Smart Parking System using Internet of Things (IoT)

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Abstract: Proliferation in the number of vehicles is leading to problems of vehicles parking at an appropriate place especially the car parking. This indirectly leads to traffic congestion. This is because of the fact that current transportation infrastructure and car park facility are unable to cope with the arrival of large number of vehicles on the road. To alleviate the aforementioned problem, the proposed system is a Smart Parking Management System that helps users to automatically find a free parking space with a smaller amount. Smart Parking involves use of Ultrasonic sensor, Arduino Uno, ESP8266-01 Wi-Fi Module, Cloud server. IOT based new parking platform enable to connect, analyze and automate data gathered from devices and execute smart parking possible. Smart parking would enable vehicle occupancy, monitoring and managing of available parking space in real-time that reducing the environmental pollution. Proposed system provides optimize usage of parking space and get considerable revenue generation.

Keywords: Smart Parking Management, Internet of Things (IoT), Traffic Congestion, Optimize Parking, Revenue Monitoring

1. INTRODUCTION

The idea of creating a Smart City is now becoming possible with the emergence of the Internet of Things. One of the key issues that smart cities relate to car parking facilities and traffic management systems in a recent research it has been found that finding an available parking spot is always difficult for drivers. It tends to become harder with the increasing number of private car users. Problems related to parking and traffic congestion can be solved if the drivers can be informed in advance about the availability of parking spaces before reaching to their intended destination. Researchers show that more than 66% of drivers are willing to pay for car parking during working hours. This directly adds value to the car parking business. It is stimulus the development of intelligent car parking services for smart cities. The system helps a user know the availability of parking spaces. The parking systems aims at providing facilities to users like find, allocate, and reserve the best available car parking lot for a user in a particular area, providing navigation instructions for reaching this lot.

2. PROBLEM STATEMENT

In recent research in metropolitan cities the parking management problem can be viewed from several angles. High vehicle density on roads this results in annoying issue for the drivers to park their vehicles as it is very difficult to find a parking slot. The drivers usually waste time and effort in finding parking space and end up parking their vehicles finding a space on streets. In worst case, people fail to find any parking space especially during peak hours and festive seasons.

The importance of smart parking is:
1. Accurately sense and predict spot/vehicle occupancy in real-time.
2. Guides residents and visitors to available parking spot.
3. Optimize Parking Space Usage.
4. Simplifies the parking experience and adds value for parking stakeholders, such as merchants and drivers.
5. Helps the free flow of traffic in the city leveraging IoT technology.
6. Enables intelligent decisions using data, including real–time status applications and historical analytics reports.
7. Smart Parking plays an important role in creating better urban environment by reducing the emission of CO_2 and other pollutants.
8. Smart Parking enables better and real time monitoring and managing of available parking space which results in significant revenue generation.
9. Provides tools to optimize workforce management.

Table 2.1 Parking System

Conventional Parking System	Smart Parking Management System
No optimum use of available spaces	Provide optimum use of all available spaces
Congestion may occur due to parking traffic	Congestion may be decreased by diverting traffic to available spaces
Increase fuel consumption to search spaces	Decrease fuel consumption to search spaces
No efficient revenue monitoring	Provides efficient revenue monitoring

3. PROPOSED WORK

The proposed system is the combination of smart parking and the Slot allocation with the Android application. In the existing system, a dynamic algorithm is carried out, which is a random allocation method. It randomly allocates parking lot to the users.The block diagram of proposed work is shown in Fig 3.1.

3.1 Internet of Things

Moving towards smart city, smart parking is a very good example for a common citizen of how the Internet-of-Things (IoT) can be efficiently and effectively used in our day to day life to provide different services to different users. Proposed application is user friendly and even non-technical person can use it through mobile device. Through this application user can search a free parking slot from anywhere in the world. Proposed system provides well-organized car parking management through isolated parking spot localization. Conventional reservation based car parking method has a limitation of space and time. Proposed smart parking system providing the free parking slot efficiently that saves time and fuel and reduces atmospheric pollution and congestion in cities. IoT based new Parking platform enable to connect, analyze and automate data gathered from devices, and execute efficiently that makes smart parking possible.

3.1.1 END –NODE

Starting from the front end, the end-node is the first node of any IoT system, without this node the 'T' part of IoT i.e. Things is not achieved. These end nodes are sometimes also called as objects and many times they work as sensing nodes. These nodes usually have dual nature. Examples of end-users are all types of sensors but these sensors are normally basic and a designer can convert it into active device. Proposed system has used Ultrasound Sensors as end node.

