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Implementation of Elevator control system based on PLC

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Abstract- This is an implementation of a control system of a four-floor elevator using Ladder Logic Control. Programmable Logic Controller is being used for the control and processing application. As we see high rise buildings and skyscrapers being developed in every city a stable working elevator is the most important feature of the same. Residing in Mumbai we hardly come across any buildings and societies which is deprived of elevator facilities, in fact most of them have more than one. The main focus of this paper is to make efficient use of programmable logic controllers to our advantage and to build the Elevator model and control of the required circuit. Position of the elevator is being sensed by using a Hall Effect Sensor.

Keywords- PLC, Ladder Logic, DC Motor, Elevator, Sensor

I. INTRODUCTION

Science has developed in innumerous ways in order to ease our life in all aspects. Climbing upstairs is a cumbersome task. And in today's fast paced life we wish to climb up the high rise building quickly without exhausting our energy. Hence Elevators form an essential part in our daily commute.

In general, there are two types of Elevators namely- Hydraulic Elevators and Cable Elevators (Traction Elevators). The elevator cabin in cable elevators or traction elevators is lifted with cables or ropes which can pull load under high tension, using a pulley mechanism having weight on the other side. In Cable Elevators or Traction Elevators only frictional force is needed to overcome in order to employ the movement. Hence there is no picture of lifting or pushing the weight of the cabin which increases the power efficiency tremendously. Hence, we preferred devising a Traction Elevator.

II. PROGRAMMABLE LOGIC CONTROLLERS

Embedded systems or Micro-controllers may also be used for the control applications but the downside of the same is that the technology is not rugged and may fail in harsh scenarios and not as reliable as PLC. Programmable Logic Controllers are digital computers which can be programmed in the following ways- Ladder Logic (LD), Sequential Function Block (SFC), Function Block Diagram (FBD) and Structure Text (ST).

Programming a PLC is also a lot easier as compared to an embedded system. PLCs offer high reliability and control which is ideal for assembly lines and robotic devices. Finding faults and errors in a PLC program is also easier. It is an example of a real-time system as the output is produced within a limited time which is in the order or milliseconds else the intended operation will not be successful.

