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Arduino Microcontroller-based Intelligent Car Parking System

Kingsley Monday UDOFIA
Department of Electrical/Electronic & Computer Engineering, University of Uyo, Nigeria
kingsleyudofia@uniuyo.edu.ng

***Abstract*—This paper aimed at designing an Arduino microcontroller based intelligent parking system that will solve the problem of car theft, improper parking and traffic jam in a car park. IR sensors are used to detect the presence of cars at the entrance and exit gates. The system gives information about the available slot at the entrance using LCD display. In checking car theft, car registration and authentication is carried out at the entrance and exit gate respectively. Optical character recognition is used in extracting plate numbers which is written into the RFID card and then assigned to the driver at the entrance. At the exit, the plate number of the car is extracted again and compares with what was already written into the card. A prototype of the system was successfully implemented and the working of the system was as expected. The system has the advantage of security, effective parking, less human interference, less man power, reduced traffic congestion and automated billing.**

Keywords—Intelligent parking system, microcontroller, optical character recognition, automatic gate control, arduino, plate number extraction

I. INTRODUCTION

In most cities, motorists experience difficulties in finding a suitable and safe place to park, especially in popular places like shopping complexes, stadiums, as the number of vehicles daily plying the road is on the increased [1]. The situation is more serious during peak times such as holiday seasons and festivals. Thus, motorists are forced to park their cars on roads or on pavements, creating unwanted traffic and road congestion.

Increase in road traffic is a major cause of unavailability of parking space [2]. According to Singh, there are two types of parking patterns: on-street parking and off-street parking [3]. On-street parking is when a space is allotted on the road for parking [4], whereas off-street parking has to do with the parking of vehicles anywhere but on the streets [5]. Off-street parking covers both outdoor and indoor parking.

Parking system can either be manually or smartly operated. The manual parking approach which depends on human interaction with its environment has proved to be unreliable. Security of cars is not ensured, payment mode is manual, and could create unnecessary queue. People also struggle a lot and waste time in finding a parking spot [6]. In manual parks, parking of cars is mostly unplanned, and people tend to park cars randomly.

Automated car parking system provides a better option than the manual system in terms information about slot availability at car parks, car security, billing, real time monitoring and managing of available parking space, among others [7, 8]. This system solves the problem of improper parking of vehicleby utilizing advanced technologies that will help mitigate the current traffic challenges [9 - 12].

In this paper, a design of an intelligent parking system that uses Arduino microcontroller is presented. The system will automate gate control and slot allotments, ensure security of the parked cars, ease payment and check improper parking. A prototype of the developed system will be implemented in order to ascertain its workability.

II. METHODOLOGY

The design of the intelligent parking system for cars is summarized in Fig. 1.

A. Slot Checking System

The slot checking system is responsible for the checking the availability of slot in a parking area and then displays it at the entrance gate. With the design in view, cars accepted into the park on the condition that slot is available. Slot availability status is continually updated each time a car enters through the entrance gate or leaves the car park through the exit gate. The aim of this system is to ensure that the number of cars in the parking area do not exceed the available slot. The flow diagram in Fig. 2 shows the slotchecking system.

B. Gate Control System

This system controls the automatic opening and closing of the gate. Sensors are used before and after the gate to detect the presence of a car, and motors are used to control the opening and closing of the gate. The sensors sends a signal to the gate controller, the controller processes the signal and actuates the motors to open or close. The gate remains at the last condition if the same output is sent again and can only change condition if a different output is sent. Once the available slots have been completely occupied, the entrance gate remains closed and cannot allow cars into the parking slot.

