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A Survey: Smart Parking System Using Internet of Things (IoT)

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Abstract- *A Smart Parking System is implemented to automate the parking using a cost-effective system where various sensor nodes are deployed on different slots of the parking area. These sensors sense the vehicle and send the data to the base station and the cloud by forming a wireless sensor network. The collected data is used for analysis and to take the parking decision based on the availability.*

Keywords- *Smart Parking System, parking slot, sensors, wireless sensor networks (WSNs), Internet of Things (IoT)*

I. INTRODUCTION

A research about vehicular traffic has brought to light a startling fact that around 30 percent of the traffic congestion is due to the vehicle drivers struggling to find parking space. Such a large amount of time and precious fuel gets wasted in a petty thing which can be avoided easily by the use of technology, especially in the urban areas. While currently drivers rely on the inefficient trial and error method of moving around to find a parking spot until one gets a free slot. The time and fuel consumed is a lot and there is no guarantee that a free parking slot would be obtained in the end. A way to get rid of this inefficient problem is through smart parking. It helps a driver find out the parking spot easily helping him save time, fuel, money and also reduces the stress substantially.

II. SMART PARKING SYSTEM

The amount of vehicles is growing day by day. Smart parking provides the simple solution. Smart parking is a parking system that utilizes various techniques to efficiently manage the current parking system [1]. Several countries including India have undertaken smart parking development. Smart parking provides an easy method to park vehicles especially on street. It works on sensors that senses the existence of vehicles and then directs the arriving drivers to vacant space.

Smart parking systems can be classified into different systems: transit based information system, PGIS: parking guidance and information system, E-parking and automated parking smart payment system [1]. In [2] the sensors and detectors used in smart parking system is classified into two major categories: in-roadway and over-roadway sensors.

- In-roadway sensors are used by drilling under the road surface and then deploying the sensors under the road. This is not used often as it increases cost and is hard to implement as it involves drilling the road and then resurfacing it. Inductive loops, Magneto resistive sensors, Active infrared sensors and Magnetometers are examples of in-roadway sensors.
- Over-roadway sensors overcome the drawbacks of in-roadway sensors as they do not require the drilling of roads and thus they are easily installed and maintained. Examples of Over-roadway sensors includes: radar, passive infrared sensor, RFID, passive acoustic array sensors, ultrasonic and video image processing, and microwave.

III. SMART PARKING USING DIFFERENT TECHNIQUES

A. Zigbee technique for smart parking

ZigBee is a wireless mesh network standard embattled at the wide evolution of extended battery life devices in wireless control and monitoring applications. Zigbee devices have short latency, which advance reduces regular current. ZigBee is a low-cost and low-power device. ZigBee chips are typically included with radios and with microcontrollers. That radios and microcontrollers have between 60-256 KB of flash memory. ZigBee operates in the industrial, scientific and medical radio bands that are 2.4 GHz in most jurisdictions worldwide; 868 MHz in Europe, 784 MHz in China, and 915 MHz in the USA and Australia. Data rates differ from 20 kbit/s to 250 kbit/s.

In [3], the parking region is alienated into grids each having distinctive identity as of which the moving object can be tracked and recognized. Here, the moving object can be a human or a vehicle. Object can be identified using size of the grid; large one is for vehicle and small one for human. Here, the system is built on WMN: Wireless Mesh Network of Zigbee nodes. It uses image sensors and LED lights equipped with sensors and Zigbee nodes which can be operated locally and remotely. The wireless nodes consisting of cameras are distributed over parking area captures the licensed plate of vehicle and sends the data to remote nodes through wireless gateway. The LEDs are controlled based on traffic allotment during variant hours. LEDs are set to full intensity or zero intensity when any object is detected to update the information. When parking has no activity then the lights will be set to dim or fully off. And the updated data about parking area is exposed on central LED/LCD screen.

In [4], the system is implemented in two phases. In first phase, an Android application is deployed on user's mobile phone and server will list out the available and non-available slots. There are two major modules that are Current-booking module and Advance-booking module. In current booking module user can book the available parking slot for specific time and specific day while in advance booking module the user can book the slot in advance. User should enter the car number and period of time for which they want the slot. Both modules also play the role for payment. After payment has been done the data is updated in the server. In second phase, the hardware implementation is done. Each car has RFID tag and the reader at the gate read the tag and sends the data to parking lot section via Li-Fi or Zigbee module. Microcontroller stores and updates the empty slot when any vehicle leaves the parking slot. IR sensor is wont to sense existence of vehicle. This sensor is interfaced with microcontroller.

