ISSN 2321 3361 © 2018 IJESC

Research Article Volume 8 Issue No.4

Mobile Application for IoT based Smart Parking System

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Abstract:

We are now in the 21st century where everyone needs everything instantly. From instant ticket booking to the recent rise in e-ǁallets ǁe'le seeŶ it all aŶd deŵaŶd ŵore. EǀeŶ a small delay in getting parking space leads to frustration and in a populated couŶtry like IŶdia it's ǀery difficult to predict which parking slot is vacant and which is not. So, voila! We have come up with a novel solution to overcome this situation by providing a Mobile Application for IoT based Smart Parking System. IŶ this paper we take a look at the same system, the components iŶǀolled iŶ ŵakiŶg the systeŵ, it's ǁorkiŶg aŶd hoǁ it staŶds apart from the other systems in existence.

Keywords: Wireless Sensor Networks, Ultrasonic Sensors, Arduino IDE, Ethernet, Internet of Things.

I. INTRODUCTION

As human beings have evolved over the years so have their requirements. From food, water and shelter to the current scenario of electronic devices, means of transport, everything has changed. So much so that almost every person living in the city has their own vehicle. In fact, in the last decade passenger vehicle ownership has nearly tripled. According to a recent study by the International Energy Agency (IEA), passenger car ownership in India will grow by 775 per cent over the next 24 years [7]. So, the question that pops up is, are there enough parking spaces to accommodate the rising number of vehicles? And, if the answer is Yes! Then is it possible for the driver of a vehicle to find a parking space in a small amount of time? The answer most of the times is No. While searching for a vacant parking spot, fuel is lost, and time is wasted; this also increases the traffic due to slow moving vehicles that are driving around the parking spaces [1]. Further it contributes to green house gas emissions (CO_2). A study from Boston University states that more than 30% of the drivers take around 7.8 minutes to park their vehicle [2]. All this leads to only one thing; the need of smart measures to park the vehicles without wasting too much time, fuel and money too!

II. TECHNOLOGIES USED

A. Arduino IDE
B. Adobe Photoshop

III.PROGRAMMING LANGUAGES USED

A. C++
B. JAVASCRIPT (JS)
C. NODE.JS
D. CASCADING STYLING SHEETS(CSS)
E. HYPER TEXT MARKUP LANGUAGE(HTML)

IV. IMPLEMENTATION

Now that we are acquainted with the pre- requisites, we can move on to the implementation part. The basic logic is divided into three parts:

- Architecture
- Hardware
- Software Interface

A. ARCHITECTURE

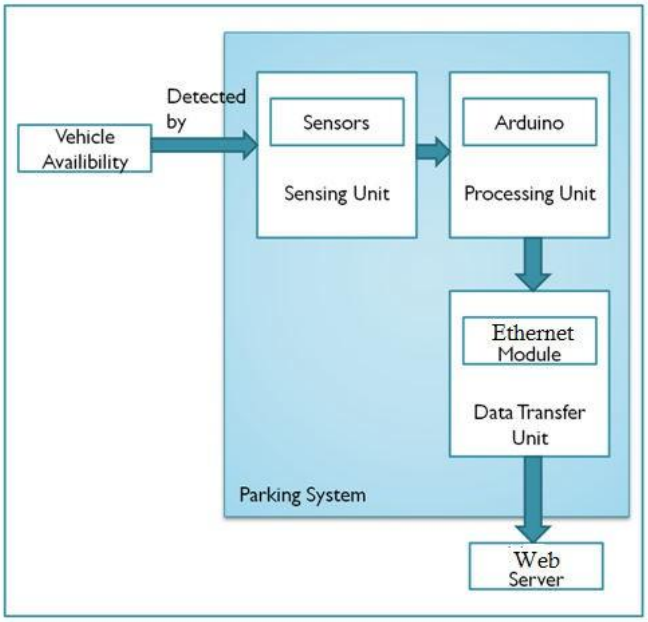

Figure.1. Proposed System Block Diagram

As the vehicle enters through the gate, it's directed to a particular parking slot. The Ultrasonic Sensors which are present on the slot detect the vehicle and send the vehicle detection data to the Arduino processing unit for processing. After processing, the Ethernet module transfers the changes reflected in the system to the centralized web server which then shows the same to the user on the Mobile Application.

