A CONTROL SYSTEM OF ELEVATORS BY USING PROGRAMMABLE LOGIC CONTROLLER (PLC)

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Abstract- *A low cost elevator control system has been developed by using Programmable Logic Controller (PLC). PLC is used as a controller for an elevator system that has two elevators with five floors. The PLC will control vertical movement of the two elevators either moving up or down simultaneously with only one PLC. The PLC also control opened and closed door process after the elevator had reached each level. The automation of this elevator process consists in providing technological means for its selective operation and control, such that the system as so conceived is enabled to deal with those situations for which a proper command has been implemented.*

Keywords: Elevator, Programmable Logic Controller (PLC), CX-Programmer, Ladder Diagram

1.0 INTRODUCTION

An elevator is designed to help people in daily life and frequently referred as a device for vertical transportation of passengers or freight to different floors or levels.

This paper present work implementation of elevators that designed to perform selective operation to reduce congestion among passengers. The elevator designed for this project is the roped elevator type. In roped elevator, the car is raised and lowered by ropes that attached to the elevator car, and looped around a sheave. A sheave, as in real-life elevator is pulley with a groove around the circumference. But for the model, a pulley with rubber surrounds its surfaces is used to holds the ropes and as the pulley rotate, the ropes move too.

The pulley is then connected to an electric motor. When the motor turns one way, the pulley raises the elevator; when the motor turns the other way, the pulley lowers the elevator. To provide enough force to lift up and down, a DC motors with gears are fitted on the top of the building. Sufficient amount of voltage supplied to the motor needed to enable the elevator to have enough power and torque, hence providing sufficient force to move it.

The elevators used OMRON SYSMAC CQM1H CPU21 Programmable Logic Controller (PLC) to control its operation. The PLC controls the selective operation of the elevators.

1.1 OMRON CQM1H CPU21

Figure 1: Omron PLC (CQM1H)

The CQM1H is a compact, high-speed Programmable Controller (PC) designed for advanced control operations in systems requiring from 16 to 256 I/O points per PC [1].

The PLC comes with high-speed processing includes the 50-µs quick-response inputs, improved scan time and interrupts. It also allows line additions, faster operation, and reduced system startup time [2].

CQM1H-CPU21 Units configuration is shown in Figure 2 [2]:

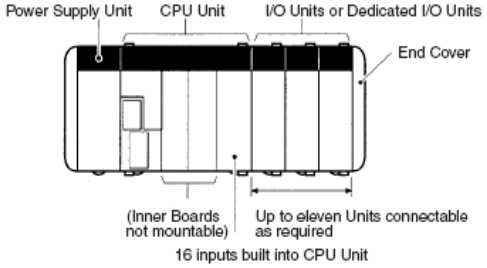

Figure 2: Configuration of CQM1H-CPU21

1.2 SPECIAL FEATURES OF THE CQM1HCPU

Each CPU has 16 transistor inputs. Four of these inputs can be configured as interrupt inputs. The response time before the interrupt subroutine is called up is max. 0.1 ms [1].

Furthermore, three inputs can be used to connect an encoder as a high-speed counter input. Pulses of up to 5 kHz are counted. Each CQM1H CPU can output pulses up to 1 kHz via a Transistor Output Unit [1].

1.3 SYSMAC WAY

SYSMAC WAY communicates via the RS-232C or RS-422 port and contains the open, OMRON-specific ASCII protocol called Host Link [1].

By default, the CQM1H communication port runs in Host Link slave mode and can therefore be easily operated from a PC, a supervisory controller.[1]

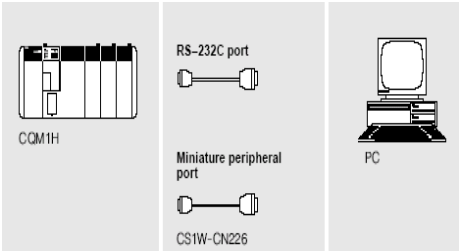

Figure 3: Communicates via the RS-232C or RS- 422 port

The Omron CX-Programmer 3.2 software is used to makes the writing of ladder diagram and developing to PLC easier. CX-programmer is a PLC programming tool for the creation, testing and maintenance of programs associated with Omron CQM1H.

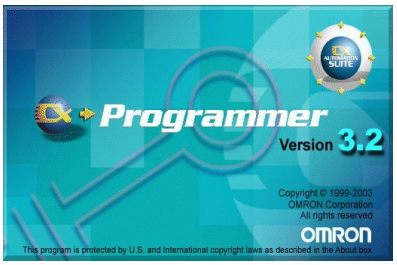

Figure 4 : PLC Programmer Software

1.4 PROGRAMMABLE LOGIC CONTROLLER

A programmable logic controller is a user friendly electronic computer that carries out control functions of many types and levels of complexity. To achieve proper control, the programmable logic controller essentially used a controller logic called ladder diagram. The resulting ladder diagram takes the place of the relays system and much of the external wiring required for control of a process.

