



Design of a PLC Based Elevator Control System

A M Anusha* and Ashok V. Sutagundar**

*Department of ECE, BEC, Bagalkot,

(Corresponding author: Bheemrao M. Kamble)

(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Elevator is an important transport medium in multi-storage building. With the development of better architecture technology, buildings are raising in height. Hence an elevator becomes an important medium of vertical transportation. There are several advantages of an elevator in the modern world. Hence more importance is given to the design of an elevator control system, which is easy for the maintenance and to perform an efficient function. Preliminarily, traditional elevator control systems work on the relay logic. More number of connections of relay logic are found in traditional elevator system. Hence it has become difficult to debug the failures in the system and also it is highly feasible job to facilitate alternate connections to the fault tolerant systems in the relay logic, where as in PLC based system, it is easy to debug the failures in the system as it contains the simple logics and easy maintenance. The main objective of this paper is to replace the traditional relay logic elevator control system with the modern PLC based elevator control system. The proposed work is tested with INDRA-WORKS ENGINEERING simulator and BOSCH-REXROTH PLC.

Keywords: Elevator control system, PLC, relay logic

I. INTRODUCTION

Elevators are the important medium of vertical transportation in both residential environment and the industrial environment. Now days, there is tremendous development in structural and architectural engineering for multi storage buildings. The main requirement of the multi storage buildings are elevators. Elevators ease the work human being and keep him/her in the comfortable zone. Elevators are used in almost all the multi storage buildings of the metropolitan cities, hence it is essential to replace the traditional elevators with PLC technology based elevators.

Traditional elevator control systems are relay logic controlled systems. These relay controlled systems have several limitations such as: high fault ratio, highly complex circuits, difficult to replace the defected parts of the automated system. It is difficult to provide fault tolerance using the relay logic. PLC is the replacement to relay logic controller, one can make the better use of PLC in the designing of the elevator control system.

The ladder logic programming is used to simulate the proposed system. This paper introduces the basic structure of elevator control system design and the simulation of the design using Indra-works-engineering which is a Bosch-Rexroth group PLC simulation software.

Some of the related works are as follows:

The authors in [1] proposed a system of elevator, which uses a AC motor to drive the elevator cabin.

This system control is based on the input that is received from the operator as well as from the sensors. Accordingly PLC makes the drive motor and door motor to work correspondingly to implement the simulated model as a prototype. The authors selected the java programming language for the implementation [2]. So that application is executed in the form of an applet. One of the classes represents all the automata. This contains seven automata. Two threads are used in the given implementation. The authors developed the elevator control program for the sake of simplicity three storage building is considered.

The development of nine storage elevators control system for a residential building is given [3]. The control system adopts PLC as controller, and uses a parallel connection dispatching rule based on minimum waiting time to run two elevators in parallel mode.

The organization of this paper is as follows Section 2 presents the elevator system structure, The block diagram of the proposed system is presented in section 3. The working of automated elevator system is depicted in section 4 through the flow chart, ladder diagram for the proposed system is presented in section 5, section 6 presents the conclusion and future scope.

II. ELEVATOR CONTROL SYSTEM ARCHITECTURE

This section presents the description of all the components in the elevator system and also about the signal control system.

The main components of the elevators are the elevator car: elevator car is the main medium of vertical transportation; it is actually which carries the passengers between the different floors. Hoist way is the second important part of the elevator control system which supports the elevator car to travel between the different floors. Elevator control system is one of the most important part of the elevator, elevator control system is needed to control all the functions of the elevator. It is the one which guides the elevator car to travel between the different floors; it also controls the opening and closing of doors at different floor, and the safety switches are also controlled by the elevator control system. Electric power driving system is another important system which is used in the proposed system, this system includes elevator car, the traction motor, door motor, brake mechanism and relevant switch circuits. Here plenty of intermediate contacts can be substituted by the PLC's contacts. The circuit of traction motor are reserved, thus the original control cabinets disadvantages like high noise and big volume are sufficiently reduced.

A. Signal Control System

The main application of PLC is in the signal control system, all the control signals are realized using the PLC, the input signals are operational modes, safety control signals, car-calls, hall-calls, floor sensors, levelling sensors, door opening and close signals.

