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Design and Implementation of a Smart Parking System

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ABSTRACT

This paper aims at developing a smart parking system that will effectively handle improper parking of cars, reduce traffic congestion by regulating the number of cars within the slot at a particular time, enhance security of cars within the car park, and automate billing system. A prototype of the designed system was successfully implemented with MATLAB software as the main controller, Arduino Uno and Mega as the client controllers, cameras for plate number image capturing, RFID reader/card for car registration and authentication, plate number extraction using optical character recognition, a network of infrared and ultrasound sensors to give intelligence to the system for autonomous control, and stepper motors for gate opening and closing. The prototype was tested using different scenarios such as opening and closing of gate, car registration, car authentication, improper parking, and checking of slot availability. The working of the entire system was as expected with an accuracy of almost 100 %.

Keywords: Smart park, car registration, authentication, billing system, improper parking, gate control, slot allocation, parking patterns, parking management system

1. INTRODUCTION

Car parking became a major problem created by the increasing road traffic [1]. It is classified based on parking patterns and management system. There are two types: on-street parking - a type of parking where a space is allotted for parking at either or both sides of the road, and off-street parking – a type where vehicles are parked anywhere but on the streets [2, 3]. Parking management system is a system that can either be manually or smartly operated. Finding a vacant parking space in a manual parking management system is a common problem especially in popular and well-travelled places like shopping complexes, stadiums, etc [4]. This situation has become more serious especially during peak time, be it holiday seasons, sales carnivals or any other festivals. The manual parking system does not ensure security of cars and the mode of payment for parking fee is done manually and most times could create unnecessary queue.

A smart car parking system generally is a system designed to handle the inefficiency of the existing manual car parks [5]. A smart parking system enhances proper parking of cars in the available slots within a car park. Also, the optimization of parking space is achieved, and hence the regulation of cars within a car park based on the availability of [6, 7]. They are mainly seven different types of automated car parking system which include: Automated Guided Vehicle (AGV) system, crane system, puzzle system, Shuttle system, Tower system, Silo system, Rail Guided Cart (RGC) system. Smart Parking will enable better and real time monitoring and managing of available parking space which results in significant revenue generation [8]. Smart parking system concentrates on solving the problem of proper parking management by utilizing advance technologies which will definitely help in alleviating the current traffic problems [9]. A smart parking system that will automate gate control and slot allotment, car security, payment and check improper parking is presented in this paper. A prototype of the design will be implemented using MATLAB as the main controller, and Arduino Uno and mega as the client controllers. RFID reader/card will be used to implement the car security system, network of sensors will be adopted to give intelligence to the system for autonomous control, while stepper motors are used to open and close the gate.

2. METHODOLOGY

The design methodology is as summarized in Figure 1. The system on detecting the arrival of a car at the gate automatically opens the gate after checking for the availability of a parking slot. On entering, the gate closes and the plate number of the car is captured automatically using image processing.

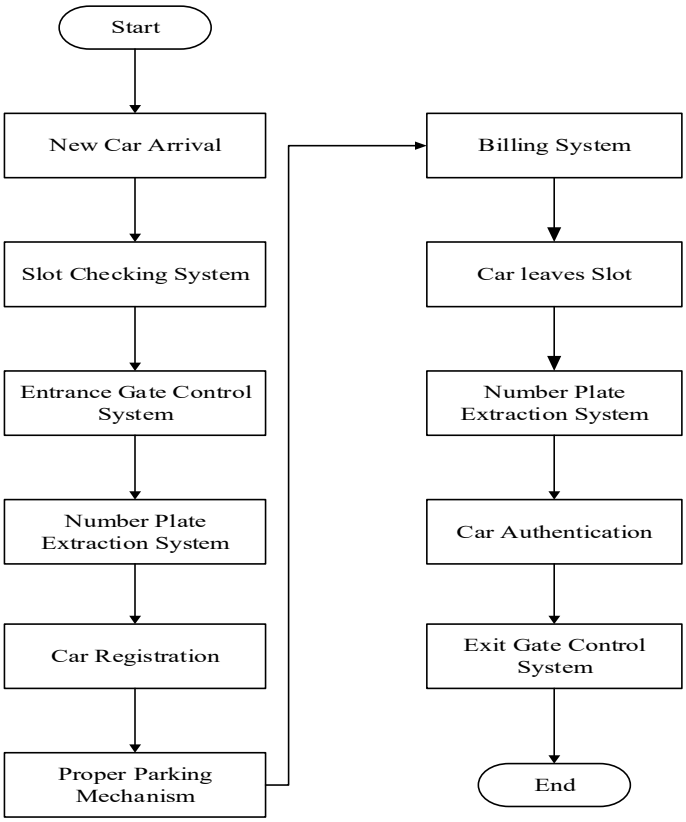

Figure 1: Flowchart showing System Methodology

The captured plate number is then used for car registration and this process permits the car to be parked at the assigned slot. Proper parking of the car is checked at the slots using displays in the individual slots to tell the driver the condition of his parking. If the car is not properly parked on the slot or parks on the driveway, the security personnel are signalled.

