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Automation of space management in vehicle parking using PLC and SCADA

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Abstract:

This work is to identify the available space in the parking area using PLC and SCADA. The main objective is to identify the empty space and indicating the driver to a particular slot. This paper attempts to design and implement an automated parking lot management system. Automated Parking Lot Management System is a fully functional and digitally controlled parking lot management system that is implemented with the use and integration of different digital circuitry and micro computing. The design involves different stages, from the main unit; process is passed on to different subunits to achieve the goal of full automation. An oncoming car will communicate (through the driver) wirelessly with the main unit attached to the Parking Facility Gate. The main unit will verify the transmitted access information and will pass control after verification to the gate mechanism drivers, this in turn drives the right gate control (either exit or entry unit). The system now monitors the activity of the driver afterwards, and for entry, as the driver moves a predetermined distance into the facility ,the system turns back the gate mechanism (for closure of gate) and passes control to the space allocation and management unit. The objective of this later unit is to manage the parking spaces available in the lot by monitoring the activity of the cars inside, allocating the spaces in an orderly manner, monitoring compliance and notify the overall control center (manned) of the space(s) available. It has a display interface for communicating with the users of the facility. There is also a control center that is manned by personnel and monitors the activities within the parking lot. It is notified of any activity, space(s) available and also the overall system can be shut down or switched on from the control center. The main goal of this project is to achieve full automation and it will find immediate usage in

large facilities with different access restrictions, government properties, and university campuses to sectionalize lecturer's car park and student's car park etc.

Keywords: *Programmable logic controller (PLC), Supervisory control and data acquisition (SCADA), Automation and Vehicle parking*

I. INTRODUCTION

The purpose of this project is to create an automated parking lot management system that is easy to operate and also does not give away anything in terms of performance. Automating a parking facility provides many advantages and can basically be used in public and commercial premises. It is effective for controlling access to different areas of a large facility and has a particular advantage in that it can be programmed to suit different operational requirement and security details. The use of a fully automated system enhances and contributes to the prestige of the protected site when it comes to using technology to enhance property value. It can also be used on university campuses to control parking areas. Due to the fact that needs will vary, this paper attempts to develop a model highly suited for non-commercial parking lots.

II. RELATED WORKS

Several research work and development have been involved overtime; say for two decades now, in developing various types and classes of automated gate operation systems which have met the diverse needs of individuals all over the world. However such systems operates only at the entry and exit points, they do not monitor the activities within the garage and manage the parking spaces.

Most previous only focuses on the entry and exit and the designs are hardwired (i.e. not easy to adopt for different systems). This system being developed, apart from controlling the entry and exit into the facility, monitors the spaces available in the parking lot, allocates space in particular order, automatically detect an empty parking space, shuts down the system when all spaces are used and also can be controlled and monitored from a control center. The main features considered when constructing this automated management system are basically the efficiency of the control system, and its reliability. Also the strength of the system is another area which needs

to be adequately catered for in other to improve the security. The reliability of the automated entry and exit parking lot system will be confirmed on testing of the constructed automated system model while the strength will be worked on in the real-life deployment. The efficiency of the control system on the other hand, is fully dependent on the quality of the components used. With the controllers and other driving circuits beneath, we hope to achieve a fully functional system that allows the driver (car or allowed personnel into a parking facility), to communicate with the gate (via gate sensor and circuit) and pass on process control to other units. Decision can either be to open the gate, to leave the gate closed or to alert security personnel. On entering the facility, the parking space management system takes over and allocates empty space to the user

The gate unit will be implemented with the use of swing gates and controls, which will be driven by a linear actuator or electric motor coupled with the necessary mechanical parts. The system will detect any entry, exit, or refusal to enter or exit (after activating gate controls) and also activate the closure of the gate arm when necessary. The parking spaces will be allotted in ascending order and activity on each space will be monitored. The system can also be fully SHUT DOWN from a control center and turned ON at the push of a button from the same center. There would also be control indicators signaling the entry, exit, shut down, turn on and the parking spaces remaining.

