IoT Based Intelligent Vehicle Parking Solution System

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Abstract

With rapid increase in population in urban cities, availability of parking space is real issue. This parking issue lead to traffic and encroachment of roads for parking. With implementation of smart cities is real time development, smart parking is integral part of this development. Intelligent parking system describe in this paper solve the parking issue and fits in the smart city development, this system is based on cloud-based parking system where user is able to get location of parking spot with helps sensors network and cloud computing. The user is updated with real time data of available parking spot near their destination, and they can choose the spot according to their convenience. The main components of the system are sensor layer, hardware layer, cloud layer and application layer. The sensor layer is controlled by Arduino board or other system on chip which manages the data collected by sensors, this data is sent to cloud through hardware layer cloud layer manages the data accordingly and data is sent to users' application on the reception of request through application. This interconnection of all the layers is main aspect of IoT (Internet of Things). This system will help user to get the spot in hassle free and quick way.

1. Introduction

The Internet of Things (IOT) is envisioned as a network that allows any device or any system to be connected anytime and anyplace. IOT can make the communication between the machine and machine or between the machine and humans much easier than by using the conventional ways. IOT extend the use of Internet by using it for the networking between different devices and also helping in monitoring the systems and tracking the devices (Things). There are two main words in IOT "Internet" and "Things". Internet means the vast network of servers which are connected around the globe, computers, tablets and mobiles which use protocols followed internationally and connecting systems. Internet enables to share the data between different devices and systems. Things in literal sense means an object, or an idea or some action, but in IOT

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"things" mean the devices which are connected together and form the net of devices which is called the internet of these devices.

IOT in general consist of, track the devices in remote areas, get data to the operating systems from the different devices and can organize and analyse the data. IOT gives the vision in which the devices and systems become smart and they start sensing and analysing their surroundings and start interacting with each other through different mediums. This smart and interactive nature of IOT can be used in many applications in real life which can make our life easier and help us steal some time for ourselves.

The most common idea that comes in mind when is thought about IOT and smart devices is "Smart Cities". And the biggest problems in our normal cities are traffic and insufficient vehicle parking. To make a smart city different from the normal city these problems have to be tackled smartly. So, in these situations IOT comes into play, using IOT, a intelligent parking system can be developed which will solve this parking issue. New applications in IoT are being built by developers due to recent advancement in embedded system which have low cost and are low powered.

One such concept that is proposed using IOT is intelligent parking system which is a reality now. The intelligent parking system concept that has been proposed includes the use of hardware(sensors), cloud storage, embedded chips and mobile application. All the above-mentioned components of the system are connected to each other forming the web or net which is used for sending, receiving and processing of data which is shared between different components. The systems helps the user in finding the free parking spot available, which is closest to the destination of the user, this helps in saving the time of the user which he/she will spend on searching for free parking spot , also this will help in reducing the traffic on the road as no unnecessary vehicle will be on the road wandering for finding parking space , this will reduce vehicles on the road and hence will help in keeping the check on traffic.

2. Background and Description
2.1.   Background of intelligent parking solution system

In the present urban parking is a serious problem in populated country like India, parking is major problem for most urban streets and many cities lots by covering streets and roads' sides of busy routes. This creates traffic and wastes lots of time for people searching for parking spots.

For the motorist, the convenience of being able to find a place to park vehicle and then be on one's way is of great importance.

This invention is based on concept of using intelligent vehicle parking systems based on cloud technologies in can be used as major application in the smart cities. Because of whole business-oriented characteristics of services like this, system will be an intrinsic section for smart cities which will inclusive in general operative models of IoT.

Internet of Things (IoT) Strategic Research Roadmap which was proposed by the Cluster of European Research Projects (CERP), named CERP-IoT [1] in September 2009 was recommended by European Union (EU) for encouraging, sharing and publicising the research work in the field of IoT , especially application of sensors in field of IoT, like Intelligent Transport Systems (ITS) [2], smart health sensors wearables. Application like intelligent homes, smart cities, etc are also includes in sensors technology. Wireless sensors [3] will be used in this technology for infrastructure-to-vehicle communication, tracking and tracing services can be enabled by real time location detection system, which will remarkably advance the ITS applications. Each individual driving to a specific area could get a perfect parking spot with help of smart vehicle parking systems which find, allot, and assign the parking spot to user. These systems establish an important part of the ITS. The user application provides service to user to navigate to parking lot. These systems provides whole business-oriented services, these characteristics of system may serve as a substructure and a common business framework for a general operational platform of IoT.

