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# PLC-Based Smart Car Parking Barrier System

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***Abstract***

*This research paper presents an innovation of a PLC-based smart car parking barrier system that is intended to improve parking management and security in urban areas. To effectively control the space efficiently and enhance the reliability of the parking system. PLCs (programmable logic controllers) are the foundation of the system, and sensors are connected to enable automated vehicle entry and exit. In this case, the up-and-down mechanism of barriers is utilized by the servomotor. In this way, we can optimize the real-time space usage and minimize the time taken for vehicle parking. Real-time collection of data makes vehicle detection efficient, and remote or automatic monitoring assists the user in locating the precise locations of specific parking lots. The system also enables automated and remote monitoring, giving administrators and users access to real-time parking data. This feature reduces search time, fuel consumption, and traffic congestion within parking facilities by helping cars find available parking spaces faster. The creation of an intelligent control system to regulate traffic flow within the parking area, optimize space allocation, and handle problems with unlawful vehicle access is the main emphasis of the project. The research concentrates on the algorithm that is designed for effective parking space management and issues regarding unauthorized access. Outcome measures are impressive improvement in operational efficiency, user satisfaction, and time savings. A PLC-based system is scalable and can adapt to various parking scenarios, and is a cost-saving, efficient solution for urban parking management for smart city parking needs.*

**Keywords:** PLC, smart car parking, automated car parking system, smart parking barriers, sensor-based car parking, automated barrier mechanism

## INTRODUCTION

A programmable logic controller (PLC) based smart car parking barrier system is a new solution that aims to control parking spaces through automatic detection by sensors and cameras for automatic vehicle entry and exit, depending on real-time parking availability. The system employs a PLC to track parking space occupancy and manage access so that cars are only permitted to enter when there is a vacant parking space. To track the occupancy status of individual parking spaces and identify the presence and movement of vehicles at entry and departure points, the system uses a variety of sensors. Cameras further improve the system by facilitating vehicle identification, surveillance, and security monitoring. The PLC is the core control unit that continually processes the sensor and camera input data to make rational judgments regarding the operation of the barrier.

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To avoid traffic jams and guarantee effective space usage, vehicles are only allowed access when there are open parking spots. The PLC not only controls the barrier movement but also continuously monitors the parking occupancy data and modifies the system status as necessary. This automated control reduces human error and eliminates the need for manual supervision. In addition, administrators can remotely monitor parking operations and create occupancy reports for improved planning and management, thanks to the inclusion of real-time monitoring [1].

 

The system consists of sensors, a PLC, and a servomotor utilized for up-and-down barrier mechanisms. Placing the sensor at different points. It is simple to identify the availability of parking spaces, which aids in identifying the occupancy status of the vehicles in the parking space. The PLC is continuously fed data from the sensors and decides whether spaces are available. Based on that real-time information, the space available information is shown on the panel board. If the parking lot contains free or vacant spaces, the PLC signals the opening of the barrier gate when the vehicle approaches the gate and permits the vehicle to pass through. But if the parking lot is full, the PLC prohibits entry by not opening the barrier. This innovation is avoiding congestion and unwanted traffic in the region closer to the parking station.

This system has no payment mechanisms or other add-ons such as security cameras; its sole intention is to control the traffic flow of vehicles in accordance with the parking capacity available in the parking station. Automatic entry and exit are achieved by an automatic barrier up-and-down mechanism. Because of this automated control process, human intervention is minimized, errors are reduced, and optimal utilization of the parking space is ensured. It also prevents congestion or blocking at the entrance, thereby enhancing the overall traffic flow in and around the parking area. This smart parking barrier system serves as a guide for users to park their cars in a parking station [2].

The smart car parking barrier system is innovative, and the use of PLC is especially valuable in heavy traffic locations (urban areas) where parking is limited and in buildings that do not need an intricate payment system. It provides an affordable, efficient, user-friendly, and uncomplicated solution to controlling parking availability, allowing only cars to gain access when there are available parking spaces, and overall improving the efficiency of the operation of the parking station. This system is particularly useful for places such as office complexes, schools, residences, hospitals, and public facilities that require dependable access control but do not require complicated payment integration. The cost and intuitive design of this system are two of its main benefits. The PLC-based barrier system is more affordable and simpler to install, operate, and maintain than more sophisticated parking systems that include ticketing devices, RFID-based payments, or mobile payment connections. Its simple design ensures dependable performance under continuous operation while reducing the technical complexity. The system ensures that only cars are allowed admission when there are open parking spots by using sensors to continuously check parking occupancy and communicate directly with the PLC. The barrier remains closed as the parking lot fills up, avoiding crowding and needless interior traffic accumulation.