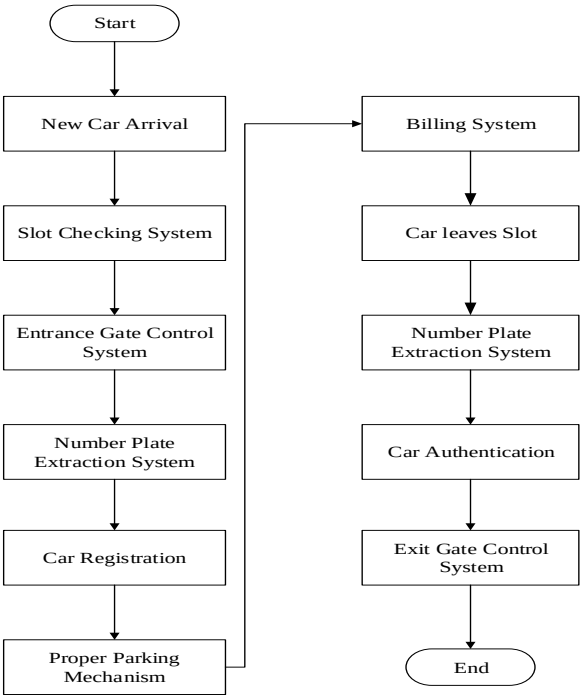

Fig. 1: Flowchart showing System Methodology

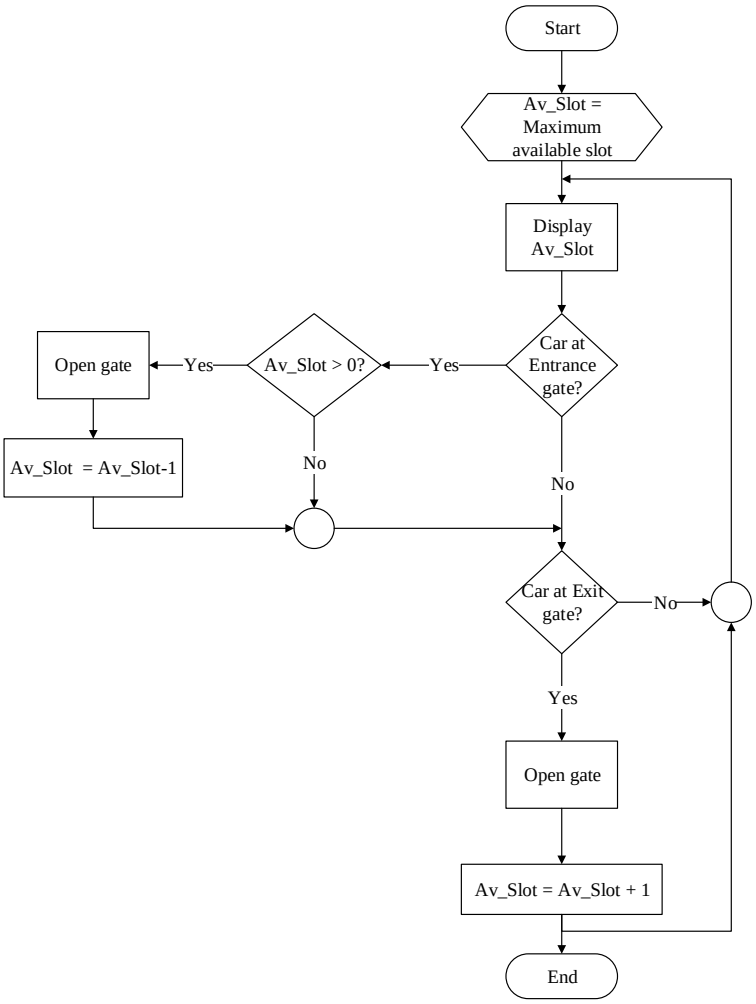

Fig. 2: Flowchart showing Automatic Slot Checking System

Fig. 3(a) shows the flowchart of the entrance gate control system in charge of the opening and closing of the entrance gate. Where GateSensor1 is the sensor before the entrance gate and GateSensor2 is the sensor after the entrance gate

Exit gate control system as shown in Fig. 3(b) is a system that controls the actions at the exit gate based on the inputs received from the sensors planted before and after the gate. GateSensor3 is the sensor before the exit gate and GateSensor4 is the sensor after the exit gate.

