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Smart Car Parking System Using Node MCU, Arduino UNO, IR sensors and Servo Motor

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Abstract - The dependence on transportation has headed to the evident of increase in the number of vehicles on the roads around the world, which have a negative impact on quality of life such as the congestion on the roads. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Problems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. The parking systems requires motorists to display available parking slots. This project will serve as the solution to the outdated and inconvenient old manual system. The Smart Parking System is an automated parking solution that utilizes Arduino and Node MCU microcontrollers, IR sensors, LCD display, and a servo motor to enable efficient and convenient parking management. The system is aimed at improving parking efficiency and reducing congestion in parking lots. The system employs IR sensors to detect the presence of a vehicle in a parking space and displays real-time parking status on an LCD display. The IR sensors detect the presence of a vehicle in a parking space and send signals to the microcontroller, which then controls the servo motor to move a barrier to allow or deny access to the parking space. The Node MCU is used to connect the system to the internet, allowing real-time monitoring of parking space availability through a mobile application or website. The LCD display provides feedback to the user on the status of the parking space. The servo motor is used to control the opening and closing of the parking gate. The Node MCU and Arduino microcontrollers work in tandem to ensure reliable and secure data transfer between the system components, thereby enhancing the overall performance of the Smart Parking System. This system represents a technological advancement in parking management and promises to improve the parking experience for drivers, reduce traffic congestion, and enhance urban mobility.

***Key Words*:** traffic, parking space, LCD display, traffic congestion, road, barrier gate

1. INTRODUCTION

Internet Of Things (Iot): The Internet of Things (IOT) is a system of interconnected computing devices, mechanical and digital machines, objects, animals or humans, each with a unique identifier (UID) and the ability to transmit data over a network without human intervention - Manual connection is required, provided. Human-Computer Interaction or Human-Computer Interaction. Things on the Internet of Things could be people implanted with heart monitors, farm animals with biochip transponders, cars with built-in sensors that warn drivers when tire pressure is too low, or any other natural or Man-made objects can be assigned Internet Protocol (IP) addresses and can transmit data over a network [1].

Due to the surge in urbanization, people don't depend on public vehicles. They use their vehicles to travel. So, traffic increases. When people travel through a city the most difficult problem is to park the vehicle. It causes not only a waste of time and fuel for drivers looking for parking, but it also leads to additional waste of time and fuel for other drivers as a result of traffic congestion. The usage of automobiles has increased which in turn has led to traffic and parking difficulties.

The most widespread solution used currently is to increase manpower to handle such traffic. Even in malls, trade centers, and business parks, the parking of vehicles has become an issue. We have all experienced the chaos, confusion, and time-consuming queues to find an appropriate parking space in such places. Nowadays finding parking in busy areas is very hard and there is no system to get the details of parking availability online. Imagine if you can get the parking slot availability information on your phone and you don't have to roam around to check the availability[2].

This problem can be solved by the IoT-based smart parking system. Using the IoT-based parking system you can easily access the parking slot availability over the internet. This system can completely change the car parking system. So here we are building an IoT based Car Parking System using Arduino UNO, NodeMCU, 7 IR sensors, LCD display and one servo motors[3]. One IR sensors is used at the entry gate to detect the car while six IR sensors are used to detect the parking slot availability. Servo motor are used to open the gates according to the sensor value.

2. LITERATURE SURVEY

1.Yousif Allbadi, Jinan N Shehab, Musaab M Jasim IOP Conference Series: Materials : In this paper he stated that over the past decade, the concept of smart cities has become very popular thanks to the Internet of Things (IoT) development and expansion for increasing the

reliability of building the infrastructure of cities. The continuous increase of vehicles in the streets with the lack of car parking is becoming a problem in most urban cities. This paper presents a smart parking system using infrared and ultrasonic sensors, which is controlled by Arduino Mega 2560. The Radio Frequency Identification (RFID) reader provides authorization to enter the smart parking system. On the other hand, a mobile application is added to allow users to know about the empty spaces based on the WiFi application[4].