2.2.   Description of Intelligent Parking Solution System

This invention is based on cloud based intelligent parking system, where the IoT is the integral part of this system. Architecture of this system is inherited from adjoining of architecture of IoT and cloud computing i.e. it will contain both hardware application and cloud based mobile application. This system consists of three layers i.e. hardware layer, cloud layer and application layer. The hardware layer includes

sensors and a hardware processing unit which is Arduino UNO for this proposed system. This layer will work as infrastructure and will provide all its information and current statuses to database which is a part of cloud layer. The cloud layer is main processing unit of the system, it consists of computing centre which provide best available parking spots location to the user on basis of user location request sent through application. The application layer consists of user interface which takes user information and current location of user and send it cloud layer and a navigation system to navigate user to available parking spot.
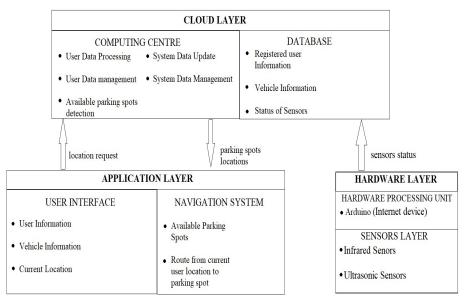

Fig.1: Architecture of Intelligent Parking Solution System

3. Detail Description of Components

3.1. Hardware Layer

3.1.1. Parking sensors

As seen from above fig1. The hardware layer consists of sensors layer. For parking system, there were options of many different types of sensors like ultrasonic sensors, infrared, passive infrared sensors [4] etc. These sensors detect the vehicles' presence and inform the system, whether the specific parking spot is vacant or occupied. In this case the infrared sensors were used because they are more accurate and efficient and can form heat image of the vehicle that is parked at the spot.

The infrared sensors are connected to the Arduino UNO boards. The sensors are externally powered by 5volt power supply through a battery, the sensors can also be powered through the Arduino boards but that would not be very efficient so it is more preferable to use external 5 volt supply(battery) to power the sensors. In this system Infrared sensors are being used. These sensors are used in detecting the presence of an object in front of it. This detection is done by either emitting or detecting the radiations by the body which is to be detected. Next, detection the focused radiation is done by infrared sensors. Then amplification of the output from the sensors is required which is done by pre-amplifiers coupled with circuitry. It is because output is very small.

3.1.2. Hardware processing unit

The processing unit comprises of the Arduino UNO board which is a processor on the chip. The work of the Arduino board is to collect the information from the sensors, process it and then send it to the cloud. It works as the intermediate between the sensors and the cloud. The data is collected by the Arduino through the input and output pins which are directly connected to the sensors, the data sent to the Arduino is then uploaded to the cloud through the internet device. Once the data is uploaded to the cloud storage then it is available to the servers and can be accessed by the app.

The Arduino Uno is a microcontroller [5] board. It is based on the ATmega328P microcontroller. It has a 16 MHz quartz crystal and a USB connection. A power jack for power supply and an ICSP header. To support the microcontroller, there are every basic element present on Arduino Uno which is required. Connection to computer can simply done through a USB cable. Also, it can be externally powered through a dc or ac source.

3.2. Cloud Layer

Cloud layer consist of two main component one is database and other is computing centre [6] as shown in fig1.

3.2.1. Database unit

In cloud, there is data of available vehicle parking lots, vehicle parking area. It also includes data of vehicles' location, users' location and their profiles, etc. It provides data storage and computation of resources of vehicle parking system. The database stores most recent data usually to assist real-time problems. On other hand the history data gets accumulated(warehousing) [7] in the cloud database. Various Map and Reduce algorithms are used for computing. One of which is recommendation algorithm for providing the suitable vehicle parking lots to users. To build an effective and scalable system, for quick and reliable decision-making process cloud system is used.

The users request locations of parking lots (on their mobile devices) from the closest location via mobile application through internet connection. The organisation of cloud-based system is in such a manner that the request is directed to the Computing Centre. Computing Centre is decision centre, the decision for the most appropriate, quickest and nearest way of parking lot to each user is made. Which is according to his/her current individual location and vehicle.

3.2.2. Computing Centre

The Computing Centre is mainly concerned with the service content and its creation. The deployment and operation of the service is also main part of Computing Centre. While control and execution of the service is also done by Computing Centre. In addition to this, some support functions are present that is initially required when each request is created, for example location management, vehicles' profile management, parking lot list etc. A depository of all profiles of both users and their vehicle is present. If there are any changes which are made by the individual user in his/her profile, then these changes or any other change in vehicle's profile are directed to the Computing Centre through user's mobile, where the source is updated. There are copies of all recently used profiles. Also, there are copies of profile updated by users. When a user is within the radius of a Computing Centre and access mobile application, the application which is installed in the user's device, and the Computing Centre mutually connect with each other. This process is facilitated through the request, feedback module within the Computing Centre. The Mobile application sends a request to the Computing Centre for user's Authorization. This request also includes a description and updates of user profile and user 's vehicle profile.

The Computing Centre directs this request to the database. This request along with the profile updates are processed. If the user is successfully authorized and there is parking spot available according to profile within the Computing Centre coverage area, a new record is generated for the user and that particular slot is occupied till the user vehicle leaves the slot.

3.3. Application Layer

On mobile device of user, the Mobile application provides the service utilization by the user. The mobile application allows the user unhindered access to the service. Through Mobile application user make a request for parking lot location while within the nearby range of Computing Centre. Application layer consist of user interface [8] for easy and simple interaction of cloud layer and user. The user interface will provide a detail form to the first-time user to fill up all his details to create an Id and get registered. This user Id can be used for getting the service of this system.

