Smart Car Parking System Using Arduino UNO & Mobile Application

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Abstract.

In this paper, we have implemented an Android-based car parking application. We have used the application for multistory parking. We have used Arduino UNO, Infrared (IR) Sensors, NodeMCU, and Servo motors. Also, we have placed one LCD at the entrance for displaying the ongoing status like Vacant/Full. Hence, this paper intends to design and develop a smart car parking system using mobile app technology. This system can control entry, exit, and slot booking for vehicles.

Keyword. Car Parking, Arduino UNO, Infrared (IR) Sensors, Mobile Applications, LCDs

1. INTRODUCTION

In the survey of metropolitan areas, it's seen that population increment causes a high density of vehicles on road resulting in poor parking facilities and traffic issues. Due to the increase in urbanization vehicle parking is a major challenge in various cities [1], [2]. Finding suitable parking spaces is a major problem for many drivers, especially visiting crowded public places like malls, cinema halls, 5-star hotels, etc. Parking slots provided in multi-stores, malls, multi-complex buildings, etc. usually operate manually i.e. a person is allocated to supervise empty slots which consume time and fuel and are hence not effective. Nowadays when people are in rush and in such inflation where fuel prices are very high, drivers tend to waste their time and fuel in search of empty slots and end up parking in non-parking areas causing jams on the road which can lead to accidents. Some studies so far have drawn attention to smart parking systems for up-gradation as per modern requirements [3]. A fully automated parking system not only solves parking issues but saves time, energy, and fuel and does its work easily without causing any trouble to other drivers. This also enhances the security system by monitoring and controlling the access of vehicles in parking areas of the government and private sector. This project eliminates unnecessary time consumption in the search for a vacant parking slot and saves fuel, also solving the majority of the above problems. In the last few years, various smart car parking methods have been proposed. The impact of IoT, sensors, and microcontrollers can be seen in smart city development [4], smart homes [5], home automation systems [6], and many more.
Parking methods are generally based on Arduino UNO, IoT, Clouds, and RFIDs. Among a