B. HARDWARE

The following hardware components are involved viz. Arduino, Ultrasonic Sensors (2 per slot), USART. As we all know that the communication between all the hardware components is through interrupts. So, we generate the interrupt from the board(Arduino). The other side ports are also made aware of the interrupt generated. The USART (Universal Synchronous/ Asynchronous Receiver/Transmitter)

which acts as a connecting link between the hosting server and the Arduino, reads the interrupt generated by the board. A port value communication table is set up which we have decided by our logic for vehicle mapping i.e. when both the sensors detect the vehicle then only can we consider that the vehicle is parked and assign a value of '1' in the port value communication table. '0' indicates that the slot is empty. As the sensors do not have the ability to function on their own, we provide them with a power supply of 5V, 15mA. We have updated the power board using a strip of parallel line for multiple sensor support.

C. SOFTWARE INTERFACE

The Software Interface updates the logical value received from the boards, into the SQL tables. From the tables we generate a display chart using the empty slotting technique. Empty slot technique uses the modulus functions for handling large number of parking slots. In short, this technique gives us a list of slots showing their status i.e. Occupied or Vacant to the end user in his/ her Web App, so that they can park their vehicle accordingly. The user is also given the freedom of booking the parking lot before arriving at the location provided, he/she reach the parking slot in a given time duration. After the user makes a booking, A Booking ID is generated which is sent immediately to the user/s on their email. On the contrary, if the user doesn't reach the parking slot on time, the booking is cancelled and the slot is made available again to other users who may wish to park their vehicle in the same.