A programmable controller is basically a CPU (Central Processing Unit) containing a program and connected to input and output (I/O) devices. The input devices in this project are keypad, Infrared sensors, push buttons and limit switches that produces a signal that can be input into the controller. The output devices of the elevator are relay turning on motor or any-other devices that can be activated by signals output from the controller.

2.0 METHODOLOGY

The processes involved in the realisation of this work are described in the followings. Most of these steps can only be taken after the preceding step has been performed. Basically, the processes involved are:

i. developed the flowchart of operation of the elevator,
ii. designed and developed ladder diagram of the control system,
iii. wired the hardware to PLC,
iv. testing the design system

2.1 PLANNING STEP

✓ Define the process to be controlled
✓ Make a sketch of the process operation
✓ Create a written steps sequence listing for the process
✓ Consider the safety of the operation and make additions and adjustment as needed
✓ Create the ladder logic diagram that will be used as a basis for the PLC program

2.2 PROCESS DISCRIPTION

The idea behind the elevator system is to build an elevator with special features of control system. The controlling features are on the selective operation. The controlling function will be incorporated with the used of push button, limits switch and sensors system. It is set to control the elevator system including the movement of the elevator, timer mode program and logic controlling system.

2.3 FLOWCHART OF ELEVATORS SYSTEM

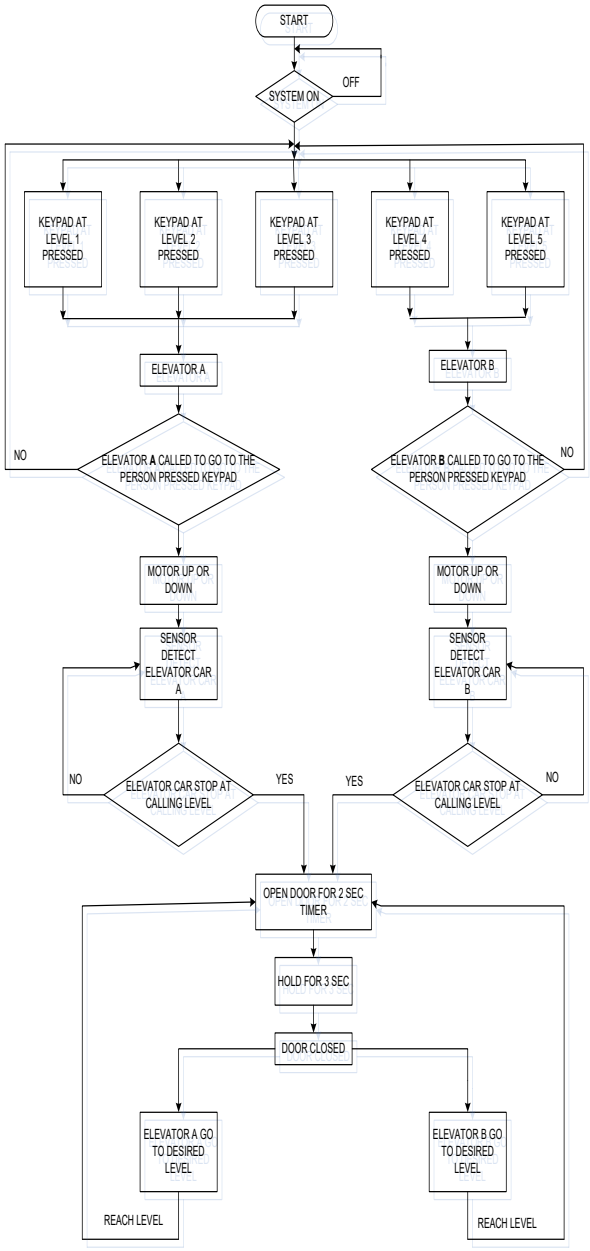

Figure 5: Flowchart of elevator operation

2.4 SEQUENCE OF THE FLOWCHART

Elevators respond a command to START the system. The system ON when the ON button is pushed. When the keypad of each level is pressed, one of the elevators responds. **Elevator A** responds to keypad pressed only at level 1, 2 and 3. **Elevator B** responds to keypad pressed only at level 4 and 5. Then each elevator will go to the called level and performed opened door operation. After the timer for the passengers to enter the elevator is off, the elevator will closed the door and continue to go to desired level and performed opened and closed door operation again.

