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IoT-Based Smart Parking System

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Abstract: ***A smart city permits the viable usage of assets and better administration of assets for the residents. Consistent advances are being seen in the field of the Internet of Things (IoT) to intensify the convenience and nature of the foundation. With the advancement of the foundation in metropolitan areas, the number of vehicles has also increased significantly in recent years, causing issues with traffic congestion and street security. IoT has helped solve different issues every day concerning street security, parking spaces, and traffic congestion. Parking spaces can be difficult to detect, particularly during the pinnacle hours in significant metropolitan urban communities, which can be extremely disorganized. In this project, we plan to introduce an altered plan of an Internet of Things (IoT) empowered smart parking system to tackle the parking issue in the city. The system includes an on-location organization of the various sensors, which are utilized to recognize the accessibility of the parking spaces and send data to the server about the equivalent. A real-time web link will be given that permits an end client to take a look at the accessibility of a parking space and book it for a given time frame. A parking executive system can be planned and sent to all smart and future urban communities with the help of sensor systems and IoT innovation. This will save the client's time and diminish the congestion undeniably.***

Keywords: Smart Parking, Reservation, Traffic Congestion, Internet of Things (IoT)

I. INTRODUCTION

The Internet of Things is an organization of actual items that comprises sensors, programming, and hardware that can interact with one another as well as with their users. It is a rapidly developing technology due to the integration of information along with the advancement of technology and the internet. The Internet of Things (IoT) has various uses, one of which is a smart city in an urban area, which promises to bring positive change in the quality and execution of urban services through information and communication technology (ICT). It also improves the quality of life of citizens by providing better services and at the same time reducing the administrative efforts for the management of the city, enabling effective utilization of resources and better quality of services.

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Different services can enhance the quality of life in a smart city, some of which are checking the strength of structures, monitoring weather and air quality, managing waste and traffic or parking, etc. With this project, we aim to solve the parking problem and create a flawless parking management system with the help of sensor systems and IoT technology. With the fusion of these two technologies, completely automated parking management can be designed and deployed in all smart and future cities. Practically, the creation of smart cities is presently possible with the advancement and development of the IoT. One of the biggest problems in smart cities these days is related to car parking and traffic control systems. Nowadays, drivers in urban areas are having problems accessing parking spaces, and the difficulty is increasing day by day due to the increase in the number of private cars. The present circumstances should be seen as a chance for these cities to improve their current actions to improve the parking system as it would lead to reduced search times, fewer accidents, and less traffic congestion. Issues related to parking can be tackled if drivers can know beforehand about the availability of parking spaces at their expected destination and surrounding areas. In today's time, developers can build new IoT-based applications more effectively as they are becoming cost-effective and require low-power embedded systems along with the advancement of various sensors. Due to this, numerous cutting-edge urban areas have chosen to send different IoT-based frameworks into and around urban communities to monitor the cities. Users can pre-book their parking slots as pre-payment services will also be available. Our system will let users know if the parking space is available and allow the user to book the available parking spot for a certain time. Irrespective of the structure and layout of any building, the proposed application can be implemented indoors and outdoors.

II. RELATED WORK

Robin Grodi et.al [1] have proposed a system that shows the occupancy of an allocated place by a vehicle. The proposed system uses an Arduino Uno that controls RFID sensors, database, web server, etc. RFID sensors identify if any vehicles or different objects are present. When the presence of a vehicle is identified, the framework needs a method for informing drivers or parking spaces being involved. The drawback of this is that only nearby places parking spots will be detected so can't be used for street parking. Nazia Bibi et.al, [2] proposed a framework which will identify the absolute number of parking spots accessible, further passing the data to the drivers and informing them about the available spaces. The image of the parking area is captured using a web camera and the status of the parking spot is checked using image processing techniques. Every time there is a change in the status of the car i.e. either if the car enters or leaves the parking lot, there is an update.

