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Cloud Enabled Smart Parking System Based on Internet of Things

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Abstract: The concept of smart cities had gained huge popularity these days. Smart cities make use of Internet of Things in a secure fashion to manage their assets. The major problem faced in recent years due to urbanization is the vehicle parking which accounts for thirty percent of the total traffic congestion. One such aspect of smart cities is the Smart Parking System, which enables the user to select the desired parking slot based on the slots available. In this paper, an implementation of the Smart Parking System is presented with the aid of Internet of Things which is integrated with the mobile application in order to provide the user with enough slots before he/she approaches towards the parking place. Depending upon the slot selected the user would proceed to park the vehicle in the earmarked parking area only. This is implemented through integration of IoT with cloud to provide enough storage capacity, computational power, scalability, availability and Interoperability. This paper emphasis mainly on reducing the time to find the parking slots which in turn even reduces the environmental issues.

Keywords: Internet of Things, Cloud of Things, Smart Cities, Smart Parking, Arduino.

INTRODUCTION

Although the concept of Internet of Things is trending over the recent years, there is lack of common architecture. As the name suggests IoT refers to things which are connected over the Internet. Here, things refer to any communicating or non-communicating devices. These devices could be tracked, monitored and controlled over the Internet. Internet of things is not a single technology, it is the concept in which many of the new things are getting networked and connected anytime, anyplace, with anything and anyone ideally using any path or network and any service in a heterogeneous environment[1][8].

According to some recent studies, fifty four percent of the total population is living in urban areas and this is expected to be increased enormously in further years. The direct implication to urbanization is the increase of traffic congestion. The major cause for this traffic congestion is the parking, which accounts for almost thirty percent of occupancy. Smart cities is an urban development vision to integrate the multiple Information and Communication technology (ICT). ICT is used to enhance quality, performance and interactivity of urban services, reduce costs and resource consumption, improve contact between citizens/ government and Internet of Things (IoT) solutions in a secure fashion to manage their assets. The targets for smart cities could be impossible without the invention of IoT. Some important benefits of internet of things includes tracking behavior; enhanced situational awareness; sensor driven decision analytics; instantaneous control and response. The scalable nature of Cloud computing allows the developers to host their applications over it. Cloud acts as an intermediate between things and applications, in order to hide all the complexities and functionalities necessary for running the application. These factors have led to the formation of new technology named Cloud of Things (CoT). Through CoT any device could be accessed from any remote location to the cloud. This enables the application to work more effective and efficient.

The proposed system make use of mobile application that is connected to the cloud. This application acts as a means to the user to know enough details before he leaves to the parking spaces. This application provides the user interface to verify the feasibility of the proposed system [2][3].

MANUAL EXISTING SYSTEM

There are basically two types of Smart Parking System. They are crowd based and the sensor based.

The common method practiced is manual searching for a parking slot and finds a slot based on chance and experience. Due to this manual search, some results suggest that at an average every person is wasting over 6 minutes in searching and parking his/her vehicle during the rush hours. This time seems to be very less but this accounts for wasting more than one million gallons of fuel every day. This would leads to fiasco if proper measures are not taken.

The following are the drawbacks of the existing manual system:

- Need of human intervention for spot detection.
- More time and effort.
- No appropriate pricing methods.
- Traffic congestion.
- Environmental issues.

PROPOSED SYTEM WITH ARCHITECTURE

This proposed system overcomes the drawbacks of the existing system. This system make use of sensors in order to carry out the operations that are shown in figure 1.

This architecture basically consists of two units. They are the System unit and Coordinator. This is analogous to the Master and Slave concept, where-in a Coordinator resembles the master and System unit resembles the slave. In this approach all the system units are connected to the Coordinator.

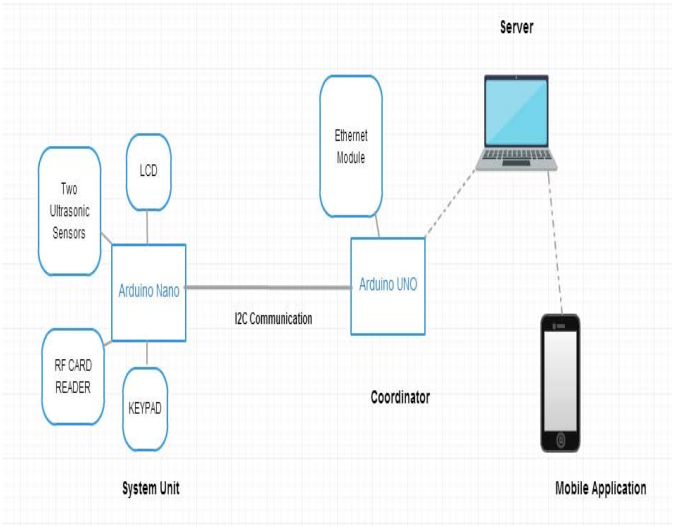

Figure 1. Architecture of proposed system

Hardware Requirements:

- Arduino Nano.
- Two ultrasonic HC-SR04 sensors
- RF Card Reader
- Keypad
- LCD
- Ethernet module
- Arduino UNO

Software Requirements:

- Arduino IDE
- A Higher level programming language

System Unit:

As shown in figure 1, the system unit basically consists of mainly five devices or sensors. They are Arduino UNO, ultrasonic sensors, RF card reader, keypad and LCD. Each system unit need to be placed at each parking slot. All the system units are then connected to the Coordinator. The basic view of the smart parking system is shown in the figure 2. All the clients are obviously connected to the server, which are in turn connected with the each SPS unit.