2."IoT-based Smart Parking System using Android Application" Nor Bakiah Abd Warif, Mohd Izzat Syahmi Saiful Azman, Nor-Syahidatul N Ismail, Muhammad Akmal Remli 2020 Emerging

In this paper, a userfriendly mobile application, named Android-based Car Parking Monitoring System (ACPMS) is built to aid in locating a particular parking place. ACPMS can provide a user with the ability to check vacant parking spaces and locate the nearest parking lot. ACPMS obtained the parking location from the current user's position with the sensor located in the shopping complex's parking lot. ACPMS is tested in a realistic environment for movement detection and location service to notify users using the mobile application. By considering seven test case scenarios, the combination of the ACPMS mobile application with a parking prototype kit shows the proposed work is to solve the parking problem[5].

3."Smart Car Parking System Solution for the Internet of Things in Smart Cities" Wael Alsafery, Badraddin Alturki, Stephan Reiff-Marganiec, Kamal Jambi 2018

This study has proposed a smart parking system that enhances the performance of saving users time to locate an appropriate parking space and reduces the general costs for moving to chosen parking space. The most obvious finding to emerge from this study is that they proposed a smart car parking system that will make ensure the reduction of transmitted data through the network and save energy in the perception layer. While in the application layer side is to save the user time, avoid traffic congestion, find available parking spaces, and reduce cars gas emissions from drivers while searching for the empty parking spaces[6].

3. PROBLEM STATEMENT

Current parking systems in urban areas are often inefficient, leading to wasted time, increased traffic congestion, and frustration for drivers. A smart parking system could help address these issues by providing real-time information about available parking spots and allowing drivers to reserve and pay for spots in advance. However, designing and implementing such a system poses a number of challenges, including integrating with existing infrastructure, ensuring data security and privacy, and managing user behaviours and expectations.

Traditional parking systems often suffer from inefficiencies and inconvenience due to the lack of real-time information on parking availability and occupancy. This leads to frustration for drivers who waste time and fuel searching for parking spots, and for parking managers who struggle to optimize space utilization and revenue. A smart parking system that leverages modern technologies such as sensors, IoT devices, and data analytics can provide a solution by enabling real-time monitoring of parking spaces and the communication of this information to drivers and parking managers. However, designing and implementing a reliable and user-friendly smart parking system presents significant technical and logistical challenges, such as sensor placement, data integration, system scalability, and user adoption. Therefore, there is a need for research and development in the field of smart parking to address these challenges and deliver a more efficient and sustainable parking solution.

A smart parking system could involve the use of sensors and cameras to monitor parking spaces and provide real-time information on availability to drivers. Such a system could improve the overall parking experience for drivers and reduce traffic congestion and air pollution in cities. Designing an intelligent parking system that can efficiently manage and optimize parking spots in a busy urban area, utilizing IoT sensors and machine learning algorithms to provide real-time parking availability updates to drivers and reduce traffic congestion. The current parking system in many cities is inefficient and time-consuming. Drivers often spend a significant amount of time searching for available parking spots, which results in traffic congestion and increased pollution. Finding a parking space in most metropolitan areas, especially during the rush hours, is difficult for drivers. Difficulty arises from not knowing where the available spaces may be at that time traffic congestion may occur.

The solution to this problem is a smart parking system that has advanced technologies to optimize parking operations. This system can provide real time information about available parking spots and can reduce the congestion.

3.1. Aim

The aim of a smart car parking system is to provide a more efficient and convenient way for drivers to find and park their cars in a parking lot or garage. The system typically utilizes technology such as IR sensors, NodeMCU, Arduino UNO and servo motor to monitor the availability of parking spaces and guide drivers to available spots.

3.2. Objectives

- To optimize the parking space by finding the best spot available.
- To reduce the traffic around parking area.
- To decrease management cost by automation and optimization of resources.
- To avoid the cramming in the car parking area by implementing an efficient car parking system.
- To provide convenience of parking at public places such as multiplex theatres, market areas, hospitals, function-halls.

4. METHODOLOGY

The idea behind our methodology is very simple, usually users spend most of their time in looking for an empty slot where they can park their vehicle which increases fuel consumption and time wastage. We came-up with a new method where we help the user in finding an empty slot number where he can park his vehicle without wasting his time for finding one .

4.1. Hardware

1) NodeMCU:

NodeMCU ESP8266 is an open-source Lua-based firmware and development board specially targeted for IoT based applications that helps you to Prototype your product within a few Lua script lines[8]. It includes firmware that runs on the ESP8266 WiFi SoC from Express if Systems and hardware which is based on the ESP-12 module, and like this, it can also be programmed using Arduino IDE and can act as both Wi-Fi Hotspot or can connect to one.
It has one Analog Input Pin, 16 Digital I/O pins along with the capability to connect with serial communication protocols like SPI, UART, and I2C. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs[7].

