Automated Car Parking System

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Abstract— This paper is presented to throw a light on our prototype of an Automated Car Parking System using Arduino. As the name suggests, the system is presented to automate the car parking system. The primary idea of designing this prototype is to avoid the congestions that happen at the parking lots in search of the vacant space. The automated parking system is planned in such a way to provide a structured approach in managing the car park using the internet of things technology. The field of IOT is used to provide wireless access to the users for the parking place so that before even going out, the users can view and search for the free space. Using this approach, the time for searching the available car park is reduced. The number of cars allowed inside the parking will be exactly equal to the available spaces. If the parking space is full, then it will be mentioned on the LCD placed on the gate of the parking and also on the user's mobile which in turn will not open the parking gate. Also, the idea of allowing only the exact number of cars inside the parking reduces the number of accidents. The proposed prototype consists of IOT modules that are used to manifest the availability of each parking space. The automated car parking system takes us one step forward to the plan of a smart city.

Keywords: Arduino Nano, Nodemcu, Magnetic Sensors, Infrared Sensors, Servo Motors, IOT, Web View

I. INTRODUCTION

India is on the second rank in terms of population and as per the Niti Aayog report published in 2018, currently, India has 22 cars per 1000 citizens. According to the International Energy Agency, India will have 175 cars per 1000 citizens by 2040. With the increase in the number of cars, the major problem that people have to face is to find a suitable car park. In this digital world, people want every detail available to them anywhere anytime. So, providing them the correct information about the nearby available parking will prove to be a great asset for them.

The main focus of this research is to build a prototype in which the number of available parking slots is recorded and the same number of cars are allowed to enter inside the parking. If all the slots are full, then a message will be shown on the parking gate and the gate of the parking will not open. Also, the information regarding the available parking space will be uploaded in the local server simultaneously. Through the web view of the server provided to the car owners, the users can search for suitable parking.

The LCD screen which will be placed on the gate of the parking will give the information about the number of empty slots and the number of slots that are filled. There are two types of sensors that are used in the designing of the prototype, one is the magnetic sensor which is coded to update the server and the other sensors are the infrared sensor which is coded to update the LCD Screen. The automation that is provided to the gate of the parking system will reduce the manpower.

Using the web view of the server, the user just needs to remember an IP Address, there is no need to download and install any separate application or software. The IP Address will be provided to the owner at the time of registration with the parking system.

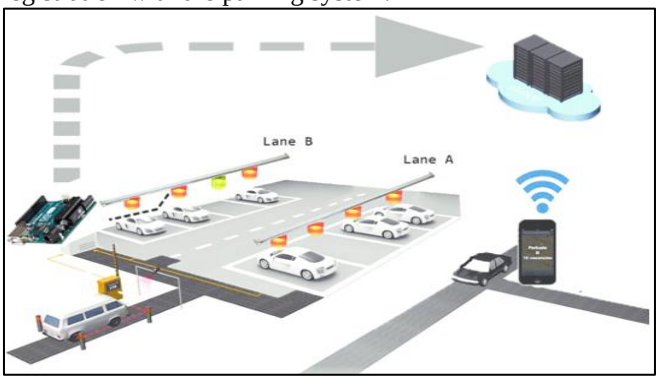


Fig. 1: Structure of Automatic Car Parking

II. RELATED WORK

In a study [1], the researcher designs a prototype of the parking gate control in which a mobile application is developed to control the gate of the parking. This design is specially made to be implemented to be used in the freezing temperature. But the prototype does not provide any means to control the traffic inside the parking. There are still the chances of traffic congestion inside the parking lot.

In another study [2], the researcher uses NB-IOT technology to implement the parking system. An android application is made to book a slot in advance. The main disadvantage of the system is that it considers only one parking area at a time. Furthermore, the user needs to install the application to use the system.

Hybrid parking technology is used to provide a rotary and automated mechanism of parking in [3]. Various sensors are used in the prototype to detect the vehicle, the speed of the vehicle and to identify the number plate of the vehicle. Different algorithms are designed to calculate the cost of parking and power consumption. The drawback of this prototype is it uses the smart card for the entry and exit of the vehicle. There is no way to book a slot in advance.

In [4], the researcher presents an algorithm that can be used to improve the efficiency of the current cloud-based smart car parking system. In the proposed system, an android application is created for users to access the parking system. Also, a Firebase data server is used in the system. But there is no provision provided for controlling the parking gate or any other hardware device present in the car parks. Another drawback is that the application designed can only be run on the Android devices but not on the Windows operating system.