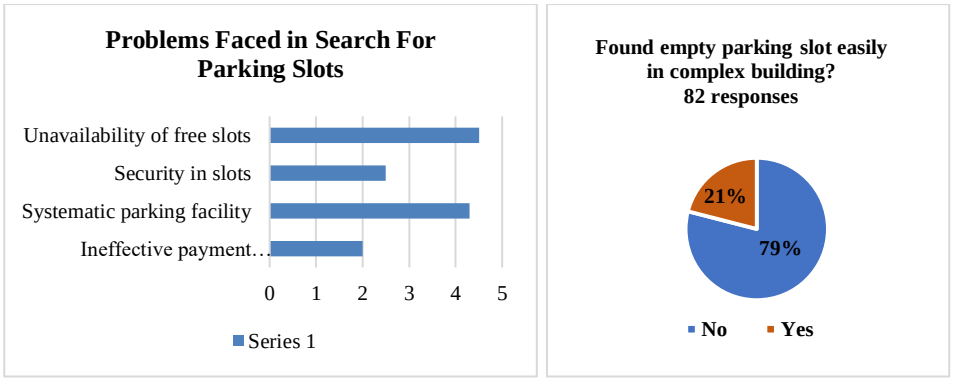
large number of proposed techniques, few techniques are reviewed in the literature survey. In [7], the system is based on the integration of web applications and electronic devices such as ultrasonic sensors, Arduino UNO, NodeMCU, Wi-Fi microchips and TCP / IP stack, and a camera. The web application contains three available components that are *Control panel*: the control panel where the controller creates spaces and configuration space, *the API*: Web-based APIs are developed for communication between other applications and web applications, *check-in point page*: used to sign in and click images to create spaces. In this system, the sensor will detect the car in space, transmit signals to NodeMCU to detect the vehicle, and dial the API to change the slot status in the web application. When the vehicle leaves the area, the sensor will detect the space again, transmit the signal to NodeMCU, and will also call the API URL to update the slot status in the web application. Barcode scanner and camera connected to a computer/laptop system in checkpoint IN there is an input field where the generated code will be added after the card is scanned. The request will then be sent to the server for a verification card. Once the card is verified, the system will prompt the user to enter the number only if the system cannot read the image number of the captured image. If the system successfully reads the number from the plate, the system will allocate space against that user and will display location information and map URL in the code.
In [8], the proposed system works on basic sensor-enabled functionality using Arduino. IR sensors detect a vehicle approaching the front gate. The gate opens when the car is found again, and the IR sensors of each space detect empty spaces and display them on the LCD. Thus, the driver is aware of the empty spaces on the door itself and can easily park in the space. There are infrared sensors in the parking lots that track the available space. The front gates do not open when there is no space. In [9], the designed method uses a cloud server / mobile application to pre-book available spaces and the internet of items in the RFID module. After accessing the premises, the Wi-Fi module helps inform the user about real-time parking. The RFID reader is connected to the Arduino UNO which receives the entry time stamp. The IR sensors in the spaces update the position as the vehicle stops. The app has a new user registration page and an existing user login page. The app gives users a set time when cars need to be parked in the desired location. The mobile app also has an e-wallet with which the user makes a payment while logging out. The IR sensor starts the timer when the user parks in the area and the charge is calculated when the user stops the timer and the value is deducted from the e-wallet only after which the exit bar opens. In [10], the system is designed based on hardware such as Arduino UNO system control, IR sensors that detect the presence of an object using infrared light, a servo motor for direct or angular motion, acceleration, and speed or input and output gates, an LCD used to display the number of spaces if available. All hardware connections are made to the breadboard. There are IR sensors at the entry and exit gates, the car approaching the gate will hear the IR sensor and send a signal to the Arduino to check for blank spaces, when the spaces are found it automatically adjusts spaces and slows down the count as soon as the car reaches the entrance gate sensor again, the bar opens for the car to enter. If there are no spaces, there is a message from the LCD saying “sorry no space” and the gate does not open. In [11], the system works on the IR sensors and the Wi-Fi module. The sensors are connected to an Arduino that sends signals when any vehicles are approaching the entrance gate. There are connected LEDs that glow red when the IR sensors receive a signal of the occupied spaces and glow green while the IR sensors do not receive any signal indicating that there are no vehicles parked in the area. The signal received by the IR sensor is compared with the boundary value and if it is greater than the limit the red light flashes in the same way when the received signal is below the limit the green light flashes. The process remains the same in all spaces and whenever any vehicle enters or exits a parking space the website is

constantly updated. All results are displayed on the LCD and in a text message on your cell phone. In [12], the proposed system is based on Arduino, GSM module, SMS, and payment method. In this app the driver needs to book and based on this the driver gets a unique android app. This application allows users to enter or exit a car park. The user entering the parking lot receives an SMS with information about available spaces and reservations. Ultrasonic sensors are located in the parking lots to send signals about the availability of spaces. At the door, the driver had to connect via Bluetooth and press the enter button. Arduino detects the signal and checks that the driver has only made a payment and sends one signal to the servo motor to open the gate and another to the GSM sending module SMS to the driver about the booked slot and immediately The slot is booked and Arduino starts the calculator time until the car leaves the parking spaces. Payment is based on a time frame until the vehicle leaves space. When you exit, there are ultrasonic sensors to detect the exit vehicle, then send a signal to Arduino and another user receives an SMS related to the exit route. Exit gates only open when the user presses the exit button. In [13], the system is designed based on Arduino, RFID, and LCDs. As the user approaches the parking lot the user is asked to choose two parking spaces or pull out the car, in selecting the parking option the user needs to select the empty spaces available. The vehicle is then positioned in a rotating position i.e. a forklift that receives a signal from Arduino to move the vehicle to a fixed position, this is achieved by sending continuous movement instructions to make a smooth movement. To retrieve the car, the driver needs to select the "restore" option and the system tells the user to swipe the RFID card. RFID information is checked on the website and a signal is sent to Arduino for retrieval. The forklift is designed in such a way that the vehicle cannot access the forklift until the user makes the required payment using RFID. In this paper, we have introduced a smart parking system using Arduino UNO, IR sensors, LCD, NodeMCU, and mobile applications. This system works on real-time data and sends the information on the mobile app and also displays it on LCD. It also helps drivers to pre-book the slots and park effortlessly. To overcome all these issues, this proposed model includes:

1. Excludes all the long signing-up process
2. Have a very easy slot booking mechanism
3. All drivers do not need to signup for the app to see availability, they can see it on the LCD and save time.

2. DESIGN & IMPLEMENTATION

The car Parking system is developed using various electronic components. From [9], we took the idea for a survey, the summary of which is listed below. From this survey, we can conclude the best way to a smart parking system.To understand the problem better we surveyed the problems related to parking in India, the responses are shown below in Figure 1. The majority of the issue is the unavailability of an empty parking slot in a suitable area followed by systematic parking facility and security of vehicles in slots as the problems identified by the surveyed users on a scale of 5. We then surveyed the empty parking slots problems with complex buildings, malls, offices, shopping stores, and cinema halls as depicted in Figure 2 which shows that 79% found it difficult to find an easy parking slot.



(a) (b)

Figure 1. (a) Problems with the manual parking system (b) Complex Parking issue

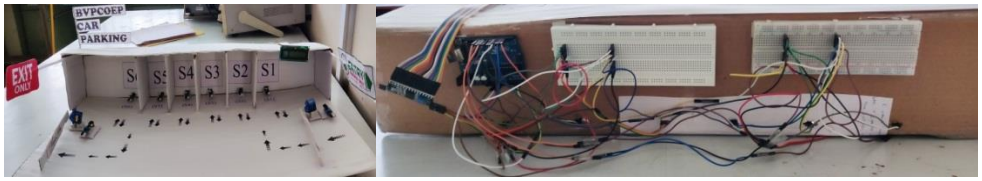
2.1. COMPONENTS USED

The list of components used in our models are:

1) **Servo motor:-** It is used for controlling the gates of the parking. In total two servo motors are used out of which one is used for opening the gate and the other for closing. The servo motor is initialized with angles like 90^0 when closed and 0^0 when open. The servo gets instruction from Arduino UNO when the IR sensor senses any obstruction to open the gate and we have set a delay for closing. We have given a 5V supply to the motor.
2) **IR Sensor**:- These are used to detect obstruction if any. We can set the range of the IR manually. We have used 8 IR sensors, one of the six IR sensors at the respective slots, and one of the two IR sensors at the entry and exit of the gate. When any car arrives or leaves, the IR sensor senses the car and updates the Arduino UNO followed by the opening of the gates. The 6 slots have a respective sensor to sense the car and these sensors update the vacancy of the parking and also help in analyzing which slot is empty or which slot is filled. We have given a 5V supply to all the IR sensors.
3) **LCD:-** It is used to show the no of vacancies the parking has and it also shows the respective slot which is empty or filled. We have given a 5V supply to the LCD and we have used I2C as a communication protocol between LCD and Arduino UNO.
4) **Arduino UNO:-** We have used an Arduino UNO board and ATmega 328p microcontroller to control the various components. Arduino UNO has 14 digital and 6 analog inputs. All the sensors are connected to the digital pin of the Arduino and the Arduino is given a supply of 5V which it gets from the laptop. We have written the codes of Arduino in Arduino IDE and have burnt it in the microcontroller. It has a flash memory of 32KB.
5) **NodeMCU:-** NodeMCU is based on ESP8266 and can be used to connect objects and transfer data through the Wi-Fi protocol. In addition, NodeMCU provides some of the most important features of microcontrollers such as GPIO, PWM, ADC, etc. Features
    - *a)* Onboard ESP32-S module
    - *b)* Onboard CH340, USB to UART converter
    - *c)* USB port for power input, firmware programming, or UART debugging
    - *d)* 2×19 pin extension headers, break out all the I/O pins of the module
    - *e)* 2× keys, used as reset or user-defined

