IoT Enabled an Efficient Vehicle Parking System

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Abstract. The parking of vehicles is one of the challenges in all smart cities and people are facing the problem on daily basis and wasting their lot of time to park their valuable vehicle on suitable places. In all parking places many human power involved, but they are still unable to manage at peak hours and people are facing the parking problem regularly. People are paying high amount of parking charges and still looking for proper places to park their vehicle which really frustrate them to search at big places and sometimes leads to traffic jam also. To solve such real problem, the proposed parking system, SCPMS (An IoT based Smart Vehicle Parking Management System) has been developed in which many IoT based sensors will be used for identifying the parking spaces of the vehicle and updated the location of display panel of parking slip counter.

The booking for parking will be based on the availability of spaces and location will be marked in the slip. As a result with less human efforts, the people can easily park their vehicle at suitable place in shortest span of time. The proposed SCPMS system can be easily integrated at required locations for managing large crowds to avoid traffic congestion.

Keywords: Vehicle · Parking · Vehicle · Sensor · IoT · Traffic

1 Introduction

We noticed that with increasing population and increase in purchasing capacity the need for personal transportation has seen a tremendous increase over the years hence the increase for parking spaces at public places such as malls, supermarkets and big housing societies has also increased to provide adequate parking space for the people. With huge parking spaces comes the responsibility to manage it efficiently and conveniently so as to provide fast and easy parking solutions for the users [1].

Currently we see parking facilities hiring assisting staff to help customers who are driving in the facility with finding parking slots. To automate this task so as to minimize and possibly remove human intervention while users park their vehicle, Our system maps the parking slots into a dynamic real time virtual map that updates the parking slot availability as the user parks the vehicle, by sensing the existence of a vehicle in a

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parking area using Infrared sensors the system updates that particular slot as occupied and then displays it as occupied on the display [2].

As a user enters the facility with the vehicle he/she can look up in the system and see which all slots are occupied and which are available slots in the virtual map and can drive straight to the slot of their choice and then park their vehicle and leave, the system will sense the presence and update the system of the occupied parking slot [3].

In this chapter we will develop a parking system which will use IOT, Arduino, NodeMCU esp8266 wifi module. We will also develop an application for the user to use. Including the NodeMCU esp8266 which is a wifi module and the android application, the user parking slots booked by the user can be monitored from anywhere around the world. By automating this task of locating an available parking slot and guiding the user vehicle to it, we remove unnecessary human interference that was required otherwise for the parking facility. This helps in putting the human force to other tasks and creates a smooth parking facility without the need to appoint multiple assisting help [4].

2 Related Work

Building up a Smart Vehicle Parking System had fluctuating difficulties. Among them was identifying and following vehicles that were entering the parking garage. Our shrewd smart vehicle parking framework was created to give permission for the recognition of a vehicle when placed in the parking area and communicate the required information to the user with the end goal. There have been various tasks chipping away at the same frameworks. Among them were Guangdong AKE Innovation Company Limited, of China [5].

The Guangdong AKE Innovation Company Limited, China is a futuristic venture which manages information procurement and data operation as its centre of innovation and development. This association has created indoor, outdoors and city urban smart vehicle parking frameworks and parking management frameworks. This indoor leaving framework utilizes a module which is ultrasonic and there is a camera as sensor to peruse the item, and vehicle to convey the framework through the RS485 communication cable [6].

The framework measures the data which is accumulated securely from the sensors and showcases the conclusion through RED markers and GREEN markers to the framework clients. A similar thought is implemented in the open air parking framework; the solitary distinction of this chapter is that it extensively uses a sensor which is geomagnetic and distinguishes the difference in magnetic field in that particular allotted territory and conveys the equivalent remotely to the worker giving the current status of parking lot to the client. This smart parking framework utilizes referential sorts of recognition sensors as outside frameworks for checking the accessibility of user parking slots in the whole parking area. The solitary contrast is that the status of the parking area is imparted through the LED lights or transmitted over the internet and it's status can be seen through the user mobile application or a web server by the clients provided for the user [7].