C. Number Plate Extraction System

The number plate extraction system is a system that is responsible for the capturing and extraction of plate numbers to enable car registration and authentication. The plate number of car is captured at the entrance of the slot and is sent to the main controller. The main controller performs image processing to extract the characters of the plate number using optical character recognition (OCR). This is done for each car that enters the parking area. The breakdown procedure for the number plate extraction system is as shown in Fig. 4.

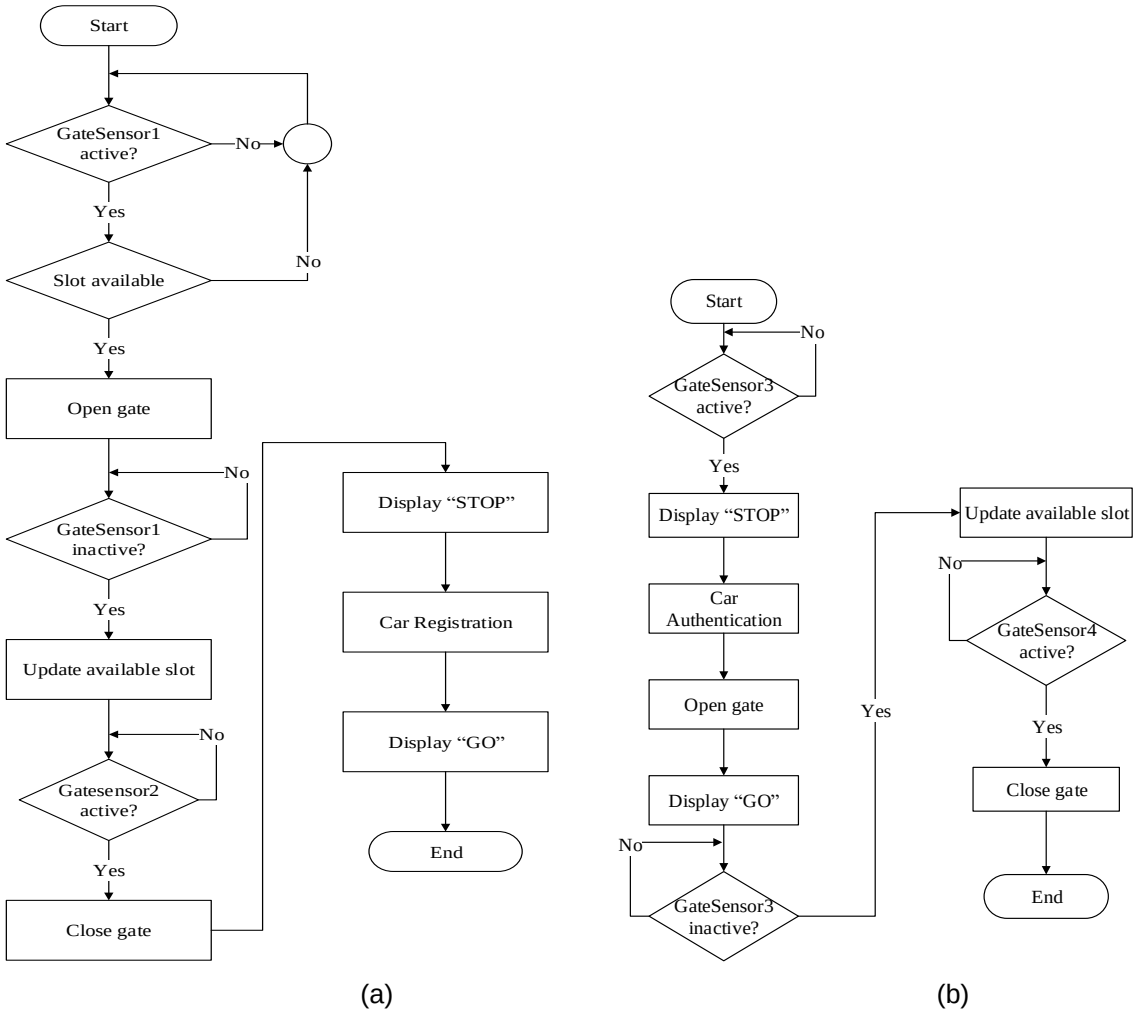

Fig. 3:Flowcharts showing (a) entrance gate control system, (b) exit gate control system