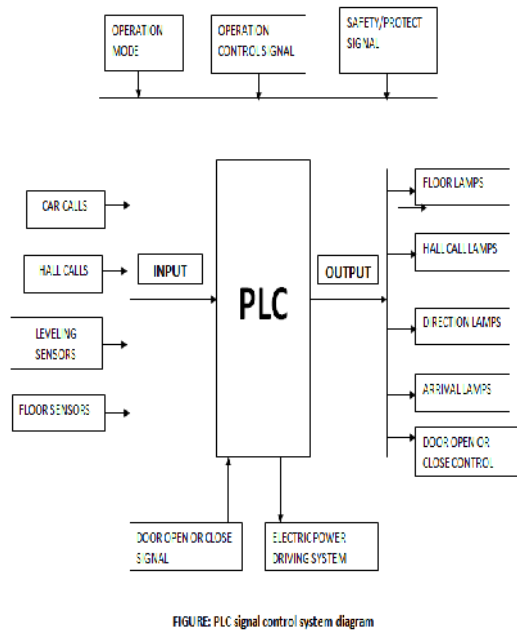


Fig. 1. Signal control system diagram.

All the functions of the elevator control systems are realized using the PLC programs, the functions includes registration, displaying the messages about the floors, monitoring the safety system, monitoring the door

opening and closing, prioritizing the hall-call, and car-calls.

Figure 1 indicates the block diagram of the signal control system. The inputs are given to the PLC unit where the corresponding outputs like floor lamps, hall call lamps, direction lamps, arrival lamps, door open or close lamps are produced.

B. PLC based Elevator

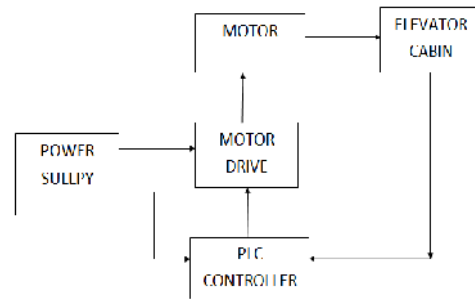


Fig. 2. System block diagram.

Figure 2 indicates the overall system block diagram of this proposed system. the power supply is applied to both motor drive and the plc controller. Motor of the elevator is driven by the motor drive unit. The elevator cabin in turn driven by the motor unit. The elevator cabin's upside and downside moment is controlled the switch operated motor. Those switches are controlled by the PLC controller.

C. Problems To Be Solved Through Ladder Diagram

This section presents the problems which are needed to solve through the ladder diagram.

Ladder diagram is used to realize the many functionalities of the elevator control system. some of the functionalities are, program should be written to make the display on which indicates the upward or downward movement, the door of the elevator should be programmed to open and close automatically, when the elevator has no request it remains at its current floor with its door opened, floor lamp should glow within the lift to indicate the current position.

Table 1: List of Inputs.

INPUTS	ADDRESSES
1-8 floor up hall-call	I0.0-I0.7
2-9 floor down hall call	I1.0-I107
1-9 floor car-call	I2.0-I2.7, I3.0
1-9 floor arrival sensor	I3.1-I3.7, I4.0-I4.1
Door open button	I4.2
Door close button	I4.3
Fire switch	I5.0

Table 2: List of Outputs

OUTPUTS	ADDRESSES
1-8 floor up hall call lamp	Q0.0-Q0.7
2-9 floor down hall call lamp	Q1.0-Q1.7
1-9 floor car-call lamp	Q2.0-Q2.7,Q3.0
Door opening	Q4.2
Door closing	Q4.3
Up moving	Q4.4
Down moving	Q4.5

A. Flow Chart

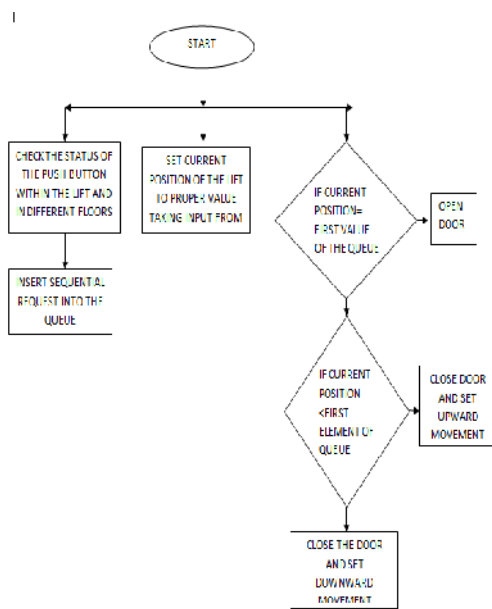


Fig. 3. Flow chart of the proposed system.

