

IoT Based Online Integrated System to Share Available Parking Space

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ABSTRACT

The drastic growth of vehicles on the road and the mismanagement of parking spaces are creating severe traffic congestion, mostly in urban areas where parking areas are scarce. Therefore, it is highly necessary to develop an internet-of-things (IoT) based integrated system to share available parking spaces that would allow the car owner to find some available parking space nearby faster whenever required. The proposed system is developed with the integration of IoT, the latest innovation in electronic devices, sensors, and computers to make the parking management system smarter. The IoT provides wireless access to the system so that the user can find the availability of parking spaces in a required area. This ensures the best use of the parking spaces, saves time, and reduces traffic problems in the long run.

Keywords: Car parking allocation, Internet of Things, number plate detection, ultrasonic sensors.

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I. INTRODUCTION

Nowadays, in many busy areas, like shopping malls and large cities, it has become almost impossible and quite expensive to create a new parking space. The improper use of parking areas almost always keeps the parking area busy, which is the cause of traffic congestion. This is because drivers often seek parking in a specific area and find no parking place, so they are bound to keep their car on the roadside or on the way. Sometimes there are many empty parking spaces of which drivers aren't aware. In an ideal city, urban-scale parking systems would be able to provide real-time information about the availability of parking slots in the parking area. In this situation, it is highly required to develop an IoT-based online parking system that would help the driver to find some suitable parking space for his/her vehicle very quickly, and it will be beneficial for the parking place owners.

At present, urban cities focus more on sustainable development and resource management technologies. The concept of IoT started with the introduction of things to connect various devices that can be controlled or monitored by a computer over the Internet. The IoT includes two distinct terms: "Internet" and "Things", where the Internet is a vast network of devices connecting servers. Generally, the IoT can be classified into two groups: sensor-based and image-based. In this paper, we developed a sensor-based IoT, which is a web-based system that provides optimized parking, reduction

of traffic jams, effective management of parking spaces, and live parking slot availability status. The developed system is time-efficient, economical, and readily available. The system is capable of capturing processes and restoring data to authorized users. Moreover, it provides parking space status to incoming vehicles, calculates due amounts from vehicles, and ensures facility payment. Also, it is a user-friendly system, thus requiring minimal personnel to operate it.

II. RELATED WORKS

Reference [1] proposed a smart parking system using IoT that allows drivers to book the parking slot if the user has a positive balance on their RFID card. This system doesn't provide a live slot availability status and it is dedicated to specific parking spaces for specific people who own their RFID cards, so it is not widely available for everyone. That's why other drivers don't know about or can't find this type of parking place easily.

Reference [2] proposed an I-SPARK system based on IoT that detects the temperature, darkness, and available slot in the parking space. This system is dedicated to local parking and it's not widely available.

Reference [3] developed a smart parking management system with an RFID reader and an RFID tag on the vehicle for automated entry and exit. This system automatically allocates slots to users on a first-come, first-serve basis. This

system doesn't provide a live slot availability status. They used manual input for live status.

In their paper, [4] proposed a system based on mobile applications. This system uses a PIR sensor to detect the vehicle at the entry point, verifies the user with a camera, and allocates the nearest parking slot. The LED on the allotted slot turns red, indicating the slot has been booked. This system lags because the driver didn't know if there were any available parking slots or not before arriving at that specific parking space.

Reference [5] introduced a system in their paper based on FPGA (Field Programmable Gate Array). The FPGA is interfaced with RFID. If the user has an RFID card that is already registered, then the door automatically opens; otherwise, the door remains closed. This system is dedicated to local parking, and if anyone needs immediate parking space, then this system can't provide that because the user needs a registered RFID card.

In this paper, we proposed a system that is time-efficient, cost-saving, user-friendly, and also able to overcome the limitations of existing systems. The drivers can find their nearby parking place very easily and can see the live slot availability status and their pricing before going to the parking place. They can also pre-book any slot before arriving, and there is no need to use an RFID card. This system aims to achieve reliable, fast, cheap, and efficient parking for vehicles.

III. ARCHITECTURE OF PROPOSED SYSTEM

The functioning of the system includes assigning parking slots, dealing with payment issues, and releasing vehicles. The system can prevent parking violations and suspicious activity, as it discloses real-time data to the admin managing the system. The system proposed an approach using ultrasonic sensors, cameras, resource-sensitive network infrastructure, a deep learning approach, and a web application that facilitates digital payments and hosts all services with a mechanism module.