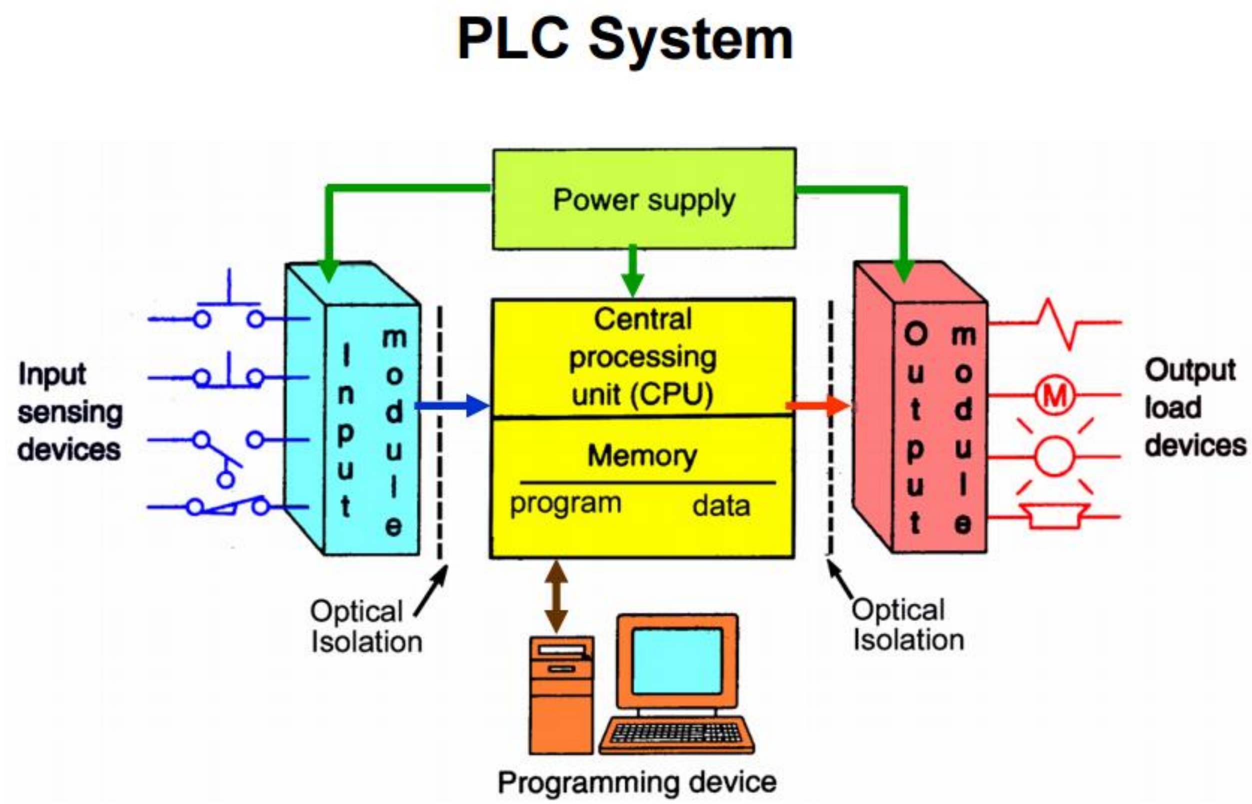

Figure.1: Basic architecture of a PLC Based System.

A PLC system is programmed using a computer on a Software environment developed by the manufacturer of a PLC. A 24V DC is used to power a PLC. Different manufacturers use different environment depending on the need and usability of the System. A PLC has an in-built storage to store the pre-requisites as well as the program of the application. The memory may or may not be extended depending on the application as well as different PLCs. The memory being used can either be EPROM or EEPROM. It is because every time a new program is loaded in the PLC the previous program is erased and the new program is stored in the memory to be executed.

It also has a Central Processing Unit (CPU) that processes the transferred code and controls the working accordingly. The output module consists of relays that switch depending on the ON-OFF logic given by the CPU. Memory of a PLC can be increased by using memory chips provided that it is supported by the Specific model being used. Number of ports can also be increased in a similar fashion. PLC can also be interfaced to a Human Machine Interface (HMI). HMI is used to control the system and enter the parameters if required. It can also display the details of the process.

III. LADDER LOGIC

Ladder logic is the procedure that is being used to implement and explain in the paper. In earlier times relay logic was used and it was only at the time of World War II, Ladder Logic was developed. It is observed that the basic diagram or structure of a Ladder Logic resembles to that of a Relay logic. It is because Ladder Logic was developed to replace the latter and hence Engineers and Technicians did not need re-training to understand and implement the logic in the new form.

Simple circuits were replaced by relay logic which were then transformed to Ladder Logic. If any modifications are needed to be done then they are simply implemented by a change in the ladder diagram. Hence in Industrial Control System where numerous complex operations are required, a PLC is preferred over a wired system.

The elements of a circuit diagram, such as normally closed and normally open contacts, and coils are linked to form networks.

Figure.2: Sample Ladder Logic Diagram

Normally open switch- The "Start" switch is a normally open switch which does not allow signal unless triggered. It is always used in the beginning of the program.

Normally closed switch- The "Stop" switch is a normally closed switch which allows the signal through it if untriggered and stops the signal when triggered.

Output- The "On" symbol stands for output of the rung.
Functional Blocks- Various functional blocks are available with the siemens S7-1200 PLC such as counters, timers, increment, decrement, memory blocks etc.

Memory bits- The NO and NC switches can also be used as Memory bits for multiple usage of the program structure.

