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Smart Implementation of Car Parking With Raspberry Pi

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ABSTRACT

The concept of smart technologies have achieved immense popularity in modern times. The growth of Internet of things has made it possible for many smart applications which were not thought achievable. Unswerving efforts are continuously made in the IoT field to enhance the reliability and efficiency of urban communication infrastructure to keep pace with the demands of economic development and population growth. The infrastructure is crucial for progress in societies and improvements in the living standards. Many of the urban problems such as, limited vehicle parking facilities, traffic congestions, etc are being tackled by IoT. An IoT-based smart implementation of car parking is presented in this paper with the help of the Raspberry Pi. The proposed Car Parking system consists of an IoT module that is used to monitor and gather information on the availability of parking space. The system is expected to improve the existing parking management system where users can check space availability and also book parking space for themselves.

1. Introduction

To find parking space for vehicles in urban settlements has always been troublesome and tedious tasks often leading to disappointments to many drivers at some point. Advancements in lifestyle have also led to traffic congestions which have become an alarming problem on a global scale. Furthermore, searching for parking spaces has led to unnecessary burning of world's fossil fuels or petroleum resources. A Smart Parking system, if properly implemented, could save the humankind with a tune of 2,20,000 gallons and 3,00,000 gallons of fuels till 2030 and 2050 respectively [1].

The Internet of Things (IoT) is a concept comprising of many objects or things which have unique identities and can also take advantages of the global internet without the assistance of humans. As these objects have identities, they can be controlled and monitored by other devices with the help of the internet. Due to the abilities of the devices or things, the applications of IoT have become more widespread and popular starting from smart farming to smart cities as depicted in fig 1. An estimation was carried out by McKinsey Global Institute which brought into light about the financial impact that the IoT market may reach $11.1 trillion on the global economy by 2025 [2]. The number of global connected devices has also seen massive growth in recent years and continues to grow rapidly. In fact, the growth of connected devices in the world is expected to be more than 125 billion by 2030 from the report in IHS Markit [3].

As IoT is a network of many physical devices located anywhere in the globe, it can sense or gather data from anywhere in the world and communicate the sensed data to anywhere and anytime for further processing and services. It also made possible for objects such as kitchen containers, fans, lights, etc to become smart objects by attaching small physical devices in them which has network capabilities and can communicate with other devices to provide services. Consequently, the IoT technology has made it possible for smart implementation even in the field of Smart Cities with respect to efficient car parking system.