In a study [5], a real-time car parking system is designed which incorporates various sensors like ultrasonic

sensors and infrared sensors. It also uses a camera and fingerprint sensor which is used to authenticate the user. LCD is used at the gate to display the vacant space and LEDs are used to ensure that the vehicle is parked safely. The system also uses a GSM module that is used to communicate with the users. But the research nowhere discusses controlling the opening and exiting gates in the situation of full parking.

III. COMPONENT ANALYSIS

A. Arduino Nano:

Arduino is the microcontroller that is used to interact with the LCD, servo motor and infrared sensor. Arduino Nano is specially used as it has an output of 3V on one of its pins which is the operating voltage of NodeMCU. So, by using Arduino Nano, we are converting the voltage from 5V to 3V.

B. NodeMCU:

It is the WiFi module that is used to receive the data from the magnetic sensor and then update the data on the server.

C. Infrared Sensor:

There are two infrared sensors used in the system, one is to detect the vehicle at the time of entry and the other is used to detect at the time of exit. They are used for the comparison with the available slots and to interact with the servo motor and the LCD.

D. Magnetic Sensor:

They are used to detect the vehicle which in turn will send the signal to the LEDs. Hence, they will be useful in updating the data on the server.

E. Servo Motor:

It is used to control the gate of the car park.

F. Seven Segment LCD Display:

It is placed at the entry of the parking system. LCD will show the number of empty and full slots in the parking.

G. Voltage Regulator:

The input power supplied to the system is 12V. But the operating voltage of all the components (except NodeMCU) is 5V. So, the voltage regulator is used to convert the voltage from 12V to 5V. The voltage regulator is providing the power to all the components.

H. Potentiometer:

A potentiometer is placed inside the system to control the brightness of the LCD.

I. Capacitors:

Capacitors are used to filter the AC voltage so that a stable power is provided to all the components.