The structure includes recordings that are obtained from the top perspective of the parking space and this video is segmented into frames, further from each segment a key frame is selected. After the RGB image is converted to grayscale then further converted to binary and the threshold is calculated. If the value is less than the threshold, then the car isn't present in that slot, or else it is present. The drawback is that if the weather is bad then the precision of the image captured can be affected. In this paper [3], Kaur has presented a framework where the number of available parking slots will be shown on a monitor in front of a garage door when the driver places the vehicle in front of it. For automatic license plate identification first, the image is captured and then the license plate is extracted, followed by image binarization and character segmentation then character recognition, and then the plate number is identified. The driver will have to give details like their mobile number and the car's plate number. After the details are shared a tray for parking the vehicle will come and will park the car in the garage. Prabhuramaswamy et.al, [4] provide an alternative to traditional parking methods to solve issues related to it and highlight the benefits of minimizing ozone-depleting substances for instance greenhouse gasses utilizing the Internet of Things (IoT). The various connecting devices are used to empower smart parking frameworks utilizing Iot such as raspberry pi, pi camera. The real-time data is sent to the cloud with the help of the internet which is connected to the pi devices. Raspberry pi camera is connected to ultrasonic devices via raspberry pi devices which control each slot of the parking area. When the vehicle is present the information about the vehicle including the number plate information is sent to the central parking system using internet-enabled devices regarding the presence of a vehicle in each lot of parking area is sent to the central parking system along with number plate details using internet-enabled pi devices. There is no service of online payment in this proposed system. In order [5] to detect the status of the parking area, a decentralized solution was presented that uses deep convolutional neural networks (CNN). CNN is used to classify the occupancy of the parking space. The solution uses cameras which have been built on the Raspberry Pi platform. Around 50 parking spaces can be monitored using one camera. Using the smart camera images of parking spaces are classified as occupied or vacant directly on board the smart camera. In this way, the binary output of the classification is the only information provided to the central server for visualization. Datasets were considered which had data of different days, different weather, and lighting situations which made the data set more reliable.

III. SYSTEM ARCHITECTURE

We have three layers in our project.

- Sensing Layer
- Networking Layer
- Application Layer

The sensing layer is essentially the real-time parking area, which consists of IR proximity sensors in each parking slot. These sensors collect data on whether a slot is vacant or occupied by throwing out infrared rays. If these rays return to the sensors, the sensors interpret that the rays were reflected by an object in front, hence concluding that the slot is occupied by a vehicle. Otherwise, the slot is vacant. In the networking layer, Arduino is used to collect all the information from the sensors in the parking slots and process it before sending it to the cloud. It is also responsible for sensor interfacing and interacting with the WIFI module (python code). It has to make an internet connection successfully before sending any packets to the internet or cloud. In our project, we used Python code to get connectivity. We use Thingspeak on our web server as our backend. Thingspeak is used to aggregate, visualize, and analyze the data on a real-time basis of the parking slots in the cloud and create connections between hardware and software. In the application layer, the data collected from the sensors is updated into our web application on a real-time basis, which helps the user get information about the parking spaces available. The user can book or reserve available slots as well, from the comfort of their own homes. Our web application is designed using React JS.