Fig. 3.1 Node MCU

2) Arduino UNO:

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms. The USB port in the Arduino board is used to connect the board to the computer using the USB cable. The cable acts as a serial port and as the power supply to interface the board. Such dual functioning makes it unique to recommend and easy to use for beginners[9].
The Arduino UNO is a standard board recommended to beginners, while Arduino Mega is used for complex projects due to its greater memory space.

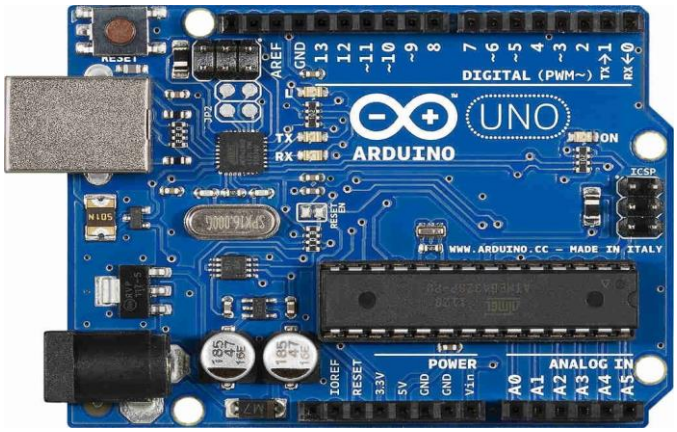

Fig. 3.2 Arduino UNO

3) Servo Motor:

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor[10].
It is just made up of a simple motor which runs through a servo mechanism. Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically, servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears.

Fig. 3.3 Servo Motor

4) IR Sensors:

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only

infrared radiation, rather than emitting it that is called a passive IR sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode that is sensitive to IR light of the same wavelength as that emitted by the IR LED[11]. IR is invisible to the human eye, as its wavelength is longer than that of visible light[12]. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

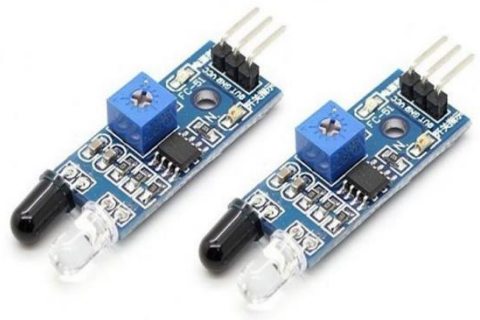

Fig. 3.4 IR Sensors

5) LCD Display:

An electronic device that is used to display data and the message is known as LCD 16×2. In LCD 16×2, the term LCD stands for Liquid Crystal Display that uses a plane panel display technology, used in screens of computer monitors & TVs, smartphones, tablets, mobile devices, etc[13].

An electronic device that is used to display data and the message is known as LCD 16×2 display. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots [13]. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. The basic working principle of LCD is passing the light from layer to layer through modules. These modules will vibrate & line up their position on 90o that permits the polarized sheet to allow the light to pass through it.

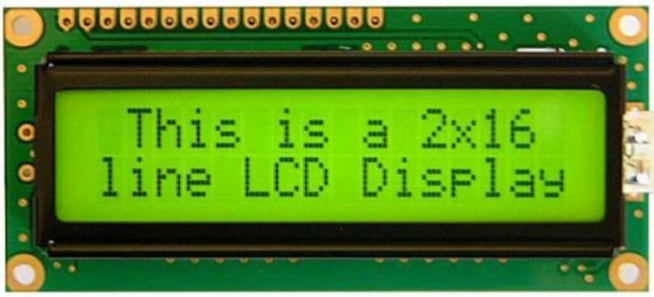

Fig. 3.5 LCD Display

6) Jumper Wires:

A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering [14]. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment [15].

Fig. 3.6 Jumper Wires

5. IMPLEMENTATION

The designed system consists of the following Hardware Components:

- Arduino UNO
- Node MCU
- IR Sensors
- Servo Motor
- LCD Display

In this system we have also used jumper wires and a cable (Type A to Type B connector).
Jumper wires are used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.
Type A to Type B connector is a cable to connect the Arduino to the power supply device.

