

PLC Based Automatic Intelligent Car Parking System

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Abstract—The main purpose of this paper was to design and implement an intelligent car parking system. The proposed system works on three modes such as ON, OFF and EMERGENCY.

The system developed is able to sense the presence of the vehicles standing at the main car parking gate through an IR sensor. These IR sensors give their output to the PLC (programmable logic controller).

Due to lack of parking spaces and skilled labour, there is a global shift towards the automatic car parking system to calculate accurate space available for car and revenue collection as a parking fee.

This new scheme provides an improvement and reliability in the current car parking system and this system can be implemented easily because it is very economical as it uses solar panel for its power consumption and also the cheap IR sensor reduces the implementation cost.

Index Terms—IR sensors, LDR (light dependant resistor), PLC (programmable logic controller), solar panel.

I. INTRODUCTION

Car parking systems have been around almost since the time cars were invented. In any area where there is a significant amount of traffic, there are car parking systems. Car Parking systems were developed in the early 20th century in response to the need for storage space for vehicles.

With the rapid proliferation of vehicle availability and usage in recent years, finding a vacant car parking space has become more and more difficult, resulting in a number of practical conflicts. Parking problems are becoming ubiquitous and ever growing at an alarming rate in every major city. Wide usage of wireless technologies with the recent advances in wireless applications for parking manifests that digital data dissemination could be the key to solve emerging parking problems [1].

There are several advantages of employing a car park system for urban planners, business owners and vehicle drivers. They offer convenience for vehicle users and efficient usage of space for urban-based companies. Automated car park systems save time, money, space and simplify the often tedious task of parking.

There are two types of car parking systems: traditional and automated. In the long term, automated car parking systems are likely to be more cost effective when compared to traditional parking garages. Automatic multi-storey automated car park systems are less expensive per parking slot, since they tend to require less building volume and less

ground area than a conventional facility with the same capacity. Both automated car parking systems and automated parking garage systems reduce pollution as cars are not running or circling around while drivers look for parking spaces.

Quickly finding a vacant space in a multilevel parking lot is difficult if not impossible, especially on weekends or public holidays. Finding spaces during weekends or public holidays can take more than 10 minutes for about 66% of visitors. Stadiums or shopping malls are crowded at peak periods, and difficulty in finding vacant slots at these places is a major problem for customers. Insufficient car park spaces lead to traffic congestion and driver frustration. If a car is parked in such a way that it occupies two parking slots rather than one, this is called improper parking. Improper parking can happen when a driver is not careful about another driver's rights [2]. Problem faced by people due to lack to car parking management is shown in Fig. 1.

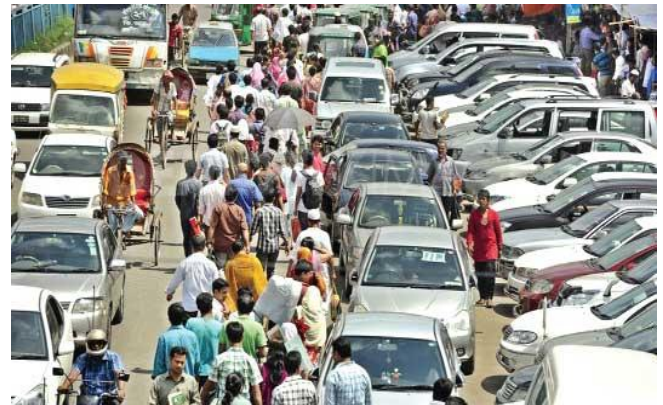


Fig. 1. Improper parking system.

To solve these entire problems we came to a conclusion of having an automatic intelligent car parking system that ensures the safety of the driver as well as saves time and parking spaces.

Some of the benefits of automatic intelligent car parking system are, it can accommodate maximum number of cars in minimum spaces, customized parking solutions, low maintenance and operation cost, safety for both car and the driver, faster parking and retrieval and eco-friendliness.

II. OBJECTIVE

To develop an Automatic Intelligent Car Parking System based on PLC using IR sensors, Light Dependant Resistor (LDR) and solar panels for power consumptions. The Automatic Intelligent Car Parking System simply uses the input module from IR Sensors and LDRs to provide it to the Programmable Logic Controller (PLC) to ensure easy, reliable and effective car parking management.