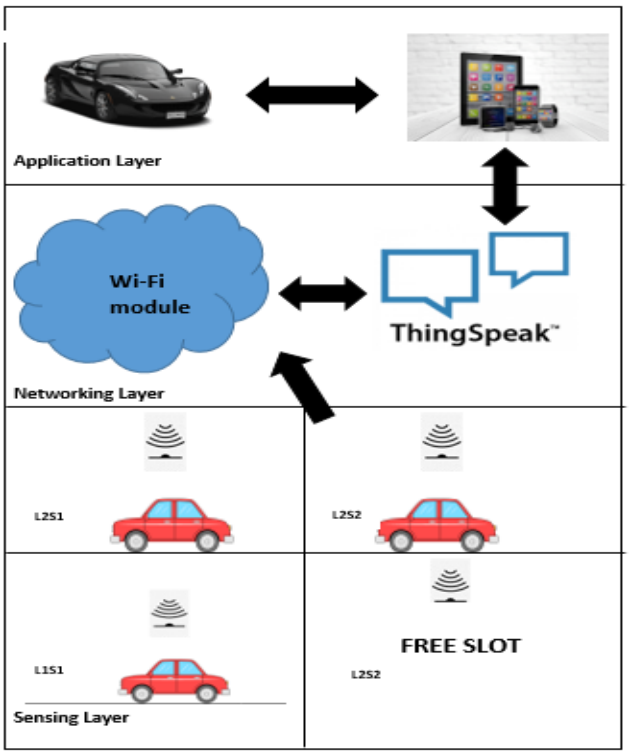

Figure 1: Basic System Architecture

IV. DETAILS OF MODULE

A. Hardware Modules

- Arduino Uno: We have used it to read the inputs from the IR sensors and control the output accordingly. It is easily available on the market.
- IR Proximity Sensors: We have used them to sense or detect the presence or absence of vehicles in the parking slots. They emit a beam of light to detect the presence of an object in front of them.
- General-Purpose PCB (Purpose Circuit Board): For power distribution, it was used to solder two capacitors and a ground.
- Capacitors: They have been used to make the power supply even for each sensor, i.e., 5V. The main purpose is to provide a smooth power supply.

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- Male berg strip: We have used it for soldering onto printed circuit boards (PCBs).
- Jumper Wires (female-female, male-male, male-female): They were used to connect the Arduino, the IR sensors, and the PCB.

V. IMPLEMENTATION

For this project, we have altered the plan of an Internet of Things (IoT) empowered smart parking system to tackle the parking issue in the city. The system includes an on-location organization of sensors, which are utilized to recognize the accessibility of the parking spaces and send data to the server about the equivalent. A real-time web link will be given that permits an end client to take a look at the accessibility of a parking space and book it for a given time frame. On the hardware side, two capacitors are soldered onto the PCB using a male-to-berg strip for a smooth power supply. We have used jumper wires to make connections and have color-coded each connection for easy understanding and to avoid complexity and confusion. We have used a yellow F-F jumper wire to self-loop two rows of the male Berg strip, which are soldered onto the PCB and charge both the capacitors to 5V. In our project, we used four IR sensors for four parking slots to detect the presence of vehicles in the slots. In our mini model, we have two levels of parking slots: Level-1 and Level-2, each containing two slots. We placed two sensors in level-1 parking slots (2 parking slots require 2 sensors) and two sensors in level-2 parking slots (2 parking slots require 2 sensors). The ground of the IR sensors is connected to the ground of the PCB using a green F-F jumper wire. The 5V of the IR sensors are connected to the 5V power of the PCB, represented by the red jumper wires. We have connected the output of our IR sensors to Arduino pins, namely 6, 7, 8, and 9, as they are general-purpose input/output pins. In the Arduino, a 5V power output pin is connected to the 5V of the PCB. Likewise, the ground of the PCB is connected to the ground of the Arduino board. We run a Python script that acts as a Wi-Fi module and runs in a loop. It updates the data from the Arduino to Thingspeak, which acts as the backend to store the data collected by the sensors in the parking slots. For the webpage, we have used NodeJS for our backend and ReactJS to create the front-end of the Parking Reservation System.

VI. RESULT AND DISCUSSION

The project aims to help individuals overcome the stress of finding a parking spot in any busy location by allowing them to view real-time information about the parking space as well as allow them to book an empty, available slot. With the help of our system, one can see the real-time availability of parking spots from the comfort of their house and book the available spot for their expected destination. This would optimize the parking spaces' usage and simplify the parking experience, thereby helping the free flow of traffic. We have made an effort to help individuals with busy schedules find an appropriate place to park their vehicles, which would save them time, reduce traffic congestion, reduce CO2 emissions, and provide a sense of relief through pre-booking. This application can be implemented indoors and outdoors irrespective of the structure and layout of any building, which makes the proposed application reliable and feasible. The results of our smart parking system are shown as follows:

Step1: Arduino is connected to 4 IR sensors which will detect the presence of vehicles in the parking slot.

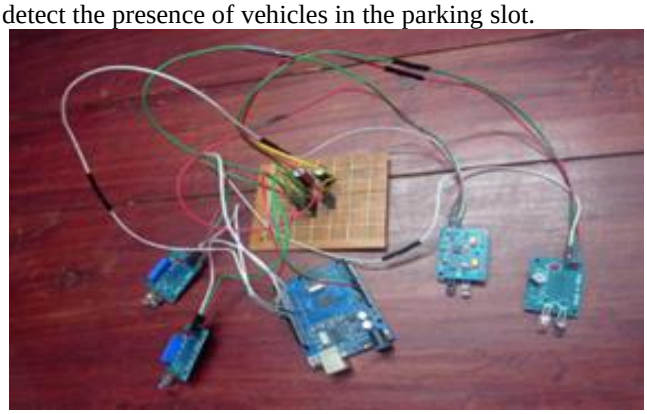

Figure 2: Arduino is connected to 4 IR sensors. The male berg strip is soldered to the PCB which helps to maintain stable power to the capacitors. All the connections made are color-coded

Step2: We created a mini-model of the parking system with 2 levels, Level 1 and Level 2, each consisting of two slots (L1S1, L1S2, and L2S1, S2S2).

