Smart Parking Finder with IoT and AR Navigation and Voice Assistance

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Abstract

The public is struggling with parking management in cities because of the rising amount of cars and the lack of parking spaces. Traditional way of doing this has created large amounts of time spent searching for parking spaces; created traffic jams because of the high volume of drivers searching for parking routes; and created a poor use of the available parking spaces. In an effort to reduce these issues with parking management, we created a smart parking system that will allow real-time detection of parking slots through use of augmented reality for customers when searching for a spot to park their vehicle. The smart parking system works by using infrared (IR) sensors attached to a Raspberry Pi Pico that sends real-time data about whether there are any parking slots available to the cloud database (Firebase), allowing users to see up-to-date information before arriving at the location where they want to park their vehicle. Additionally, the augmented reality interface provides the user with visual and verbal instructions on how to get to the available parking spots using directional arrows on the screen as well as voice instructions. Therefore, our smart parking system will improve the parking process by increasing the efficiency of parking, decreasing the time spent looking for parking, and providing a high level of convenience to the user. The results of our tests demonstrate the success of creating a smart parking system providing reliable real-time information about available parking spaces and an uncomplicated way to navigate inside the building using augmented reality.

Keywords: Smart Parking, IoT, Augmented Reality, Raspberry Pi Pico, Firebase, Indoor Navigation.

I. Introduction

As a result of rapid urbanisation and rapidly increasing vehicle counts, parking management within cities faces many challenges to be solved. Significant amounts of time are usually spent by drivers searching for available parking spaces, causing traffic congestion, wasting fuel and contributing to environmental pollution. Unfortunately, traditional parking systems have no real-time monitoring or intelligent guidance and are no longer effective in today's urban environment. However, by using

new 'smart city' technologies like the Internet of Things (IoT) and other technologies such as cloud computing and AR, these issues can be addressed. Smart parking applications employ a combination of wireless communications, sensor networks and cloud connectivity technologies to track the availability of parking space and provide live information to users on an ongoing basis. Wireless sensors can provide data about available parking space and vehicles in the vicinity (nearby) in real time. Pham et al. proposed a cloud-based smart parking system using IoT devices to efficiently supervise and manage residential and commercial parking areas. El-Seoudetal. outlined a variety of mobile and web-based applications that can be integrated into the existing infrastructure to improve access and usability of parking and to provide accurate real-time data acquisition and cloud integration within the current parking system. Interactive visualization and navigation are two areas in which Augmented Reality (AR) has also gained popularity as an effective means of assisting users with their interactions with the environment around them. An AR system allows users to see/detect digital data that has been placed in relation to their current location, providing the users opportunities to interact with the physical world using visual displays, thus enhancing both navigational efficiency and spatial awareness. This reading is composed of a variety of examples of recent studies on the possibilities of AR methodologies applied to smart city developments, navigational methods, and urban planning overall. In addition, AR-based navigational systems allow users to be directed to their nearest available parking space, which will allow them to minimize the amount of time it takes to find available parking, thus enhancing the experience for the users. As we look towards future developments of intelligent transportation solutions, researchers have focused their attention on the integration of IoT sensing technologies and AR data visualization; thus making use of the development of cloud-enabled mobile apps for smart parking, where several smart parking solutions provide drivers access to multiple live parking options by accessing real-time parking information through cloud technologies. Additionally, improvements in AR tracking technologies and mobile computing have made it possible to deploy AR solutions into the real world [6],[13]. This study proposes a new Smart Parking System with Augmented Reality Navigation that utilizes the internet of things as the interface into these two technologies. The system uses infrared sensors to detect available parking spaces in real-time and transmits collected data to the Firebase Cloud for instant updates on parking supply. A web-based AR interface to retrieve the data and provides users with visually oriented guidance and audio feedback. The overall architecture of the system is shown in figure 1. With the goal of reducing wait time, spotting spots becomes faster. A reduction in the number of headaches during the busy periods then follows. The system will aim at minimizing the time taken to search parking spots, and optimize on the space utilization of the parking facility and offer a more convenient experience of parking in an indoor parking facility. Moving through space is hassle free. The layouts are comprehensible at a glance. It is not as difficult to find a place as it may seem.

