Application of PLC for Elevator Control System

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ABSTRACT
In this research paper an attempt has been made to integrate the programmable logic controller (PLC) with elevator for developing its control system. Thus, this paper describes the application of programmable logic controller for elevator control system. The PLC used for this project is GE FANUC with six inputs and four outputs. The programming language used is ladder diagram.

Keywords
Programmable logic controller (PLC), Elevator

1. INTRODUCTION
With the overall rapid development taking place in all spheres, the living standard of human being particularly in urban areas has tremendously increased as such the high rise buildings are constructed for malls, and housing purposes. Thus the installation of elevators in these high rise buildings becomes an integral part of the infrastructure for the movement of goods and people. So, the control system is essential in the smooth and safe operation of the elevator. It guides the elevator in what order to stop at floors, when to open or close the door etc. [1-4].

Programmable logic controller (PLC) is a digital computer used for automation of industrial processes such as control of machinery on factory assembly lines. Unlike general-purpose computers, the PLC is designed for multiple inputs and outputs arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input condition within a given period of time, otherwise, unintended operation will result. PLCs are used in many different machines such as packaging and semiconductor and in various industries for monitoring and controlling.

PLC has many advantages over other control systems. It is known for its flexibility, low cost, operational speed, reliability, ease of programming, security, and it is easy in implementing changes and correcting errors [3].

PLC is divided into three parts namely the Central Processing Unit (CPU), the input/output (I/O) selection and the programming device. The block diagram of PLC can be seen in fig.1.

The CPU reads input data from various sensing devices, executes the stored user program from memory, and sends appropriate output command to control devices. The I/O system forms the interface by which field devices are connected to the controller. The purpose of this interface is to condition the various signals received from or sent to external field devices. The programming device, or terminal, is used to enter the desired program into the memory of the processor. This program is entered using relay ladder logic. The program determines the sequence of operation and ultimate control of equipment or machinery. [1]

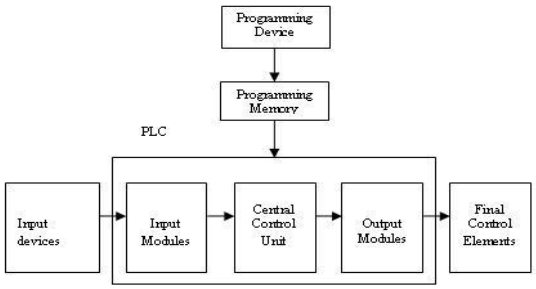

Fig 1: Block diagram representing the different parts of PLC.

2. APPLICATION OF PLC FOR CONTROL SYSTEM
The working principle of PLC for elevator control system functions in the similar manner as that the elevator we use in our daily life. The motion of the elevator that people normally use is controlled by a stepper motor. It consists of a pulley which helps in upward and downward movement of the lift. The position feedback is provided by the limit switches.

The principle of this set up is; whenever the cabinet is called to any level, the motor either runs in forward or reverse direction and then stops at the level indicated. The indication of the level or the position of the cabinet is given by the limit switches which act as a sensor and gives the signal indicating that the cabinet has reached the required position.

3. DEVELOPMENT OF HARDWARE AND SOFTWARE FOR INTERFACING PLC WITH ELEVATOR
PLCs may need to interact with people for the purpose of configuration, alarm reporting or everyday control. A Human-Machine Interface (HMI) is employed for this purpose. HMIs are also referred to as MMIs (Man Machine Interface) and GUIs (Graphical User Interface).A simple system may use buttons and lights to interact with the user. Text displays are available as

well as graphical touch screens. More complex systems use programming and monitoring software installed on a computer, with the PLC connected via a communication interface. [6]

3.1 Hardware

The different devices used for the development of this set up consist of a GE-Fanuc Nano PLC, Stepper motor, voltage supply, push buttons, switches and connecting wires. The details of each of the elements mentioned above are given below:

3.1.1 GE-FANUC PLC

General Electric Fanuc PLCs offer the perfect solution for smaller packaging machines, dispensing machines, and relay replacement applications with 6 inputs and 4 outputs. In spite of its small size, this versatile controller provides powerful programming features such as built-in-high-speed counter functionality, support for floating-point function blocks and subroutines, ability to assign passwords and privilege levels, override capability etc. It operates on +24V DC nominal input power and accept inputs from 6 positive or negative logic inputs.