III. Proposed System for vehicle parking

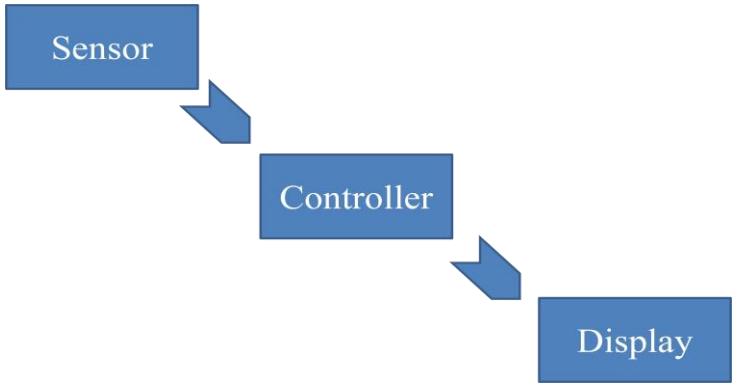


Fig 1.Block Diagram of PLC based vehicle parking system

In this work we have developed the parking system which is as follows: driver can see the availability automatically and if the car parking lot is full, the user can find another parking area or can do alternative (leave or wait for empty place). This automatic parking aims to ensure collision-free motion within the available space and to enhance the comfort and safety of driving in constrained environments.

A. Object Detection Sensor

An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion. Infrared sensors are broadly classified into two main types:

- **Thermal infrared sensors** – use infrared energy as heat. Their photo sensitivity is independent of the wavelength being detected. Thermal detectors do not require cooling but do have slow response times and low detection capabilities.
- **Quantum infrared sensors** – provide higher detection performance and faster response speed. Their photo sensitivity is dependent on wavelength. Quantum detectors have to be cooled in order to obtain accurate measurements.

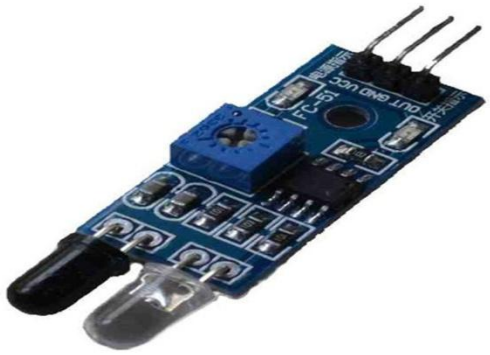


Fig 2.Object Detection Sensor

B. Stepper motor

A stepper Motor is basically a synchronous Motor. In stepper motor there is no brushes. This motor does not rotate continuously, instead it rotates in form of pluses or in discrete steps. Thats why it is called stepper motor. There are different types of motors available on the basis of steps per rotation, for example- 12 steps per rotation, 24 steps per rotation etc. We can control or operate Stepper motor with the feedback or without any feedback.

Working Principle Of Stepper Motor:

The principle of Working of stepper motor is Electro-Magnetism. It constructs of a rotor that is of permanent magnet and a stator that is of electromagnets The following figure shows the construction of a practical stepper motor:

Fig 3.Stepper motor

Now when we gives supply to stator's winding. There will be a magnetic field developed in the stator. Now rotor of motor that is made up of permanent magnet, will try to move with the revolving magnetic field of stator. This is the basic principle of working of stepper motor.

Step sequence for Clockwise

	L1	L2	L3	L4
0	1	1	0	0
1	1	0	0	1
2	0	0	1	1
3	0	1	1	0
4	1	1	0	0

Step sequence for Counter clock wise

	L1	L2	L3	L4
0	1	1	0	0
1	0	1	1	0
2	0	0	1	1
3	1	0	0	1
4	1	1	0	0

For every full step sequence stepper motor rotates for 7.5 deg . Hence for our application we have to rotate stepper motor 90 deg for gate opening and closing so we have to execute full step sequence 12 times.

C. L293D Motor Driver

L293D is a motor driver IC used in this project to control the gate motor. L293D Motor Drive IC is a dual H-bridge type motor driver and is available in 16-pin Dual in-line Package. With the help of this motor driver IC, we can control two motors at a time with both forward and reverse direction control for individual motors. Motor drivers are generally used to drive high current drawing devices like DC Motors, stepper motors, high intensity lights, etc. They act as simple current amplifiers as their input is a low current signal usually from a microcontroller and their output is a high current signal to drive the loads.

D. PLC

A programmable logic controller (PLC), or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis. A PLC program is generally executed repeatedly as long as the controlled system is running. The status of physical input points is copied to an area of memory accessible to the processor, sometimes called the "I/O Image Table". The program is then run from its first instruction rung down to the last rung. It takes

some time for the processor of the PLC to evaluate all the rungs and update the I/O image table with the status of outputs. This scan time may be a few milliseconds for a small program or on a fast processor, but older PLCs running very large programs could take much longer (say, up to 100 ms) to execute the program. If the scan time were too long, the response of the PLC to process conditions would be too slow to be useful.