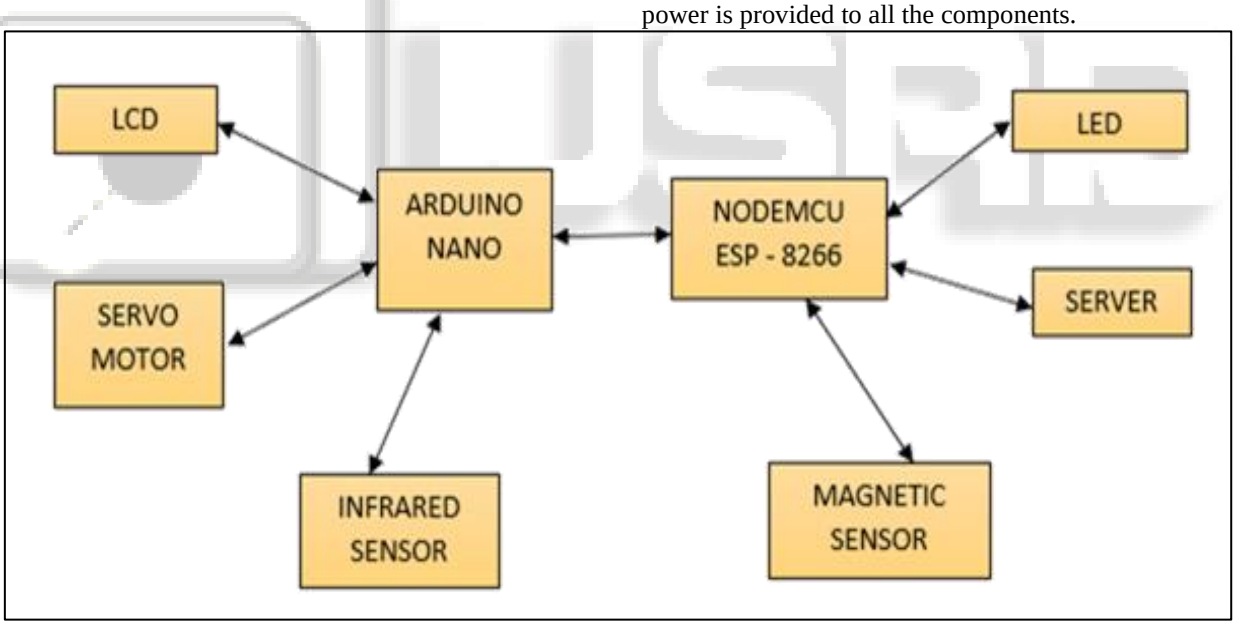
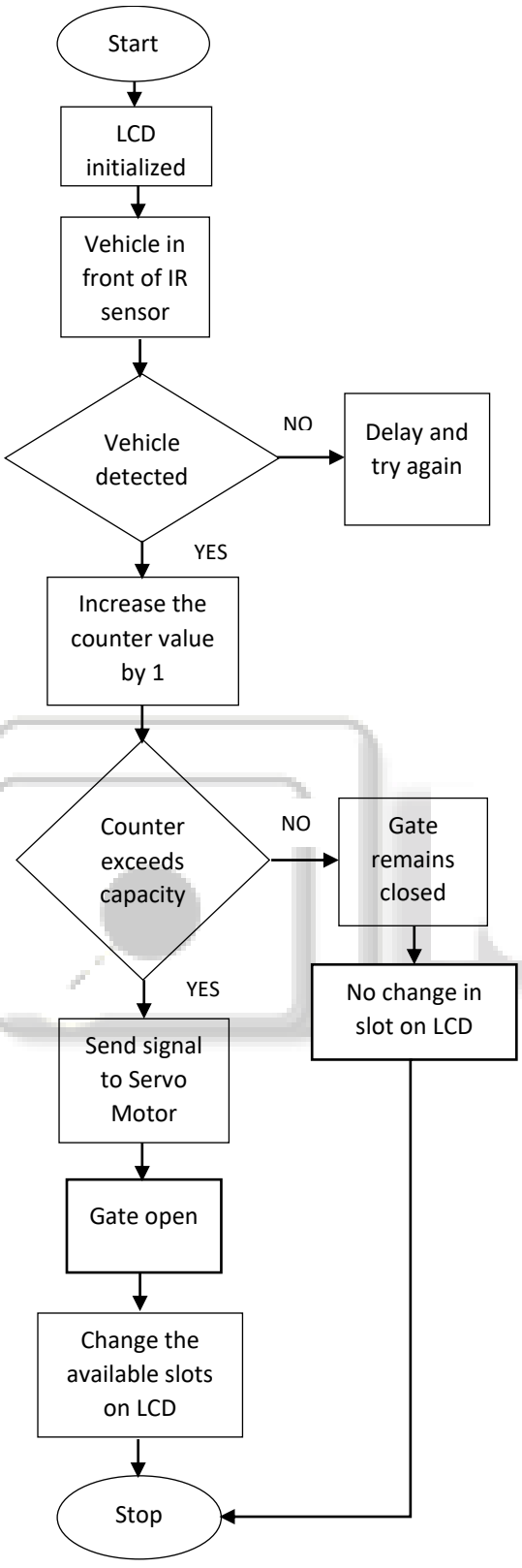


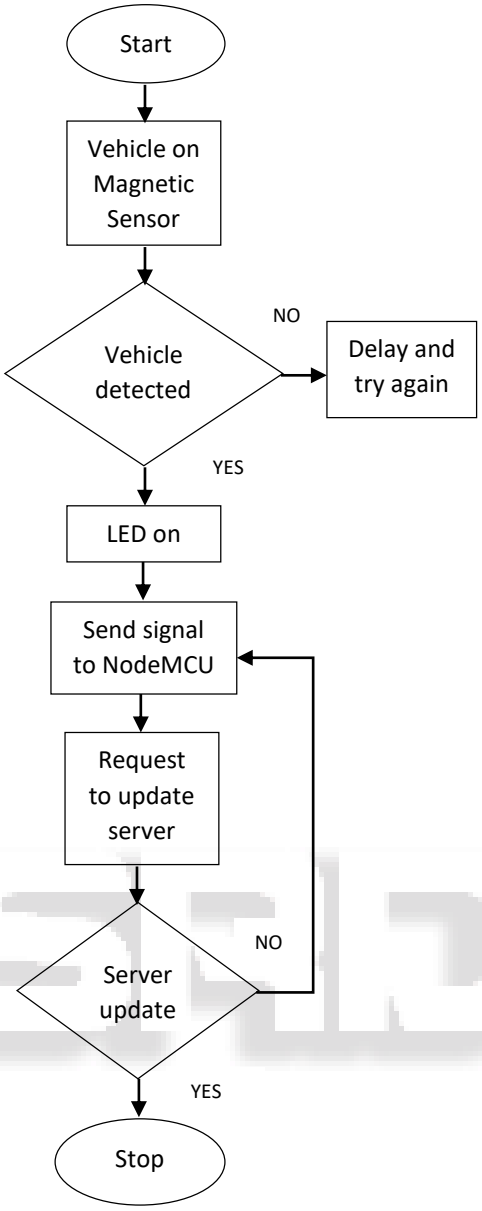
Fig. 2: Component Interaction Diagram of the System