Table 1. Specification of GE-Fanuc Nano PLC

Description	Specification
Weight	150 grams
Module Dimensions	Height : 80 mm Depth : 47 mm Width : 75 mm
Typical Scan Rate	1.2 ms/K for Boolean logic
Inputs	Six 24 VDC positive/negative logic input circuits
Outputs	Four transistor outputs
Output Power Supplies	+5 VDC on pin 7 of Serial Port, 100 mA max
Maximum number of slave devices per RS-485 network	8 (can be increased with a repeater)
Real-time clock accuracy(for timer functions)	+/- 0.5%

Fig 2: GE-Fanuc Nano PLC

3.1.2 Stepper Motor

The stepper motor is an electromagnetic device that converts digital pulses into mechanical shaft rotation. Advantages of step motors are low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment. The main disadvantages in using a stepper motor is the resonance effect often exhibited at low speeds and decreasing torque with increasing speed. There are basically three types of stepping motors; variable reluctance, permanent magnet and hybrid. They differ in terms of construction based on the use of permanent magnets and/or iron rotors with laminated steel stators. The motor used for the development of the set-up is permanent magnet type. The permanent magnet motor, also referred to as a "canstack" motor, has, as the name implies, a permanent magnet rotor. It is a relatively low speed, low torque device with large step angles of either 45 or 90 degrees. Its simple construction and low cost make it an ideal choice for non-industrial applications, such as a line printer print wheel positioner.

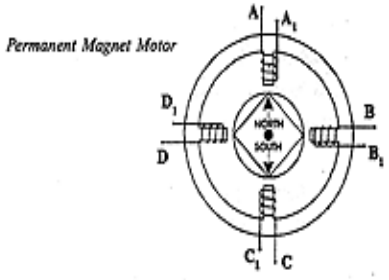

Fig 3(a): Internal arrangement of Permanent Magnet Motor

Unlike the other stepping motors, the PM motor rotor has no teeth and is designed to be magnetized at a right angle to its axis. Figure 3(a) shows a simple, 90 degree PM motor with four phases (A-D) and fig 3(b) shows the photographic views of PMM. Applying current to each phase in sequence will cause the rotor to rotate by adjusting to the changing magnetic fields. Although it operates at fairly low speed the PM motor has a relatively high torque characteristic. [2]

Fig 3(b): Permanent Magnet Motor

3.2 Software

The software used for the development of the set-up is the "Versapro 2.02". The programming language used in this software is ladder diagram. The ladder diagram language is basically a symbolic set of instructions used to create the

controller program. These ladder instructions are arranged to obtain the desired control logic that is to be entered into the memory of the PLC. [1].

3.3 Interfacing of PLC with Elevator

PLC used in this set up is GE FANUC with six inputs and four outputs. The photographic view of interfacing of PLC with elevator is shown in fig 4. The inputs are connected to three limit switches and three push buttons and the four outputs are connected to the stepper motor to generate a pulse. PLC consists of an on delay timer which is used to generate a pulse and also resets itself. A bit sequencer is also used in the program to generate four pulses continuously in sequence which is also used to change the direction of the motor. The program also consists of thirteen markers which are used as an internal output because of the less number of output ports. These markers can be used in the program as per the requirements.

For storing the logic to PLC from the software, firstly the PLC is to be selected and connected to the port address that is to be used. After this, the ladder program has to be created by using the ladder options and then the program can be stored to the PLC after the addressing has been given.

