International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

IoT- Based Smart Parking System

Mahek Shaikh[1], Ammar Ansari[2], Hasan Phudinawala[3]

[1,2]Student, Computer Science faculty, Royal college of Arts, Science & Commerce
[3]Assistant professor, Computer Science faculty, Royal college of Arts, Science & Commerce

Abstract
To be more relevant, private car owners in urban areas (and their parking needs) are going to be much more important as demand spikes. Parking operations that are more intelligent and efficient can be achieved through the integration of IoT (Internet of Things) technology. The system uses sensors, real-time data, and an AdaFruit Raspberry Pi to determine and show you open parking spaces in a lot. The aim is to free up roads by encouraging drivers to use the app, which identifies unoccupied parking spaces closest to their destination so they don't have to circle the block endlessly looking for somewhere to park. The system has online payments and the ability to book the space beforehand. Parking is a major focus area, helping save time and fuel from circling the block. Better technological urban brain and better infrastructure of the city that is also sustainable. Ultrasonic, infrared sensors are utilized constantly to measure the parking space availability and report the status to a master unit. This data is processed by the Raspberry Pi and analyzed on a cloud server. The result is conveyed to users through a mobile application or digital signage, and payment is made online. Further, the pre-reservation option of parking lots provides maximum utility in congested metropolitan areas to shop for vacant lots. Hence, integrating an IoT-based smart parking system is a giant leap toward making amends for the clumsy and unsustainable nature of urban areas.

Keywords: Internet of Things (IoT), Smart Parking Management System, Traffic Congestion, Vehicle Detection.

1. Introduction

Smart parking is an e-solution effectively designed for improving the parking system mainly in the high-density region. Implementing elements like sensors, IoT data analysis, and application technology, smart parking solution systems aim at reducing the amount of time drivers spend hunting for parking spots and hence reducing congestion in the roads. One of the components being implemented in such systems is real-time availability determination whereby sensors in the parking area identify open spaces. The above information reaches the drivers via mobile applications or digital signage where they can easily differentiate available zones

Automated payments of the service also reduce the number of direct transactions with drivers because they can pay for parking through applications or kiosks. Most smart parking systems involve dynamic pricing which means that the rate of parking changes with the demand and location and particular time in a certain area to ensure high turnover space in this area or lower rates in this area. Another important element is the parking management system for which the drivers to the available distant spaces in real-time.

In addition to convenience, smart parking systems are friendly to the natural environment because they

allow cars to spend minimal time on search of parking space or idling within these spaces. Fewer cars in search for parking space translate to efficient traffic flow with less instances of jam. Therefore, smart parking is about enhancing the users' satisfaction, the organizational performance, and developing environmentally friendly urban transportation systems.

mart parking also produces important data about parking usage that help the planner of the city and Operators. This data enables the identification of the patterns of the demand over the day, ways of pricing, and making of better management decisions. And of course, data on the distribution of vehicles also work for city authorities to determine which areas are not popular for transport and therefore require development in the future.

Smart parking is an extensible system capable of connecting with other smart city initiatives as an advantage. For instance, smart parking solutions can engage with the smart transportation system hence ensuring integration with public transportations. Evolution of Transportation parsed from horses to unmanned vehicles. Define smart transportation as the next generation solution to transportation based on IoT and 5G technology. Such deployment helps drivers park their cars at some distance away from residential, business and other densely populated areas and then finish off tasks in public transport, this in a way helps to rescue traffic in those congested regions. In addition, the introduction of EV charging stations in smart parking zones will encourage people to shift from traditional combustion engine vehicles to new green electric ones.

The other area that smart parking can influence is security. The incorporation of advanced technologies such as license plate recognition as well as surveillance integration also makes smart parking system track vehicle entry and exit in a secure way, protecting the drivers and the parking system operator as well. Besides preventing the access of unauthorized vehicles, only increases the level of security of parked cars, therefore making the urban environment safer. Smart parking is not just an application of technology but the key to better urban accessibility, less pollution and improved quality of the city. With city population growth, and the resulting demand for transportation increasing, the benefits and application of smart parking to create cleaner, better-managed, and more sustainable cities will only become more crucial.

2. Literature Review

In this paper, a review of the literature on smart parking systems is presented, where the Internet of Things (IoT) plays a critical role. Smart parking systems including those based on the use of IoT technologies have played a crucial role to revolutionize parking spaces for use in urban areas. This is because the use of vehicles especially in congested urban areas has for instance tripled hence rendering traditional parking systems as being very inefficient hence resulting to a lot of congestion, wastage of fuel and a general decrease in the quality of air in such regions. Concerning these problems, smart parking systems are designed to incorporate IoT together with sensors and real-time data analysis plans to effectively resolve these challenges by enhancing the use of parking spaces, relieving traffic congestion, and providing optimum user satisfaction.