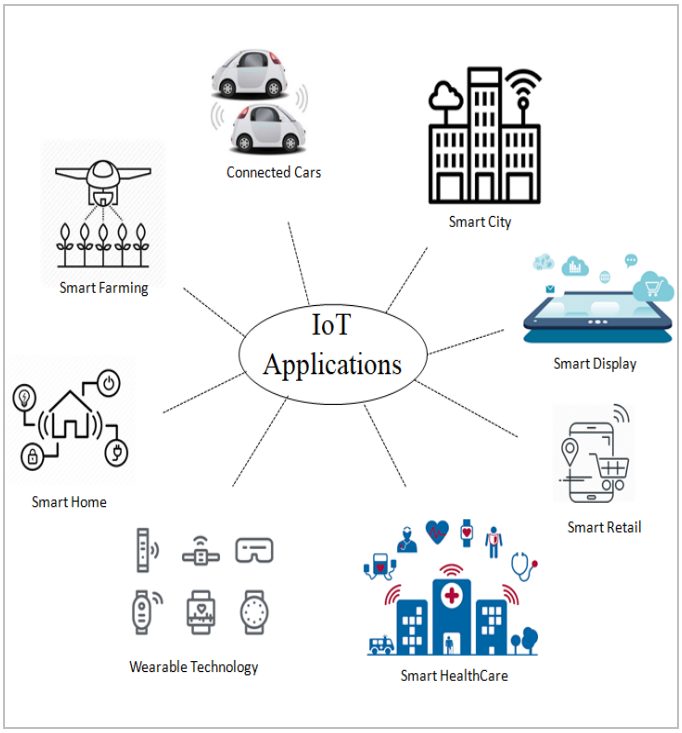

Fig 1. IoT Applications

The fast growth in the number of cars in cities made it a difficult task for drivers to find parking space and often led to time and fuel wastage for city dwellers. If there is a way of knowing availability of parking spaces prior to reaching the destination, many congestion and searching time problems with respect to traffic and parking areas would be resolved. As such, managing vehicle parking and traffic system in cities becomes the major issues when implementing Smart Cities [4]. The advancements in sensor technology helped many cities in deploying sensors for many smart applications. The car parking system proposed is implemented using an IoT device Raspberry Pi 3. The proposed system helps drivers quickly in

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finding and reserving parking spaces by using the reservation system provided.

2. Related Works

The authors in [5] developed a parking system with the help of optical sensors in wireless sensor network. They made use of two optical sensors which are used for differentiating vehicles and pedestrians. Furthermore, ease of installing and maintaining are guaranteed in the optical WSN. However, their system is still prone to failure and accurately detecting registration plate of vehicles is not possible.

The authors in [6] proposed a parking system based on reservation which uses Zigbee sensors for detecting vehicles and Bluetooth connectivity for booking parking space and for checking identity of drivers. Simulation of the proposed system was carried out based on real-world map and traffic of the city. However, their system suffered from lack of ease in installing and maintaining such a system and limited range of the bluetooth communication technology.

The authors in [7] designed and implemented a parking system which uses RFID and internet technology. Management of the parking spaces is done with the help of RFID tags for services such as entry, position and exit systems for vehicles. Internet is used for helping drivers in getting information about availability of parking spaces. Nonetheless, RFID tags can be damaged which may lead to failure in the parking system.

The authors in [8] presented a cloud-integrated IoT-based parking system which uses an IoT module for monitoring and acquiring the available parking space. The user or driver can book parking space by making use of the mobile application. IoT has helped in many ways such as solving, improving, simplifying and automating our daily tasks or processes. Various implementations of IoT technology can be seen in the fields of healthcare [9], home automation [10], supply chain [11] and manufacturing sectors [12].

3. Methodology

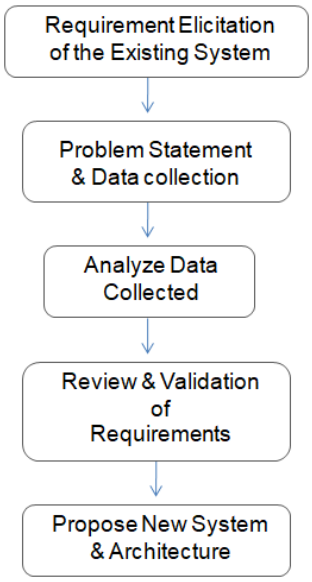

Fig 2. Methodology of the Parking System

IoT consists of small constrained devices which can communicate with one another through internet for specific tasks without human intervention. These devices can be sensors, computing devices, microcontrollers and other machines capable of gathering and processing data. User, on the other hand, can control and monitor these devices remotely and can use the data collected by these devices. Sensors are used to sense the vehicles and collect data from the real-world environment. These sensors have connectivity to a cloud, which is accessed using the internet with the help of Wifi, GSM or the Ethernet.

When the data gathered by the sensors are sent to the cloud or server via the internet, data processing is performed which can be viewed and accessed by the user. Details about parking space information can be known after processing the data. Sensors such as IR and ultrasonic sensors are connected to the Raspberry Pi. The data collected by these sensors are stored in the cloud via the IoT device in real time for users using the parking system.