III. METHODOLOGY

The automatic intelligent car parking system is a smart system which uses a set of LDRs and IR sensors to ensure effective and safe car parking management. The intelligent car parking system works in three modes such as ON, OFF and EMERGENCY.

The ON mode gets activated at the day time when the use of car parking system is at its peak. The OFF mode is used at night when there is least use of car parking system. The EMERGENCY system gets activated whenever the parking authority staff presses the emergency push button when something unlawful happens. In emergency mode the PLC directs to close all the gates and no car is allowed to enter or leave the car parking.

At the car parking ground we have a space for six cars and six LDRs are placed on each car space to detect the presence of a car over it. If six cars are parked at the parking then the LDR sends this output to PLC.

One set of IR sensor is placed at the main gate of the car parking which detects the presence of a car waiting to enter the car parking. If the IR sensor detects the presence of a car, then the output is sent to the PLC.

The PLC manipulates the data provided to it by the LDR and the IR sensor to ensure whether a car can be parked or not. If the data provided by the LDR shows the possibility of available space for car parking and also the IR sensor detects the presence of car waiting to get parked, then the PLC directs the main parking gate to open and allow the car to enter the parking area.

If the data provided by the LDR shows the possibility of fully occupied parking space, then the PLC stops the main gate from opening and directs the car to next parking ground. The Simulation image of the car parking system is shown in Fig. 2.

The whole parking system is very economical and feasible as it uses the solar panel for its power consumption. Intelligent car parking system uses a series of batteries that are charged by the solar panel using the solar radiations from the sun. The solar panel system is placed at the unused vacant space in the parking premises where it uses the sun's radiation and converts it into DC power and stores in heavy battery. The heavy battery can provide power backup for a longer period depending upon how frequently a car enters the parking system [3].

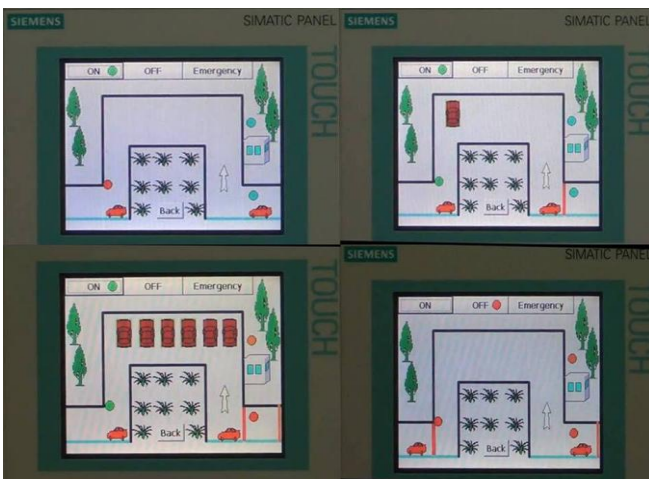


Fig. 2. Simulation of intelligent car parking system.

IV. PROCESS DESCRIPTION

The chapter gives a detailed explanation of the various processes taking place in Automatic Intelligent Car Parking system. The automatic intelligent car parking system's operations are shown in Fig. 3.

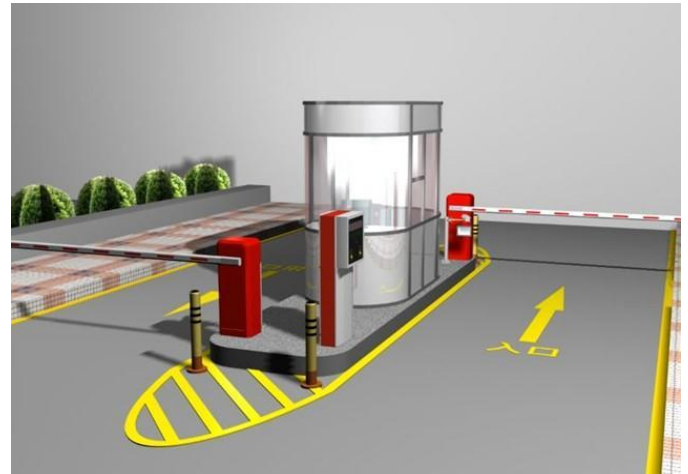


Fig. 3. Automatic Intelligent Car Parking System.