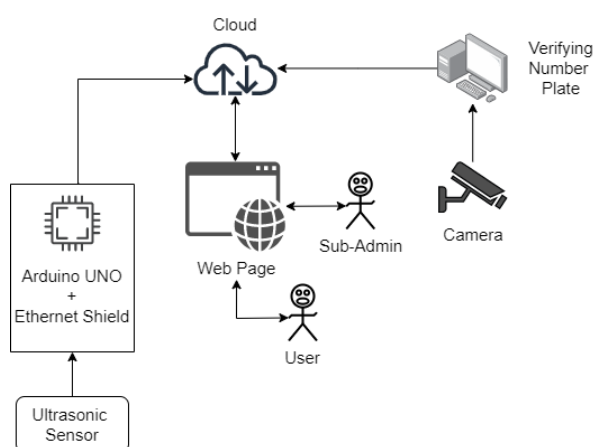


Fig 1. Architecture of the proposed system.

Data generated or required during operations is stored and made available with the help of cloud-based databases. Dependable data can be accessed by an authenticated and registered user to check the availability of each parking slot

in the nearby parking place. The cloud database is updated in real-time when a user books, parks, or departs, so other users can immediately get the updated status of the parking slot. The solution considers the cost factor as well as the user's privacy and security to provide a trouble-free process. Everything from finding a parking spot to paying for space occupancy while entering the parking slot can be done contactless virtually, ensuring that the user doesn't have to come into contact with anyone. Hence, the system would be beneficial for both parking place owners and users. The overall architecture of the proposed system is shown in Fig. 1.

The ultrasonic sensors measure the distance to the target by measuring the time between the emission and reception. We can set an exact range to verify if the car is parked or not. This data will be sent to the cloud by the Arduino UNO and Ethernet Shield. After that, the cloud will process the data and show it on the web page.

Users then find their nearest parking spot through the website. Then he/she will say if there are any available slots or not and also see their pricing. Then the user will book a slot and give the vehicle information. When the car arrives at the gate, the camera verifies the number plate and let the car park. The details of the used hardware systems are described in the following subsections.

A. Arduino UNO

The Arduino Board as shown in Fig. 2 is specifically used as a microcontroller board. This board is specifically based on the ATMEGA328P. The total number of pins is 28. The number of input and output pins in this is 14. Of those, 6 can be used as analog inputs and the other 6 can be used as pulse width modulated outputs.

The ceramic resonator is 16 MHz. It also includes a Universal Serial Bus (USB) connection, along with a power jack and an ICSP header. The Arduino Uno contrasts from all other past Arduino boards as it is not based upon the USB-to-serial driver and, instead of the USB-to-driver, it includes the ATmega 16U2, which is personalized as a converter to USB-to-serial. It needs a 7V to 12V DC input.

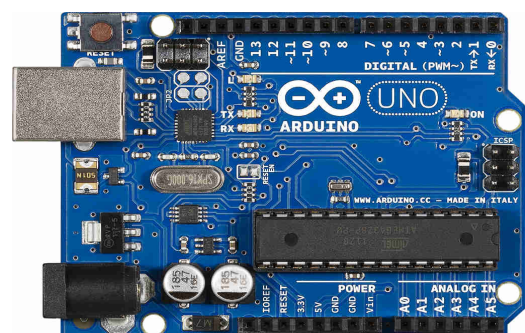


Fig 2. Arduino UNO.

B. Ethernet Shield

The Shield as shown in Fig. 3 allows an Arduino board to associate and interact with the internet and communicate data to and from the web. A W5100 Ethernet chip is used in the shield. The W5100 Wiznet gives an IP (Internet Protocol) IP stack that fits in both the Transmission Control and User Datagram Protocol.

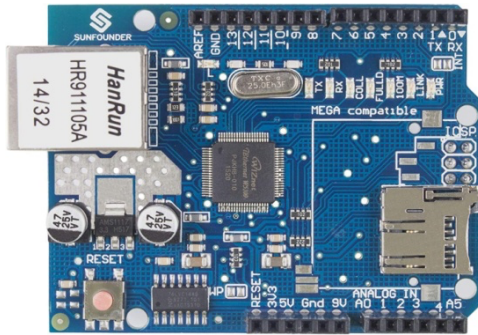


Fig 3. Ethernet Shield.

C. Ultrasonic Sensor

Ultrasonic sensors as shown in Fig. 4 measure the distance to the target by measuring the time between the emission and reception. An optical sensor has a transmitter and a receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception.