The above figure represents the interconnection between the different components of the Automated Car Parking System. The way the components communicate with each other is depicted in the diagram. When a vehicle enters the car park, LCD will interact with the Arduino and show if there are free slots available in the parking or not. If the slots are available the vehicle will move and then the IR sensor will detect the vehicle and send the signals to Arduino Nano. Arduino will interact with the servo motor and rotate it at an angle of 175° and the parking gate connected to it will be open for a while. As soon as the vehicle reaches the slot, the magnetic sensor will detect the vehicle and the Led gets light up. The glowing Led signifies that the slot is full and this data will be updated in the server via the NodeMCU module. Any other use which is simultaneously accessing the system will be updated in no time that the car park has now one less slot available than before. When the parking is full, it is notified via the LCD and then the gate will not open until an exit is made.

IV. ALGORITHM



Algorithm – 1



Algorithm - 2

The first algorithm depicts the working of the Arduino microcontroller when the vehicle is either on the entry point or the exit point. The first step is to initialize the LCD. LCD will show the free slots and the filled slots. Then the infrared sensor will try to detect the vehicle. If the vehicle is detected, then the control moves further otherwise after a certain delay the sensor will again try to detect the vehicle. There are two counter variables, one is Up_counter which is increased by one when the vehicle enters the parking and the other is Down_counter which is decreased by one when the vehicle exits from the parking. When the vehicle is detected, then the value of the counter is changed accordingly that is when the vehicle is entered in the parking and detected by the first infrared sensor, the value of Up_counter will be one more than the previous value and when the vehicle leaves the parking lot and detected by the second infrared sensor, then the value of Down_counter is one less than the previous value. Then the upper limit of the Up_counter is compared with the capacity of the parking and the lower limit of Down_counter is compared with zero.

If the value is within the range, then the signal is sent to the Servo Motor and the gate is opened. After that, the number of available slots is changed on the LCD. If the value is not within the range, no signal is sent to the motor and the gate remains closed. In this case, the display on the LCD will not change. It will remain the same until any parking slot becomes empty.

The second algorithm shows the working of the NodeMCU ESP-8266 and also depicts the way data is uploaded on the server. The work of NodeMCU starts when the vehicle has passed the gate of the parking. When the vehicle comes to the slot for parking, then the magnetic sensor will try to detect it. If the vehicle is detected by the magnetic, then only the control moves further; otherwise, the sensor will wait for a short duration and after the waiting period expires the magnetic sensor will again try to detect the vehicle. When the vehicle is detected, the LED of that particular slot will start glowing. As soon as the LED glows, a signal is sent to the NodeMCU and the request is made to update the server. If the server is updated then the algorithm stops. The same update is reflected in the web view which is provided to the users. If there is an error in updating the server, an error message is sent to the WiFi module. The algorithm will end only when the server is updated.

V. FEATURES

A. *Automatic gate in the parking slot:*

The gate that is placed inside the parking is automatic. The gate is operated using a servo motor which is controlled by an infrared sensor. This reduces the manpower which is required to operate the gate. Hence the cost of the system will be reduced. The feature of the gate remaining close if the parking is full is an enhancement to the system.

B. *LCD display:*

The LCD placed at the gate of the parking will give the correct status of the parking. The number of slots that are empty inside the parking is visible on the LCD screen. Hence, the accidents inside the parking will be reduced. There will be no traffic congestion inside the parking.

C. *Web view of the server:*

The web view of the server will help the user to search for a vacant slot easily. The server will be updated every ten seconds. Therefore, there will be no wastage of fuel in finding a nearby free slot. In order to view the correct status of the parking lot, the user just needs to browse the IP Address which is given to the user by the owner at the time of registration for the parking lot. Therefore, in our daily hectic schedule, it becomes easy to access the automated parking system.

D. *Magnetic sensor:*

Magnetic sensors are used at each slot for the detection of a vehicle. Every vehicle has some magnetic components. So, it is suitable for detecting the vehicles and the server can be updated easily. Using a magnetic reed switch as a detector is a very affordable solution.