When a car approaches the parking spot, the IR sensor detects it and sends a signal to the Arduino.

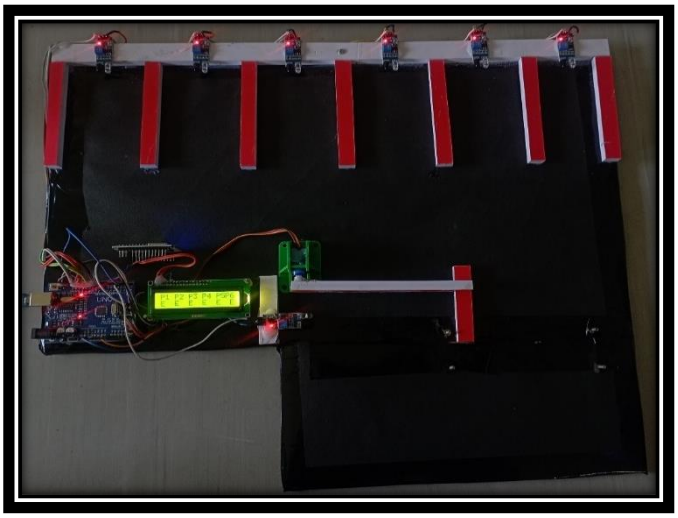

Fig. 4 Prototype Image

The IR sensor is used to detect the presence of a vehicle in the parking spot. It emits an infrared beam, which is reflected back when a vehicle is present.
The sensor then sends a signal to the Arduino, indicating that the parking spot is occupied.
The Arduino processes the signal from the IR sensor and sends a control signal to the servo motor to open the parking spot barrier.
The servo motor is used to rotate the barrier arm, which allows the vehicle to enter or exit the parking spot.
Once the vehicle is detected in the parking spot, the LCD display shows a message indicating that the spot is occupied. This provides real-time feedback to users on the status of the parking spot.
The Node MCU is connected to the internet and sends data to a cloud-based server about the availability of the parking spot.
When the vehicle leaves the parking spot, the IR sensor detects the absence of the vehicle and sends a signal to the Arduino.
The Arduino then sends a control signal to the servo motor to close the parking spot barrier.
The LCD display shows a message indicating that the parking spot is available again, and the Node MCU sends data to the cloud-based server to update the availability status of the parking spot.

To implement a smart car parking system using Arduino Uno, Node MCU, servo motor, and IR sensors, you can follow these steps:

1. Gather the necessary components, including the Arduino Uno board, Node MCU, servo motor, IR sensors, breadboar, jumper wires, and USB cable.
2. Connect the IR sensors to the breadboard and then connect the VCC pins of the IR sensors to the +5V power rail on the breadboard. Connect the GND pins of the IR sensors to the ground rail on the breadboard.
3. Connect the signal pins of the IR sensors to required digital pins of the Arduino Uno board.
4. Connect the servo motor to the breadboard and then connect the VCC pin of the servo motor to the +5V power rail on the breadboard. Connect the GND pin of the servo motor to the ground rail on the breadboard. Connect the signal pin of the servo motor to digital pin 9 of the Arduino Uno board.
5. Connect the Node MCU to the Arduino Uno board using jumper wires. Connect the TX pin of the Node MCU to the RX pin of the Arduino Uno board and connect the RX pin of the Node MCU to the TX pin of the Arduino Uno board.
6. Connect the USB cable to the Arduino Uno board and the computer. Open the Arduino IDE software on the computer and select the correct board and port.
7. Install the necessary libraries for the project. Install the "Servo" library for controlling the servo motor and the "ESP8266WiFi" library for connecting to the Node MCU.
8. Write the code for the project. The code should include the following functions.

- A function to read the IR sensors and detect the presence of a car in each parking spot.
- A function to control the servo motor to open and close the parking gate.
- A function to connect to the Node MCU and send data about the parking spots' occupancy status.

9. Upload the code to the Arduino Uno board and run the project. The IR sensors will detect the presence of a car in each parking spot and send the data to the Arduino board. The Arduino board will then control the servo motor to open or close the parking gate based on the occupancy status of the parking spots. The Node MCU will also receive data about the occupancy status and send it to a remote server or display it on a web page.
10. Test the system to ensure that it is working properly. Place a car in one of the parking spots, and the gate should open automatically. When the car leaves the parking spot, the gate should close automatically. Check the Node MCU to ensure that it is sending data correctly.

