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PLC based Gate Automation

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Abstract – *Automated Gate is an automated movable barrier installed in entrance of any infrastructure for restricted access. At present, main gate of MVP's KBT College of Engineering is being operated manually thus it is hectic for the guards to open and close for every entry and exit of a vehicle, also it is time consuming. So, it needs to be automated to reduce human efforts, to save time and avoid traffic. The project consist of a Rack and Pinion and a Boom Barrier assembly, whole system is controlled using PLC controller. Both the assemblies i.e., rack and pinion and boom barrier are operated using AC motors with gear box. Also, the lamps at the entrance of the college are controlled using same PLC.*

Key Words: Automated Gate, Rack and Pinion, Boom Barrier, PLC controller, AC motors.

1.INTRODUCTION

Programmable Logic controller (PLC) is the most powerful tool, which bought change in the electronics world in automation sector. PLC is well suited to the cyclic and repetitive operations. Unless a system reconfiguration is required the functions executed by a PLC are fixed, the programs need not be changed.[2]

Automotive technologies are gaining importance in modern days traffic, safety and security control systems.[2] The manually operated gates of schools and colleges are hectic to operate, time consuming and may lead to unforeseen accidents. Hence there is a perpetual need for safety critical gate control automation to avoid traffic jams, considering human life safety, and to reduce human efforts.

Therefore, in this work we have developed a PLC based Gate Automation System, in which PLC is going to control two sub gate systems i.e., Rack and Pinion and Boom Barrier assembly. The system is developed for main gate of MVP's KBT College of Engineering. Both the assemblies are operated using AC motors and gear trains. Besides sensors and limit switches are used to ensure proper operation of the gate. It is found that the implemented system works efficiently.

2. LITERATURE REVIEW

In [1] literature, the author describes that, Automatic parking barrier is one among the recently developed technologies operating at the parking facilities and entrances to the restricted areas. During this research author implemented the prototype of an automatic barrier system controlled by a mobile application. The user of the application must have the particular mobile app that's connected to the Bluetooth model integrated into the barrier system to unravel problem. Upon connecting to the network, the user requires pressing the "open" button on their mobile phones to enter into the restricted area. Arduino platform is employed to develop the algorithm, connect the mobile app to the system, and control the automated parking barrier from the vehicle with the mobile app.

In [2] literature, the author describes that, an automatic railway crossing gate system has been developed employing a Programmable Logic Controller (PLC). For this purpose, they used Allen-Bradley MicroLogix PLC and Rockwell software for PLC programming.

In [3] literature, the author describes that, Automatic gate is an automatic movable barrier installed in the entry of any infrastructure to limit access. This system is operated by different mechanisms like sliding on screw, rack and pinion, piston operated and rotary operated. Rack and pinion mechanism is best in overall comparison with other drives like chain drive, belt drive etc. Frictional resistance is less and which is affect in overall reduction of power requirement and energy consumption. By using finite element analysis, the stress distribution and therefore the deformation of elements are been determined.

In [4] literature, the author describes detailed study on switching frequency is taken for experimental study with retro reflective sensors. The significant study of the switching frequency and therefore the comparison of the performance the statistical methods like descriptive statistics, correlation and chi-square test are used.

In [5] literature, the author explains the decision to have sensitive places protected, using an intelligent gate controller system, from unwanted individuals or group of peoples that sometimes take advantages of loose security systems at the point of entry. The controller used is smartphone that integrated by android program. The software used for this project is Arduino program. The controller is linking with the software and hardware component.

3. PROPOSED SYSTEM

3.1 Block Diagram

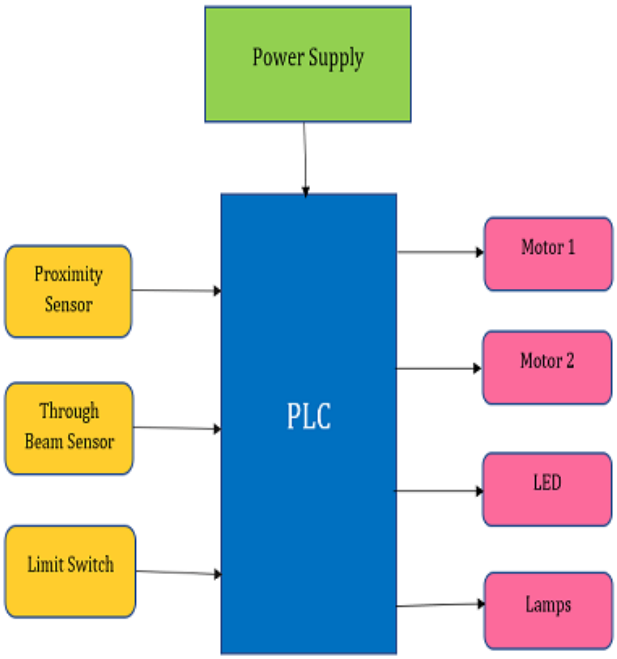


Fig -1: Block Diagram

3.2 Components Used

Selection of appropriate components is the major and important phase of the project for building the system, we have used following components for our gate automation system.