2.5 SOFTWARE DEVELOPMENT

Figure 6 shows an example of the software development using CX-programmer. The ladder diagram represents the operation of the elevators system.

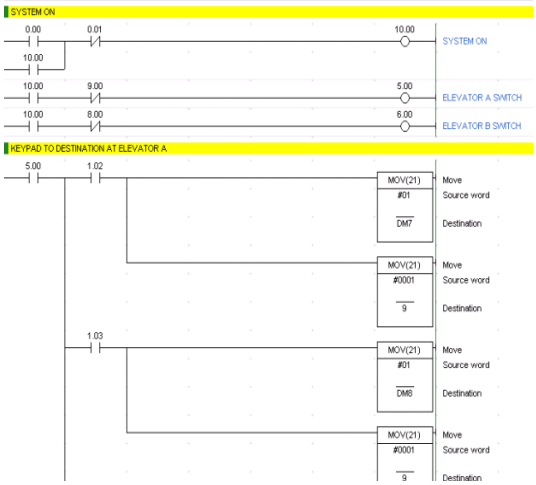

Figure 6: Example of the software development

2.6 WIRING BETWEEN HARDWARE AND PLC

Figure 7 below shows the wiring of the hardware to the PLC. The wiring connection from hardware to PLC must appropriately wired according to the address of the input and output assignments.

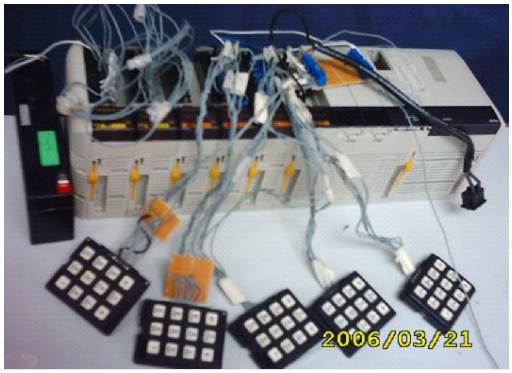

Figure 7: PLC wiring

3.0 RESULTS AND DISCUSSIONS

The two elevators control operation using Programmable Logic Controller design system has been developed and test in the laboratory. The elevators are successfully move up and down and able to open door at each level that reached.

Figure 8: Elevators

3.1 LADDER DIAGRAM AND THE TIMING DIAGRAM OF THE SYSTEM

The elevator is programmed base on the timer mode. Figure 9 below shows the ladder diagram of the operation to go to desired level.

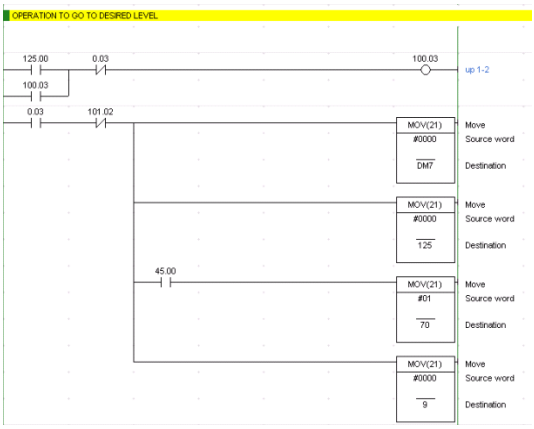

Figure 9 : Ladder diagram of operation to go to desired level.

Figure 10 below shows the timing diagram of the operation of the motor move up after keypad to desired level is push.

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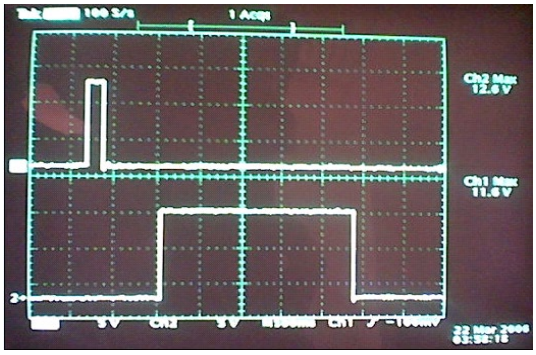

Figure 10: Waveform for motor up On when keypad pushed.

Figure 11 below shows the ladder diagram of the motor for open and closed door operation.

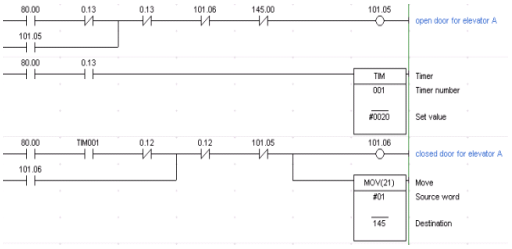

Figure 11 : Ladder diagram of open and closed door operation.