The figure 3 shows the flow chart that indicates the working procedure of the elevator control system. The flow chart consists of three threads first thread checks the status of the push button within the lift and also status of push buttons in different floors, and also the management of the request queues are also monitored in the first thread.

Second thread sets the current position of the lift to proper value taking input from the queue. Third thread is responsible for the upward and downward movement of the elevator car. If the current position of the elevator cabin is less than the first element of the queue then the elevator cabin should move in upward direction. If the current position of the elevator cabin is greater than the first element of the queue the elevator cabin should move in the downward direction.

B. Ladder Program

This section presents ladder diagram of different modules. The overall functionality of the elevator is categorized into different modules and these different modules are implemented through ladder diagram. The entire system working is composed of 6 modules hall-call registration and display module, car-call registration and display module, elevator-location display module, floor selection module, the door open or close module, safety maintenance module.

A. Hall-Call Registration And Display

There are two kinds of calls in the elevator they are hall-call and car-call. When the passenger presses the button in the control panel which is outside the elevator cabin that is the hall-call. When the passenger presses the button on the control panel which is inside the elevator car that is the car-call. The below figure shows the up-hall call registration and display

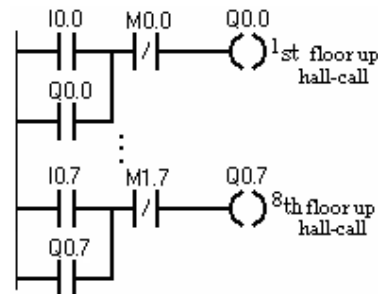


Fig. 4. Ladder diagram for up hall-call registration and display.

B. The Cancellation of The Hall-Call

This program performs the two functions ,
 -Make the elevator response the normal down hall-calls when it is moving down, and when a down hall-call is served, its registration is cancelled.
 -When the elevator is moving up, the corresponding floors down hall-call it passing by is not served and the registration is remained.

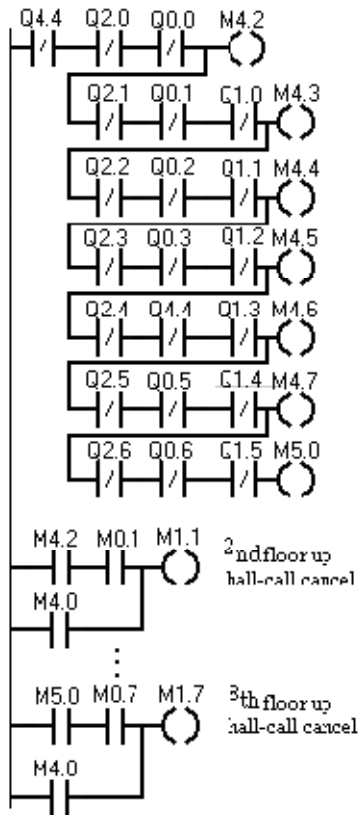


Fig. 5. Ladder diagram for the cancellation of the hall-call.

C. Up-Moving of Elevator

The below shown ladder diagram indicates the up-moving of the elevator. The combination of hall-call and car-calls are used to decide the elevator movement in upward or downward direction. If the current position of the elevator is less than the first element of the queue then the elevator will move in the upward direction.

D. Fire Sensor Ladder Logic

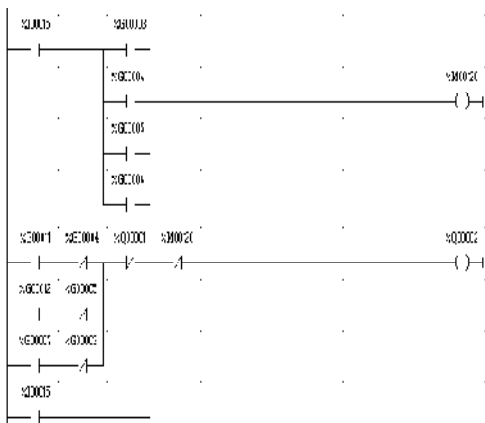


Fig. 7. Ladder diagram for the fire sensor ladder logic.

