST button

Two SPST switches are used with a view to switching the elevator on and off.

2.10 Voltage regulator (7805)

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

2.11 Bred board

A bred board is used for build up the total connection for this circuit by the connecting wire.

3. WORKING PRINCIPLE

3.1 Principle

In this application, an industrial elevator will be controlled with 3 floors. The program controls various phases of the elevator motion. Figure 2 shows the model of the proposed industrial elevator which has a lift car. There have three floors with three floor sensors. The total working principle can be divided into three modules.

Sensing circuit:

All types of sensors are used here to sense their respective work. Three IR sensors are used as a floor sensor. Those are sense the floor position of the elevator. One earthquake sensor is used to sense the earthquake vibration. A voltage comparator LM339 has been used to collect signal from the sensors and send this signal to the microcontroller

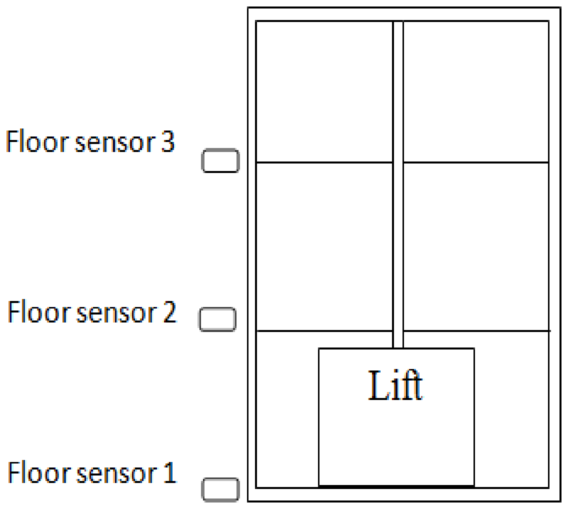

Fig.2: Industrial elevator model.

Controlling circuit:

In this circuit microcontroller is the main control system. Here we use PIC16f73 which have 6 input pin and 4 output pin. All the input should kept on the range of 0-5V. Micro controller also supplies 0-5V output. PICKIT2 loader is used to load the program at microcontroller. Voltage regulator (7805), Variable resister, Capacitor, Crystal 20MHz, Resister, SPST button all are used to control the whole system.

Motor related circuit:

The microcontroller passes the signal to the motor driver ULN2003. Then the motor driver drives the stepper motor. This stepper motor drives the elevator up and down.

Figure 3 shows the block diagram of the whole system accordingly their work. Figure 4 shows the total working step of the procedure.

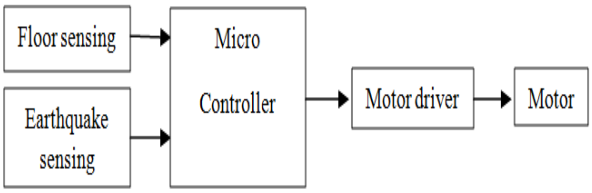

Fig.3: Block diagram of the system.

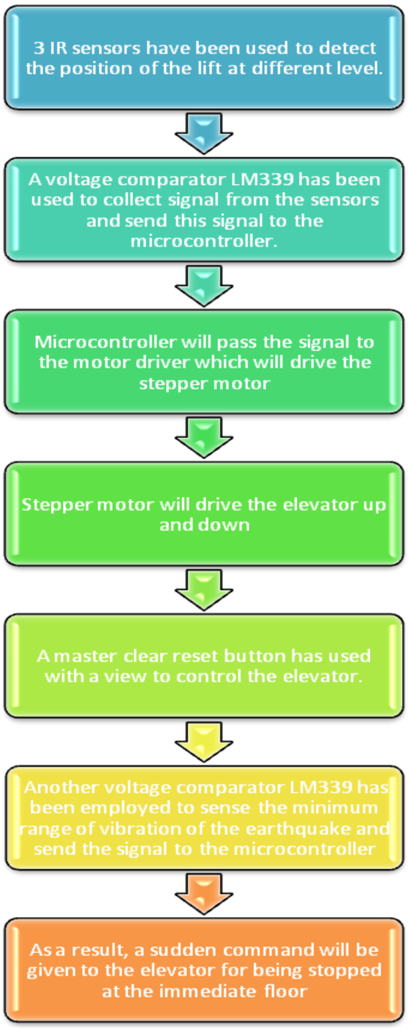

Fig.4: Working flowchart.

3.2 EARTHQUAKE SAFETY

Voltage comparator LM339 has been employed to sense the minimum range of vibration of the earthquake with the help of an accelerometer. When the earthquake is occurred, it sends the signal to the microcontroller. As a result, a sudden command will be given to the elevator for being stopped at the immediate floor.