II. Literature Review

The rapid growth of urban populations and the increasing number of vehicles have motivated researchers to develop intelligent parking management systems. Smart parking solutions have been widely explored as part of smart city initiatives, where real-time monitoring, efficient resource utilization, and user convenience are key objectives. Several studies have investigated the integration of Internet of Things (IoT), cloud computing, and mobile technologies to address parking challenges. Early research on smart city infrastructures emphasized the importance of connected systems and collaborative platforms for urban innovation. Schaffers et al. [2] discussed the role of future internet technologies in enabling smart city services, while Kitchin [3] highlighted the significance of real-time data and analytics in modern urban environments. These studies laid

the foundation for intelligent transportation and parking management systems. IoTbased smart parking solutions have gained significant attention in recent years. Pham et al. [4] proposed a cloud based smart parking system that uses IoT technologies to monitor parking availability and provide real-time updates to users. Similarly, Dsouza and Hussain [17] presented an integrated smart parking solution aimed at improving urban parking efficiency. El-Seoud et al. [5] developed a parking system that combines web and mobile technologies to enhance accessibility and user interaction. These systems demonstrate the effectiveness of cloud connectivity and sensor networks in modern parking infrastructures .

Figure 1: Architecture of the proposed IoT and AR-based smart parking system.

AR has been mentioned many times in assisting individuals in locating objects and accessing them visually. Pokric and team [1] developed smart city technologies based on safe IoT installations to ensure that users receive helpful information in their surroundings. Capece et al. [7] developed an arrangement where applications are interconnected with a server to display position, grounded on AR. Subakti and jiang [12] created an AR guide that involves the use of markers in campuses. These demonstrate how the AR can assist an individual to comprehend space and navigate with ease. There are studies that consider how to monitor and present things better in the real life.

Gorovyi and sharapov [6] enhanced the tracking of images using AR. Lim and colleagues [9], [10] had mobile AR done on the active spaces. AR was also used by others to visit cities, get details about cars and plan [18], [20], [21]. This is indicative of the rising position of ARs in smart cities. Nonetheless, the majority of parking systems only inform whether the spots are available, there is no walkthrough and step by step assistance, nothing evident. The application of IoT-based sensing and AR visualization can be used to make smart parking systems much more useful [22]-[26]. Integrating IoT-based sensing with AR visualization can significantly enhance the usability of smart parking systems. Motivated by these limitations, this work proposes an IoT-enabled smart parking system that combines real-time sensor data, cloud based storage, and augmented reality navigation to improve parking efficiency and user experience.

III. Proposed System Architecture

The smart parking system in question uses a combination of Internet of Things (IoT) sensors, cloud computing, and augmented reality (AR) technologies to monitor available parking spaces and provide users with navigational assistance in real time. There are four primary components to the architecture that integrates with the IoT component: a sensing layer, a processing unit, a cloud-based database, and a user interface. Each parking space will have an infrared (IR) sensor that is installed within it. The infrared sensors are affixed to Raspberry Pi Pico microcontrollers that will continuously monitor the status of each parking lot's occupancy level. As vehicles occupy/leave a parking space, the system will detect the change and transmit status to the Raspberry Pi Pico microcontroller, which will then send the new status to a cloudbased Firebase Realtime Database via Wi-Fi. The cloud-based database will serve as the primary data repository for parking-related information and will be regularly updated by the Raspberry Pi Pico microcontrollers. A cloud-based augmented reality application will then make accessible the parking information to the user through visual indicators of available parking spaces. The AR interface can provide the user with multiple directional arrows, as well as voice-guided directions, which can help users quickly find available parking spaces. Figure. 2 illustrates the overall block diagram of the proposed system. The design ensures real-time monitoring, efficient communication between hardware and cloud services, and an intuitive user experience through AR-based navigation.

IV. Methodology

The proposed solution is a smart parking system that combines IoT (Internet of Things) sensors with cloud-based data synchronization and AR (Augmented Reality) visualization. The methodology for the project consists of four key components: 1) detecting parking slots; 2) transmitting the data from the cloud; 3) maintaining a continuous watch on the database in real time; and 4) guiding the user via AR navigation from their device. When there is a vehicle in vacancy at a given location, IR (infrared ray) sensors positioned at each parking space will detect whether or not there is an obstruction from a vehicle. These sensors will be connected to a Raspberry Pi Pico microcontroller, which will measure the data output from the sensors on a consistent basis. The microcontroller logic processes all inputs from each ISO-7580- compliant IR sensor and returns the current status of that specific parking spot to a Firebase Realtime Database via Wi-Fi. The latest information regarding each parking location is stored within cloud database, which allows remote applications to access and query/obtain from the cloud database in real time.