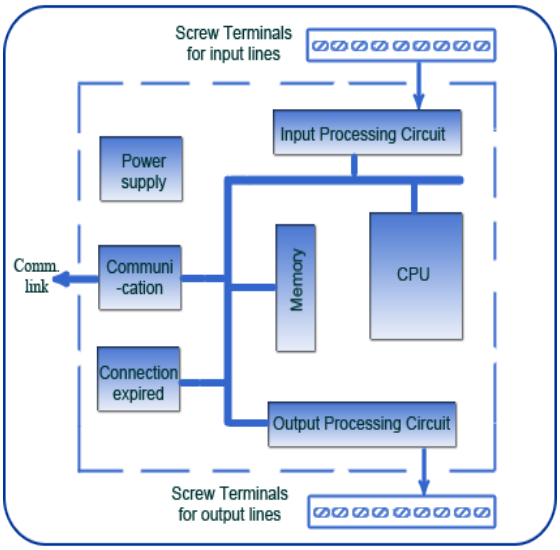
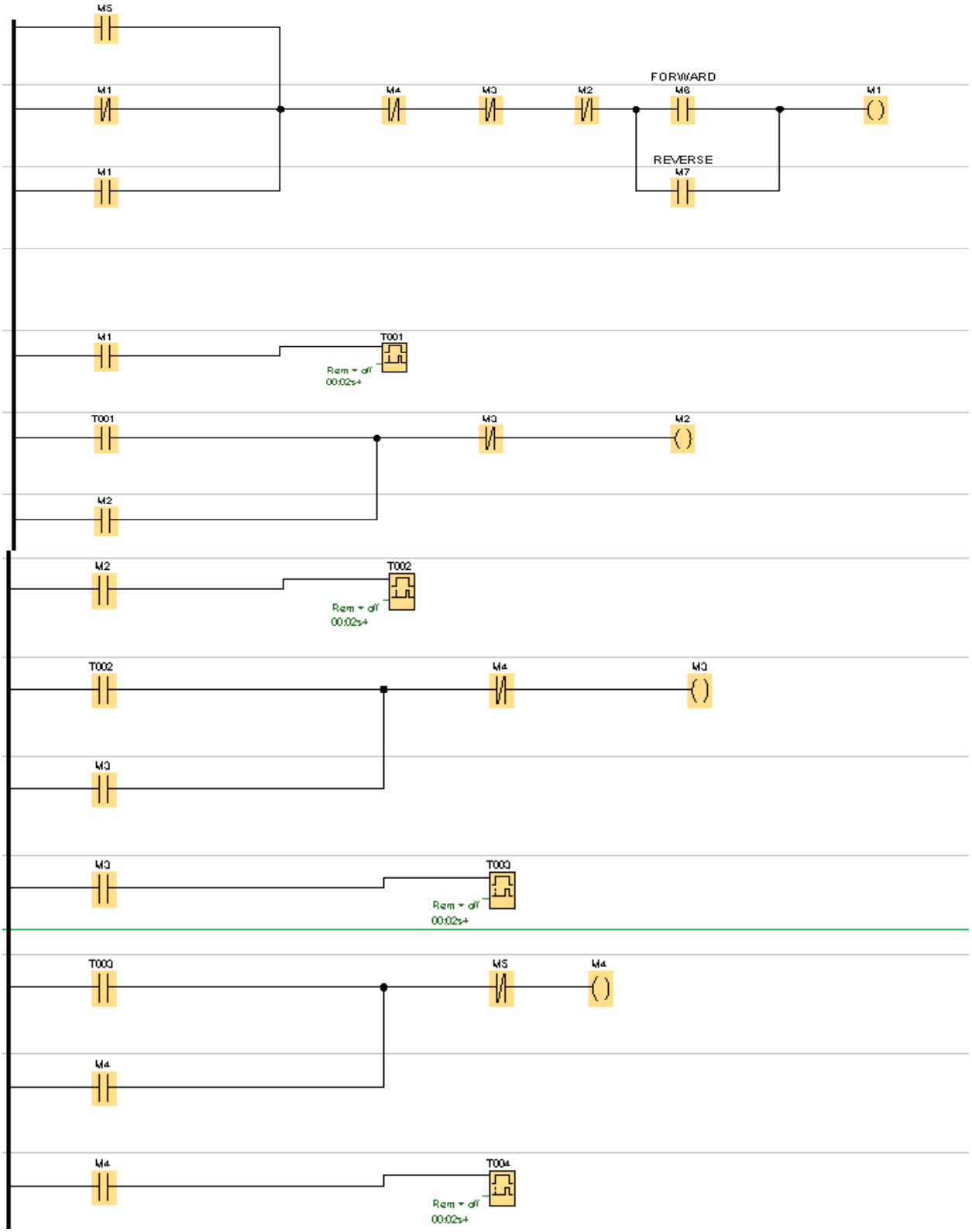