IV. PROPOSED SYSTEM

Designing a complete system as a whole is difficult hence it is divided into discrete modules which eases to understand the process and enables us to test them individually and solve the errors if found by debugging them. The System is hence divided in 3 modules – Floor, PLC and the Elevator. The block diagram of a PLC system is given in the diagram (4). The design comprises of 6 components namely-

1) Push Button
2) Hall Effect Sensor
3) Programmable logic controller (Siemens- S7-1200)
4) Bi-directional H-bridge DC motor
5) Display Unit
6) Elevator

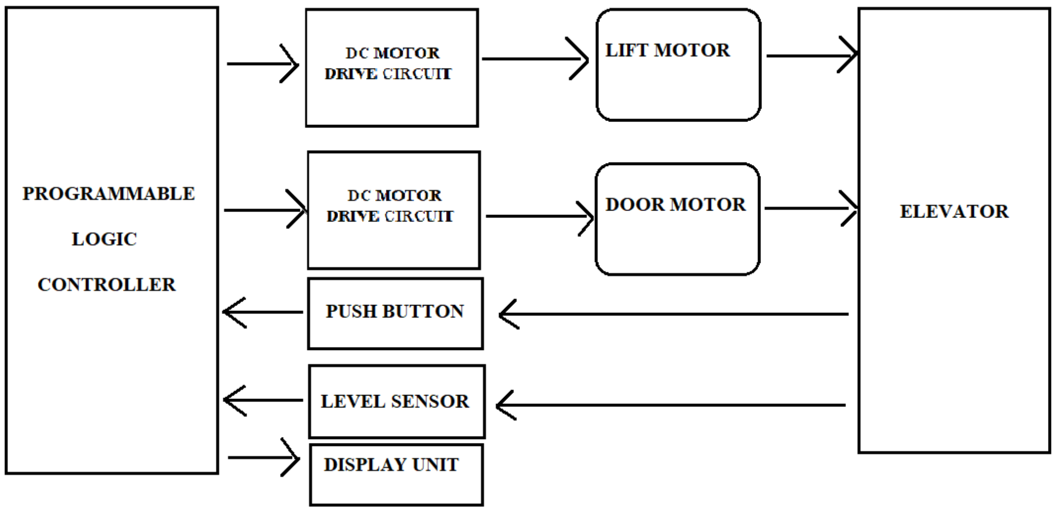

Figure.4: Basic architecture of the proposed System.

Push buttons are used to interface between the input and the PLC. The Push buttons will command the PLC to do the needful action. Sensors are employed to sense the position of the Elevator which is displayed on the display system. A step by step comparison is used for the movement of the elevator. First, the input by the user is sensed and if it is found to be greater than the current value of the floor number, the lift has to move upwards and if the input value by the user is less than the current floor number then the lift will move downwards. If the values are same then the lift does not move at all. The direction of the working of motor is set accordingly by the PLC.

Power unit is used to power the system while the sensor unit is used to sense the position of the elevator.

4.1. POWER SUPPLY UNIT

DC power supply is used to power the PLC and the motor. PLC works on a potential difference of 24V and the Motor works on a potential difference of 400V DC. Proper rectification has to be done if the main supply is an AC. Also, the fluctuations are needed to be stabilized for the PLC to be safe.

4.2. PUSH BUTTON

Push buttons are nothing but simple buttons which have a spring mechanism to come back in its original position. Most electronic devices such as calculators, telephones and kitchen appliances make use of this button.

4.3. HALL EFFECT SENSOR

Hall effect sensor is nothing but a transducer that gives electrical signals at the output pertaining to the Magnetic field produced. It involves the usage of a thin P-type Semiconductor. It has 3 terminals- supply voltage, ground and output. The supply voltage also acts as the refence voltage. It works in the range of 5V to 12V.