3. METHODOLOGY

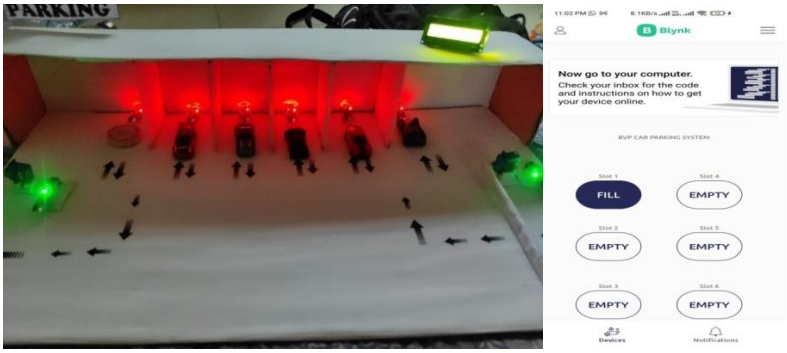
The project revolves around the parking problem that we face in malls, hospitals, and public places where proper guidance and knowledge of availability lacks which leads to time loss as well as fuel loss. In this project with the help of a microcontroller and several sensors, we have designed a smart car parking as shown in Figure 2 (a) & (b) in which the availability and the available spot can be known in advance. The commuter can either use the LCD that is placed on the entrance gate or the mobile app to see the available slots to park the vehicle.



(a) (b)

Figure 2. (a) Front portion (b) Back portion of our proposed Model

The model has a total of 6 slots in which the car can be parked and 2 gates, 1 at the entrance and 1 at the exit. Both the gates automatically open as they are integrated with the IR sensor which detects the motion of the approaching cars. The components used include 1 LCD, 2 servo motors, 8 IR sensors Arduino UNO, and Node-MCU Esp32 as shown in Figures 2 & 3 (a). LCD is used to display the total available slots and also the individual slot that is empty as shown in Figure 4 (a-d).



(a) (b)

Figure 3. (a) Figure showing LCD model(b) Mobile application Showing Slot Status

The servo motor is used to control the gates of the parking. The IR sensors are used to detect the presence of the cars on either of the gates or the slots. 6 IR sensors are used for the 6 slots while 2 are at the gates 1 at the entrance and the other at the exit. Arduino UNO is used to receive the data from the sensors and direct it to the gates to open or close them and also to the LCD to display the required information. NodeMCU is used as a Bluetooth module to connect to the app and send the data over the mobile app. The code for the Arduino is done in the Arduino IDE which is embedded in C. The availability of the slots gets updated every 5 seconds. The LCD first displays the name of the parking i.e. 'BVP CAR PARKING SYSTEM' then the no. of available slots as shown in Figure 4 (a) and then the specific slot

if it is full or empty and as depicted in Figure 4 (b) if the IR sensor at the slot senses a car the LCD shows the slot status as 'fill' and ‘Empty’ when no car is detected. The same information is shown in the Mobile app illustrated in Figure 3 (b). The complete parking model block diagram is illustrated in Figure 5.