In [5], the parking guidance system works on two main modules named parking information collection and parking information distribution. The parking information collection module uses geometry sensors which are installed on parking space and detects the incoming and outgoing vehicles and finally collects and updates the data. The second module which is parking information distribution will transport the collected data through Zigbee. The Zigbee then releases the data in various ways such as in desktop application, mobile application or traffic guidance screen.

B. Smart Parking automation supported by ultrasonic sensors.

In [12], the indoor and outdoor parking slots are equipped with wireless sensor motes which is combination of Ultrasonic sensor and Bluetooth. These wireless sensor motes are equipped on the ceiling of the parking area for indoor parking slots and for outdoor parking slots the magnetic sensors are used. The wireless sensor motes collect the information from ultrasonic sensors and communicate with user's smart phone application using BLE (Bluetooth Low Energy). It also sends mode ID and USIM (Universal Subscriber Identity Module) ID to server through Zigbee. The motes collect the data about parking slots and receive the USIM Id of Smartphone through Bluetooth. To get the service users can exploit the web application or mobile application.

In [8], each parking place is outfitted with one ultrasonic sensor which is managed by Arduino Uno controller. Here, SRF05 ultrasonic sensor is used. In order to make the system wireless, the Arduino Uno uses a Wireless XBee shield and an XBee Series 2 module. The Arduino Uno runs the Labview code which connects the sensor to MYSQL server and then it starts to sense the data. The sensor senses the occupancy of slot and this information is sent to user notification system which can be accessed through any computer or any smart device and it is built using Node.js javascript.

C. WiFi based Smart Wireless Sensor Network for Smart Parking System

In [13], the system comprises of chiefly three modules named parking space detection module, vehicles positioning module and background processing server module. In the parking space detection module, a sensor node with magnetometer monitors the magnetic field around the parking lot and determines the availability of parking slots via detection algorithm. In vehicle positioning module the WiFi is united with sensor network which provides the information about the location of moving vehicles to the server. All the data is processed by the server and provided to the user via application.

D. Smart parking by Wireless sensor networks

In [6], there are four major modules. 1. Wireless sensor networks module: this module collects the data from the light sensor and checks the status of parking area in real time. It then sends these details to Embedded Web-Server 2. Embedded Web-Server: It is responsible for receiving parking information from wireless sensor network and tracking the position of parking slots. It also sends the data to central Web-Server. This module is built on Arduino Uno and Zigbee module which uses IEEE 802.15.4 networking protocol for fast peer to peer networking. 3. Central Web-Server: It receives the information regarding parking from the Embedded Web Server. It displays the parking slot state and stores the data into MYSQL database. It is built on Linux Mint (Version 12) PC running Apache Tomcat 5 and MySQL database. Then it sends the data to user's mobile application. It immediately updates the information into MYSQL database as soon as it receives it from Embedded Web server. 4. Mobile device of driver: It gets connected to Central Web- server and receives the information from Embedded Web server and it also displays the available nearest parking slot.

In [7], the system operates using Proximity sensor that detects the parking spot at every two minutes interval. If car is available then no action will be taken. But if the space is empty then the wireless sensor node broadcasts the location to the server located at each parking spot. The server sends this information to the back-end server which stores the data into database. When the user enters the parking area with an active mobile application the server finds the vacant nearest parking lot and sends the location to the user.

In [9], the system is built on IRIS WSN motes with attached MTS420/400 light sensor boards and a base station connected to a PC. When a car enters the parking area it arrives the entry node first and it plows the light sensors. That time a fresh unique identifier is created and transmitted to the network. The sensors at the parking slots calculates the amount of light propagated and send the details to base station for further processing at every second. The program then creates a map that shows the available and non available slots to the user. When the user enters the parking lot the light from the sensor will be blocked and an ID will be recorded for that spot. And there is no distance between sensor and vehicle the slot will not be available in the map. When user leaves the spot the sensor again calculates the distance and

when the car arrives to exit node the lot will be available over again into the map. The user then pays according to the time they have used the parking facility.