With these steps, you can implement a smart car parking system using Arduino Uno, Node MCU, servo motor, and IR sensors.

6. RESULTS

We have developed Smart Car Parking System which includes 6 parking slots, IR Sensors, Servo Motor, Node MCU, LCD Display and Arduino UNO .

- When any vehicle enters in the parking slot, the IR sensor present near the entry gate will detects the object i.e vehicle and sends a signal to the Arduino.

The Arduino processes the signal from the IR sensor and sends a control signal to the servo motor to open the parking spot barrier.

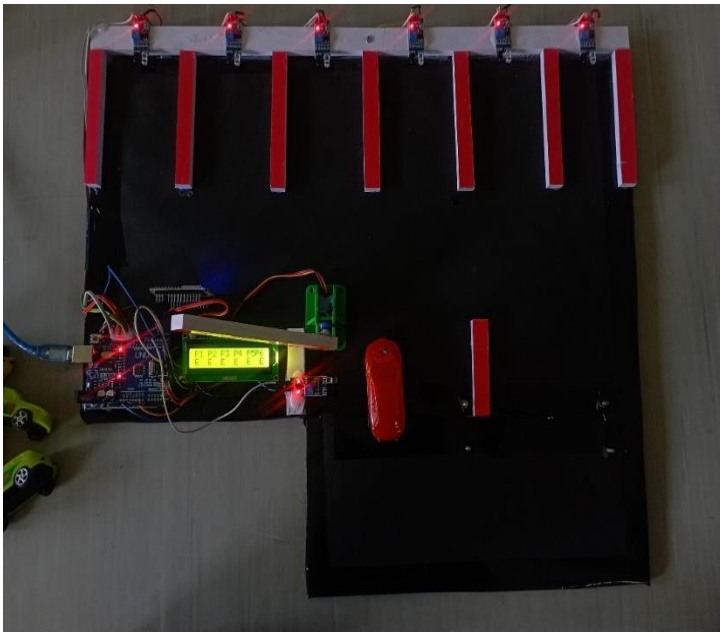

Fig. 5 Prototype (when vehicle enters and gate opens)

- When no vehicle is parked in the parking space then the LCD display will show that all the slot are empty and the same will be display on the console.