Ultrasonic transducers operate at frequencies in the range of 30–500 kHz for air-coupled applications. As the ultrasonic frequency increases, the rate of attenuation also increases. Thus, low-frequency sensors (30–80 kHz) are more effective for long ranges, while high-frequency sensors are more effective for short ranges. Ultra-sonic sensors have the highest distance range, 10 m to 12.5 m.



Fig 4. Ultra-sonic Sensor.

D. Ethernet Cable

The Ethernet link is a popular type of link used on systems integrated with wire. Ethernet cables connect two or more devices within a local area network, similar to Ethernet Shield, PCs, routers, switches, and other devices.

IV. IMPLEMENTATION

We have divided this system's work process into three categories as follows:

A. User Section

In the top part of the homepage, users will get a 'Login or Register' option. Using the register option, a user can register him/her in the system. After registering himself/herself in the system, he/she could login into the system using his/her given email and password at the register option. Fig. 5 illustrates the registration form where a user submits his/her required information.

In the top part of the home page, users will see a navigation bar where all categories are arranged horizontally. Users will be able to access these categories with just a click. In the navigation bar, users will find a "Your Profile" option where a registered user can make his or her profile. Users will see a "Search Location" bar under the navigation bar as illustrated in Fig. 6.

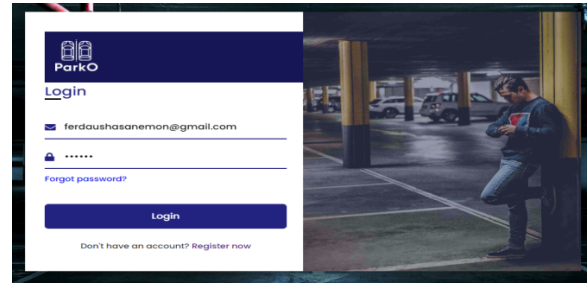


Fig. 5. Registration form.



Fig. 6. Search location.

Users can search for their desired location and, after that, they can see the availability status of each slot and pricing.

B. Admin Section

To control the whole system, the administrator logs into the admin panel. Fig. 7 illustrates the login dashboard for admin.

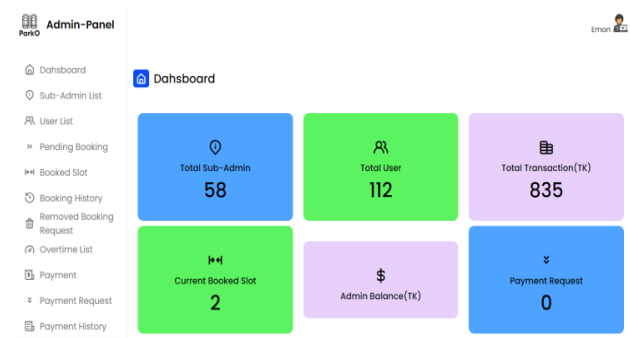


Fig. 7. Admin Dashboard.

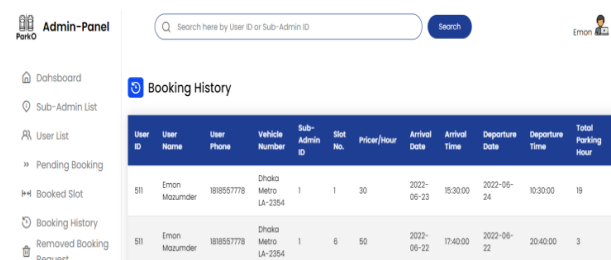


Fig. 8. Booking history.

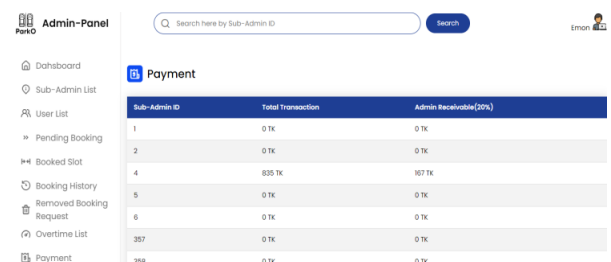


Fig. 9. Payment details.

After logging in, the admin is redirected to the admin panel dashboard. Then admin has a lot of options to manage and control.

In this option, the admin can control all users, manage all current booking slots, pending bookings, payment history, and also know user and sub-admin details. The booking history and payment details are illustrated in Figure 8 and 9 respectively. The admin can also access all sub-admin total hours of overtime.

C. Sub-Admin Section

The sub-administrator needs to go to the “Work with Us” page to access the panel. Through the 'register' option, a sub admin can be registered in the system. After registration, the sub-admin could login into the system with the given email and password.