i. PLC

- The controller used for automation system is SIEMENS PLC SIMATIC S7-1200 CPU 1214C DC/DC/DC with 24V DC , 1.5 amp supply.
- 14 Digital inputs, 10 Digital outputs and 2 Analog inputs.
- We have used Programmable Logic Controller for Controlling the motors (o/p), with sensors and limit switches(i/p).

ii. Rack and Pinion Assembly

- A rack and pinion is a type of linear actuator that comprises a circular gear (pinion) engaging a linear gear (rack), which operate to translate rotational motion into linear motion.
- Module- 2.5M

Fig -2: Rack and Pinion Assembly

iii. Rack and Pinion Motor (Motor 1)

- It is simple single phase AC, 6 amp. 1/2 HP motor with rotating speed of 1425 RPM.
- We have used it for forwarding and reversing of rack and pinion assembly with the gear box to reduce speed of the motor.

iv. Boom Barrier

- Boom-type barrier comprises of a boom mounted on a bracket or stand for movement between open and barring positions.
- The Barrier used is of 4m.

v. Boom Barrier Motor (Motor 2)

- The motor used is a capacitor single phase AC 4.5 amp.,1 HP motor with rotating speed of 1425 RPM.
- Having Chain and Gear assembly to reduce relative speed.
- It Ups and Downs position of Boom barrier.

vi. Proximity Sensor

- Inductive Proximity Sensor with 10mm range.
- For sensing the extreme Up and extreme Down position of Barrier.

vii. Through Beam Sensor

- In proposed system we have used through beam sensor for vehicle detection.
- It is a PNP type, with 10-30 VDC supply and of 20m range.

viii. Limit Switches

- To check extreme left and extreme right position of the gate.

4. IMPLEMENTATION

4.1 FLOWCHART

There are two modes of operation:

i. Manual Mode

ii. Auto Mode

i. Manual Mode:

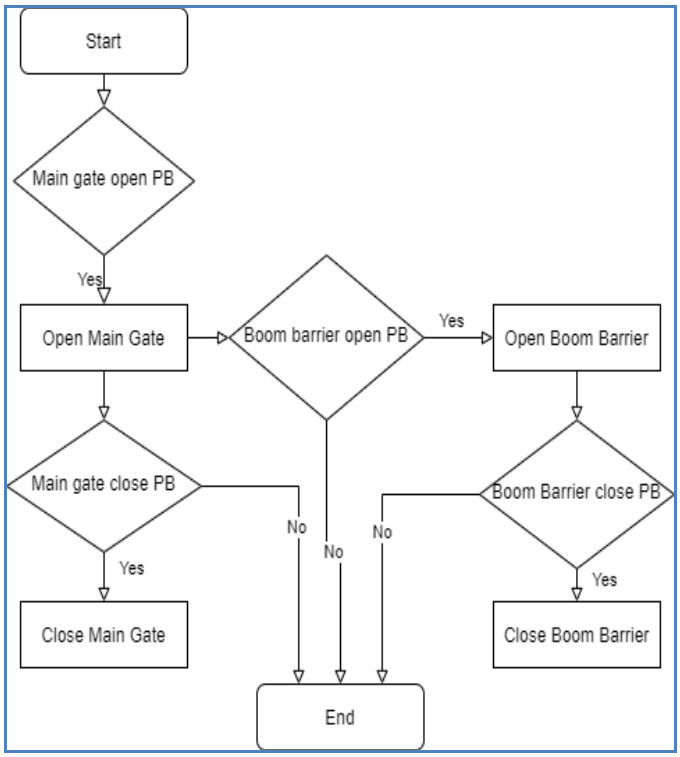


Fig -3: Flow Chart (Manual Mode)