Figure 12 below shows the timing diagram of the motor for open and closed door operation.

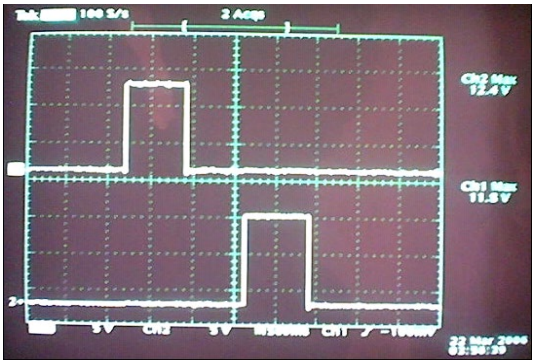

Figure 12: Waveform for open and closed door

Figure 13 below shows the ladder diagram for calling operation and operation to go to desired level.

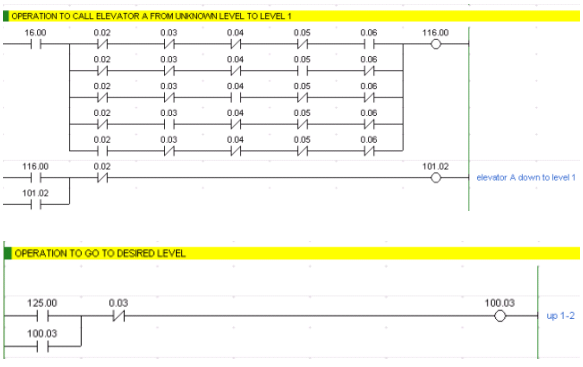

Figure 13: Ladder diagram of calling operation and operation to go to desired level.

Figure 14 below shows the timing diagram for calling operation and operation to go to desired level.

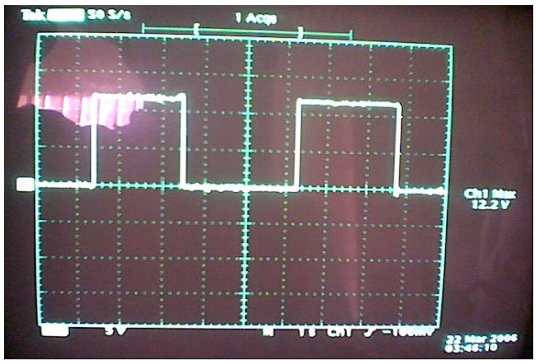

Figure 14: Waveform for calling elevator and then go to destination

4.0 DISCUSSION

In this project, a control system for the elevators has been build using a Programmable Logic Controller (PLC). The type of PLC used is the Omron Sysmac CQM1H CPU21 controller. There are two stages in this project which are the software part and hardware wiring. The first stage is to develop the system by identifying all components needed to develop a program of the system. The second stage is also important where at this stage it shows the implementation of the controller to the system.

In first stage, the program of the system is developed by first identifying the process that need to be control. Then the input and output to the PLC is identified before the program of the system is written. The program in PLC is written in the ladder logic form after the ladder diagram has been constructed. The problem in this first stage are to identified components needed to be controlled by the PLC since the elevator system is a big process and very delicate and need to focus well to choose the system that want to be controlled.

In second stage, the problems arise when it goes to the wiring connection of the input and output to the PLC. There are too many wiring needed to be controlled the input and output of the controller. Wired are need to be labeled and arranged in wire trucking so that it look neat and easy for trouble shoot purposes.

5.0 CONCLUSION

Programmable Logic Controller (PLC) is originally designed to provide flexibility in control based on programming and executing logic instructions. Major advantages were realized by adopting the ladder diagram programming language simplifying maintenance and reducing cost of spare part inventories. Also PLC allowed for shorter installation time and faster commissioning through programming rather than wiring. The control operation given to the elevator to be performed is accomplished. The elevator is capable to perform the up and down movement and also opened and closed door successfully.

6.0 FUTURE DEVELOPMENT

For future development, the elevator can be upgraded by adding some special features to the software or the hardware.

For the hardware upgraded, the Omron Digital Proximity sensor could be used to stop the elevator automatically when emergency situation appears. The feature comes with adjustable distance of detection, colors detection mode and its come with friendly set instruction and digital displays mode (Easy-to-read digital displays). Since the digitized detected and threshold values can be checked at the same time, settings are simple and reliable for just about anyone.

Figure 15: Omron Proximity Sensor

To optimize the wiring problem, building should be adding with a centralized control box system that will hide all the wiring connection and make it easy to maintain and troubleshoot the circuits.

7.0 ACKNOWLEDGEMENT

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