VI. IMPLEMENTATION

Automated Car Parking System is specially designed to provide the users with a systematic way to find a suitable car park for themselves. When the user registers for a particular parking lot, he will be provided with a private IP address. The private IP address is bought by the owner of the parking lot from the Internet Service Provider. Every parking space will be provided with a unique IP Address to automate every parking in the city. When the user browses that IP address, a web view of the server of that particular parking lot is in front of him. The web view will show the information of every parking slot in the chosen parking lot. If the parking is full that information is also clearly visible to the user. In this way, the user just needs to remember the IPv4 address to check the parking.

In the situation when the device of the user may get corrupted due to any hardware or software issue, then also the user can check the parking with some other device. There is no need to sign up or sign in in this prototype. As the web view will give a read-only copy of the server, so there is no issue of the security breach. The web view is not having any information about the user; therefore, the details of the user are safe with the owner. There is no scope of any web attack in the system.

The main motive of using a web view as a platform for interaction with the user is its dynamic nature. When some car is parked at the slot in the parking simultaneously it will be shown on the web view. At this particular moment, this prototype is designed only for one parking slot. But when this prototype is approved, another web page is accommodated in the system which will allow the user to select one parking from various parking lots. This is the working of the user interface part.

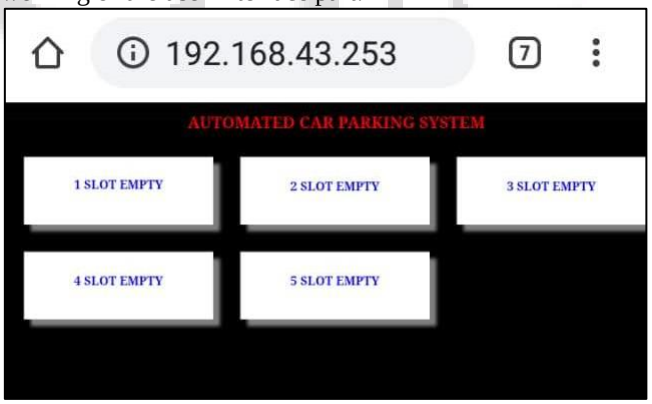


Fig. 3: Web view of our local server

The prototype is designed with a parking space of five slots. All the slots are given a particular sequence number in increasing order. The vehicle can be parked at any slot. There is no restriction of parking in a particular order. The user can park the vehicle as per his convenience. This prototype can be extended according to the parking space in the parking slot. The above figure depicts the scenario when all the parking slots are freely available. The user can park the vehicle at any of the available free slots.

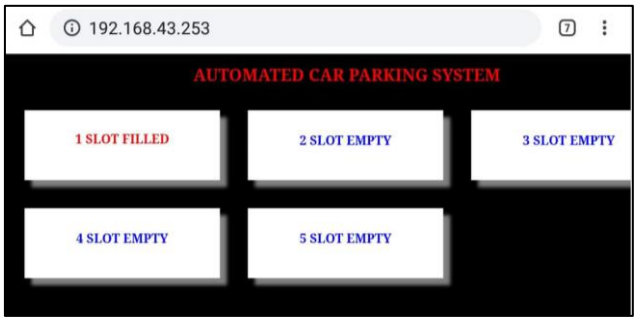


Fig. 4: Web view when one slot is full

The figure above depicts the scenario when slot number 1, which is the slot which is provided with a sequence number 1, of the parking lot, is full and all the other four slots are available for parking. The user can now park in any of these four slots. When the slot with sequence number 1 is free, then it will be shown in the web view within 10 seconds.

The proposed system also provides a hardware setup that needs to be installed in the parking lots. When any user reaches the parking lot, the first thing that the user witnesses are the LCD screen. The LCD screen shows the number of slots that are free inside the parking and also the number of full slots. The change on the screen depends on the number of times the two IR sensors detect the vehicle. The first infrared sensor is placed in the first lane which is the entry lane and the second infrared sensor is placed in the second lane which is the exit lane. So, both the sensor can work simultaneously in the case when a vehicle is entering and another vehicle is exiting at the same time.

The figure below shows the scenario when the parking lot is empty. In this figure, we can also see a car which is entering the parking. When the vehicle is detected by the IR sensors, then the gate will be opened and the vehicle enters the parking. The vehicle will then be parked and the value of empty slots and filled slots will be changed on the LCD screen.