In [10], the design of Smart Parking (SPARK) management system consists of following main parts: WSN, Sink, Automated Guidance, and Entrance Display, Parking Management, and Client Reservation subsystems. The system will be able to display real time information related to the occupancy of parking slot to the users graphically and also enable users to reserve parking slot from distant locations. The system will also lead the users to their proper location.

E. Raspberry Pi technique for Smart parking

In [11], the system is consisting of major six components. 1. Centralized Server that manages the database which contains the information of parking areas in the city. 2. Raspberry pi: the microcontroller which is used to apply smart parking system and it is connected with raspberry pi camera. 3. Pi-camera is used to capture the image of parking area constantly to authorize the slots which are either full or blank. 4. Navigation system: which navigates to the nearest available parking slot. 5. Display device: This is at the admin side that modifies the data by observing the occupancy of the parking slot. 6. User device: user can interact with the system by mobile or web application.

In [14], the system is based on Raspberry pi and ultrasonic distance measure sensor and Pi-camera. Both Pi-camera and sensor is connected to Raspberry pi. The camera captures the images of number plates and sent to Raspberry pi which broadcasts the presence of vehicle. Raspberry Pi which is installed with Wiring Pi APIs will be using OCR4J for rasterizing received image feed to find the number plate details of the car.

F. RFID based Smart Wireless Sensor Network for Smart Parking System

In [15], the system is made as such so that the users are divided into 2 i.e. the regular users and the temporary users. The regular users are issued the RFID tags/cards which can be read by the readers at the entry and exit points. The temporary users are not issued the cards and hence they are provided with cards at the entry point which they will have to submit back at the exit point. In the case of regular users, the RFID tag is read at the entry point and then the driver is directed to the empty spot in the parking lot. If there is no parking spot available then a display of "no parking spot available" is shown at the entry and thus the user could directly exit. The parking spot is indicated by the way of sign boards through which each driver is able to find his/her respective spot easily.

In [16], the working of the system is divided in 2 parts. In the first part the identification of the vehicle is done in order to carry out the further operations. If the vehicle is registered in the database then the RFID tag is read and the database entry is then updated. But in the case of an unregistered vehicle, a new RFID tag is generated on a temporary basis which is then returned and reused after the exit of vehicle. After the identification phase an OCR is used to read the number plate of the vehicle. This is done by using the image processing algorithms and because the format of the number plate of a vehicle remains the same, an accurate output can be generated. After generating the number, it is then entered in the database for the record. Similar record is made when a vehicle leaves the parking. Separate facilities are also provided such as VIP parking wherein a separate parking slot is kept vacant for the VIPs or in some cases ambulances as well.

In [17], the system works with the help of the several sensors which are placed in the parking lot. These are called as the R nodes and RR nodes. They are used to check whether the parking slot is occupied by the assigned vehicle or not. They relay the information to the central server which keeps a record of all the activities. If a parking spot is occupied by an unauthorized vehicle or a vehicle has been at a spot for a time more than what the customer has paid for then a message is sent on the app of the traffic police stating that there should be a fine to be paid by the owner. There is also a payment gateway incorporated in the system itself which works via NFC. When a mobile phone is brought near the payment bridge within 2 to 3 cm, the required amount gets deducted from the user's account.

TABLE I. COMPARISON OF WIRELESS TECHNIQUES

Technology	Standard	Frequency	Range (meters)	Power Consumption	Data Rate	Cost	Security
Zigbee	802.15.4	2.4GHz, 868Mhz, 915MHz, 784 MHz	~10-20	Low	250kbps	Low	128bit AES
WiFi	802.11	2.4GHz, 5GHz	~30-100	High	54Mbps	High	SSID
Raspberry pi	802.11	1.2GHz	~1-10	Low	150Mbps	High	SSID

IV. CONCLUSION

Automating the parking system has led to the ease in parking as compared to the traditional parking that creates traffic and wastes the time and also increases the carbon footprint. Smart parking system helps a driver find out the parking spot easily helping him save time, fuel, money and also reduces the stress substantially.

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