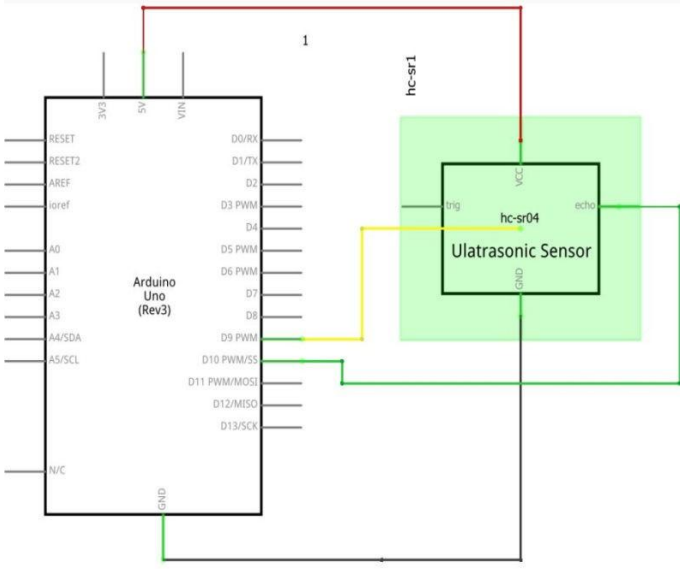

Figure.2. Interfacing of Arduino with Ultrasonic Sensor

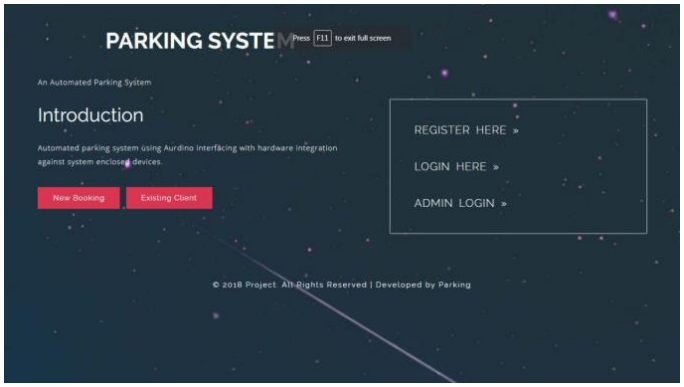

Figure.3. UI for Web Application

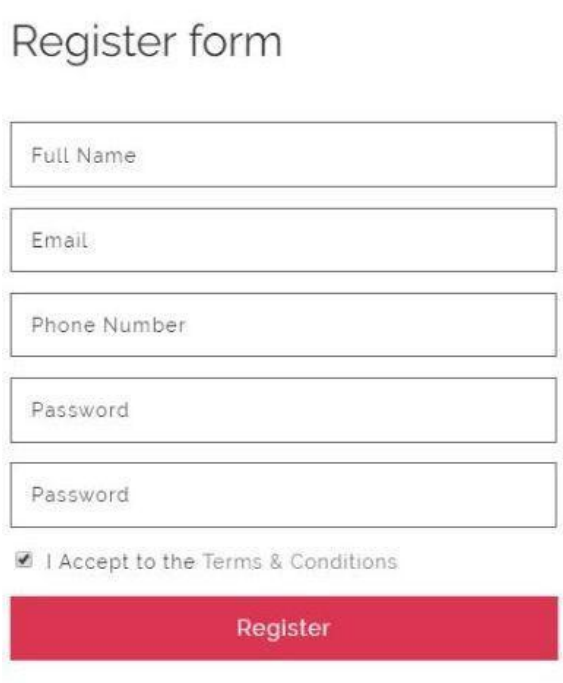

Figure.3. Registration form Implementation

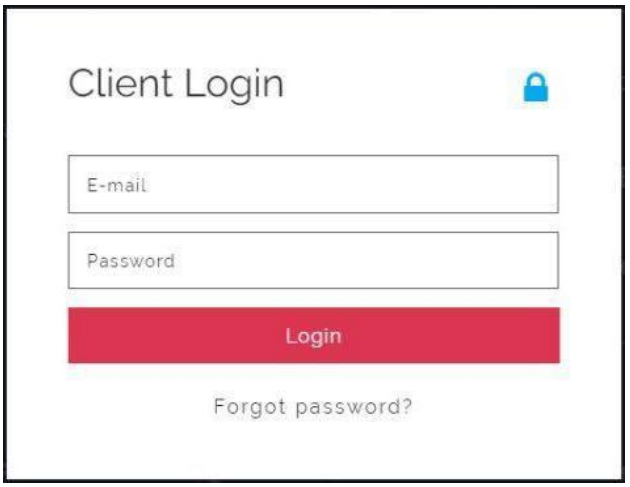

Figure.4. Client Login Implementation

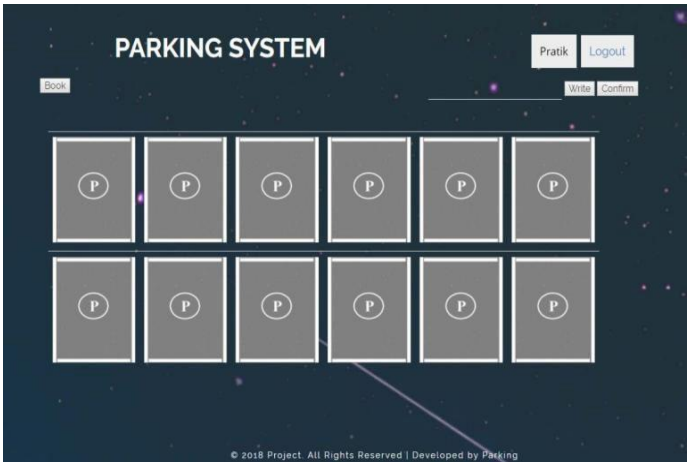

Figure.5. UI after Login

V. COMPARATIVE STUDY OF ALL METHODS

The comparative study of all the techniques that provide solution to the problem of finding parking spaces in an efficient manner is given in the below table.