A comparable task had been finished by Smart Vehicle Parking System utilizing IoT [8]. In that chapter they gathered information from the sensor and got the yield through examining and preparing the information. Then Arduino transmits the signal from itself

to the servo motor and GSM module which is connected to it which then helps in giving instructions and sending notifications to the user. Every vehicle must have a RFID vehicle so as vehicle enters the parking lot the RFID vehicle of that particular vehicle will be scanned by the reader module which will help in maintaining the authenticity of the user details. Also this will help in giving the information about the available parking slots to the user along with the details of the lot which the user would have registered through a SMS on the registered mobile number of the user [9].

It consists of the Arduino devices and IR sensors. Interaction of users and parking lots will happen via these devices. The second section comprises cloud web services which will interconnect the user and vehicle parking area. All the updates in parking availability happen on the cloud side by side. There is an admin to administer the cloud but the user can check the availability of the slots too. The third section of the chapter architecture is dedicated to the end users. The availability of the user parking spots and the details of the registered slots are sent to the user via SMS. This is done through the GSM module. The user uses the mobile application to interact and find the parking area which is updated at real time because it is connected to the cloud. The user receives notification about the availability of the parking lot. This helps in saving time and fuel [10] (Figs. 1, 2 and 3).

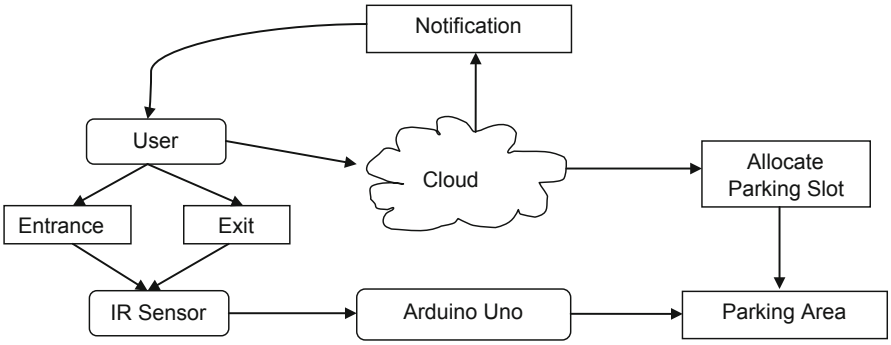

Fig. 1. System architecture [8]

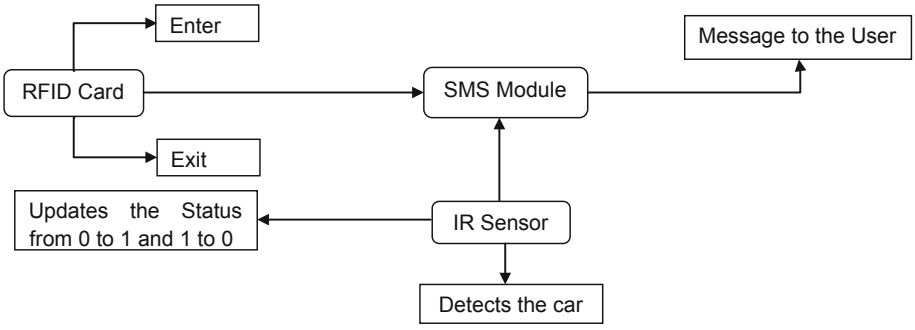

Fig. 2. Hardware architecture [9]

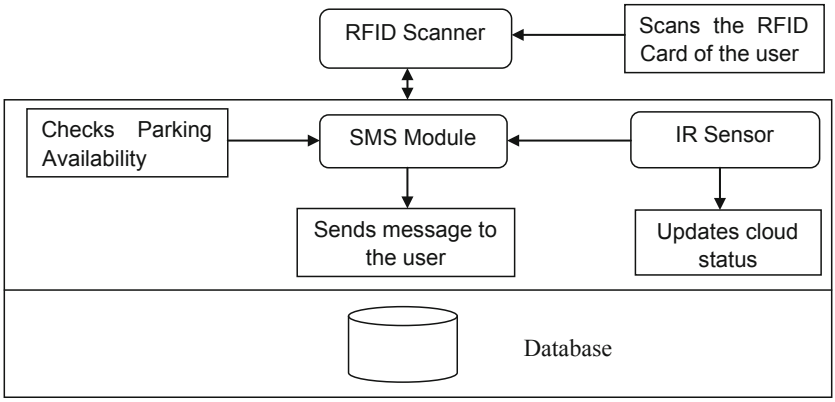

Fig. 3. Software architecture [10]