3.1.2 PROCESSING NODE

Processing node is the central important block. It is used to provide an artificial intelligence to the whole circuitry. It processes the data and information received from end-nodes and transfers it to further link for next action which in this case is a cloud platform. In our system we have used Arduino Uno as the processing node .
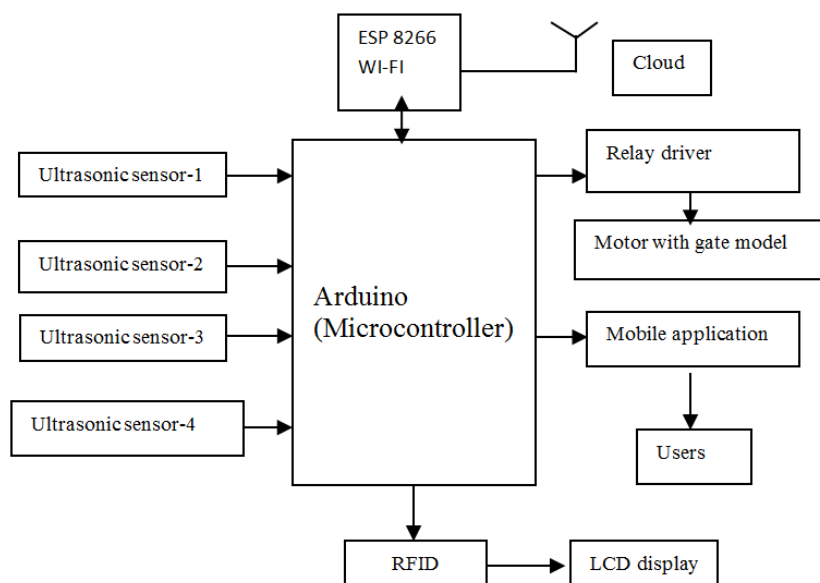

Fig 3.1. Block diagram

4. FLOW OF PROPOSED SYSTEM

In any system, wired or wireless Connectivity is important to establish a connection. Proposed system used ESP8266-01 Wi-Fi Module to send data over the cloud. It consists of many network layers to establish a connection between software and hardware. Physical layer deals with the mechanical and electrical support to the system. Every system has a unique MAC address. This system dynamically assigns IP address to each node and users. So a DHCP enabled connection can be used. A secure and fast connection MQTT protocol is used along with TCP (wired connection). This protocol works on pub/sub (publish and subscribe) basis Pub/sub allows one too many communication and in this the clients are unknown to each other.

The proposed system will have Ultrasonic sensor, Arduino Uno(Fig 4.2), ESP8266-01 Wi-Fi Module, Cloud server i.e. www.thingspeak.com, User-End Application on Smartphone. The ultrasonic sensor is used to determine the availability of the vehicle at the parking spot. It is connected to the Arduino Uno module interfaced with Wi-Fi shield in fig 4.1 . The Arduino Uno module is connected to the cloud server through an Internet connection to transfer the data from the local car park. At the user end application a software system runs on Android operating system. The user has to install this application on their smart phones and use it to reserve parking spaces.

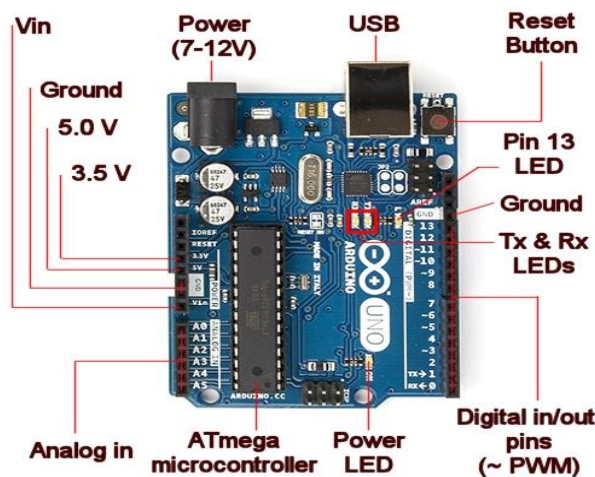Fig 4.1 Arduino interconnected ultrasonic sensor

Fig 4.2 Arduino UNO

5. WEB APPLICATION

The end point in IoT system is the Cloud based service provided by Thingspeak which is essential to see the true output of the project or the output of the data send forward end nodes . Fig 5.1 Users can modify and manipulate the information available on this node easily and can apply various techniques to make its representation effective. In this parking system we have used Thingspeak tools on their website page to view the output. It consists of Application, Transport, Network, Data Link and Physical Layers in fig 5.2. The diagrammatic representation of Arduino interfaced with ultrasonic sensor is shown in Fig 5.3
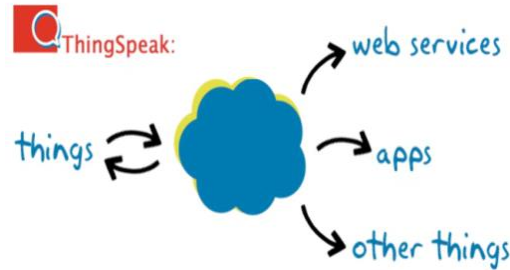
Fig 5.1 Thingspeak cloud –IoT