There will an option to set a default vehicle which is used by the user regularly, user can change the default vehicle. Once the user is registered, there will be an option to enter the location where user needs

parking. This location will be sent to Computing Centre as a location request, the computing centre will provide available parking spot in that parking location. User can select a particular spot and route to that particular spot will be provided from user current location.

User application would also require GPS navigation system [9] for direction of available parking spot.

4. Detail Working of Intelligent Parking Solution System

In the below section the idea of intelligent parking has been explained in more detailed and classified manner. In order to ensure the pliable and adaptive service provision which are present in each of the three layers of the system, it must interact so that user is satisfied in the best available way, no matter what type of request the user encounter. The following description describes the whole interaction that takes place between the different layers of architecture. The user get access to the information about the parking spots near them through mobile phones.

the content of the service must be more user friendly and gadget friendly so that it supports maximum devices. In the initial request, the user's mobile application sends the location and the type of the user car. Then this information is then sent to the Computing Centre which reads the user's vehicle description and location from the depository and according to this, find and provide the best available parking spot. Before using the application, every user has to register with vehicle details so that the system can provide them with best possible parking spot according to the vehicle. In this case, during the initial request the Mobile application sends a full description of the user's vehicle information. This request is forwarded to the Computing Centre which outline a sample interaction between components involved in the intelligent parking [10-11] system provision. As the user's vehicle enters the covered area of a Computing Centre. The Application which is installed in the user mobile and the Computing Centre mutually interact. The application sends a request to the Computing Centre for user's authorization. In this initial request, the user's mobile application sends the user data to the database and make the user profile and updates it whenever new data is provided. The Computing Centre registers the user in its database and updates the profile, this is done before computing user's request which come along user profile. However, profile is updated first time for the new user and if the user uses of the application regularly, the Mobile application could spontaneously predict the users request, i.e. once the application is opened, the Mobile application automatically send requests for parking location for the user's vehicle. The application directs the user request to the Computing Centre. Networks of sensors in the vehicle parking area constantly update the Computing Centre in real time so as to provide the users with real time availability of the parking area available. However, the system can be updating at larger interval during the evening period and during weekends as the rush for parking spots in this time or days is relatively low. Cloud consisted an ordered list of available parking spaces. These are according to their nearest distance to the user's desired destination. The Computing Centre then finds the current location of the user based on the location of the device. The Computing Centre then provides the best directions from user's current location to each of the available spaces.

Once the user receives the ordered list of parking spaces, s/he chooses a desired parking space. Directions to that space is given via application. Once a space is chosen, the Mobile application check the details of the space and displays accurate directions. An audio description of the route with visual directions on map will be best for this service as it will give least distraction to the user while driving. Occupancy of spot sensed by the network of sensors, any other users will not be given details of that space. When the user leaves the parking space, the sensor network sense this and send the confirmation to the Computing Centre. The Management Module within the Computing Centre accounts for the duration of the user's stay. Once the user/ service profiles have been updated, the service is terminated.

5. Application Results of Intelligent Parking Solution System

The above-mentioned invention was implemented in college campus area of AIACT&R Geeta Colony, Delhi. Sensors with Arduino board were installed in the parking spots available in the campus, available parking spots will be allocated for students and visitors in the campus area.

Staffs' parking area was excluded from the implementation and these spots will not be allocated to anybody.

Students and visitors with vehicle when used this system for parking, were able to find the spot in less time. This system worked in the same way as mentioned in description user through his/her mobile application sends a request to server with all details of vehicle.

The cloud server search within its database for available spots. Database of such spots was created through interactions with sensors installed in parking area. On detection of no vehicle in front of sensors sends the following information to the server. These spots will be marked as free spaces. The servers on the request of user send these spots list to the user application.

Now user can select the best spot for the vehicle and the location and route of that spot from the user's vehicle will be shown on the user application.

Unauthorised parking at spots available for authorised user can be avoided by further implementations of new techniques and idea in this system. User registered via mobile application to this system doing unauthorised parking could be requested via application with help of few enhancements in this system.

PROS

1) Reduce human effort in finding parking spot.

2) Reduce traffic on road.

3) Help developing smart city model.

CONS

1) Any nonuser cannot be stopped to occupy the space having our hardware unit.

2) The parking spot for users cannot be booked, as it is open and free parking for all.

6. Conclusion

At last conclusion on this invention is that; this Smart parking system will be a better solution for increasing parking issues of public in urban cities where parking is a major problem for general public going to a particular area. Implementation of this system on large scale could avoid wastage of time and traffic due to vehicle roaming for parking spot in a busy area.

This system can be integral part in implementation of smart cites, where public can park their vehicle efficiently without affecting movement of other free moving vehicles.

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Author's Biography

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She has also delivered an expert talk, guest lecturers in International Conference and a member of technical program committee in an International Conference in

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