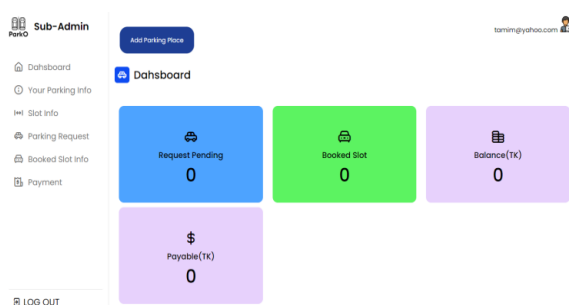


Fig. 10. Sub-admin dashboard.

After logging in, sub-admin will redirect to the sub-admin panel dashboard and get lots of options to manage and control. Fig. 10 illustrates the Sub-admin dashboard panel. The sub-admin can manage the parking request, booked slot, total balance, and admin payable.

V. NUMBER PLATE DETECTION USING CAMERA

Whenever a car arrives at the parking spot, a camera takes a snap of the car's front side.

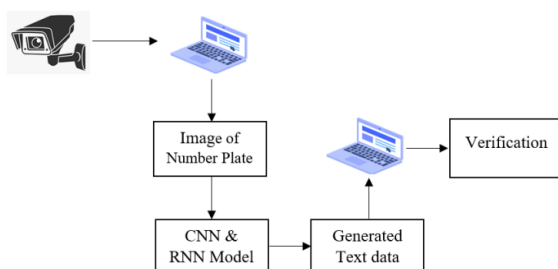


Fig. 11. Vehicle verification process.

This image is then used to generate the digital form of the text written on the number plate. In the sub-admin panel, this image is fed into a CNN and RNN model trained with the IAM dataset [7]. The IAM dataset is a popular dataset of handwritten text data in the form of an image. This dataset is widely used in various machine learning and deep learning sectors of research. A combined model of CNN and RNN then generates the text form of the written data in the number plate. The text data is finally used to check the

appropriate car for a particular parking request. The vehicle verification process is illustrated in Fig. 11.

VI. HARDWARE CIRCUIT CONNECTION

To check the status of a parking lot at a parking place, we enlisted the help of IoT. We connected two ultrasonic sensors to simultaneously detect the presence of the car accurately. These sensors are also used to monitor unauthorized use of the parking lot. To make the sensors work perfectly, they must be connected to the microcontroller, and the Ethernet shield is to send the data to the system over the network. Besides, to get connected to the network, the Ethernet shield is directly connected to a Wi-Fi router. Through this router, the sensor data is transmitted to the internal database of our system. The actual picture of the hardware system circuit connection is shown in Fig. 12.

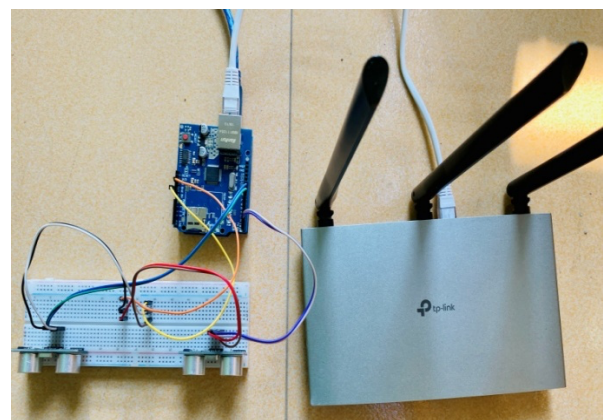


Fig. 12. Circuit Connection of Hardwares.

VII. SYSTEM OUTCOMES

The integrated system of hardware and software performs a significant task to reduce the problem related to a lack of parking space. Those who need a parking space can easily trace the available parking space for their vehicle. People can utilize unused parking spaces and get the opportunity to find their available parking spaces. Users are also relaxed with their valuable time since the system is time-saving, faster, and secure. Moreover, the system is able to control the number of cars inside it, monitor the movement of the parking lot, and check the space for the cars to be parked very precisely, thus delivering an effective system for the users. It shows the real-time status of data that can help to prevent parking violations and suspicious activities if taken by the employees or security guards in the parking zone. In this manner, the system boosts safety in the parking areas. In a nutshell, the significance of the developed system plays a vital role in the reduction of parking problems. If it's well-maintained and well-monitored, then the system could be able to help urban areas get rid of parking concerns.

VIII. CONCLUSION

The significance of a smart car parking system is inevitable. Our developed system is capable of reducing parking-related problems. It is a secure, efficient, intelligent,

and reliable system that ensures space availability, proper management of the parking lot, real-time status, and negotiation of the parking fee.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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