The IoT (Internet of Things) helps to make parking smarter in the concept, the idea, the plan, and the implementation to take effect. Previous parking systems which were common are normally characterized by blockage and instabilities resulting from a lack of proper control in drilling and parking space as well as the use of outdated methods to access parking facilities. The traditional parking system uses paper-based ticketing systems, requiring customers to receive aticket when

they enter the parking area and pay a price when they leave [13]. The developed system can deal with the aforementioned challenges by providing dynamic allocation for parking slots while taking into consideration the overall parking situation, providing a mechanism for booking a specific parking slot by using our Artificial Intelligence (AI) - based application, and providing a mechanism to ensure that the car is parked in its correct place.[13]. The work mentioned in [14] is they created a method where they provide a user with empty slot number where the user can park his vehicle with wasting his time.

They also displayed the start time and the end time so the user would know how much he have to play. The work mentioned in [15] is to design a parking monitor and control system to count the number of vehicles entering and leaving a parking space, open the gate for users, create database to provide statistics about people entering or leaving the parking space in this project they have used components like Rfid, LCD, Ardino etc. With the advancement of wireless technologies, wireless mobile-based methods have been employed in car parking system. A mobile app based car parking system will be more efficient and effective method [16]. The work mentioned in

[17] Is that the user first makes the selection of slot from his mobile device then he will check for the slots if the slots are available then he will book that slot and will pay using an online payment method. Then as soon as the vehicle enters the parking slot the timer will gets ON and measure the total time and then when the vehicle moves out of the parking slot the timer will get off and the total cost will be displayed. India's automation market was pegged at 3,641,233 units in 2022 and is expected to reach 4,375,409 units in 2023. It is expected to grow at a compound annual growth rate of 9.7%from 2023 to 2030 [1]. The total number of all category of vehicles registered till end of march 2024 was 36.59 crore, and 46.43 lakh vehicles registered in current year alone as per the Parivahan Sewa portal of the Ministry of Road Transport and Highway [2]. The goal of smart transportation is to enhance the control and organization of the processes and to increase the safety of movement [3]

Taken collectively, these reviews provide an effective overview of the fundamental enabling technologies and issues related to the implementation of smart parking systems.

3. Methodology

A vehicle presence detection system implies formulation of a plan and work that is mostly physical with components of software development. Sensors in traffic signals, cross roads and roads in order to capture live information in order to manage traffic. Self-driving car system interacting with smart city systems so that decisions needed are made on the spot; improving safety and operations [3]

System Design:

The first strategic process of the plan is the architectural of overall system; which is the identification of the components such as sensors, micro controllers and interfaces. Analyze determinant specific infrared sensors and microprocessor such as Raspberry pi based on aspects that concern the detection range, power consumption rates and costs. Moreover, proper choice of the gateways and the communication devices should be chosen to provide the reliability of the data transfer between the sensors and a server.

At the same time the structures of the software part of the system are developed. This include; firmware for the microcontrollers that are going to control the sensor‘s operations and data acquisition. They also involved web based platform for storing the data and for analytical processing. Lastly, user application will be developed to show that there is a car and it can as well have the notification or reservation

interface.

Hardware Setup:

After that, the parts of the different types of hardware are established in terms of their designs. These are located in effective zones for identifying vehicles and the alignment of the sensors makes a lot of difference. The microprocessor like Raspberry Pi is maintained for connecting to the sensors to obtain the data.

One of the other activities is the formation process of a network. This entails establishment of the link between the sensors and microcontrollers and a server through the suitable interface. Three possibilities have being descried namely Wi-Fi and LoRaWAN depend on the concept of the parking area requirement.

Sensor Technologies in Smart Parking

Product features of smart parking systems include the use of sensors in identifying vehicles and relaying parking space information. These include:

Infrared Sensors (IR): Khanna & Anand (2016) explain how parking space availability can be determined by IR sensors that identify time and relay the data to a control system [4].

Ultrasonic Sensors: These are outbound and typically employed with respect to distance measurement in aiding the perception of the presence of vehicles and passing data to cloud servers for analysis [5].

Magnetic and Pressure Sensors: These display parking availability in the surroundings and work through variation in either magnetic fields or pressure due to the weight of the car [6].

Future Trends:

It is logical to assume that consequent research initiatives will concentrate on improving these systems employing AI and machine learning tools, which may presuppose accurate prediction of parking demand and, therefore, rational distribution of resources. Additionally, the facilitation of smart parking into the overall smart city frameworks like public transportation is believed to enhance the mobility and thus sustainability of cities [9, 10].