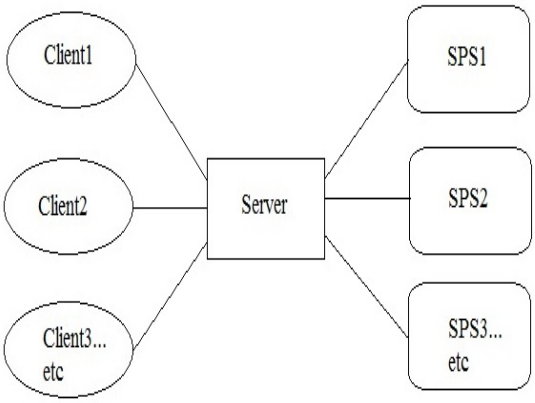

Figure 2. Server as interface between the clients and system units

After comparing with other sensors available, the ultrasonic sensor is the most accurate and the IR sensor is found to be not very accurate mainly under the sunlight and the available IR sensors had a range less than the ultrasonic sensors. In order to detect the car not moving objects, a pair of ultrasonic sensors are being used. The readings of both ultrasonic sensors are being collected in such a way that they are free from both collision and interference.

The RF card reader, keypad and LCD are used for basic payments. The proposed system could be further developed so that the above payment devices could be replaced with the real time devices.

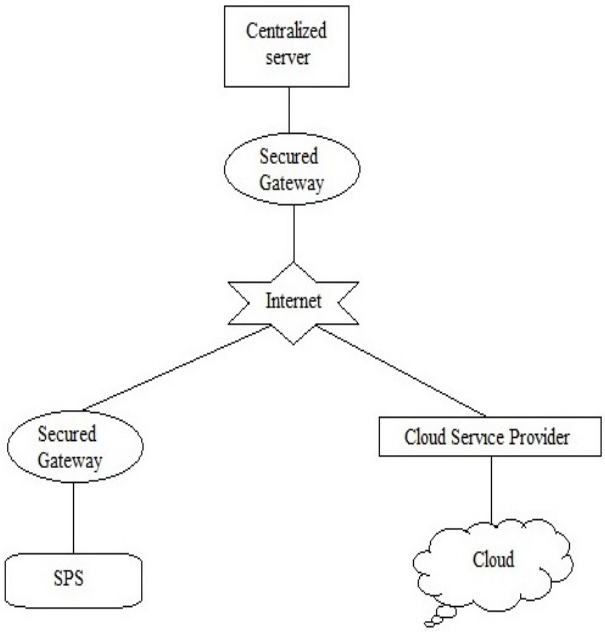

Figure 3.Integration with the cloud

The figure 3 depicts how cloud be used in this SPS. Here, Cloud acts as an intermediate between the things and applications in order to remove the complexity and provide the functionalities necessary for running the application [7]. The storage capacity, computational power, scalability and interoperability are some of the factors which have led to the amalgamation of Cloud and the IoT [4][5]. In figure 3, the

centralized server consists of all the details of parking slots which are occupied or empty. This serves as the collection of all the application data. The SPS unit is being connected to the server by means of Internet(figure 4).

The software application can be used to check in, pay and check out operation details. The user interface consists of all the available slots and is provided to select the required slot.

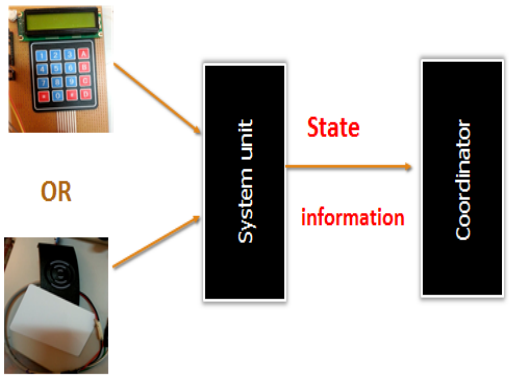

Figure 4.Payment system

IMPLEMENTATION

The basic flow chart for the proposed system is shown in the figure 5.