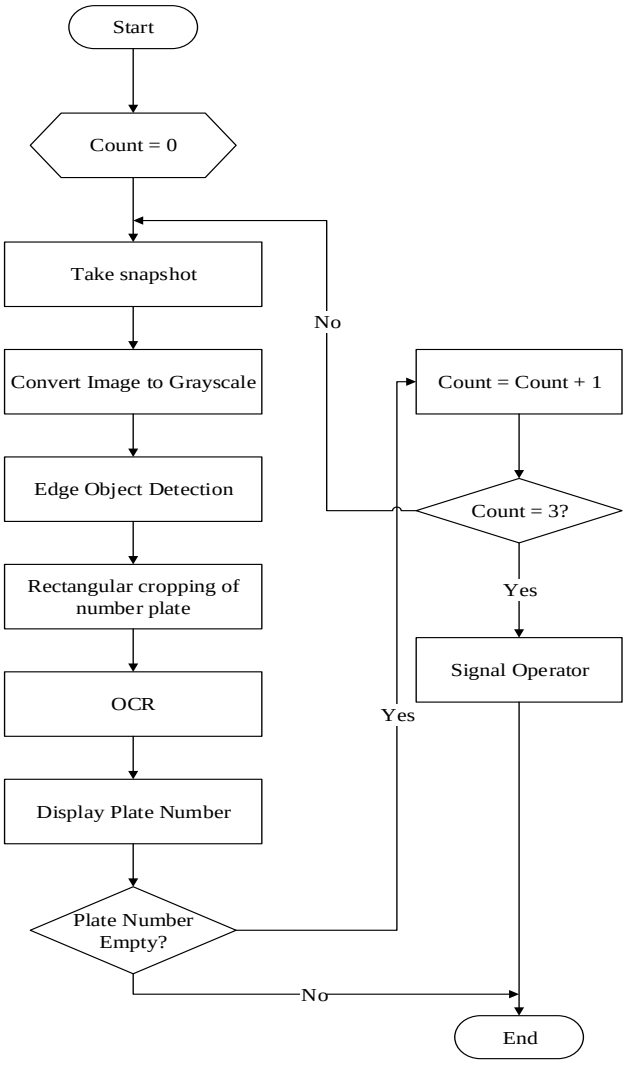

Fig. 4: Number Plate Extraction System flowchart

D. Anti-theft System

The anti-theft system is developed to ensure the security of cars within the parking area. This system is divided into two different units: car registration and car authentication. Car registration takes place at the entrance gate. When a car comes into the car park, the car is registered to grant permit for the car to be parked at the assigned slot. At the exit, car authentication is done to confirm car theft and payment status. With this system, the security of cars within a parking area will be increased.

The procedure for car registration is shown in Fig. 5(a). At the entrance, the result of the extracted plate number is written into a tag using RFID. This tag is assigned to the driver as a permit to park at the assigned slot.

Car authentication process is seen in the flow diagram in Fig. 5(b). At the exit, the number plate extraction is done and the result of the extracted plate number is displayed. The content of the tag initially assigned to the driver at the entrance is compared with the result of the extracted plate number. If the matching is successful, the payment status is checked. If the matching is not successful, initialise a count and if the count is equal to 3, signal the security and terminate the operation of the system.

E. Billing System

When a car enters the car park, the entrance time is clocked into the card assigned to the driver. The payment of the bills is made when the car is about to leave the car park, the driver presents his card and the time is read from the card to determine the duration spent. The bill is determined using

$$\text{Bill} = A + RT \quad (1)$$

where A is a fixed cost, R is the rate of charge per minute, and T is the duration spent (in minute) in the car park.