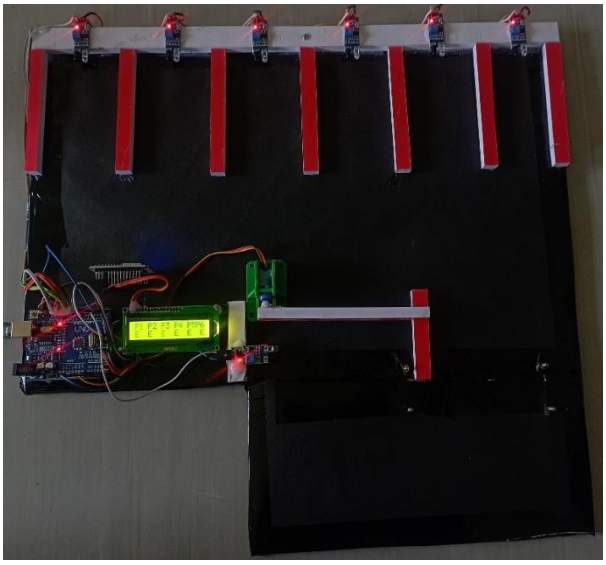

Fig. 5.1(A) LCD display all slots are empty

Fig. 5.1(B) Console

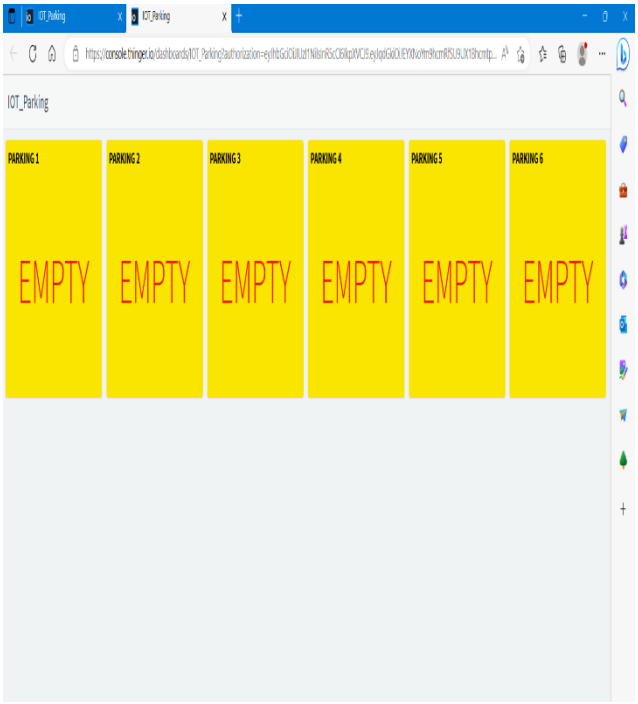

Fig. 5.1(C) Web Platform (All slot are empty)

- When 3 vehicles are parked in the parking slot, the specific occupied slot number will be display as full on the LCD display, and same will be display on the web platform.