A. Block Diagram

The block diagram of the automatic intelligent car parking system is shown in Fig. 4. The diagram shows the input and output components connected to PLC.

The input component comprise of six LDR sensors, IR sensors and a security camera. The output components comprise of entry gate and exit gate mechanism. The input, output and the PLC are connected to the batteries that are charged with the help of solar panel.

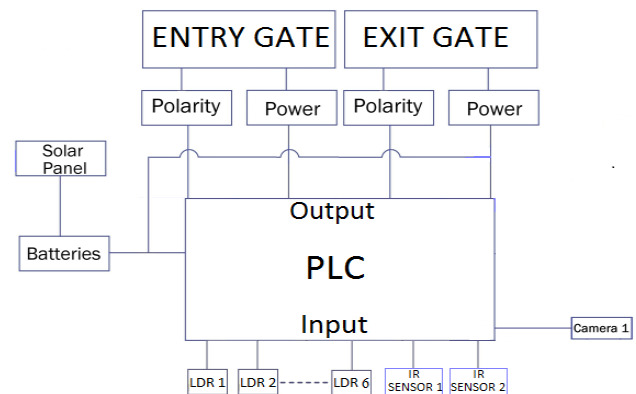


Fig. 4. Block diagram.

B. Input Module

The input module of the automatic intelligent car parking system includes the IR sensors, LDRs, Camera and Push button Switch. There are two sets of IR sensor. First IR sensor is placed at the entry gate to detect the presence of the vehicle at the entry gate. Second IR sensor is placed at the exit gate which helps in detecting the vehicle at the exit gate and directs the PLC to open the gate.

There are six LDR sensors placed on each of the car parking ground of the automatic intelligent car parking system. The LDR detects the presence of the vehicle over it and helps in calculating the exact number of spaces available in a particular parking ground whose output is

given to the PLC.

Push button switch stands for security measurements. The push button switch is used whenever an emergency situation occurs. If the security guard finds something unusual or suspicious through the security cameras then he pushes the push button switch to enable security mode of the parking system. The push button enables the security alarm and directs the PLC to shut down all the gates of the car parking system.

C. Output Module

The output module of the automatic intelligent car parking system consists of entry gate and exit gate mechanism. These mechanisms are attached with the batteries that are charge by the solar panel.

The opening and closing of the gate depends upon the IR sensors output. Entry gate opens whenever the IR sensor detects a vehicle at the entry gate and a space is available for parking. The exit gate opens whenever the IR sensor detects the presence of a vehicle at the exit gate and also when the emergency mode is inactive.

D. Signal Processing

The input voltage to the PLC should be 24 V therefore the output of the IR sensors and LDR sensors cannot be given directly to the PLC. Hence they are given through signal conditioning circuits which condition the input signals and in turn gives it as an input to the PLC. For safety purpose the inputs are not given directly to the PLC. They are given through relay circuits. The relay consists of 3 terminals — common, NO and NC, this circuit is also known as Reverse Polarity Circuit and is shown in (Fig. 5). The 24 V which is to be pulled into the PLC will be available in the common terminal [4]. Hence depending upon the necessary signals the circuits closes or opens thereby connecting to the PLC [4].

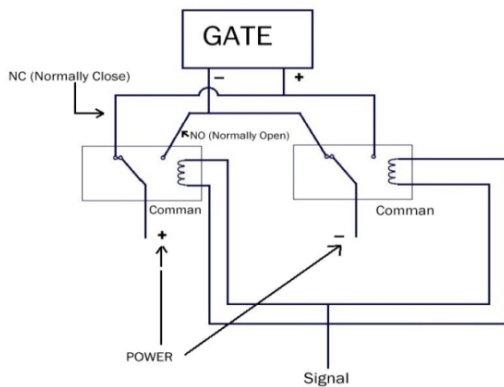


Fig. 5. Reverse polarity circuit.