3 Problem Statement

We noticed that with increasing population and increase in purchasing capacity the need for personal transportation has seen a tremendous increase over the years hence the increase for parking spaces at public places such as malls, supermarkets and big housing societies has also increased to provide adequate parking space for the people. With huge parking spaces comes the responsibility to manage it efficiently and conveniently so as to provide fast and easy parking solutions for the users. The major problems are faced as follows:

- Increased number of private vehicles leading to chaos
- Need for huge parking areas
- Human assistance required during parking
- The time taken to find a parking spot.

4 Objective

Our chapter of a smart vehicle parking system will help to find the parking spot without wasting fuel and wandering in the lot or requiring human resources to guide the users. Also there will be an application for user convenience to check free free slots in the parking lot. The app will update the status of the parking lot in real time and the user can check the location on his phone instead of finding it manually (Fig. 4).

- Generating data regarding the slot vacancy
- Quick parking spot locating using the data
- Reducing the human assistance substantially
- Automating the whole parking procedure in huge parking areas.

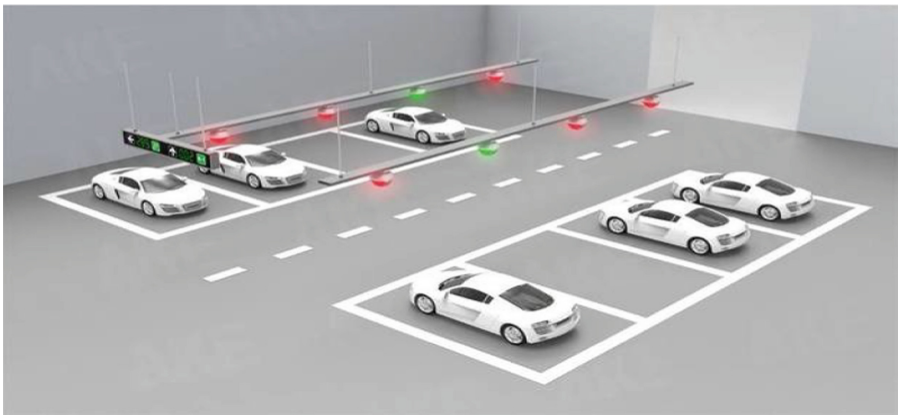

Fig. 4. Smart vehicle parking system

5 Proposed Methodology

There are 3 way approaches:

- Using RFID to register the vehicle entry and making payments
- Using IR sensors to register the vehicle presence in a particular parking slot
- Displaying the layout and availability of parking slots in the area.

The parking area is segregated into 2 parking lots.

- Parking A
- Parking B

Every vehicle leaves three spaces &each opening has an infrared sensor integrated in it. For each parking lot we have 1 IR sensor (infrared sensor), therefore there will be a total of 6 IR sensors. Each IR sensor is utilized to identify the presence of a vehicle which comes at that particular parking spot. These IR sensors are connected to Arduino. When a vehicle enters the parking slot, Arduino sends signals to the connected NodeMCU esp8266 wifi module, at that point NodeMCU sends signal to the mobile app through the cloud.

6 Implementation Analysis

6.1 Arduino Board

We will be using an arduino board to convert the input to output. Arduino is a developed reliable open-source platform for electronic development which is very developer friendly in terms of both hardware and software. Then these arduino boards take the inputs from the sensor which is activated whenever a light falls on it or when a finger is put the button or a specific type of message notification and it turns it into desired

output which could be turning a device motor on, switching on an LED. The board can be programmed such that it does a particular task on a particular set of instructions which are sent to the microcontroller which is attached to the system. To do the programming on Arduino an IDE is used which facilitates the same [11].