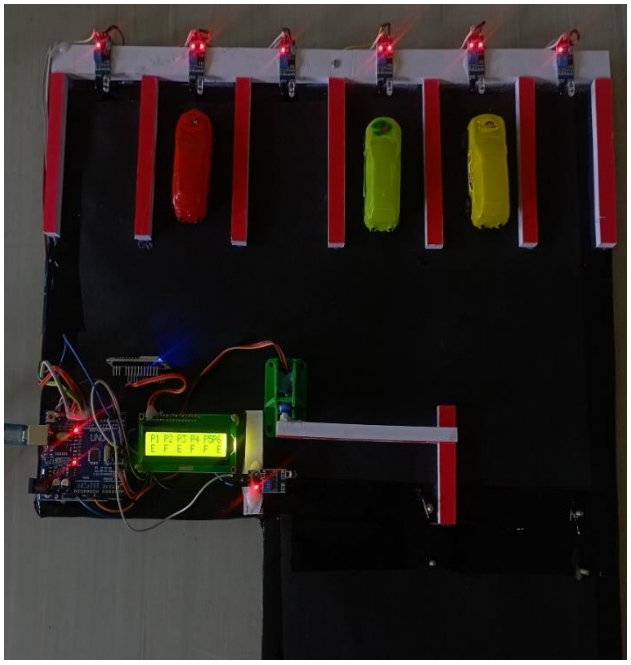

Fig. 5.3(A) LCD display 3 slot are full

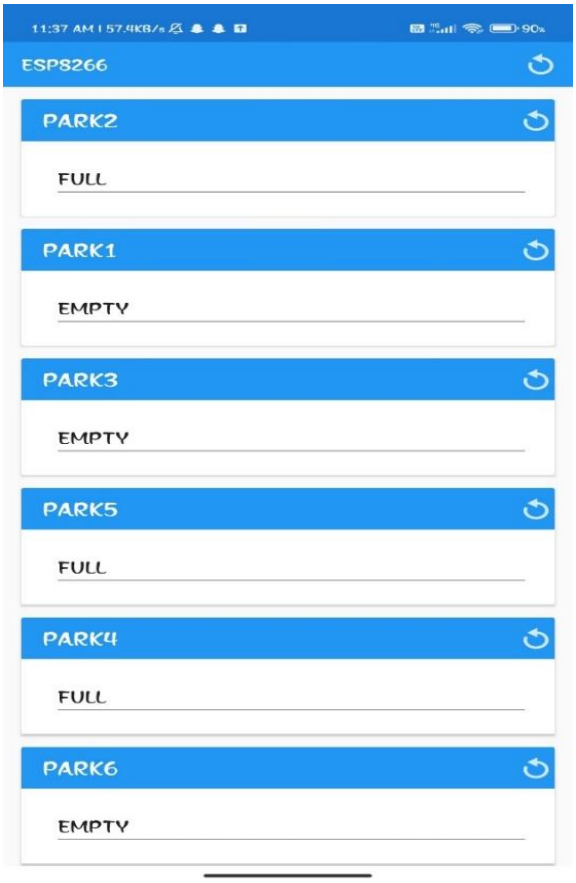

Fig. 5.3(B) Console

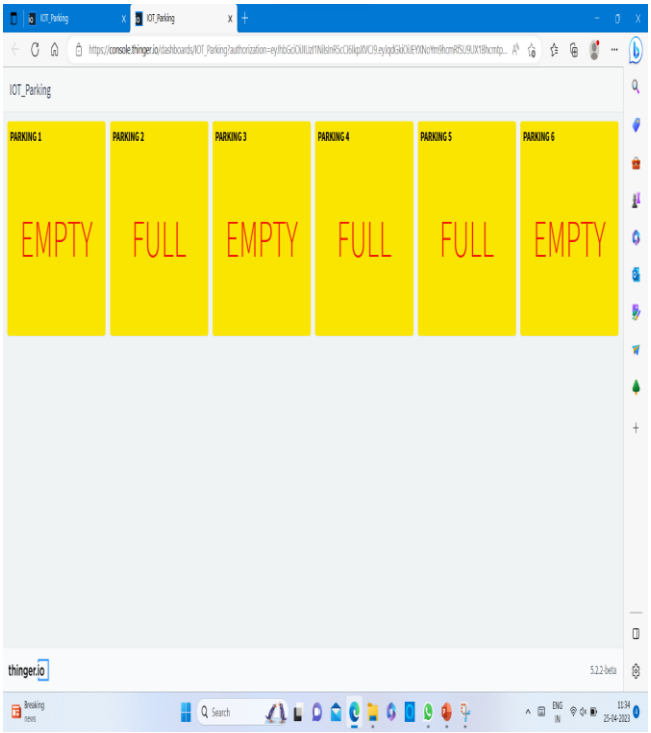

Fig. 5.3(C) Web Platform (3 slots are full)

- When all the parking slots are full, the LCD display will show that all slots are full and same will be display on the console.