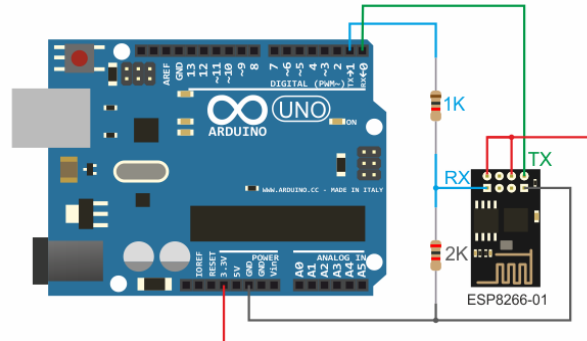|	
Application layer	MQTT
Transport layer	TCP
Network layer	IPV4/IPV6
Physical and data Link layer	802.15.4 MACCC layer IoT gateway

Fig 5.2 Architecture of IoT

Fig 5.3 Arduino interfaced with ultrasonic sensor

6. CREATING WEB APPLICATION

STEP 1. As always, we first set up the network connection on the ESP 8266 Wi-Fi. If you have already done so, please continue with "Step 2", otherwise click the below link and follow the instructions.
STEP 2. Next, we will have to create an account on the Thingspeak platform.
Go to thingspeak at https://thingspeak.com and signup.
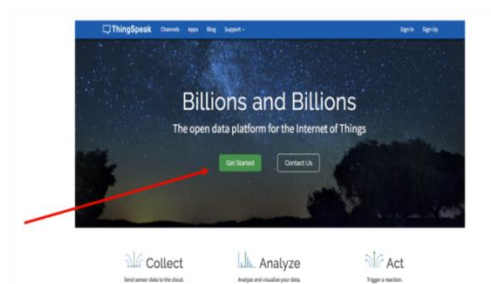
STEP 3. After signing in, Click "**New Channel**".

STEP 4. Now we have to define the name for our new channel and the name of the data we want to submit. We can set up to 4 different fields to receive values.

STEP 5. To submit data to the ThingSpeak cloud and assign them to a specific field, we have to go to the "**Data Import/Export**" section and copy our API Key link.

STEP6. Whether or we have set up everything correctly, we can test by pasting our API link directly into the web browser address bar and trigger the data update event. New data should be shown in our ThingSpeak chart view.

STEP 7. Now it's finally time to equip our ESP 8266 Wi-Fi with the new features. Just copy the API Key from the ThingSpeak website and paste it into the block.

STEP 8. Whenever the code block is executed, we will see a notification about the progress on the display of the ESP 8266 Wi-Fi Likewise, we will see our chart on the ThingSpeak platform updating.

7. ANALYSIS AND PLANNING

The rapid growth in the number of vehicles worldwide is raising the problem of the scarcity of parking . According to industry data, 30% of the traffic congestion occurs due to the struggle of vehicle drivers to find parking space. These in turn are magnifying the necessity of efficient and smart parking systems . Today's intelligent parking management systems are capable of providing extreme level of convenience to the drivers, automating and simplifying the business operation and administrative functions of the parking site owners. Trends are emerging in Parking some of are the few trends having the greatest effect on Parking Industry . The high growth rate in the registration of new cars worldwide, with major boom from regional economies like Asia Pacific (APAC), will open the window of opportunities for parking management business. The upcoming and ongoing smart city projects worldwide will create room for the intelligent parking management systems. From 2014 to 2019 the global parking management industry is expected to expand at a Compound Annual Growth Rate (CAGR) of 11.4%. In 2014 the parking management market is estimated to be at $5,025.9 million. The growth in vehicle ownerships and parking facilities development is expected to grow the market in tandem . The key drivers for the parking management industry are the need for smooth traffic flow, business benefits to the parking site operators, less hardware and connectivity costs. Traffic congestion and gasoline prices lead the list for the major changes having significant influence on parking. The population growth of rural and urban city is shown in Fig 7.1
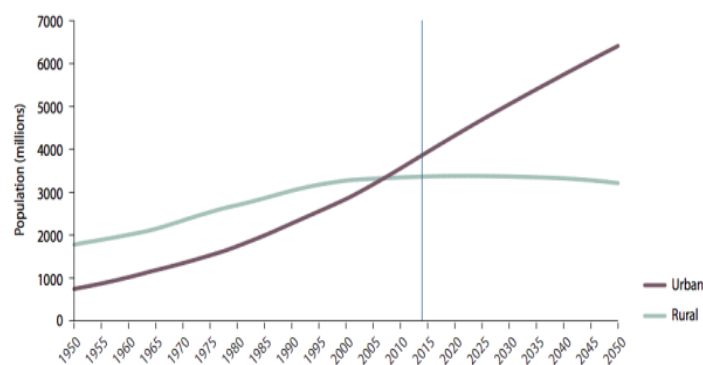