(a) (b) (c) (d)

Figure 4. (a-d) Showing Slot Status in LCD

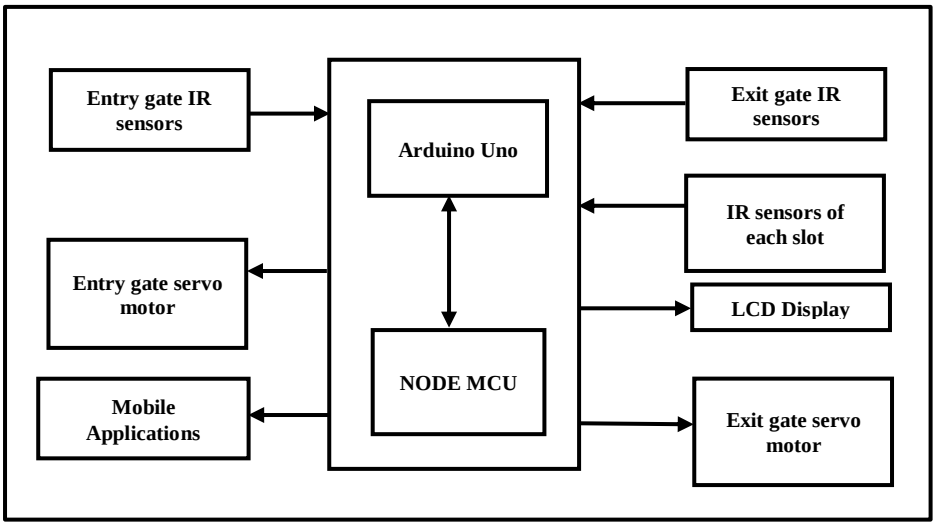


Figure 5. Model Block Diagram

3.1. WORKFLOW

The design and development of this model are divided into two parts entry and exit part, the explanation is depicted in the flowcharts given in Figure 6. The flowchart shown in Figure 6 depicts the methodology that has to follow by any user who enters the parking area. When the user reaches the area he can see the total vacancy of slots on the LCD screen and can check the slot number for parking on the mobile application and can continue booking for the slot. As soon as the user parks the car the IR sensor senses the car and sends information to Arduino and the Arduino update the information on both, LCD as well as a mobile application as shown in Figure 3. Figure 7 depicts the exit flow process of this model which starts as the user removes the vehicle from the slot. As soon as the car gets removed, the IR sensors detect the space and send the information to the Arduino which increases the empty slot number on the LCD as well as the mobile app. This helps other users access the application and find empty slots.