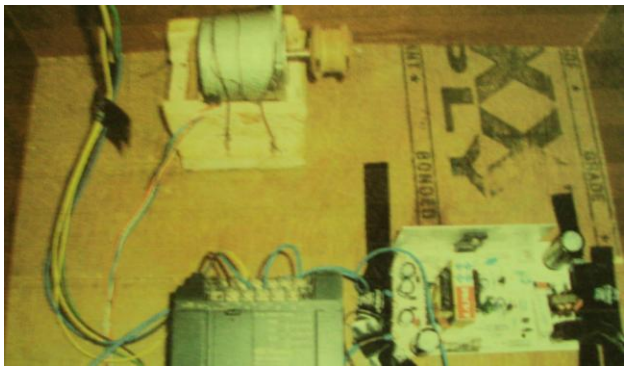

Fig 4: I*nterfacing PLC with Elevator*

4. RESULTS AND DISCUSSION

After the interfacing of PLC with elevator followed by thorough checking for errors, the trials of the setup were done and the said setup successfully worked as per the designed and developed control system.

When push button for the first level is pressed then the motor runs in reversed condition till the cabinet reaches its required position and actuates the limit switch which enables the motor to stop and if the cabinet is already in the required position then the motor won't get actuated.

Again, when push button for the second level is pressed then the motor runs either in forward or reversed condition according to its position till the cabinet reaches its required position and actuates the limit switch which enables the motor to stop and if the cabinet is already in the required position then the motor will not get actuated and subsequently it worked successfully for other levels too.

Apart from the ladder diagram we can also use the block diagram to control the elevator.

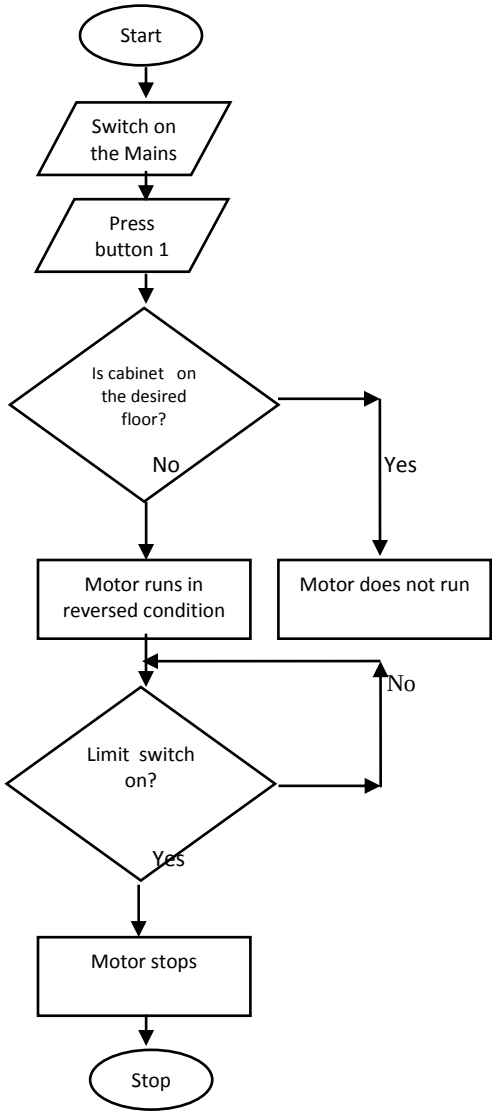

Fig 5: Flow Diagram of the whole operation of the PLC based controller for elevator.

5. CONCLUSION

In this paper, the authors have discussed the application of a Programmable Logic Controller for an Elevator Control System. The authors successfully designed and developed PLC based control system for elevator.

The following conclusions have been drawn from this research work:

(i) Nano PLCs can also be interfaced with an elevator.
(ii) Markers can be used as an internal output.
(iii) The generation of adequate pulse by the PLC based control system for developing the required torque in the motor for the movement of the elevator else elevator will not function satisfactorily.

(iv) It is observed that the PLC based controller for elevator works better than the other control systems. the industries and other business establishments will be greatly benefitted from this type of control systems. However, before pressing this type of control system for commercial use, the indepth study, experimentation and validation is required.

6. REFERENCES

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