## DESIGN AND METHODOLOGY

The approach used in a PLC-based intelligent car parking barrier system is based on automatic parking station operation for the entrance and exit of the vehicle. For this automatic operation, a PLC is applied to control and track the components of the system.

### System Components

The key elements for this innovation are the PLC for automatic control, ultrasonic or infrared sensors for vehicle detection, servomotors for the up-and-down mechanism of gates and barriers, and a control interface with a display board. The PLC is the central processing unit that interfaces with the sensors and servomotors for barrier mechanism control.

### Vehicle Detection

Ultrasonic or infrared sensors are placed at the entrance and exit points for the constant detection of vehicle presence. If a vehicle is detected approaching the parking lot entrance, the sensor triggers a signal to the PLC.

### Entry Control

- If a parking spot is free, the PLC goes through the data of the sensor and energizes the motorized.
- Barrier opens barrier. The system opens the barrier only if the parking space is vacant or empty and ready to be used.

 

**Exit Control**

When a car leaves, the sensors identify the car leaving, and it is processed by the PLC. The barrier is then activated to shut down, maintaining security and stopping unauthorized access.

**System Reset**

- Once a car leaves, the system resets automatically and is ready for the next car to enter.
- This method increases automation and efficacy in handling parking lots, curbing human intrusion, and streamlining traffic within parking zones.

**Control Panel or Display Unit**

The function of the display unit is to display information regarding the available space in the parking station. It serves as a guide for the user by showing the precise number or position of the parking lot to park their vehicle, which also saves the user's time.

## OBJECTIVES

- *Automatic access control:* Automated vehicle entry and exit.
- *Space management:* Optimizes parking space use.
- *User-friendly interface:* Facilitates user interaction through the provision of information on the control panel.
- *Real-time monitoring:* Provides real-time parking availability updates through space detection.
- *Security features:* Increase safety through an alarm system for security against unauthorized entry.
- *Data collection:* Real-time data collection through sensors using a PLC to monitor the parking status.
- *Energy efficiency:* Lowers power consumption through smart controls.

## DESCRIPTION AND LADDER DIAGRAM

The PLC-based smart car parking barrier system is an automated system for controlling vehicle entry and exit in parking lots using a PLC. The system includes parking servomotor-based barriers, sensors, and a PLC that operates all of them. Sensors at the parking lot entrance and exit sense the presence of vehicles and track available parking spaces or parking lots. The system comprises vehicle detection sensors, servomotor-driven barriers, and a PLC that controls and coordinates all activities [3]. The entry and exit gates open, close, and move smoothly, precisely, and dependably, owing to the servomotor-based barrier mechanism. The number of available parking spaces is continuously monitored by sensors placed at the entry and exit of the parking lot, which also detect the presence of cars. The PLC receives real-time data from these sensors, interprets them, and uses the current occupancy levels to decide whether to allow or prohibit vehicle access. The sensors identify the presence of a car approaching the entry and notify the PLC of the same. The PLC triggers the servomotor to raise the barrier and permit admission if parking spots are available. However, the system limits access if the parking lot is full to avoid crowding and traffic jams. Similarly, sensors at the exit point identify departing cars and automatically update the number of parking spaces, guaranteeing precise and instantaneous occupancy tracking.

When a car approaches the entrance, the PLC scans for free parking spaces. If a parking space is free or vacant, the PLC instructs the barrier to open so that the car can enter. When the car departs, the system checks the actual time status of the space and increases the available parking number. The barrier automatically closes once the car departs from the parking lot.

This system dispenses manual operation or human intervention, easing traffic flow, clearing congestion or obstruction, and guaranteeing the optimal use of parking spaces. It provides a straightforward, automated means to manage access to parking lots without the need for supplementary complicated systems [4–6].

 