F. Parking Mechanism

Parking mechanism is a system developed to ensure that cars are properly parked in the slot and it is designed to check the parking of cars on the driveway. The parking slots are divided into blocks and each car is entitled to park on one block. The flowchart in Fig. 6 explains how the parking mechanism is achieved.

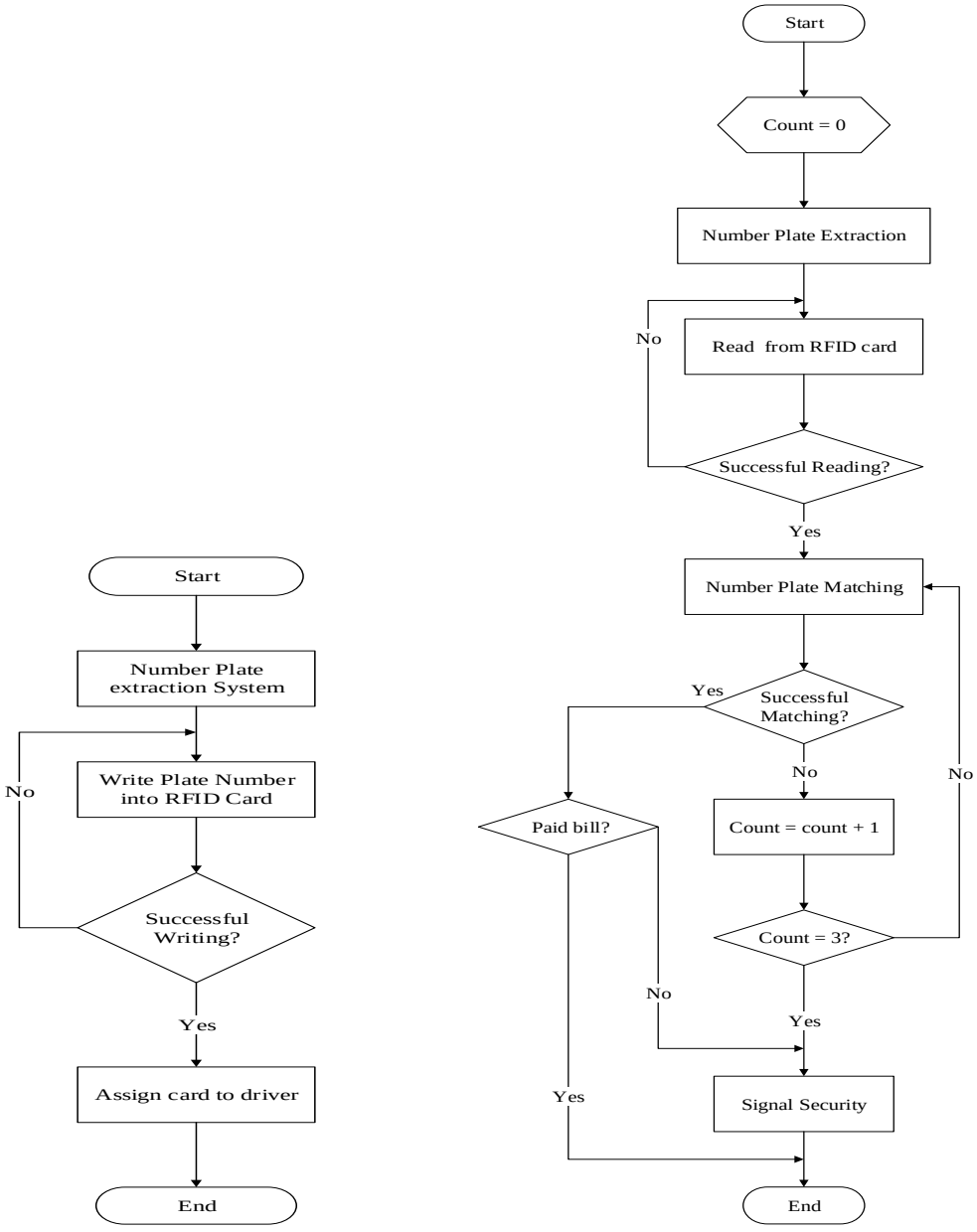

Fig. 5: Flowcharts showing (a) Registration System, (b) authentication System

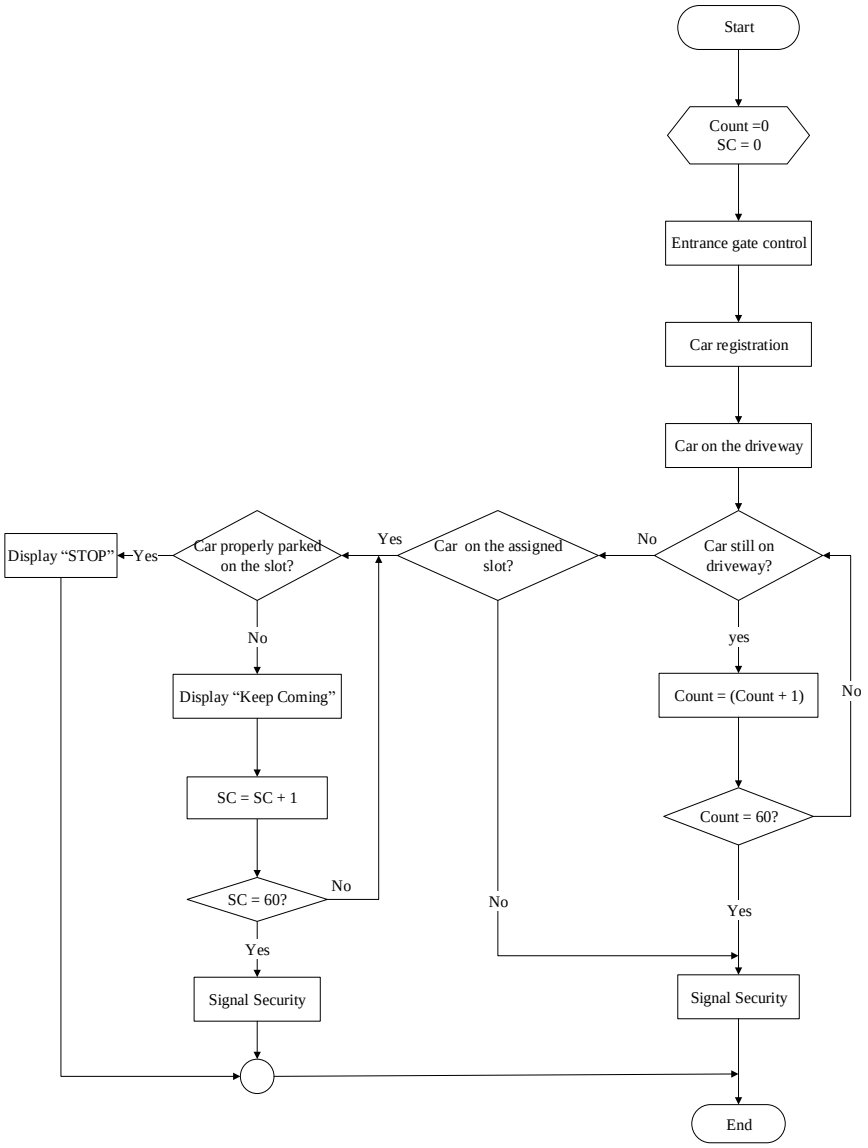

Fig. 6: Flowchart showing parking mechanism

III. IMPLEMENTATION AND RESULT

The design of the system is implemented as a prototype as shown in Fig. 7. A display board (LCD) is at the entrance gate to show the availability of parking slots. There are IR sensors before and after the gate for car sensing and onward opening and closing of gate by the stepper motor. At the point of registration, there are Red and Green LEDs that ensure car get registered, and are assigned RFID card before driving in. There is also a camera to capture plate number as part of the registration process. Ultrasonic sensors are placed at each slot to determine the parking condition of a car in the slot. There are Red and Green LEDs at the slots to direct the motorist to park well. There are IR sensors placed at the driveway to detect any car wrongly parked.