E. Programmable Logic Controller (PLC)

The PLC used in is SIMATIC S7-300, CPU 316-2DP with integrated 24 V DC power supply, 128 KBYTE working memory 2nd INTERF. DP-MASTER/SLAVE.

The details and information of PLC S7-300, CPU 316-2DP is given in Table I [5].

A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or

light fixtures. The PLC was designed to provide flexibility in control based programming and executing logic instruction. PLC allows for shorter installation time and faster commissioning through programming rather than wiring [4].

TABLE I: PLC S7-300 TECHNICAL DATA

CPU and Product Version		S7 timers	
MLFB	6ES57 316-2AG00-0A00	• Adjustable retentivity	from T 0 to T 127
• Hardware version	01	• Preset	No retentive times
• Firmware version	V 1.1.0	• Timing range	10 ms to 9990 s
• Matching programming package	STEP 7 V 5.0; Service Pack 03	IEC Timers	Yes
		• Type	SFB
Memory		Data areas and their retentive characteristics	
Work memory		Retentive data area as a whole (inc. flags, timers, counters)	4736 bytes
• integral	128 KB	Bit memories	2048
• Expandable	no	• Adjustable retentivity	MB 0 to MB 255
Load memory		• Preset	MB 0 to MB 17
• integral	192 KB	Clock memories	8 (1 memory byte)
• Expandable FEPRAM	Up to 4 MB	Data blocks	511 (DB 0 reserved)
• Expandable RAM	no	• Size	max. 16 KB
Backup		• Adjustable retentivity	max. 8 DB 4096 data bytes
• With battery	All data	• Preset	No retentivity
• Without battery	4736 bytes	Local data (non-alterable)	max. 1536 bytes
		• Per priority class	256 bytes
Processing times		Blocks	
Processing times for		OBS	See Instruction List
• Bit instructions	0.3 µs minimum	• Size	max. 16 KB
• Word instructions	1 µs minimum	Nesting depth	
• Double integer math	2 µs minimum	• Per priority class	8
• Floating-point math instructions	50 µs minimum	• additional levels within an error OB	4
		FBS	max. 256
		• Size	max. 16 KB
		FCS	max. 256
		• Size	max. 16 KB
Timers/Counters and their retentive characteristics			
S7 counters	64		
• Adjustable retentivity	from C 0 to C 63		
• Preset	from C 0 to C 7		
• Counting range	0 to 999		
IEC Counters	Yes		
• Type	SFB		

A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operations will result. Programs to control machine operations are typically stored in battery-backed-up or non-volatile memory [5].

The advantages involved in PLC's are:

PLCs are more reliable and faster in operation.

They are smaller in size and more readily can be expanded.

They require less electric power.

They are less expensive compared to electromechanical relays for the same number of Control functions.

PLCs have very few hardware failures when compared to electromechanical relays. Special functions like time delay actions and counters can be easily performed using PLCs [2].

F. IR Sensors

A typical system for detecting infrared radiation is given in the block diagram (Fig. 6).

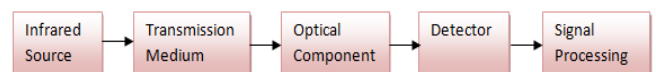


Fig. 6. IR sensor block diagram.

G. Infrared Source

All objects above 0 K radiate infrared energy and hence are infrared sources. Infrared sources also include blackbody radiators, tungsten lamps, silicon carbide, and various others. For active IR sensors, infrared Lasers and LEDs of

specific IR wavelengths are used as IR sources.

H. Transmission Medium

Three main types of transmission medium used for Infrared transmission are vacuum, the atmosphere, and optical fibres. The transmission of IR – radiation is affected by presence of CO₂, water vapour and other elements in the atmosphere. Choice of IR band or a specific wavelength is dictated by the technical requirements of a specific application.

I. Optical Components

Often optical components are required to converge or focus infrared radiations, to limit spectral response, etc. To converge / focus radiations, optical lenses made of quartz, CaF₂, Ge and Si, polyethylene Fresnel lenses, and mirrors made of Al, Au or a similar material are used. For limiting spectral responses, band pass filters are used.