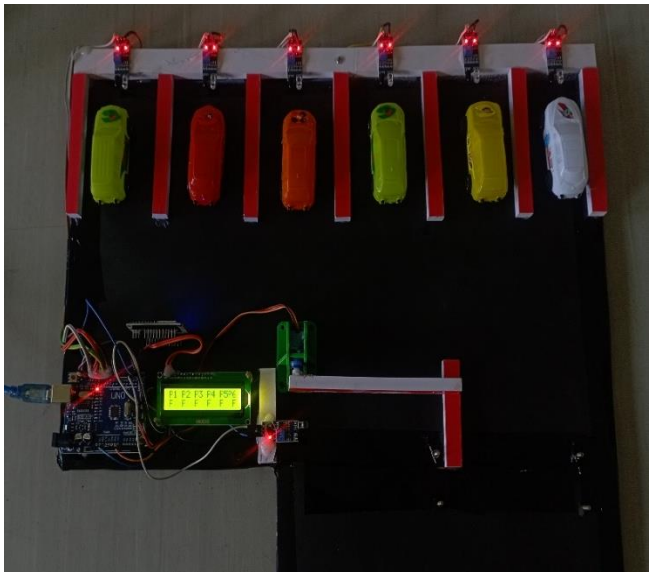

Fig. 5.4(A) LCD display all slots are full

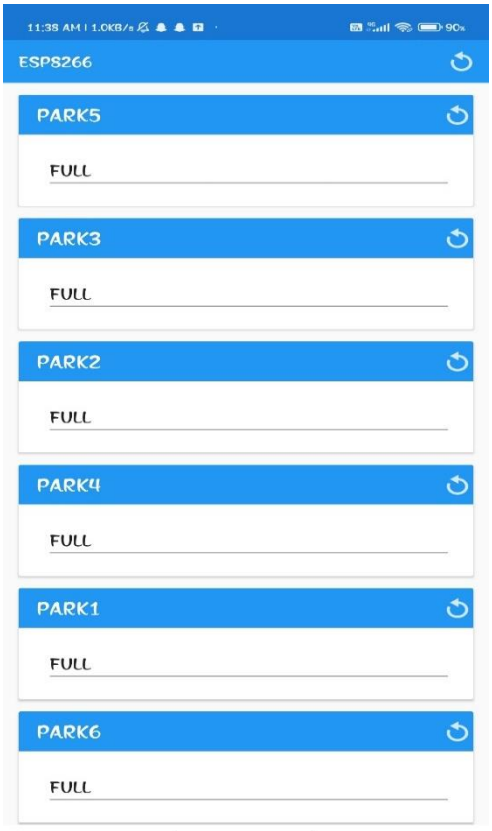

Fig. 5.4(B) Console

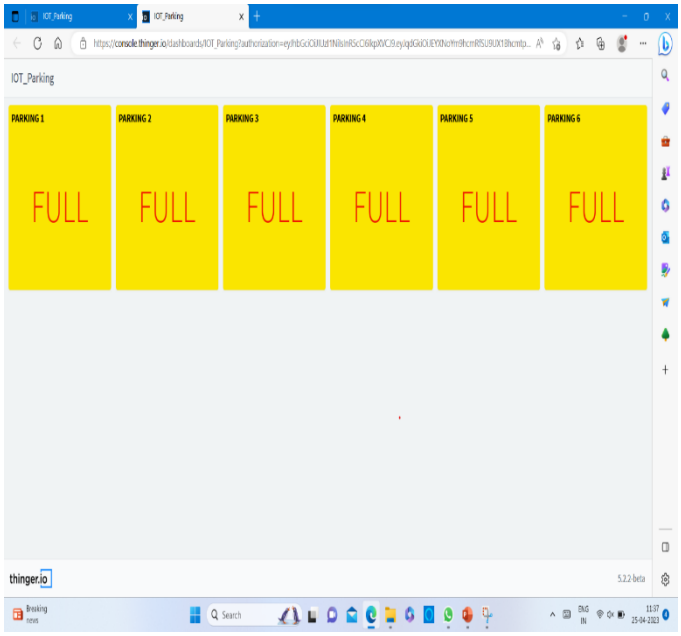

Fig. 5.4(C) Web Platform (All slot are full)

- If all slots in the parking space are already full and any vehicle comes near the gate , the gate will not open as all the slots are full , and display the message as “Parking Full” on the LCD display .

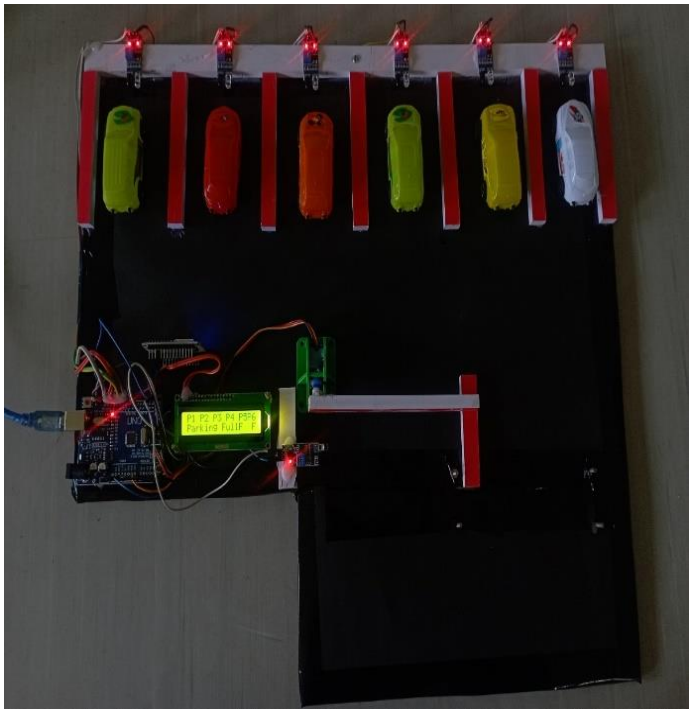

Fig. 5.5 LCD display shows “Parking Full”

7. CONCLUSION

The prototype of this parking system is developed for six parking slot. This project presents an efficient solution for finding a parking space and Internet of Things (IoT) is the main concept which is used to develop the smart car parking system using IR sensor. The IoT based Car Parking Management System using IR sensors is a prototype that is developed to assist the drivers in finding a vacant or available parking slot. In this project, we addressed the issue of parking and present an IoT based smart parking system. The system that we propose provides real time information regarding availability of parking slots in a parking area.

The results show that the smart parking system is effective in improving parking efficiency and reducing congestion, providing a convenient and cost-effective solution to parking management. By implementing this project, all the objectives which were considered earlier are achieved.

8. FUTURE SCOPE

The Future Scope is to enhance the project into a paid parking system. We can also allot the parking slot to the vehicle according to the size or dimensions of the vehicle. Another future scope is to adopt this Smart Parking System(SPS) so that availability of parking slots could be viewed on a mobile phone application. It can also be enhanced to send notifications to the user's mobile phone when vehicle enters to a particular shopping malls and some streets in a city etc. In future works, this framework can be enhanced by including different applications.

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