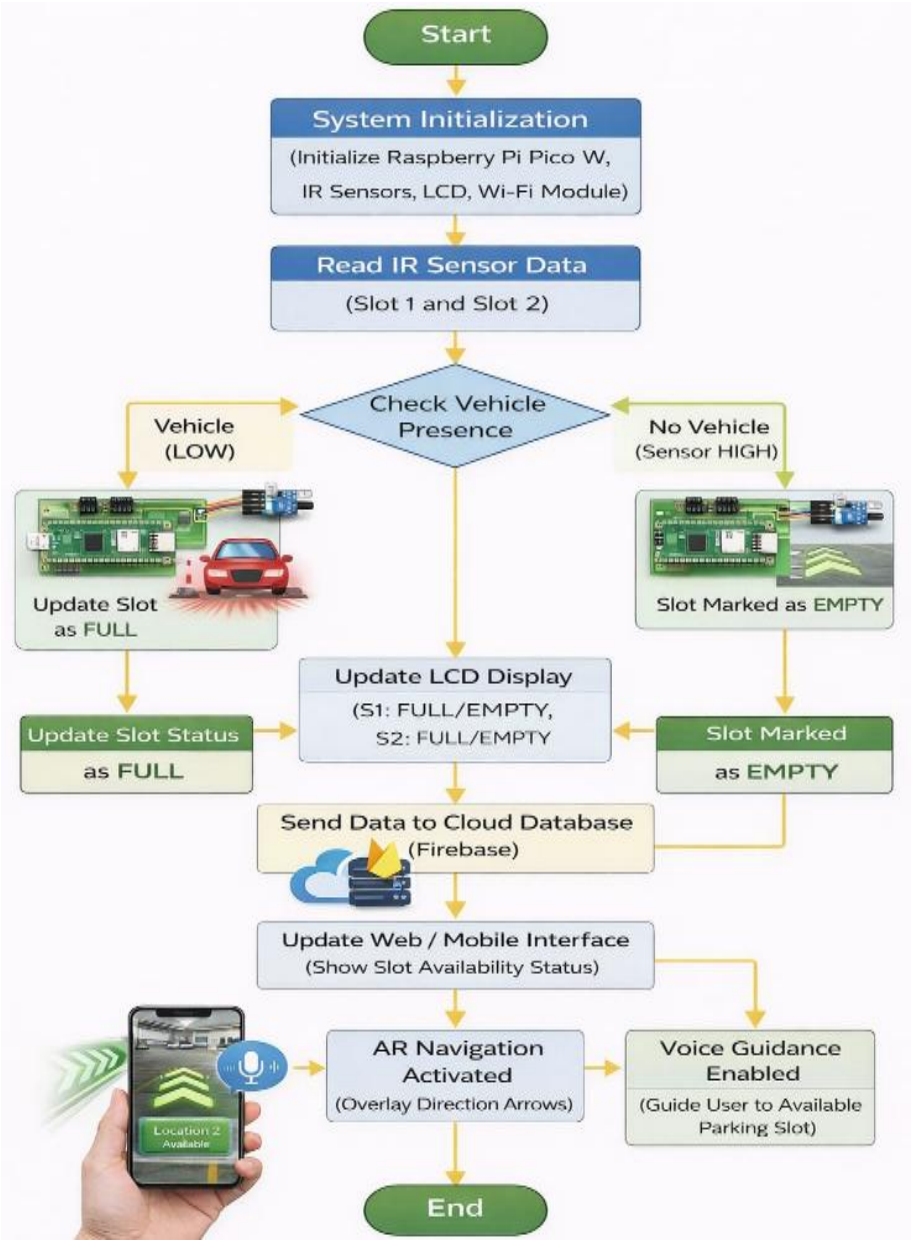

Figure 2: Block diagram of the proposed IoT and AR-based smart parking system.