Table.1.Comparison of Sensor Technologies

Technique	Installation	Maintenance	Cost	Accuracy
Proposed System (Ultrasonic Sensors)	Two per parking slot	Medium	Moderately Expensive	Accurate
Visual Sensor Network	Ceiling Mount	Medium	Expensive	Fairly Accurate
RFID	Ceiling Mount	High	Economical	Accurate for limited range
Magnetic Sensor	One in each two parking spots	High	Economical	Highly Accurate

The proposed system uses Ultrasonic Sensors that are reliable and efficient. The use of 2 Ultrasonic Sensors per slot increases the accuracy of the system. They have an effective range of 4.5 m and operate within a wide range of temperatures from -10 $^{\circ}$C to +50 $^{\circ}$C. It is efficient because of its fast response time of 25 milliseconds and sensing angle of 15°. Also it provides good amount of accuracy in the result obtained, so this system is quite favorable. The only drawback of this system is that it's a little bit expensive. Visual Sensor Networks have vision capabilities which enable easy monitoring of the available parking space. A comprehensive and integrated system without human intervention can be developed using Visual Sensor Network of distributed Cameras. The system works on Analyze-then-Compress technique which reduces the generation of multimedia data. A simple file system can be used to store the images generated by camera. Mobile smart devices are used for end users which facilitates navigation of vehicle to the available parking spot. Some limitations of this system are as follows: The Cameras generate a large amount of data which makes it difficult to manage and process data. It also consumes a high amount of power which makes it difficult to operate using embedded OS. The System may not provide proper results if the climatic conditions are bad especially during heavy rains. The cost of the system increases as different cameras need to be installed for night vision. RFID is low cost and low power technology. It consists of RFID tags and readers. RFID tags are passive devices i.e. RFID tags don't need a source of energy to operate. They get powered with the electromagnetic field generated by RFID reader. RFID tags also have memory to store information. This memory can be used to identify the object which is being tagged uniquely. RFID tags have a good lifetime. Their lifetime can be measured in decades.WSN consists of low power embedded devices (ex. Sensor nodes). Sensor Nodes are able to self-configure and self-organize. Overall advantages of this smart system will be that traffic congestion will be reduced as drivers will be informed in advance about the availability of parking spaces at and around their intended destination. Ultimately road accidents rate will decrease as people will not park vehicles on the roadside. Also finding the parking spot will become easy. Searching time for parking spot reduced. In a case of some emergency, this searching time can be utilised for some other work. One of the main limitations of this system is that RFID tags get powered up only when they come in the electromagnetic field generated by RFID reader. Thus, the range between RFID tag and RFID reader is the biggest constraint. But it can be overcome by WSN. The sensors used in WSN must be efficient i.e. they should sense and react immediately. As RFID reader will be continuously functioning regular maintenance of the RFID reader will be required. Magnetic Sensors have great potential to be employed in critical situations, as it can withstand drastic weather changes. The magnetometers available can sense magnetic fields with the geomagnetic field below 1 Gauss hence they can be used for detecting the vehicles made of ferrous objects that disturbs the earth's magnetic field. Also, the resistivity obtained for each object is different hence it is very easy to distinguish between ferrous objects and any other object. The algorithm for detecting change in magnetic field can accurately detect parking space occupancy. The system is stable and has high detection accuracy. The key advantage is that the network can be deployed easily and can operate without the need for any pre-existing infrastructure. It provides end user application which navigates to desired parking space without any time consumption. Total cost of system is affordable and easily installable allowing for the use of the proposed solution in whichever existing parking area. Some drawbacks of this system are proper maintenance of sensors is required and as number of sensors is proportional to the parking slots hence it becomes difficult to maintain them. Also efficient data processing and data analyzing units required to process such a huge data generated by sensors. Work is needed both at sensor level and signal processing level to improve the reliability of the reading.

VI. CONCLUSIONS

We have seen an overview of all the techniques involved to provide a smart parking system to reduce the time involved to find a parking space in the parking lot and also save fuel. So, after studying all the techniques involved in finding a solution to the given problem, checking feasibility of implementation of the proposed system and with the proof available we can conclude that the use of Ultrasonic Sensors is by far the best technique in our opinion. Their advantages easily outweigh the limitations of the other techniques involved and hence the use of Ultrasonic Sensors becomes a unanimous choice.

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