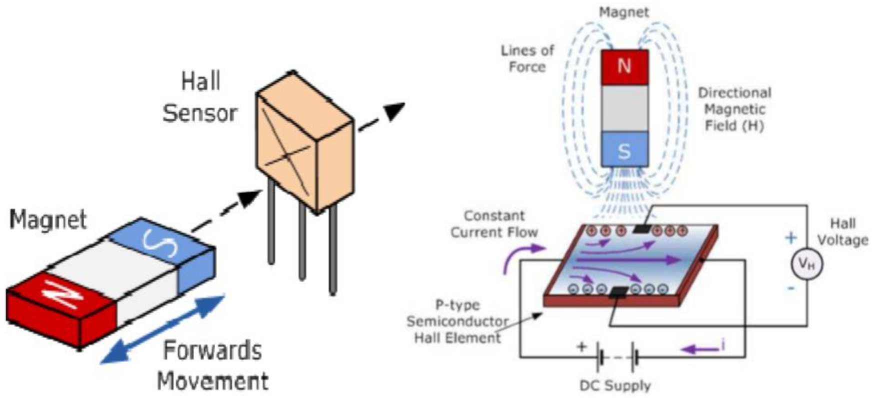

Figure.5: Working of a Hall Effect Sensor.

4.2. H-Bridge DC motor

The H-bridge circuitry enables the dual direction control of the DC motor. The figure (6) shows the basic structure of an H-Bridge. It is called so because of its shape similar to the alphabet 'H'. This motor is best suited for the required application. Albeit it can be formed manually but, already built integrated circuits are also now available. 4 transistors together enable the motor to rotate in either direction.

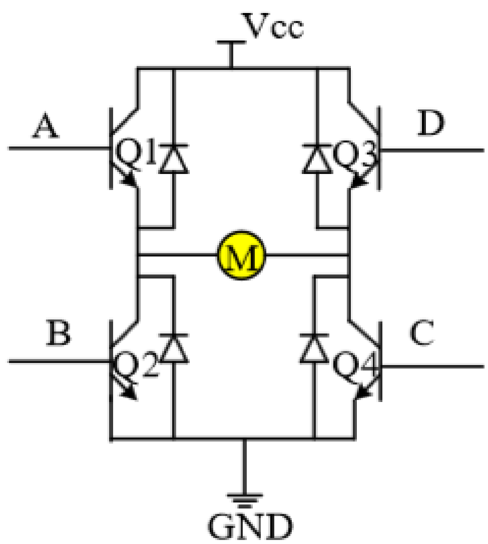

Figure.6: H Bridge Circuitry

The transistors used are n-p-n transistors. When transistors Q1 and Q4 are forward biased the other two transistors are reverse biased, the voltage across motor is positive and the motor moves in forward direction. When transistors Q2 and Q3 are forward biased the rest are reverse biased, voltage across the motor is negative and rotates the motor in the opposite direction.

V. CALCULATION

The calculation for the output power and output torque is given below:
Counter weight = 200 kg
Weight of empty cabin = 200 kg
6 persons with 70kg = 420 kg
For constant speed operation of 1m/s = 60m/1min
The power, work and force and torque are calculated using the equations (1), (2), (3), (4) and (5).
Power = work done/ time (1)
Work = (Force applied) x (distance travelled) (2)
Force, F = mass (m) x gravitational acceleration (g) (3)
Power = (Force applied) x (distance travelled) / time
So,
Power = (Force applied) x velocity (4)
F = 420 x 9.8 = 4116 N
P = 4116 x 1m/s = 4116 W
1hp = 745 W
4116 W = 5.52 hp (approximately 6 hp)
Rotational Speed = 1500rpm
The torque of the motor can be calculated by using the equation
Torque of the motor = (Power in Watts)/(2*3.14*rotational speed) (5)
= 4116/(2*3.14*1500)
= 0.437Nm