A web-based AR application supports the AR display and dynamically refreshes the user interface at each data refresh from the cloud database, using the latest digital information (i.e. parking location status, vacancy status) to highlight available spaces to the user and provide directional arrows to direct the user toward available parking spots. Additionally, AR navigation will provide an audio prompt to assist users with parking location, maximizing usability and increasing overall efficiency when navigating to their parking destination. Through its multi-component parts and workflow, this system provides users with minimal delay to detect parking availability, while providing all users an intuitive experience through visual guidance.

A. Algorithm for Parking Slot Detection

Algorithm 1 : Parking Slot Detection Using IR Sensors
Initialize Raspberry Pi Pico Configure IR sensor pins as input

```
while system is active do
    Read sensor value from Slot 1
    Read sensor value from Slot 2

    if vehicle detected then
        Set slot status = Occupied
    else
        Set slot status = Available
    end
end
```

B. Algorithm for Cloud Database Update

Algorithm 2 Updating Firebase Realtime Database

```
Connect device to Wi-Fi network
Initialize Firebase connection

while system running do

  Read slot status from sensors

  if status changed then

    Send updated value to Firebase

    Store slot availability in database

  end if

 end while =0
```

C. Algorithm for AR Navigation

Algorithm 3 Augmented Reality Navigation

```
Start AR application
Fetch parking data from Firebase
Identify available parking slots

if slot available then
  Display navigation arrows
  Provide voice guidance to user
else
  Display message "No Parking Available"
end if =0
```

V. RESULT AND DISCUSSION

The suggested smart parking system based on IoT was installed and tested to analyze its performance in terms of real-time monitoring and its performance as an AR-based system. The prototype will be composed of infrared sensors, which will be linked to a Raspberry Pi Pico, a Firebase Realtime Database to synchronise data with the clouds and a web-based augmented

reality interface to interact with the user. and the secure federated learning. Overall, the discussion substantiates the fact that the proposed CAI-DA model not only fulfilled its functions but also exceeded its functions through offering a balanced, secure, and high-performance model of distributed cloud data analytics development of the state distributed cloud data analytics in a technical and ethical manner.

Figure 3: The hardware prototype of the suggested smart parking system.

Figure .3 illustrates the hardware prototype of the system. The system consists of two parking spaces with IR sensors attached, a Raspberry Pi Pico microcontroller, and a display in the form of LCD which will be used to show locally whether a slot is available. The microcontroller keeps on checking the sensors and sends the status of parking to the cloud database via a wireless connection network. Firebase realtime database will be used to record the status of every parking slot so that the data can be synchronized in real time between the hardware module and the user interface.

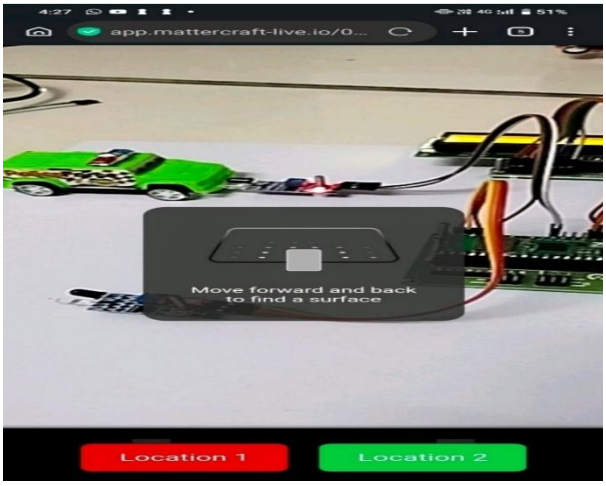

Figure 4: Firebase Realtime Database showing parking slot status.

The cloud database interface that includes an update of the parking slot status in real time is illustrated in Figure. 4. The database organization will have individual records of every slot, which will be easily monitored and accessed to retrieve the data on parking.The augmented reality application will retrieve the parking data in the cloud and display the positions of the parking slots.

Figure 5: Augmented Reality interface directing users to an available slot.

Figure.5 illustrates the AR navigation interface where directional indicators assist users in locating empty parking spaces. The integration of AR enhances usability by providing intuitive navigation compared to traditional parking systems. Experimental testing shows that the system is capable of updating parking availability in near real time. When a vehicle occupies a parking slot, the IR sensor detects the change and the updated information is transmitted to the Firebase database within a short delay. The AR interface reflects the change immediately, ensuring that users receive accurate parking guidance. The results demonstrate that integrating IoT sensing with cloud computing and augmented reality significantly improves parking management efficiency. The proposed system reduces the time required to search for available parking spaces and enhances user experience through interactive navigation support.