Fig 7.1 Population growth

8. CHALLENGES

Cities must turn into gentle, smart and efficient places and evolve to become Smart Cities. Regarding mobility it should imply
– Improve infrastructures and public transport flow.
– Availability if dynamic systems to guide the traffic towards its final destination, the parking.
– Promote the use of autonomous, connected, electric, smart and non-polluting vehicles to reduce traffic, noise and pollution.

– Get a more effective and ecological parking that allows the driver to find the free parking space quickly, safely and with the minimal energetic consumption.

The challenges for the proposed system are wide from protecting the system from environmental conditions and harsh weather so as to making it operational in all weather. Integration of the devices amongst various hardware and software modules. Protection can be provided by using a proper insulator case for the hardware module which will not affect the functionality of the device and also provide durability, resistance against external weather and mechanical forces. The major challenge in Parking Systems is of system integration due to wide variety of hardware and software platforms involved and hence possess a great concern to the system scalability. The technology platform supporting P&E, PARC and PUCRS systems comprises of dynamic messaging systems, a myriad of hardware sensors and traffic control devices, wireless and wire line telecommunications systems, computer clients, servers and hardware drivers and application interfaces. Enabling all these devices from thousands of different vendors to communicate with each other and tying them together into one platform is the greatest challenge in reducing the complexity and cost of smart parking. The variety of infrastructure hardware and software systems that need to be integrated is enormous and an add-on to it the conventional older hardware making investment in Smart Parking solution. It is highly risky and fragmented. Another major pain point comes from the electronic payment vendors. These payment processors provide permit based electronic payment, typically for a convenience fee.

Scalability is the key to many of these hosted solutions which is the ability of the transaction processor to support over wide geographical market and service areas with minimal cost.

10. FUTURE SCOPE

The smart parking management system can be broadly applied for many future applications. Apart from its basic role of parking management of cars it can also be applied for plane and ship and fleet management. With the ever growing field of Internet of Things many concepts can be interfaced along with our system. Smart Parking system can be modified into fleet management of ship and plane with very few external hardware changes and almost the same software just replacing the interface fonts of cars with ship or plane for better Graphic Interface and real world application based visual appearance.

For residential and domestic parking system the device can be interfaced with Home Automation system which can control the various home appliances by sensing whether the user is arriving or departing from the parking space. For instance if the user has arrived then the module will sense the presence and will send information about arrival to the Home automation system which can accordingly switch on the selected appliances like HVAC (Heating Ventilation and Air Conditioning) units, Coffee maker, toaster, Wi-Fi routers etc. Likewise by sensing the departure of the user the module can send the information to Home appliance system which can then switch off all the appliances except the programmed list of refrigerators and misc applications. It can also activate the home security system.

For commercial parking system the device can be interfaced with a module which can sense the arrival of employee and can switch on his computer and HVAC systems and accordingly switch off the appliances when the employee departs. The system can also be used to track the reporting and departing time of the employee for all days with precision thus acting as an attendance system. Thus many such modules can be interfaced with our system to provide better facility, security, and optimization of electricity and resources with the principle idea of flawless fleet management system. This is a prototype which has a potential market in Indian ecosystem so this project can be developed into product if the implementation is as desired and gives real-time output. In the long run, smart parking can transform the very makeup of our urban landscapes and making them more manageable to people rather than cars.

CONCLUSION

Smart parking facilitates the problems of urban livability, transportation mobility and environment sustainability. Smart Parking technology is used for enhancing the productivity levels and the service levels in operations. It also benefits in terms of lowering operating costs and increases revenues and facility value. Proposed system has developed from traditional servicing channels like toll-booth and parking attendants. It involves the use of Ultrasonic sensor, Arduino Uno, ESP8266-01 Wi-Fi Module, Cloud server. The Internet of Things integrates the hardware, software and network connectivity that enable objects to be sensed and remotely controlled across existing network. Such integration allows users to monitor available and unavailable parking spots that lead to improved efficiency, accuracy and economic benefit.

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