VI. PLC PROGRAM

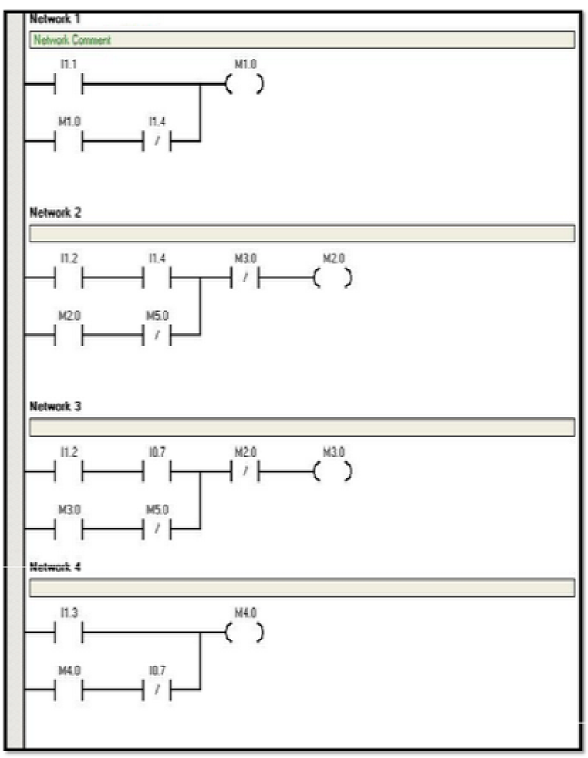

Figure.7: Program page 1

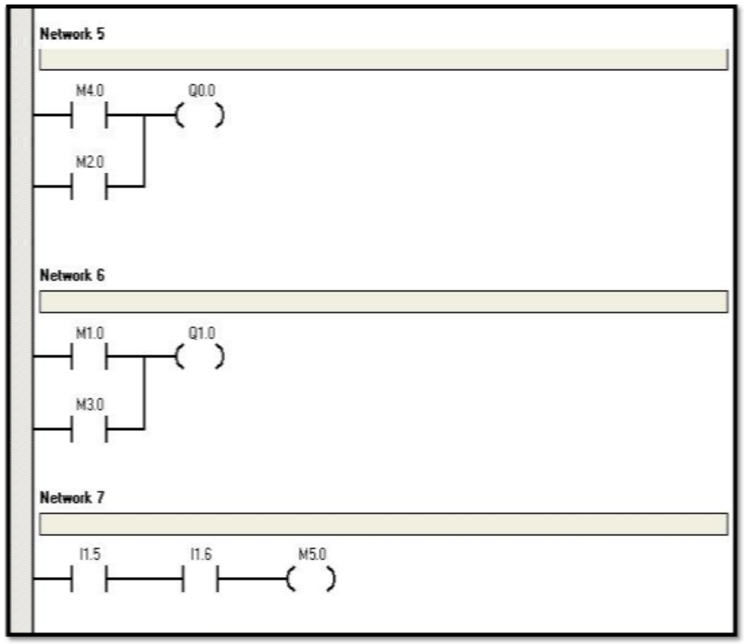

Figure.8: Program Page 2

VII. CONCLUSION

Hence, a controlled Elevator System is enacted using the program and the Programmable Logic Controller. More advancements can be made towards implementing facilities and increasing the safety of the Elevator.

REFERENCES

I. Darshil, Sagar, Rajiv, Pangaokar and S.A. Sharma "Development of a PLC Based Elevator System with Colour Sensing Capabilities for Material Handling in Industrial Plant", Jiont International Conference on Power System Technology and IEEE Power India Conference, 2008,pp.1-7.
II. A M Anusha and Ashok V. Sutagundar "Design of a PLC Based Elevator Control System", International Journal on Emerging Technologies (Special Issue on NCRIET-2015) 6(2): 32-36(2015).
III. Xialoling Yang, Qunxiong Zhu, Hong Xu,, "Design and practice of an elevator control system based on PLC", In proceedings of IEEE workshop on Power Electronics and Intelligent Transportation System, pp. 94 - 99 2008.
IV. Pillay, P., and Krishnan, Modeling of DC Motor Drives. IEEE Trans. Industry Applications, 1988, pp. 537-541, Vol. 35. no.4. IEEE database.