J. Infrared Detectors

Various types of detectors are used in IR sensors. Important specifications of detectors are

- Photosensitivity or Responsiveness
- Noise Equivalent Power (NEP)

NEP represents detection ability of a detector and is the amount of incident light equal to intrinsic noise level of a detector. The working of IR Sensor is shown in Fig. 7.

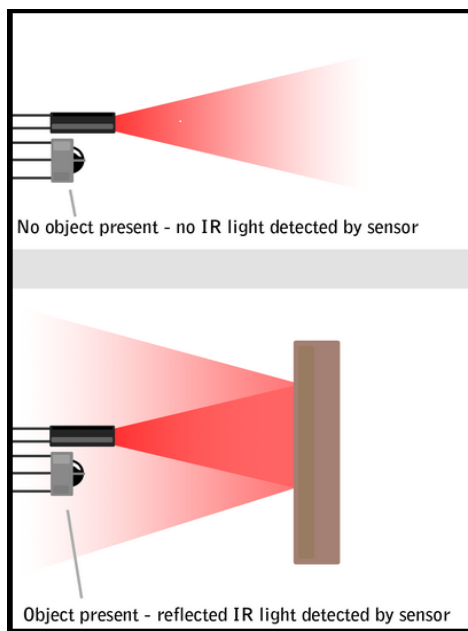


Fig. 7. Working of an IR Sensor.

In addition, wavelength region or temperature to be measured, response time, cooling mechanism, active area, no of elements, package, linearity, stability, temperature characteristics, etc. are important parameters which need attention while selecting IR detectors.

K. Space Detection Using LDRs

In automatic intelligent car parking system we have space for five cars. In order to calculate the exact number of car spaces available in the parking system, LDRs are used.

Five LDRs are placed above the parking ground and output is provided to the PLC to get the exact number of car space available in a parking ground. As a vehicle moves

over the LDR, the PLC gets the information that one space has been occupied by a car and four spaces are still vacant in the parking system. When all the vacant spaces are occupied by cars then the PLC directs the car towards next car parking ground.

L. Parking System Powered by Solar Panel

A solar panel is a collection of solar cells. Lots of small solar cells spread over a large area can work together to provide enough power to be useful. The more light that hits a cell, the more electricity it produces. Solar panel converts the sun's radiation that is in the form of light into electricity [6].

The IR sensors and LDRs are powered by photovoltaic panels mounted on the lighting structure. The photovoltaic panels charge a heavy rechargeable battery, which provides power to the components of car parking system during the night.

System work is simple, the use of photovoltaic solar cells made of the principle effect of solar panels during the day and to receive solar radiation into electrical energy output [6].

V. CONCLUSION

The main objective of this paper was to develop an Intelligent Car Parking system based on public reviews and specifications. This system was successfully implemented using PLC. We considered this paper as a journey where we acquired knowledge and also gained some insight into the subject which we have shared in this report.

The Intelligent car parking system provides a unique 22nd century automated car park system. In this system basically there are LDR (Light dependant resistor) panels powered by solar energy installed within the parking area. The automated barrier will have the required knowledge of the available space through a database directly connected with the control centre of LDR panels.

This parking system was designed in order to minimize human labour and to save the precious time of car owners waiting to find a parking spot. This system's data could be also incorporated in to an app which would let users to access information about the availability of parking spots in different locations with this system installed in them.

This system would also decrease the cost of electricity as the whole system functions on solar energy. This is a complete eco-friendly energy system. This project tout's green energy.

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Mohammad Adil was born in a small town of Uttar Pradesh, India on September 28, 1991. Mr. Adil moved to Kuwait when he was three. He completed his secondary and senior secondary education from Fahaheel Al-Watanieh Indian Private School in 2007 and 2009 respectively. He is currently pursuing his electronics engineering degree at Zakir Hussain College of Engineering and Technology, Aligarh Muslim University. He is the founder of India's leading shopping comparison website known as "Pullbird". His area of interest for specialization is in the field of instrumentation and control systems.



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