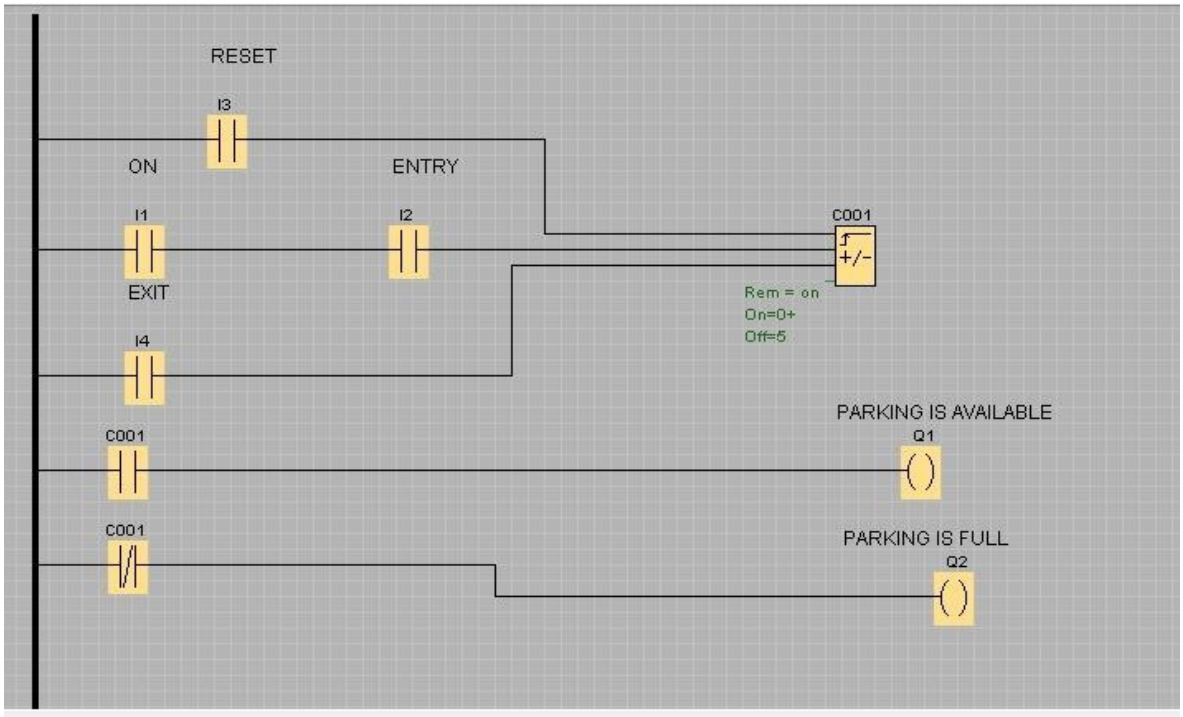


**Figure 1.** Ladder logic.

Diagram illustrates the ladder logic applied to this system. It has a switch I1 (ON) to initiate the system. In addition, it has three XIC contacts, I2, I3, and I4, which are utilized as an 'Entry', Reset', and 'Exit', respectively.

The up/down counter 'C001' is used to count the number of vehicles entering and exiting the parking lot [7–10]. Two auxiliary contacts of counter 'C001' are used to drive two LEDs (Q1 and Q2) to indicate whether parking is available, as shown in Figure 1.

## WORKING PRINCIPLE

When a car approaches the parking lot, sensors at the entry point detect their arrival, and the PLC validates the car's credentials. The PLC instructs the barrier gate to open. Once the car has departed, the system can automatically recognize an empty parking space or instruct the driver to an empty space by providing information on the digital screen or control panel.

Once the car exits the parking lot, the process is also automated: sensors detect the car's departure, and the system ensures that the gate opens based on the car's clearance. The PLC continuously updates the parking lot space availability and controls all the associated functions in real time, ensuring smooth traffic flow operations.

## FUTURE SCOPE

- *Integration with IoT:* Increased connectivity for real-time monitoring, reservation, and payment systems using mobile applications.
- *Automation and AI:* Application of AI for predictive maintenance and smart traffic flow management in parking lots.
- *Scalability:* Simple scalability to larger or multi-level parking systems with centralized control and remote monitoring.
- *Energy efficiency:* Incorporating renewable energy sources (e.g., solar) to energize barriers and ensure sustainability.

 

## ADVANTAGES

- *Efficiency:* Both entry and exit are computerized, reducing human intervention and increasing traffic.
- *Cost-effective:* Automation reduces the need for manpower, lowering long-term operational costs.
- *Space management:* Space use can be maximized by guiding cars to empty spaces and reducing congestion.
- *Real-time monitoring:* With sensor and PLC integration, the parking area can be tracked in real time, enhancing operational efficiency and providing detailed information for analysis.
- *Guide for users to park vehicles:* by providing information on the control panel about a particular slot or parking lot.

## CONCLUSION

The PLC-based intelligent car parking barrier system efficiently improves parking management through automation and efficiency. With PLCs, the system can monitor parking space availability, barrier access management, and optimize space utilization. This technology reduces human error, increases security, and facilitates easier parking for users. Finally, the application of such a system results in enhanced traffic flow, user satisfaction, and overall parking facility management, which is an efficient tool for smarter urban infrastructure or metropolitan cities where parking is the primary issue.

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