Figure 3: Mini-Model of the proposed Smart Parking System

Step 3: The 4 sensors are set up in each slot. In the figure below, we see that the sensors have detected the presence of a vehicle in the parking slot and the sensor light is switched on.

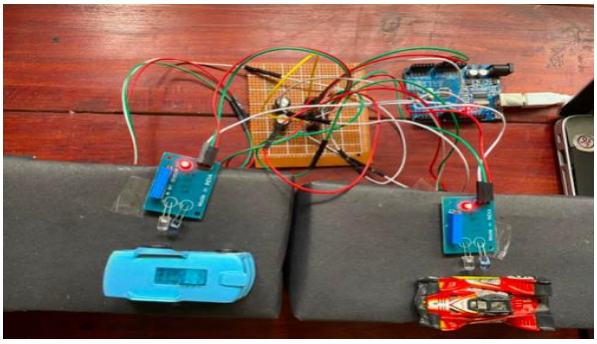

Figure 4: The sensors detect the presence of a vehicle in the parking **slots and the sensor lights are switched on. This data is then updated to Thingspeak**

Step4: Python code is used as a Wi-Fi module. It runs in a continuous loop. The code gathers the sensors 'data from the Arduino and updates it into Thingspeak.

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Step5: The python code updates Thingspeak accordingly. In the figure below, we see that L2S1 is occupied(white) while the rest of the slots are vacant (green).

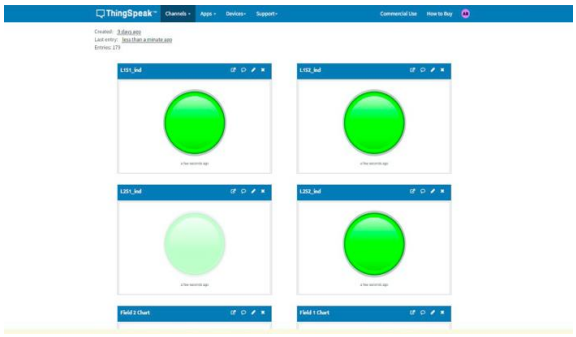

Figure 5: Thingspeak is updated through the python code. Here, 3 slots are empty and are represented by green color while one slot is occupied and represented by white color

Step6: The web application is updated as well. The figure shows that L2S1 has been reserved or occupied while the rest of the slots are vacant. Users are free to reserve vacant slots according to their preference by confirming the details.

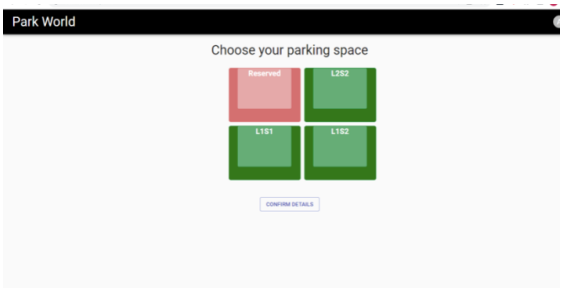

Figure 6: Real-time representation of the parking system

VII. CONCLUSION AND FUTURE WORK

Irrespective of places like offices, shopping complexes or schools there is always a problem with finding a parking space, especially during rush hours. This problem is pressing in urban cities where the number of vehicles is dramatically increasing continuously. The problem is not just about finding a parking spot but there are other side effects such as overcrowding of vehicles leading to congestion, loss of time of an individual, illegal parking, and some indirect effects such as excess CO2 emission and waste of fuel while trying to find free parking space, noise pollution from vehicles, unplanned urbanization, anxiety amongst the user, etc. Therefore, to address this problem, we have proposed The Smart Parking System using advanced IoT-based technology to overcome the above-mentioned problems permanently. This system provides solutions to the parking problems. In our future work, we plan to make a mobile application for the parking system and provide extra security by scanning the license plates.

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