Fig. 5: LCD Screen

As soon as the vehicle moves inside the parking, the infrared sensor will try to detect the vehicle. If the vehicle is detected by the sensor, then the parking gate, which is automated through a servo motor, will open otherwise there will be no movement in the gate.

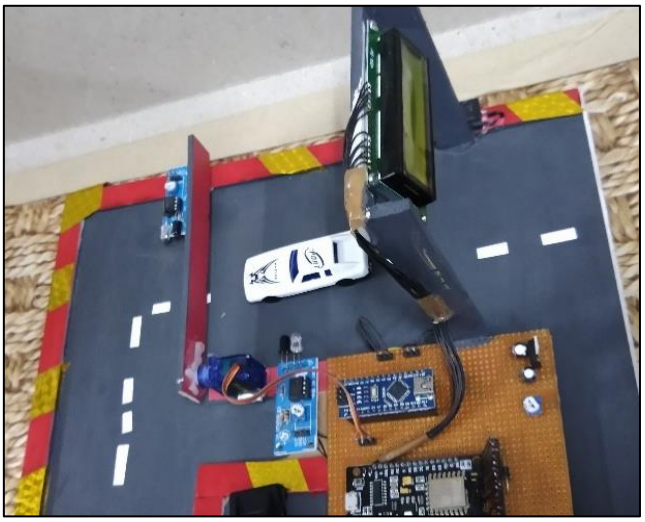


Fig. 6: Servo Motor Gate

The LCD screen will be updated simultaneously. But if the parking is full and the user still tries to enter in the parking, then according to the coding inside the Arduino, the gate will remain closed. Hence, the congestion inside the car park is avoided.

Fig. 7: LCD Screen Output

When the vehicle reaches the parking slot, the magnetic sensor will detect it. Each slot is associated with a LED which shows the safe parking of the vehicle on the slot. As soon as the vehicle is detected by the sensor and parked safely, the LED will glow. Then the LED will send a message to the microcontroller regarding the unavailability of one slot. At the same time, this information is updated on the server.

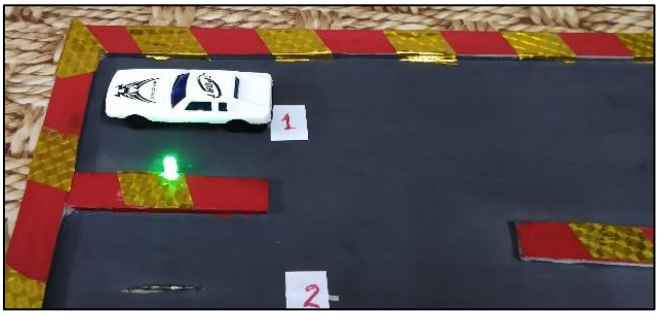


Fig. 8: Parking Slot with LED Indication

The following figure shows the interconnection between the two microcontrollers that is the controlling unit of the automated car parking system. All the slots inside the

parking are connected to this unit. The coding of the web view of the server is also placed inside this unit only.

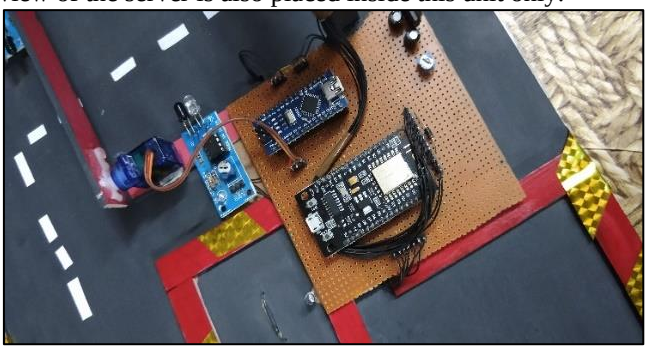


Fig. 9: Arduino nano & NodeMCU

The following figure depicts how the automated car parking system will look like. The same model will be placed inside a car parking. This proposed system can be applied to any existing parking system.

Fig. 10: Automated Car Parking System Model

VII. CONCLUSION

The proposed system reduces the time to search nearby parking and thus, it reduces the fuel consumption of the vehicle while idling or driving around the parking lots which in turn leads to less carbon dioxide emission in the environment. The parking lots can be systematically managed using this approach as it can be extended to cover all the parking spaces in the city. The number of accidents by the collision of cars inside the car park is almost zero as if the vehicles will not be allowed after the capacity is fulfilled. The manpower required for operating and managing car parking is also reduced with this approach. The automated car parking system will prove to be a great asset in the path of a smart city.

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