6.2 IR Sensor

An IR sensor which is used to detect the vehicle in this particular chapter. These sensors detect and capture the infrared emitted radiation. These radiations have wavelength greater than 0.7 micrometer There are three male headers in IR sensors named, VCC, GND and OUT(from left to right respectively). We connect the Arduino to the VCC pin of the IR sensor. Ground of the IR sensor is connected to the ground of the arduino. And finally the OUT pin of the IR sensor is connected to IO pins of the arduino [12].

6.3 NodeMCU ESP8266

NodeMCU ESP8266 is a budget friendly, WiFi module which is used to connect chapters of IOT or similar domains, to the internet. The electrical and mechanical equipment which we use today don't have an inbuilt feature to connect to the internet on their own. One can integrate these equipment with NodeMCU ESP8226 to perform many operations like controlling, monitoring etc. which require internet connectivity. NodeMCU ESP8266 can be considered as a System on Chip or SoC. A System on Chip is basically a circuit which integrates and includes every component of the computer or any other electronic device to be used [13].

6.4 Display Unit (LCD)

LCD displays everything on it's screen thus making it a very user friendly device. It has an inbuilt controller which intelligently converts alphabets and digits into their individual ASCII code and then displays it on the screen and the plus point is we don't have to manually specify which LCD combination will light up when a particular alphabet or digit comes [14].

6.5 RFID Tag

In the RFID tag there is an antenna and a microchip through which data is transmitted and received. Sometimes this tag is integrated in a circuit and is called IC. The user codes the RFID tag for whatever purpose he wants. The RFID tags are divided into two types, first is Battery operated tags and second is passive tags. Like the name in battery operated RFID tags there is a battery and a power supply for the tag. If we talk about a passive RFID tag, it uses the electromagnetic energy which the RFID reader transmits to the information. Apart from these two types there is also a battery operated RFID tag available [15].

There are basically three frequencies which a passive RFID tag uses. First is LF (Low frequency) which is in range 125–134 KHz. Second is called HF (High Frequency) range

which is around 13.56 MHz and third range is called NFC (Near - Field Communication) which has frequency in the range of 865–960 MHz. NFC is also sometimes referred to as UHF (Ultra High Frequency). There are different tags available with different frequencies.

6.6 Details of Work

The primary stage is to distinguish the left vehicle. For that, one IR sensor will be introduced in each parking lot. The sensor will be introduced before the vehicle, at a height of hundred centimeters from the beginning. The principal stage will be effective when the sensor will recognize the vehicle inside its vicinity.

When an arduino transmits the signal to an IR sensor and those signals are received by IR sensors, then sonic waves are emitted by it. These waves then travel and reach the vehicle standing in the parking lot and are reflected by it. After reflection of these waves they are sensed by IR sensors. Which then tells us if the lot is empty or not. The time elapsed between this process of reflection and sensing highly depends on the distance at which the object (in this case our vehicle) is present with respect to the IR sensor. Sensor then sends a signal to the arduino. The signal sent is in the form of a timing pulse. The timing of this pulse depends on two factors, distance and the program which is uploaded in the module. If after processing the information the distance between sensor and vehicle comes out to be greater than 150 centimeters, it will consider the slot as empty and the red led in the user application is turned to green. And if the distance comes out as less than 150 centimeters then similarly green led turns red in the application. We will be doing the following steps to implement this chapter-

Step-1: Every vehicle leaves three spaces & each opening has an infrared sensor integrated in it.
Step-2: For each parking lot we have 1 IR sensor (infrared sensor), therefore there will be a total of 6 IR sensors.
Step-3: Each IR sensor is utilized to identify the presence of a vehicle which comes at that particular parking spot.
Step-4: These IR sensors are connected to Arduino.
Step-5: When a vehicle enters the parking slot, Arduino sends signals to the connected NodeMCU esp8266 wi-fi module.
Step-6: At that point NodeMCU sends a signal to the mobile app through the cloud.
Step-7: Now the user can see the status of the slots using the app.
Step-8: If any user does not want to use the app, then he/she can go to the parking lot and see the status of the parking lots from the LCD screen which will be present outside the parking lot.
Step-9: When the user enters the parking lot, their RFID tags will be scanned using the RFID scanner.
Step-10: This scanned RFID tag will be used for payment purposes (Fig. 5).