At the exit point, there are Red and Green LEDs that ensure RFID card assigned to the car is authenticated. There is also a camera to capture plate number that will be matched with what was initially written into the card. The payment status is automatically confirmed. There are IR sensors before and after the exit gate that control the opening of the gate with a stepper motor.

The prototype was tested using different case scenarios, some of which are presented in Figs. 8 to 10.

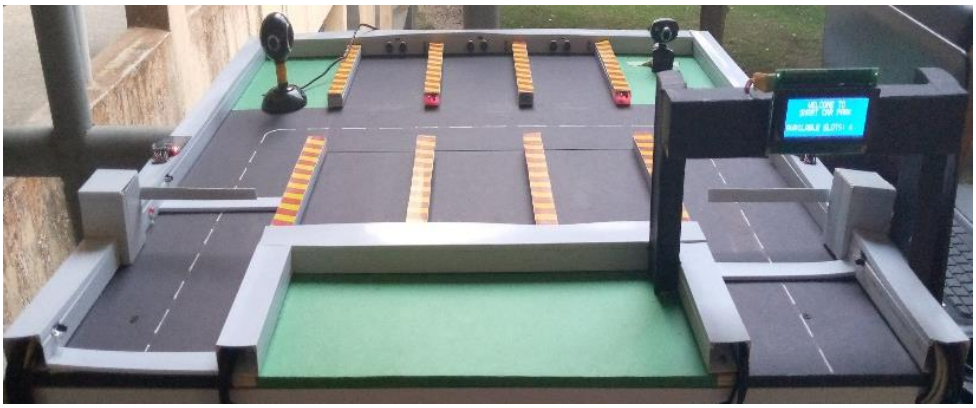

Fig. 7: A pictorial view of the constructed Prototype

(a) (b)

Fig. 8: Pictorial view of (a) opening of entrance gate, (b) proper packing

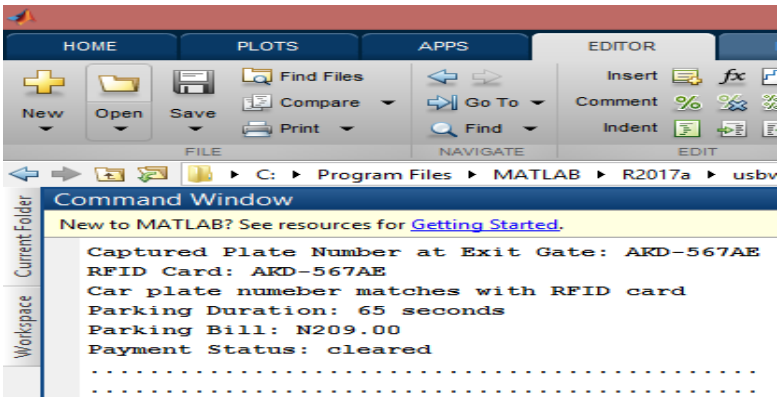

Fig. 9: Successful plate number matching and payment confirmation

(a) (b)

Fig. 10: Pictorial view of park with slots (a) available, (b) filled

IV. CONCLUSION

In this paper, an intelligent parking system that automates gate control, check available slots, ensure security of parked cars, automate billing and payment as well as ensure proper parking was developed. The system makes used of Arduino microcontrollers, IR and ultrasonic sensors for car sensing and proper parking, RFID technology for security checks, cameras for image capturing, optical character recognition for plate number extraction, stepper motors for gate opening and closing, and LCD cameras for slot availability display. A prototype of the system was constructed and tested for different scenarios. The results obtained were perfect.

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