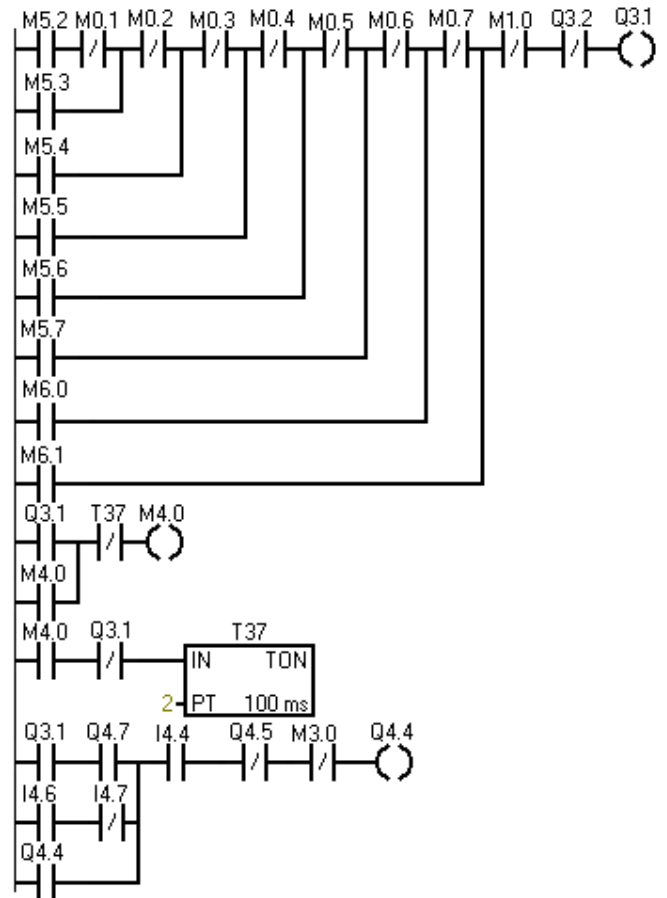


Fig. 6. Ladder diagram for the up-moving of the elevator.

The input terminal will detect the fire, and as the output the elevator will stop to the nearest down floor. Fire sensors are placed at every floor whenever there is a detection of fire the sensor values are given as the inputs to the PLC which automatically guides the elevator car to the nearest down floor.

III. CONCLUSION AND FUTURE SCOPE

In the modern developed world elevators are becoming more important with the development of architecture technology. The design of elevator based control system is more important as it is more essential to perform the entire task. Ladder diagram programming is selected as it is easy to program the different PLCs. Indra works engineering is used to simulate the developed ladder diagram for this proposed system. Different ladder diagram modules are implemented as given in this paper. Different sensors are configured at different floors to perform many functions.

The proposed system can be extended for the two different elevators operating at the same time, and also the safety of the system can be improved by adopting more safety techniques.

REFERENCES

- [1] 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.
- [2] Dae-Woong chung, Hyung-Min Ryu, Young-Min Lee, "Drive systems for high-speed gearless elevators", *IEEE industry Applications Magazine*, vol. 7, pp 52-56, 2001
- [3] Darshil, Sagar, Rajiv, Pangaokar, S.A. Sharma, "Development of a PLC Based Elevator System with Colour Sensing Capabilities for Material Handling in Industrial Plant", *In proceedings of IEEE Joint International conference on Power System Technology*, pp 1-7, 2008
- [4] Eunson jung, HyunjaeYoo, Seung-ki Sul, Hongsoon Choi and Yun-Young Choi, "A Nine-Phase choi and Yun-Young Choi, an Ultrahigh-speed Elevator", *IEEE Transactions on Industry Application*, vol.48, pp 987-995.
- [5] Peng Wang, "A Control System Design for Hand Elevator Based on PLC", *In proceedings of IEEE Conference Publications*, vol.1, pp 77-74, 2012
- [8] Jayawardana H.P. A.P., Amarasekara. H.W.K.M., Peelikumbura. P.T.S., Jayathilaka. W.A.K.C., Abeyaratne .S.G. and Dewasurendra. S.D. "Design and implementation of a statechart based reconFigureurable elevator controller", *In proceedings of 6th IEEE International Industrial and Information Systems, IEEE Conference Publications*, pp 352-357, 2012
- [9] Jae Sung Yu, Sun Mo Hwang and Chung-Yuen Won (2009) "Performances of fuzzy-logic-based vector control for permanent magnet synchronous motor used in elevator drive system", *In proceedings of 30th Annual Conference of IEEE Industrial*, pp. 98-112, 2009