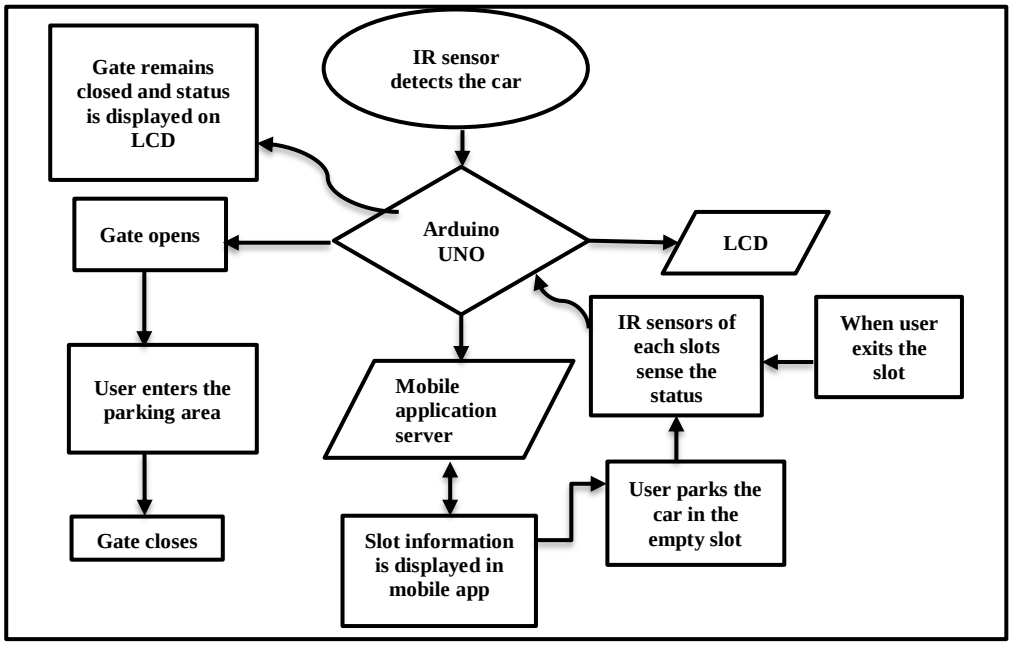


Figure 6. Entry Process Flowchart

3.2. EXIT WORKFLOW

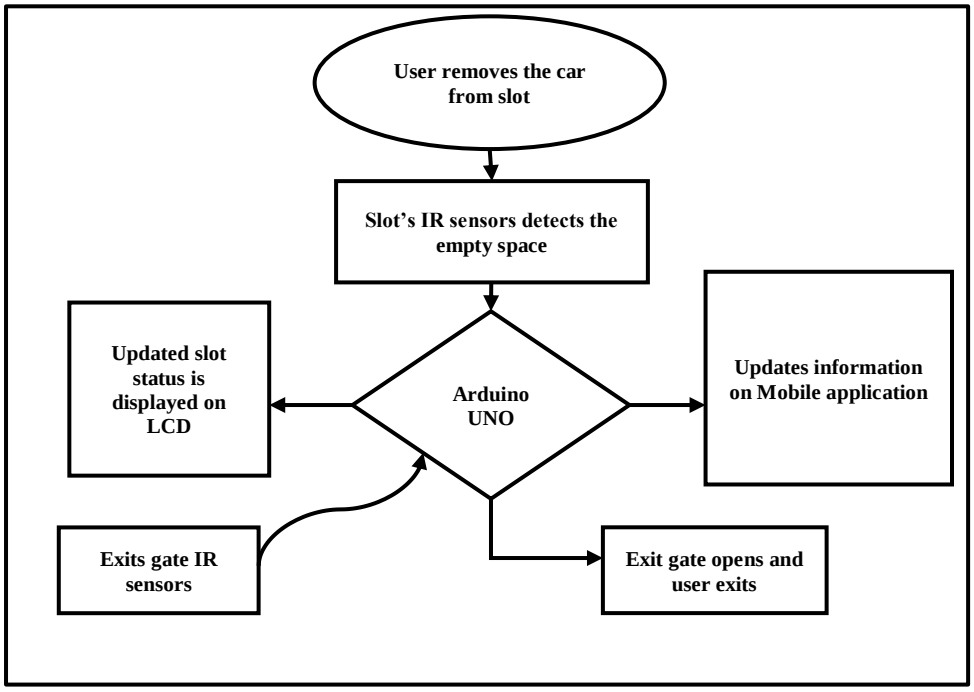


Figure 7. Exit flow chart

4. CONCLUSION

This paper showcases a smart Car parking system using Arduino UNO, NodeMCU, and Mobile Applications. This system makes parking allocation easier since there is no registration required and directly guides people to the exact location of the empty slot. In case there is no empty slot remaining the entry gate does not open which saves lots of time. This system has both an LCD as well as a Mobile application where through LCD users can get to know the status of slots without downloading the application and users can book the slot if available. The slot will be allotted in order of numbers and if any slot in between gets empty that empty slot will be allotted first to any user, and if any user does not park the car after booking the slot, after 2 minutes the booked slot will be updated as empty. This feature makes our model more efficient than others.

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Biographies

Dr. Amit Kumar obtained his Ph.D. from Jamia Millia Islamia, New Delhi in 2020 in the field of antennas and is currently serving as faculty at NIT Srinagar, Hazratbal, India. He was born in 1988 in Bihar, India. He has guided 23 successful M.Tech dissertations. He has been credited for publishing more than 18 research articles in reputed journals having more than 250 citations along with the completion of one funded project of 17 lacs sponsored by MHRD, Govt. of India. Previously he worked as an Associate Professor at BV(DU)COEP, and as an Assistant professor at BMSIT Bangalore and Galgotias group. He has also served as a TEQIP-III faculty at DCE Darbhanga, Bihar.

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