IV. CONCLUSION

My research explored how to design a smart parking system with an Internet of Things (IoT) enabled system that can also be combined with augmented reality (AR) navigation. The developed smart parking system uses infrared sensors connected to a Raspberry PI PICO W to receive real-time data about the occupancy of parking spaces. This data is sent from the sensors to a Firebase Realtime database, which allows the data to be synchronized immediately between the user interface and the physical hardware place of the user searching for parking. Users can access this data from the cloud through an ar web app, which will give them visual directional and voice assistance to navigate to the available parking spaces. The experimental results demonstrated that the system can accurately identify whether there is an available space and update this data in almost real-time. This IoT sensing, cloud computing, and AR visualization will be a significant efficiency improvement to parking and, therefore, reduce the total amount of time spent by drivers in their attempt to locate a free parking spot. The new smart parking will provide a user with a navigational tool that is easy to use in the case of indoor parking spaces, and it will create an economically viable and scalable tool of smart parking management in contemporary urban areas. The future research

will focus on expanding the proposed smart parking to include the domain of larger parking zones and devising ar navigation functions applicable to all forms of parking (indoor/outdoor).

References

[1]. B. Pokric, S. Krco, and M. Pokric, "Augmented reality based smart city services using secure IoT Infrastructure," in Proc. 28th Int. Conf. Advanced Information Networking and Applications Workshops (WAINA), 2014, pp. 803–808.

[2]. H. Schaffers, N. Komninos, M. Pallot, B. Trousse, M. Nilsson, and A. Oliveira, "Smart cities and the future in ternet: Towards cooperation frameworks for open innovation," in Future Internet Assembly, 2011, pp. 431–446.

[3]. R. Kitchin, "The real-time city? Big data and smart urbanism," GeoJournal, vol. 79, no. 1, pp. 1–14, 2014.

[4]. T. N. Pham, M.-F. Tsai, D. B. Nguyen, C.-R. Dow, and D.-J. Deng, "A cloud-based smart-parking system based on Internet-ofThings technologies," IEEE Access, vol. 3, pp. 1581–1591, 2015.

[5]. S. A. El-Seoud, H. El-Sofany, and I. Taj-Eddine, "To wards the development of smart parking system using mobile and web technologies," in Proc. Int. Conf. Inter active Mobile Communication, Technologies and Learning (IMCL), 2016, pp. 10– 16.

[6]. I. M. Gorovyi and D. S. Sharapov, "Advanced image tracking approach for augmented reality applications," in Signal Processing Symposium (SPSympo), 2017.

[7]. N. Capece, R. Agatiello, and U. Erra, "A client-server framework for the design of geo-location based augmented reality applications," in Proc. 20th Int. Conf. In formation Visualisation (IV), 2016, pp. 130–135.

[8]. M. S. Jin and J. Il Park, "Interactive mobile augmented reality system using a vibro-tactile pad," in IEEE Int. Symp. Virtual Reality Innovation (ISVRI), 2011, pp. 329–330.

[9]. C. Lim, J. Choi, J.-I. Park, and H. Park, "Interactive augmented reality system using projector-camera system and smart phone," in IEEE Int. Symp. Consumer Electronics (ISCE), 2015, pp. 1–2.

[10]. C. Lim, C. Kim, J.-I. Park, and H. Park, "Mobile augmented reality based on invisible marker," in IEEE Int. Symp. Mixed and Augmented Reality Adjunct (ISMAR), 2016, pp. 78–81.

[11]. J. Park, D. Lee, and J. Park, "Digital map based pose improvement for outdoor augmented reality," in IEEE Int. Symp. Mixed and Augmented Reality (ISMAR), 2012, pp. 309–310.

[12]. H. Subakti and J.-R. Jiang, "A marker-based cyber physical augmented-reality indoor guidance system for smart campuses," in IEEE Int. Conf. High Performance Computing and Communications; Smart City; Data Science and Systems, 2016, pp. 1373–1379.