- When system is in manual mode all operations will be done manually.
- In this project we have two basic motors
  1. Motor 1 – Main gate motor
  2. Motor 2 – Boom barrier motor
- The task to be achieved is that when vehicle comes in front of the main gate the boom barrier should go up and as the vehicle leaves the second sensor the barrier should go down.
- To achieve this we have at present four sensors
  1. Sensor 1 – Main Gate full open position
  2. Sensor 2 – Main Gate full close position
  3. Sensor 3 – Boom Barrier full up position
  4. Sensor 4 – Boom Barrier full down position
- When the operator press the main gate open push button (PB).
- As soon as the button is pressed the main gate will open and remain in the open state till someone press main gate close PB.
- The extreme open and close position will be sensed by limit switches.
- When the main gate is open then if the operator press up PB the boom barrier will go up and remain up until someone presses down PB.
- The extreme up and down position will be sensed by the inductive proximity sensors.

ii. Auto Mode:

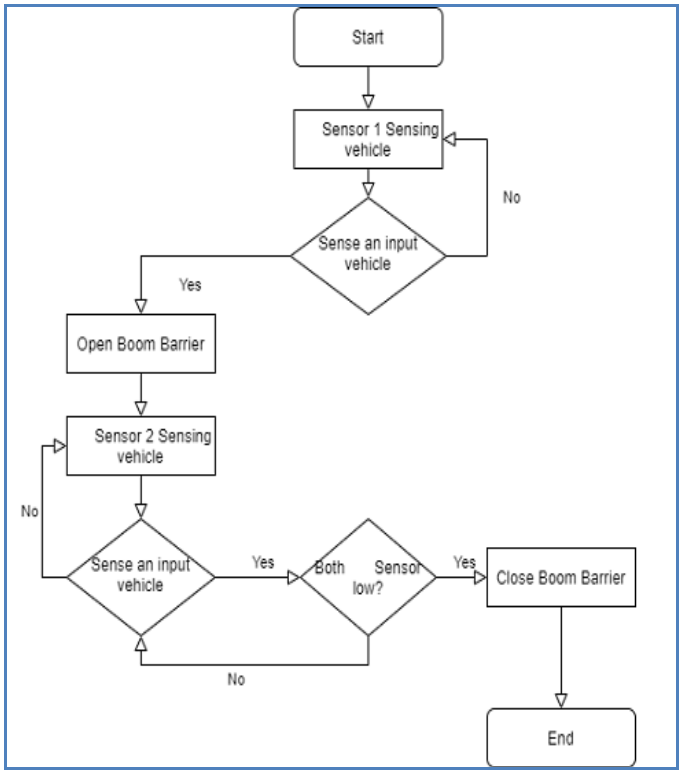


Fig -4: Flow Chart (Auto Mode)

- When the system is in auto mode the Through Beam type sensor comes in picture.
- When the entry sensor is sensed then the boom barrier will go up automatically and remain in that position until the exit sensor senses high to low. After this it will come down.
- Vice versa for exit operation.

5. SOFTWARE DEVELOPMENT

The software used for programming siemens PLC's is Totally Integrated Automation Portal (TIA Portal) this Innovative simulation tool is highly flexible, secure, and easy to operate. It has advanced options like smart selection wizard for error-free configuration and ordering, Configuration options

can be tested and simulated in advance, we have used student version of TIA V13.

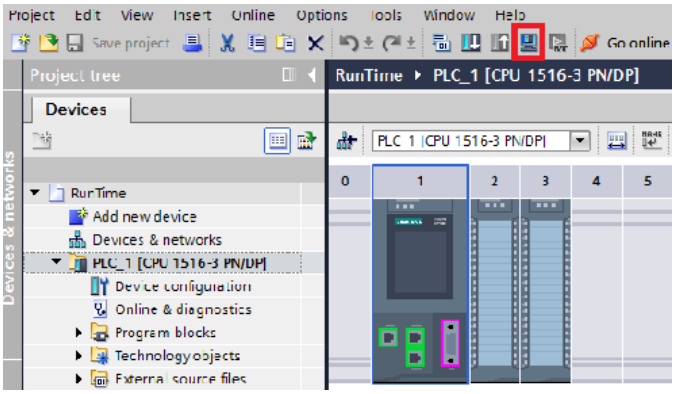


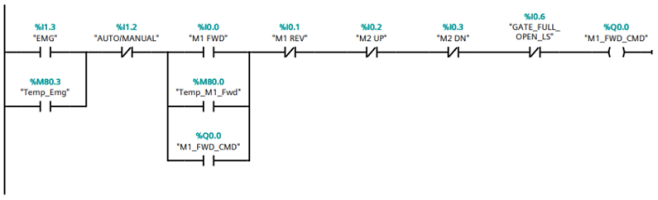
Fig -5: TIA Portal Software

5.1 Programming – Ladder Logic

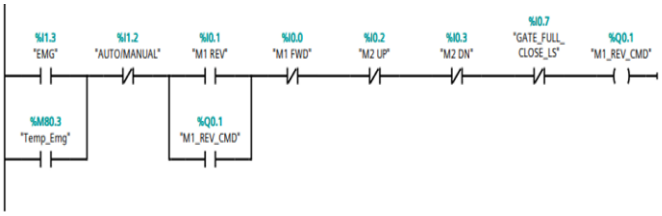
Here are some of the programming logics of our system in the ladder programming.