Fig 4.Block Diagram of PLC

IV. PLC Program

PLC program for automatic vehicle parking system is given in this section. PLC programs are typically written in a special application on a personal computer, then downloaded by a direct-connection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non- volatile flash memory. Often, a single PLC can be programmed to replace thousands of relays. Under the IEC 61131-3 standard, PLCs can be programmed using standards-based programming languages. The most commonly used programming language is Ladder diagram (LD) also known as Ladder logic. It uses Contact-Coil logic to make programs like an electrical control diagram.


M5
M1
M1
M4
M3
M2
FORWARD
M6
M1
REVERSE
M7
M1
T001
Rem = off
00:02s+
T001
M3
M2
M2
M2
T002
Rem = off
00:02s+
T002
M4
M3
M3
M3
T003
Rem = off
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T003
M5
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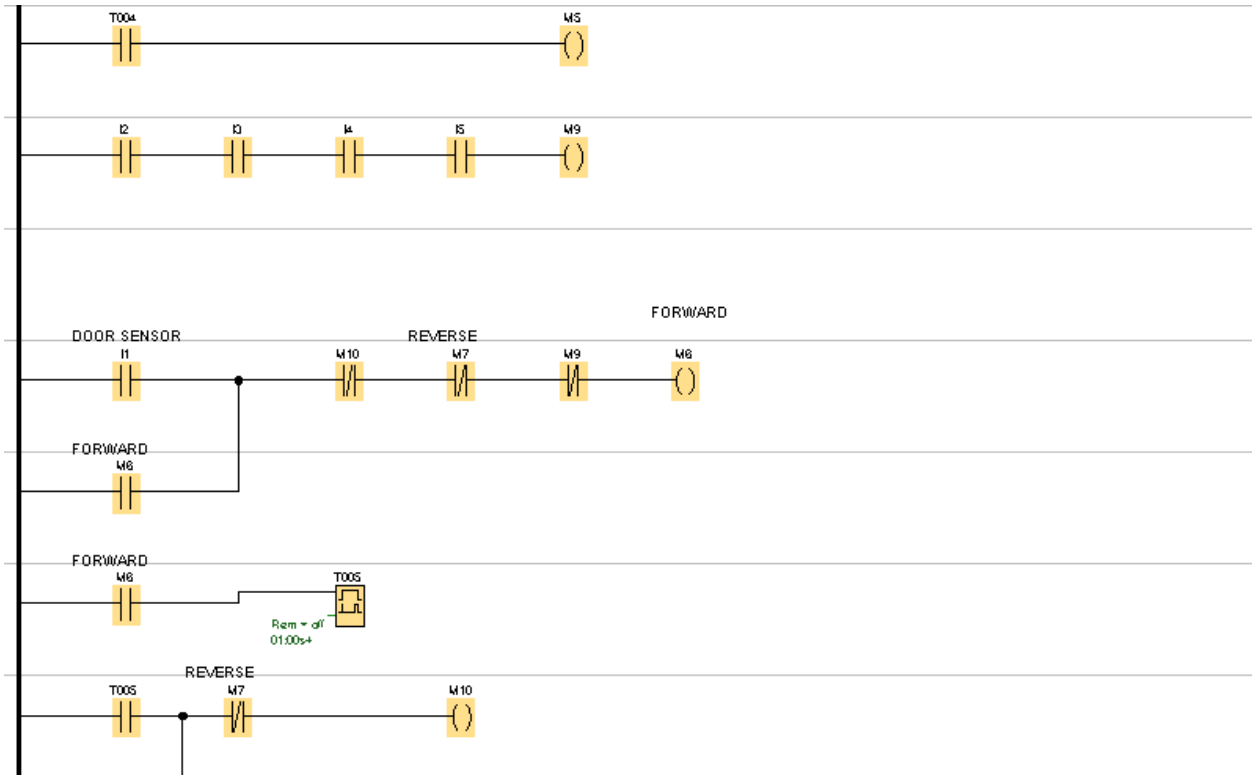

V. Conclusion

The available parking method is street parking. By using the object detection sensor, the empty slot is identified and the car is directed to that slot.After accessing the performance of the proposed system, we were quite pleased with the results and the overall performance of the project. From the working of the IR remote, from the car to the receiver, gate mechanism driver and controls. The operation of the reset button at the control center and also the timing was excellent.

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