4. EXPERIMENTAL SET UP

At first, the main structure is constructed by the wood and the structure of the frame of the elevator is constructed by the aluminum steel. The total length of the structure is about 24 inch. There have three floors and each floor is about 6 inch height. The length of the elevator is about 6 inch. The width of the elevator is about 5 inch and the width of the structure is about 6 inch. There have a hole at the top of the structure to contain the steeper motor. The elevator is connected with the stepper motor by a wire.

Figure 5 shows the front side view of our developed elevator. The car of elevator is connected with the stepper motor by a strong thickness wire. Three IR sensors are connected on the left side of the structure which also shows the floor level [5]. Total structure are made by wood and it stands on a base which also constructed by the wood. The total structure is running successfully. Figure 6 shows the circuit diagram of the connection of all equipments of the control system. All the equipments are connected with each other on the bred board by the connecting wire.

Fig.5: Front side view of the elevator.

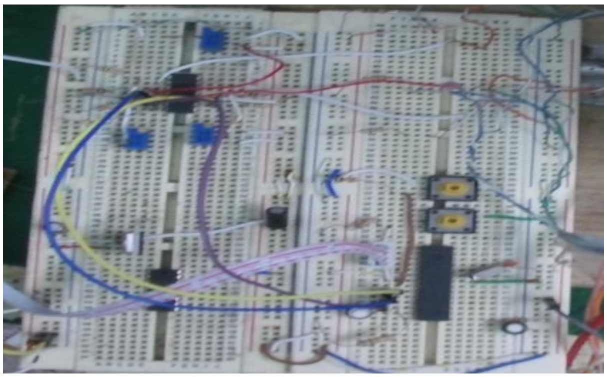

Fig.6: Circuit diagram of the elevator.

An accelerometer is used to sense the vibration of the earthquake which again sends this data to the comparator circuitary. From the top-left corner of the Fig.6, it can be seen that there is a comparator IC (LM339) which is used to compare and sense the earthquake as well as the floor distace and sends the data to the microcontroller.

5. PROTEUS SIMULATION

In Proteus simulation there are six commanding buttons. Those are Up, Down, 1st floor, 2nd floor, 3rd floor. The last button was used to give the earthquake sensing commands manually to the microcontroller as it is impossible to simulate the earthquake here in this Proteus software. When earthquake happens in real time, the sensor would sense this incident and set the earthquake pin (here, RB5 register of the PIC 16f73) high. From the four outputs of the microcontroller, motor driver was driven. Here, outputs of microcontroller are worked as inputs of the motor driver. The corresponding four outputs of the motor driver were directly connected to the four inputs of the stepper motor. The 5th input of the motor is connected to +12V dc supply which in turn helps the motor to drive. If the Up button is pushed, the microcontroller gives the output to the motor driver and it gives the output to the motor, and then it will start to run. All the buttons are worked as similarly. Figure 7 shows the Proteus simulation of the control program. It can be showed to play and run by the Proteus software.

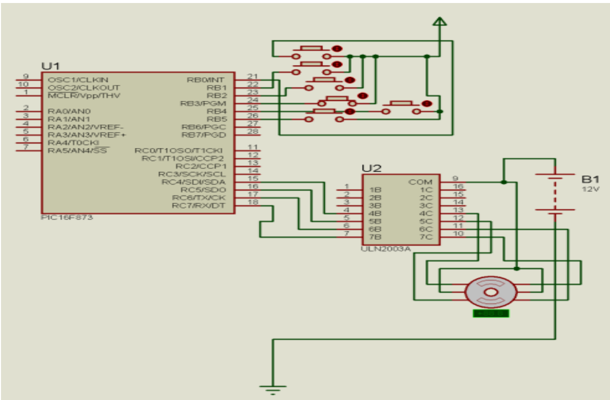

Fig.7: Proteus simulation.

6. DISCUSSION

In a brief, in this paper, we worked with microcontroller based control system. We also tried to differentiate among different types of automation and control systems. Advantages of proposed elevator control system from as usual conventional systems are:

1. It has both automatic and manual control system.
2. The response of proposed system to earthquake is instantaneous, i.e. with the happening of earthquake the elevator will stop in the immediate floor.
3. The system is very cheap because of the use of microcontroller.
4. The system is highly responsive to the earthquake.

7. CONCLUSION

Considering the fact that environmental disasters are not uncommon, earthquake safety is necessary for industrial elevator. The main purpose of this paper is to build up automation in industrial lifting and transferring processes with earthquake safety. A small model elevator is developed and tested with an earthquake safety system which is being controlled by microcontroller system. To save human life from various natural disasters it is important to build up such automation system with earthquake safety.

8. REFERENCES

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