[13]. A. K. Paul and J. S. Park, "Multiclass object recognition using smart phone and cloud computing for augmented reality and video surveillance applications," in Proc. Int. Conf. Informatics, Electronics & Vision (ICIEV), 2013, pp. 1–6.

[14]. B. Cui, W. Zhou, G. Fan, and Z. He, "System design for local culture protection based on smart item," in Proc. Int. Conf. Computer Science &Education(ICCSE), 2016, pp. 144–147. on Advancement in Renewable Energy and Intelligent Systems (AREIS), Thrissur, India, 2024, pp. 1-6, doi: 10.1109/AREIS62559.2024.10893651.

[15]. Y. Lim, Y. Park, J. Heo, J. Yang, M. Kang, and Y.-C. Byun, "A smart phone application based on AR for Jeju tourism," in ACIS/JNU Int. Conf. Computers, Networks, Systems and Industrial Engineering (CNSI), 2011, pp. 271–272.

[16]. U. ¨ Ozcan, A. Arslan, M. Ilkyaz, and E. Karaarslan, "An augmented reality application for smart campus urbanization: MSKU campus prototype in Int. Istanbul Smart Grid and Cities Congress, 2017, pp. 100–104.

[17]. K. B. Dsouza and S. M. Y. Hussain, "Smart parking—An integrated solution for an urban setting," in 2nd Int. Conf. Convergence Technology, 2017.

[18]. B.-J. Park, J.-W. Lee, C. Yoon, and K.-H. Kim, "A study on augmented reality of vehicle information using head up display," in 6th Int. Conf. IT Convergence and Security (ICITCS), 2016, pp. 1– 2.

[19]. Y. Hwang and K.-H. Kim, "Effects of displaying augmented reality information on the driving behavior of drivers," in 6th Int. Conf. IT Convergence and Security (ICITCS), 2016, pp. 1–2.

[20]. R. N´ obrega, J. Jacob, A. Coelho, J. Weber, J. Ribeiro, and S. Ferreira, "Mobile location-based augmented reality applications for urban tourism storytelling," in 24th Portuguese Meeting on Computer Graphics and Interaction (EPCGI), 2017, pp. 1–8.

[21]. L. Carozza, D. Tingdahl, F. Bosch´ e, and L. Gool, "Mark erless vision-based augmented reality for urban planning," ComputerAided B. I. T, M. K, M. P and A. A, "E-Commerce Site Payment Fraud Detection using Machine Learning Technique," 2025 8th International Conference on Circuit, Power & Computing Technologies (ICCPCT), Kollam, India, 2025, pp. 916-919, doi: 10.1109/ICCPCT65132.2025.11176484.

[22]. Jegadish Kumar K J,Kaythry P,S. Santhosh,Sheeba M, "IoT Based Non-Invasive Blood Glucose Measurement Using Galvinic Skin Response Sensor", Journal of Next Generation Technology (ISSN: 2583-021X), 3(1), pp. 23-30. July 2023

[23]. Hemanth kumar B V,Jhanani M, S.Balaji, "IoT Based Health Monitoring System for Drivers", Journal of Next Generation Technology (ISSN: 2583-021X), vol. 5, no. 2, pp. 140-148, April 2025. DOI: 0.5281/zenodo.15667748

[24]. Telu Dinesh, Chokkamreddy Prakash, "Impact of IOT on Marketing Strategies and The Optimization of Marketing Promotional Activities", Journal of Next Generation Technology (ISSN: 2583-021X), 5(4), pp. 9-19. June 2025. DOI: 10.5281/zenodo.15785053

[25]. Mahamad Sohel, Gollapolu Surendra Babu, Maraka Ganesh, Nandipati Ganesh, K.Ratna sunil, "Wearable Smart Multimeter Equipped with Smart Watch Using Embedded and IOT Systems", Journal of Next Generation Technology (ISSN: 2583-021X), 5(5), pp. 85-95. July 2025. DOI: 10.5281/zenodo.16870483

[26]. Mahamad Sohel, Gollapolu Surendra Babu, Maraka Ganesh, Nandipati Ganesh, K.Ratna sunil,"Wearable Smart Multimeter Equipped with Smart Watch Using Embedded and IOT Systems", Journal of Next Generation Technology(ISSN: 2583-021X), 5(5), pp. 85-95. July 2025. DOI: 10.5281/zenodo.16870483.