4. System Architecture and Working

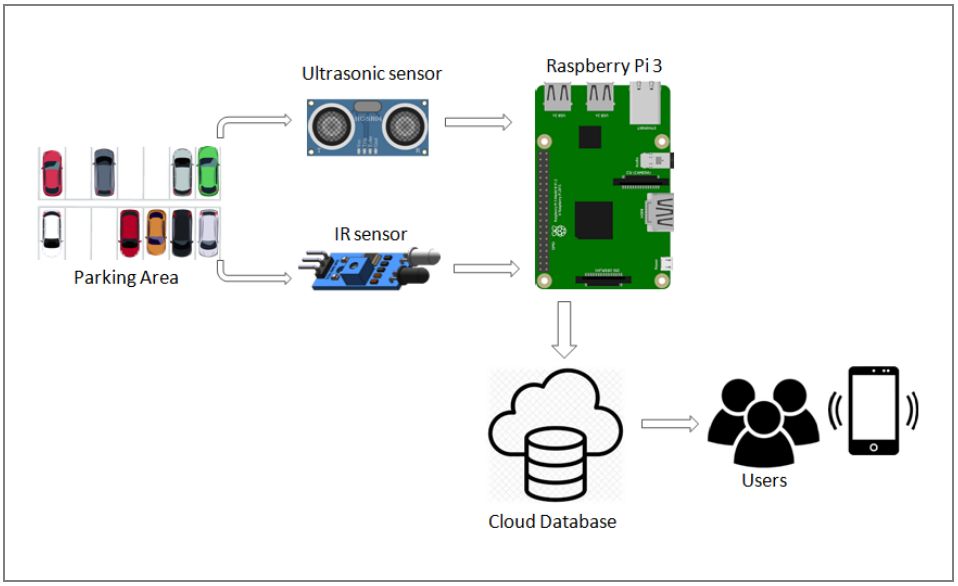

Fig 3. System Architecture

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The system architecture is given in Fig 3, which consists of ultrasonic and IR sensors used in sensing and gathering information about the parking area. This information helps us to know the availability of parking space and also the presence of any parked vehicles. The sensors are connected to a Raspberry Pi 3, which is the processing unit and act as an interface between the sensors and the cloud. As the Raspberry Pi 3 has 40 GPIO pins, connecting as many as 40 sensors becomes an easy task. The status of these pins is checked by a python script running on the processing unit, which sends this information to the cloud.

Data collected by the sensors are transmitted by the Raspberry Pi using MQTT protocol [13] to the MQTT server. Since this server is on the cloud, the cloud can act as a repository for storing all information about the parking areas and the users who have access to the system. All users or drivers using the parking system are tracked with the help of the cloud. It also keeps record of car parking time, duration of parking, amount paid with respect to parking time and the mode of paying the amount. An interface between users and the parking system is provided by a mobile application. This application helps in getting information about parking spaces and booking a parking slot if it is available. The mobile application and the Raspberry Pi have to subscribe topic on the MQTT server for ensuring effective communication between them.

5. Algorithm

Step 1. Install the mobile application into your phone
Step 2. Search parking spaces in your area with the help of the application
Step 3. Select the parking area
Step 4. Book the parking slot
Step 5. Choose the duration for parking the vehicle
Step 6. Pay the required amount by selecting mode of payment
Step 7. Parking space is allotted to the user
Step 8. Park the vehicle and confirm occupancy
Step 9. If duration is more than chosen one, pay extra amount

6. Implementation

The process of implementing the proposed Parking System is given as a flowchart in Fig. 4. The user has to log into the mobile application. After logging in, he sends request for parking space to park the vehicle. If there is no available space, the system notified the user. The user can book space once there is availability of parking space. Payment is made based on the duration of parking, which is stored in the cloud database. After this process, space is allotted to the user and parking is done by the user which should be confirmed in the mobile application. If the time duration is exceeded by the user, the user has to extend the time and pay according to the additional time.