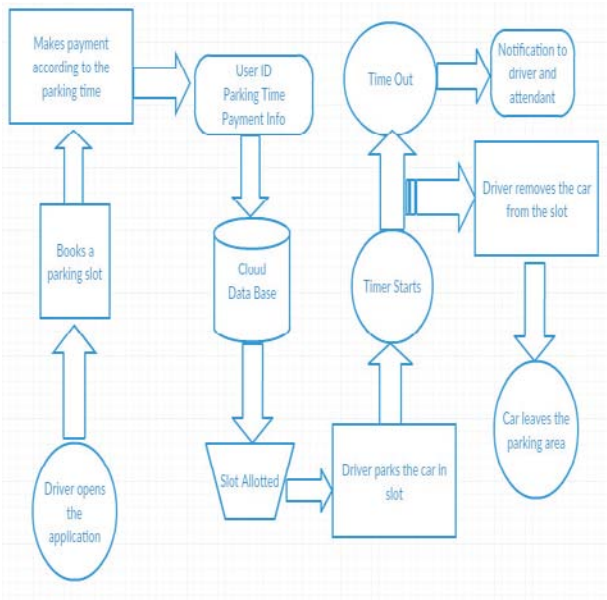

Fig. 5.Flow chart for proposed system.

The following are the steps involved in processing of the application.

- **Step 1**: User opens the mobile application.
- **Step 2**: Search for a required parking area.
- **Step3**: Browse through the parking slot in the respective parking area.
- **Step 4**: Select a particular parking slot.
- **Step5**: Select the appropriate time needed to park your vehicle in the parking area.
- **Step 6**: Payment is done through the keypad and card reader.
- **Step 7**: Once you park the vehicle in the selected parking slot confirm it in the application.
- **Step 8**: User need to leave the slot after elapsing the allocated time.

As many as slave units are utilized in this system, there is a need to connect all the slave units with the master unit by the means of communication. Basically the communication could be carried out in three ways UART, SPI and I2C [6].

If Universal asynchronous receiver and transmitter are used such that only one device could be able to transmit the data. Both Serial peripheral interface and Inter-Integrated circuit make use of addressing. The use of I2C enable to connect the coordinator i.e. as many as units up to 127 without using any additional hardware.

The coordinator continuously request data from the connected units. The communication between different Arduino's is shown in figure 6. The two connected lines represent the Serial data and Clocks.

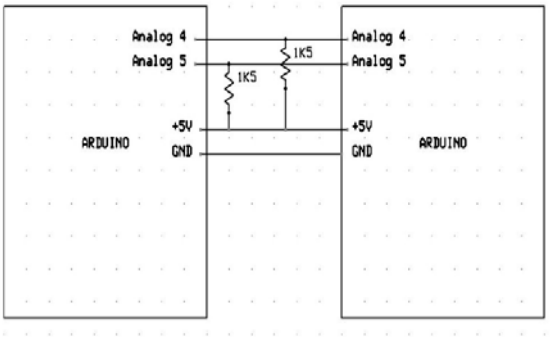

Figure 6. Communication between the Arduino's

The coordinator is connected to the Ethernet module in order to connect to the server. Whenever the data is received in the coordinator from the slaves the coordinator would parse these information and store them according to the state in the server using the Ethernet module.

The results of the above proposed system is as follows:

The figure 7 depicts the presence of both occupied and unoccupied parking slots as A1,A2…

It shows that A2 slot is not available. This implies that user needs to select the slot other than A2.

Figure 7. Displays the parking slots

Figure 8 states that the user need to provide the specified time it needs for a parking slot. The figure states that user had selected the slot for duration of 1 hour.

Figure 8. Select the amount of time

Once the user had occupied the parking, he needs to confirm its occupancy so that the selected slot will be unavailable for others in that duration of time opted for.

This application is also enabled with features such that it ensures that the driver would not occupy a wrong slot. The above case is depicted in the figure 9.

Figure 9.Confirm the occupancy

ADVANTAGES

The illustration of the advantages of the proposed system is given below:

- Adequate information for drivers.
- Reduction in searching times.
- Decrease traffic congestion.
- Elimination of queues.
- Increased revenue and profitability.
- Appropriate pricing methods.
- Manages the traffic well inside the rush places without any havoc.
- Plays an important role in making for environment free from pollution by reducing emission of CO, CO2 and NO2.
- Increased Safety and service.
- Limited parking spaces could be used efficiently.

CONCLUSION

It is evident that a good number of people are migrating from rural to urban areas for a better livelihood, hence there is a huge demand for advancements in making smart cities a reality. The innovations of Internet of things and Cloud technologies have made its task easier. The major problem persisting is fast urbanization and traffic chaos. So in this paper, the focus is emphasized on decrease in traffic congestion. This project is integrated with the mobile application to help users in finding their parking slots with less time. It is well managed to access from any remote location through the mobile application. The integration of this system with cloud has made the storage aspect easier and secure. This smart parking system provides an effective solution to reduce the emission of pollutants in to the atmosphere which includes improved performance by reducing the costs of moving to the parking areas. Thus, the proposed system in this paper reduces the risk of finding the parking areas and eliminates the unnecessary movement of vehicles over the parking areas. If GPS module is also included in each unit, we can store the location of each unit so that slots could be identified in a better way. Addition of further ultrasonic sensors helps in detecting any type of vehicle accurately. If the above proposed system is integrated with the ordinary real time payments like bank accounts, it would be extremely simple and hassle free.

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