Components:

- **Raspberry Pi 3b+:** The Raspberry Pi is a single-board computer (SBC) that is small, inexpensive, and has many uses

Figure 1: Raspberry pi 3b+

- **Jumper wires (female to female):** Jumper wires are electrical wires that connect two points in a circuit without soldering.

Figure 2: Jumper Wire (Female to Female)

- **IR Sensors:** Infrared (IR) sensors are optoelectronic devices that detect infrared radiation, which is part of the electromagnetic spectrum. In the project they are used to detect the presence of vehicle

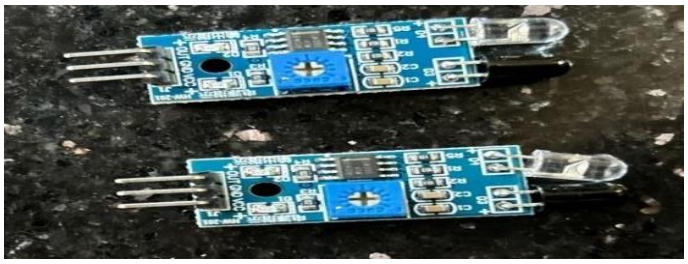

Figure 3: Infrared Sensor (IR sensors)

- **LCD:** The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates a display of 16 characters per line in 2 such lines.

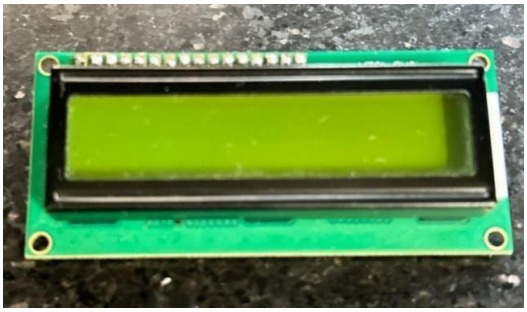

Figure 4:16X2 LCD

- **PCB board**: A brown PCB board is a printed circuit board (PCB) with a brown- colored substrate that is used for electronic prototyping.

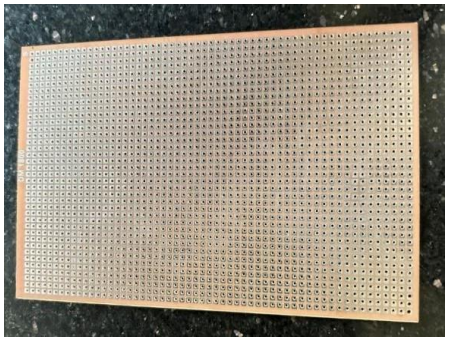

Figure 5: Brown PCB board

4. Result and Discussion

The emergence of IoT has become a game changing improvement to urban infrastructure as concerning smart parking solutions. Using technology, we have moved from the traditional tiresome and time-consuming ways of searching parking to a streamlined process. Parking systems possess sensors that provide, only for an instance, a present status of the parking places to the drivers. For this reason, they will not have to waste unnecessary time looking for an open-place over here. Simplistically, our application allows fast real time verification of parking information that the users seek. In this way, the users will be able to look for and locate the nearest possible parking spaces without any hassle and therefore will be able to do the parking in no time.

This will facilitate the reduction of traffic jam and enable better transport efficiency in the cities. The parking management authorities, in addition to utilizing our sensors for parking operation optimization, also utilize the information created to successfully position the resources or evaluate the factors that might need to be addressed in terms of pricing policies. Overall, the success of the scheme has determined that parking has become easier and more convenient for urban residents, since our project has a proper technology design to the problem of parking space. Our smart parking project has been retrofitted with a number of positive outcomes, including increased efficiency and mobile city sustainability, which is hugely devoid of inconveniences.

Software:

Figure1.1: Registration Page

Figure 1.2: Login Page

Figure 1.3: Home Page

Hardware setup:

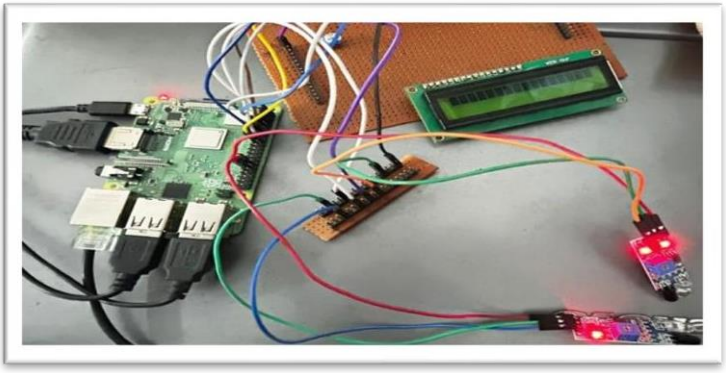

Figure 2.1: Parking System using Raspberry Pi 3b+

5. Conclusion

Thus, the paper aims at introducing an IoT-enabled smart parking system to tackling escalating parking issues in urban environments. This state-of-the-art system incorporates sensor technology with Raspberry Pi devices and real-time data to track the number of available parking spaces and for operations optimization. It offers several benefits to drivers, for example, saving a lot of time looking for an available parking space, simple payment procedures through the internet and the opportunity to book in advance.

Similarly, the smart parking system contributes to the enhancement of a sustainable urban ecosystem due to the minimizing of car engine running. The data collected provides key information for the urban planners; they can now reconsider the pricing strategy and adjust it accordingly in order to make it more effective, they can rewrite the infrastructure and create better design for the system, and better integrate this type of system with others relating to smart city such as the public transportation system. Also, such components as license plates recognition improve security for end-users and parking administration.

In conclusion, the right smart parking solutions should be put in place as urban areas expand and with growing city populations. The paper also provides a section on the methodology on how the system will be designed and what hardware will be used, as well as a brief literature review of smart parking systems.

6. Future Scope:

Integrating IoT with autonomous vehicles will undoubtedly free up more road space and significantly

improve people's mobility. IoT parking system incorporates safety measures such as vehicle number plate tracing and driver face recognition to efficiently detect theft. IoT Parking system will undoubtedly enhance the customer experience through real time information and seamless automated payment option.

Reference

1. "India Automotive Market Size, Share & Trends Analysis Report", By Passenger Vehicle, By Light Commercial Vehicle, By Heavy Truck, By Bus & Coach, And Segment Forecasts, 2023-2030,(2023).
2. "Driving forward: Prospects for India's automobile industry", Infomerics Valuation and Rating Pvt. Ltd, 2024
3. "An Introduction to Smart Transportation: Benefits and Example", Mazur, S, (2020, December 9)
4. "IoT based smart parking system", Khanna, A., & Anand, R. (2016). In 2016 International Conference on Internet of Things and Applications (IOTA). Maharashtra Institute of Technology, Pune, India, 22–24 Jan 2016..
5. "A Blockchain-Based Architecture for Integrated Smart Parking Systems", Ahmed, S., Soaibuzzaman, M. S., Rahmany, M. S., & Rahaman, M. S. (2019).In International Conference Computer Science and Engineering.
6. "An IoT based smart parking system", Chandran, M., Mahrom, N. F., Sabapathy, T., Jusoh, M., Osman, M. N., Najib Yasin, M., Hambali, N. A. M., Jamaluddin, R., Ali, N., Abdul Wahab,
7. Y. (2019). In International Conference Computer Science and Engineering.
8. "A novel architecture of parking management for Smart Cities", Giuffrè, T., Siniscalchia, S. M., &Tesoriere, G. (2012). In SIIV—5th International Congress—Sustainability of Road Infrastructures.
9. "A review of smart parking using internet of things", Rupani, S., & Doshi, N. (2019). In 3rd International Workshop on Recent Advances on Internet of Things: Technology and Application Approaches.
10. "Sensor technologies for intelligent transportation systems", Guerrero-Ibáñez, J., Zeadally, S., & Contreras-Castillo, J. (2018).
11. "IoT (Internet of Things) Wireless & Cloud Computing Emerging Technologies" Course (School of Electrical & Electronic Engineering, Yonsei University, Coursera , Chung, M ,(2018).
12. "Smart parking: IoT solutions to optimize parking operations", ParkHubBlog , (2020).
13. " Smart Parking System ", Suraj Kumar, Sunny Kumar Singh , Utkarsh Kumar , Vijendra Raj , Mr. Suman Jha, on 5th May 2023.
14. "A Smart Real-Time Parking Control and Monitoring System", Abdelrahman Osman Elfaki, Eassim Messoud, Anas Bushnag, Shakour Abuzneid, Tareq Alhmiedat , On 10th December 2023
15. "Smart Parking System", Raj Mani M, Vagish V Bhat, 2019/2020
16. "Parking Monitoring Control System", Ali Al Misbah Muneer, Al-Hashim, Salman Al- Belaihi , Mustafa Al-Qurain, 2012-13
17. "Smart Parking System", Raahul Suresh, 2022/23
18. "Smart Parking Management System" , Amol Pomaji, Suraj Boinwad, Shrikant Wankhed, Pushpendra Singh, May 2019.