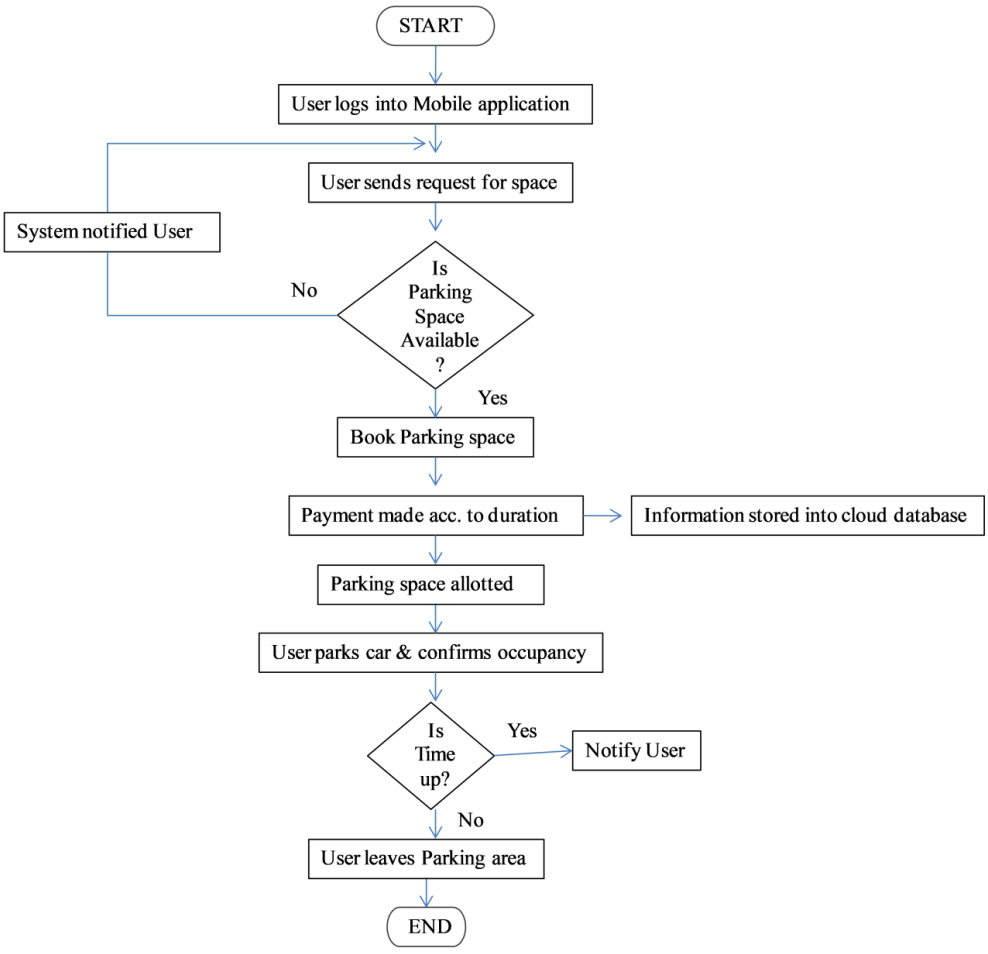

Fig 4. Flowchart of Parking System

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7. Conclusion

Designing and implementing car parking system based on IoT devices and cloud technology is carried out in this paper. With the improvements in lifestyle, many cities are facing overcrowding in terms of limited parking spaces and traffic congestion. This situation where unnecessary wastage of fuel and time can be taken as challenge to be solved for creating Smart Cities for providing better traffic maintenance. Recent advances in technology such as IoT and cloud have helped us in realizing the dream of developing Smart Cities with respect to better road communication facilities. The system proposed helps in providing real-time data for finding availability in parking spaces easily. Using the mobile application, any user can book parking space from any locations. The system can help in reducing time wastage, fuel wastage and traffic congestion caused by endless searching of parking spaces. The Parking system can be very practical, helpful and improve daily life in the cities across the world

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