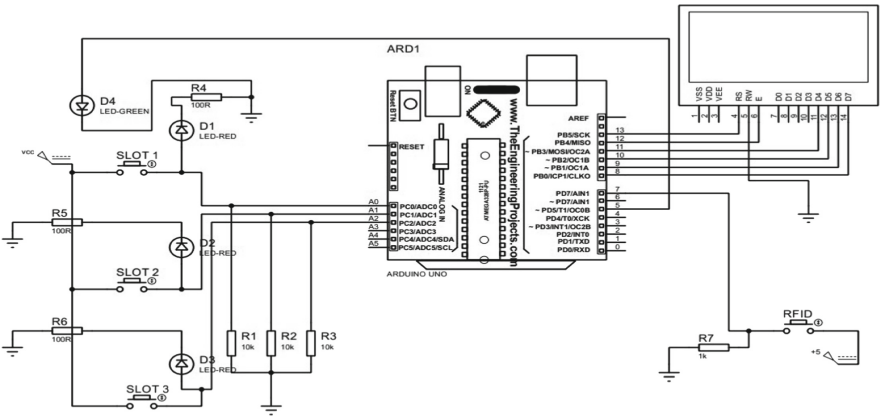

Fig. 5. Circuit diagram

7 Analysis of Results

As a result of the Smart Vehicle Parking system we aim to increase the convenience to the users and save the need to hire helping staff by the parking facility. In simulation, we successfully implemented the Smart Vehicle Parking system which uses RFID. Any vehicle without RFID will not be permitted inside the parking lot. The status of the parking slots will be displayed on the LCD screen in real time.

We further plan on adding some more convenience and advanced features like Automated payment gateway through the vehicles RFID tag, Nearest parking slot navigation assistance, Integrating nearby parking facilities to work in tandem and parking slot booking in advance etc. (Fig. 6).

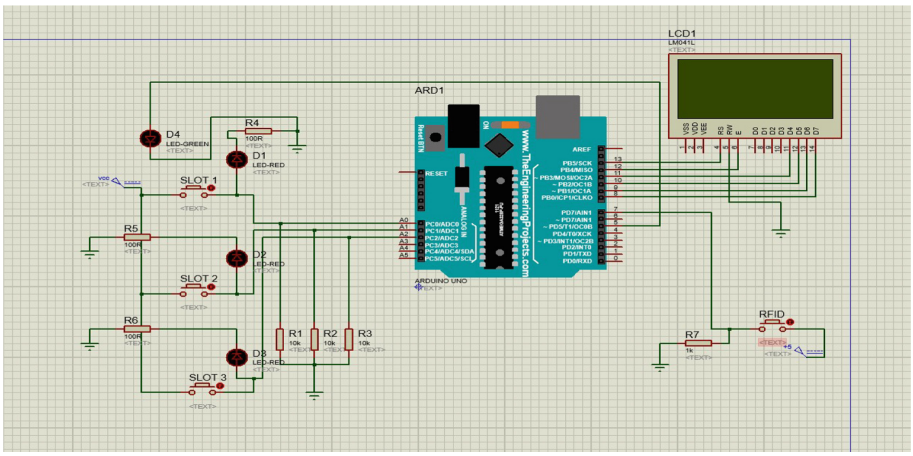

Fig. 6. Proposed smart vehicle parking system

8 Conclusion and Future Scope

Smart vehicle parking systems will successfully help in parking without the help of human assistance and thus increasing the efficiency of the parking facility through automation. In future scope, we would further like to add the following features:

- Automated payment gateway through the vehicles RFID tag
- Nearest parking slot navigation assistance
- Integrating nearby parking facilities to work in tandem.

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