i. Manual Mode:

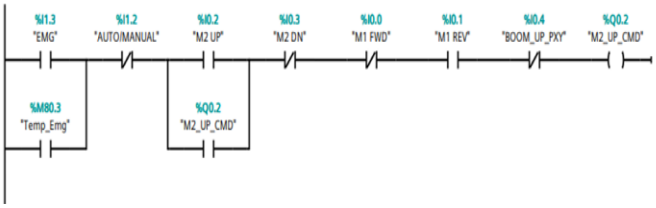
a. Network 1: Motor 1 Fwd logic



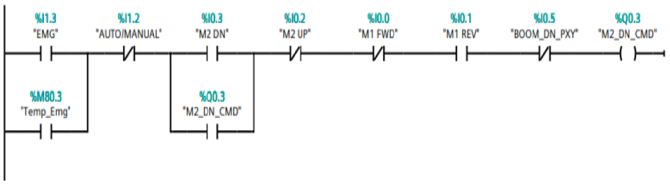
b. Network 1: Motor 1 Rev logic



c. Network 1: Motor 2 Up logic

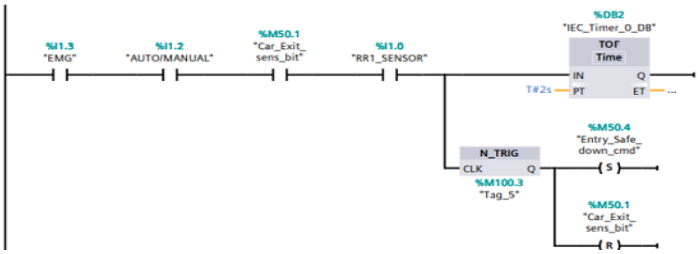


d. Network 1: Motor 2 Down logic

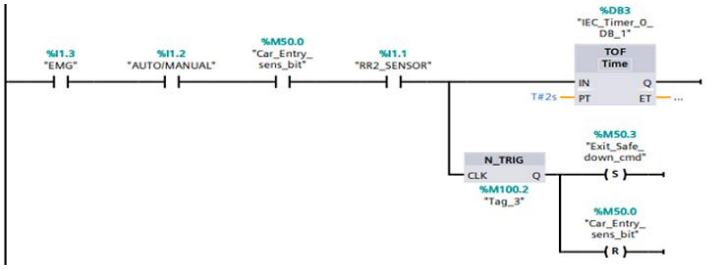


ii. Auto Mode:

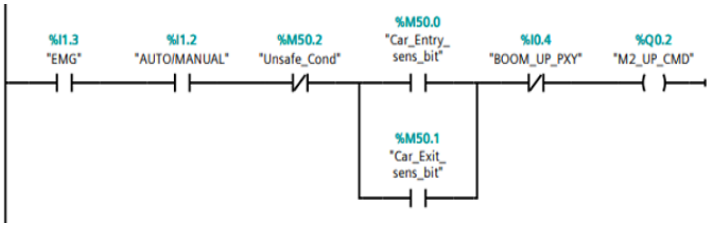
a. Network 1



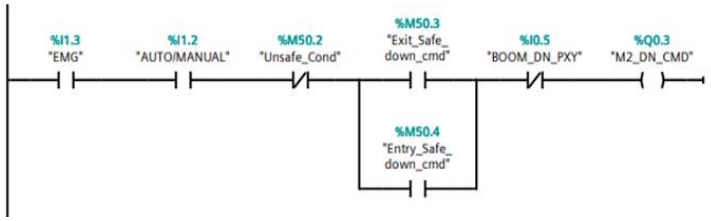
b. Network 2



c. Network 3



d. Network 4



6. CONCLUSIONS

Now a days, PLC's are being used to reduce maintenance and labour cost of many control systems. Therefore, it is highly recommended that operations like gate controlling will be based on such advanced controllers by considering risk factors, we have developed such a control system. The

proposed system is designed to control a Institution gate with the help of PLC controller, Proximity sensors, Through beam sensors, Limit switches and Motors. The auto control of this system will reduce human efforts, labour cost, wastage of time and traffic.

Also, the project contributes to a smart campus of a engineering institution. After on field implementation and successful testing of the whole system, it was found that the developed system operates very well.

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