The system also ensures that cars are not parked on the driveways by using network of sensors. The billing is computed based on the duration of time the car is in the premises. At the exit gate, the plate number is captured again and image processing is used to extract the plate number. The extracted plate number is compared with the plate number captured on registration. If there is matching, the gate automatically opens, otherwise the security personnel is signalled.

3. CONSTRUCTION AND TESTING

The design of the system is implemented as a prototype. The prototype is made up of various units as shown in Figure 2. The gate sensors and motors are connected to the gate controller. The gate sensors initiate the opening and closing of the gate. The gate sensors also activate the cameras to take snapshot of the plate number region of the car. The motor controls the opening and closing of the gate. The cameras are used to take snapshot of the car at both the entrance and exit respectively. The cameras are connected directly via serial port to the main controller where the image taken is processed to extract the plate number.

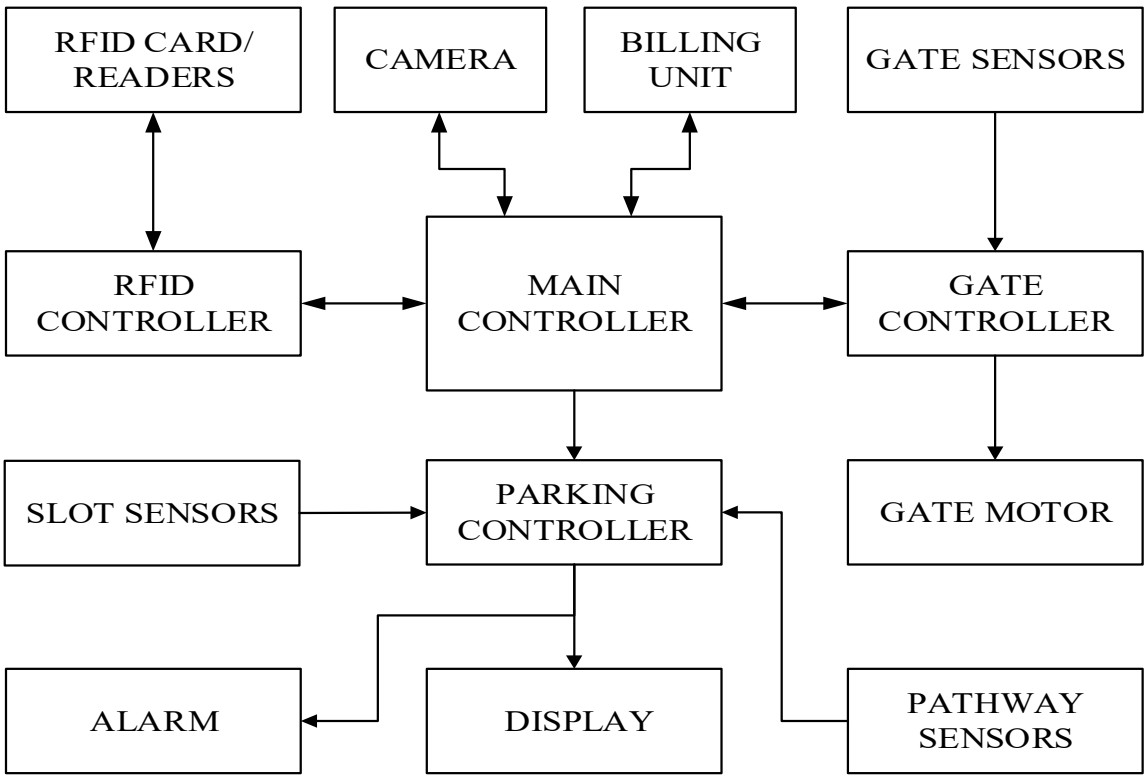

Figure 2: Block Diagram showing interconnection of various units

The RFID readers are connected to the RFID controller which in turn is connected to the main controller. The extracted plate number is sent to the RFID controller via the serial port. Once the RFID card is available on the reader at the entrance gate, the RFID controller writes the extracted plate number on the card and it is assigned to the driver as a permit to park at the assigned slot. At the exit gate, the RFID reader reads the content of the card that was initially assigned to the driver. The parking controller has four units connected to it which includes: display, slot sensors, parking sensors, and alarm. The display unit displays the number of available slots in the parking area at the entrance gate. This information on the display is updated anytime a car enters or leaves the car park.

Slot sensors ensure appropriate parking on the slot. The pathway sensors are used to put a check on improper parking of cars along the pathway. It is interfaced with an alarm to signal the security whenever a car parks on the driveway for a time longer than necessary. The prototype of the designed was constructed and tested shown in Figure 3 and Figure 4.

Figure 3: Construction of the Prototype

Figure 4: Testing of Prototype

4. CONCLUSION

In this paper, a smart parking system for cars that automates gate control, slot allotment, car antitheft mechanism, payment and improper parking mechanism is developed. A prototype of the system was implemented using MATLAB as the main controller, Arduino Uno and Mega as the client controllers. RFID reader/card was used for the car antitheft system, a network of infrared and ultrasound sensors was adopted to give intelligence to the system for autonomous control, while stepper motors were used to open and close the gate.

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