RESERVATION BASED S-PARK SYSTEM USING EMBEDDED SERVER AND ANDROID APPLICATION

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Abstract

Searching for a parking space in most metropolitan areas, especially during the rush hours, is difficult for car drivers. This problem arises from not knowing where the available spaces may be at that time; even if known, many vehicles may pursue very limited parking places to cause serious traffic congestion. In this project, we design and implement a prototype of smart parking (S-Park) system that allows drivers to effectively search and reserve the available parking spaces using an android application. By polling the parking status from the sensor networks deployed in parking lots, the reservation service is affected by the change of parking status. The drivers are allowed to access this system application on their Android Smartphones. The proposed reservation-based parking policy has the possibility to simplify the operations of parking systems, as well as minimize traffic congestion caused by parking searching thus making the parking system two-way efficient, that is, cost wise and time wise.

Keywords: *Smart Parking System, Android Application, Embedded Server, One Time Password.*

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1. INTRODUCTION

Finding the parking space in metropolitan areas is now becoming time inefficient. Due to mismanagement in the parking places, it is difficult for drivers to find the parking slot which outturns more traffic congestion and air pollution by constantly wandering in certain area for available parking place. Many parking systems are trying to reduce such traffic congestion and improve convenience for car drivers. There are some currently working parking guidance systems which traces available parking space information from deployed sensors and provide it to drivers[5]. However, these systems are not helpful to guide the drivers to find the proper parking slot in the parking place. When available parking spaces are limited, and if more drivers are heading towards these spaces, it will cause traffic congestion. Even though driver reaches the parking area, there are certain issues such as blind search [3] in finding the empty slots. It causes not only wastage of money but wastage of fuel and time also. To solve this problem, techniques like buffered parking information sharing(BPIS) [3] are used. But determining the number of buffered spaces is another problem and it is difficult. If buffered spaces are less, there is problem of "multiple-cars-chase-single-space". If buffer is large then that is inefficient utilizations of parking slots.

There are some systems like smart parking service based on wireless sensor networks [1] which uses wireless sensors to effectively find the available parking places. But to use this system, additional hardware is needed to be installed in the car which is not feasible. New Smart Parking System Based on Resource Allocation and Reservations [2] has facility to reserve the parking space for fixed amount of time. However, if the driver is not following the timings as per reservation it will cause inconvenience for others.

The solution proposed in this project works as when user wants to park car in the legal parking, the user uses the Android (S-PARK) application to check for available parking slots [13]. The availability is updated by the server when the user opens the Android application. If the slot is available, then appropriate information is displayed on screen.The user then enters the user name, payment mode and payment details. These details are stored on the server and an One Time Password (OTP) is generated, which is then displayed on screen after payment is verified. This OTP is then valid for a specific amount of time after which it expires. The user when reaches the parking, is required to enter the valid OTP on provided keypad and based on the current availability of the parking slots, the available parking slot is allocated.

The proposed solution provides an efficient method for providing parking space to the user as they are allotted specific and unique OTP (One Time Password) on successful booking of parking slots from their mobile. This eliminates the need of human intervention at the parking space, as the user simply needs to enter the OTP at the console provided at the entrance of the parking. Also the provided OTP remains valid for a pre-defined amount of time which eliminates the issue of the user booking the space and not showing up which can result in under utilization of the parking lot.

2. SURVEY

2.1 Literature Survey

The major focus of the technology being reviewed here is Parking Assistance Information (PAI) System. It is known that the first PAI system in the world was started in Aachen,

Germany, in the early '70s. Ever since then, the technology has been deployed effectively all across the globe. There are a variety of sensor technologies like infrared, lasers, machine vision, ultrasonic and inductive loops. The data collected by the sensors is sent to a central computer for processing.

Parking Guidance System (PGS) is state-of-the-art technology brought to India by AutoPass India, in collaboration with ST (Singapore Technologies) Electronics. Some features include: Providing drivers with real-time & accurate indication of available parking spaces, sensors located at each parking space monitor the occupancy, directional displays at each decision making junction, motorist guided to available space via shortest route, LED sign boards within lanes show the current occupancy.

Applying wireless technology, AKE Urban Parking Guidance System, China acquired the whole city's car parking information and displays real-time parking availability on dynamic guidance board at urban arterial road. The real-time information can be checked on guidance screen, mobile phone, vehicle navigator, website log-in and AKE service application. Data calculation & analysis are regularly done in the controlling system to show the equipment operating status, space available ratio and the real time parking information.

2.2 Component Survey

This section lists down the components used in the project and its features:

2.2.1 Server

Fig 1 Raspberry Pi as a server

The server used in the system is Raspberry Pi. The Raspberry Pi is a series of credit card–sized single-board computers developed in England, United Kingdom by the Raspberry Pi Foundation with the intent to promote the teaching of basic computer science in schools and developing countries. The model used is Raspberry Pi 2 Model B and its specifications include:
a. A 900MHz quad-core ARM Cortex-A7 CPU
b. 1GB RAM
c. 4 USB ports
d. 40 GPIO pins
e. Full HDMI port
f. Ethernet port
g. Display interface (DSI)
h. Micro SD card slot

Raspberry Pi has been configured as a server where it takes care of the requests from clients and serves them accordingly.

2.2 Sensor

The presence of cars can be detected in two ways. One, using proximity sensors and second, using camera based machine vision technologies. A proximity sensor has been used in the project so as to detect the presence of cars in the respective parking slots. Infrared, lasers, ultrasonic and inductive loops are some of options while considering proximity based detection. Of the above mentioned options, an ultrasonic sensor provides a stable and accurate detection of presence of cars at respective parking slots. HC-SR04 ultrasonic sensor has the following specifications:
a. Effectual angle (angle up to which the obstacle can be detected): 15°
b. Ranging Distance: 1cm to 450 cm
c. Resolution: 0.3 cm

The large ranging distance helps to detect a wide range of cars having varying ground clearances.

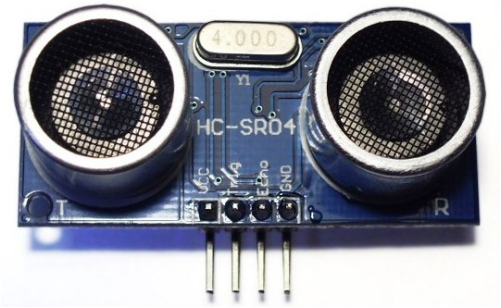


Fig 2 Ultrasonic Sensor HC-SR04

2.3 Display

A display is used to interact with the user. The display is used for displaying the parking slot ID that is allotted to the user once the user has entered the OTP. Display can be using seven segment LED or a LCD display. A 16 x 2 is used in the project as the number of GPIO pins that are required for an LCD display is much less than that required for LED display. Specifications of the LCD are:
a. Display Format: 16 Character x 2
b. Data: 4-Bits or 8-Bits interface available
c. Display Font : 5 x 8 Dots
d. Power Supply: Single Power Supply (5V±10%)

Fig 3 LCD Display

3. METHDOLOGY

In the system, the server sends the signals to the sensor controller which checks for the availability using the proximity sensors installed at each of the parking spaces. Based on the status of these proximity sensors, the occupancy and availability is updated on the server and appropriate information is then shown to the user whenever availability is checked on the android application. Now, when the user wants to book a parking slot, and a slot is available, payment method is chosen and payment details are entered by the user. On authentication and verification of the payment details, a space is booked on the server and a One Time Password (OTP) is generated which is a unique identification code for the user. That OTP is stored at both sides, that is, at the user side (android application) and server side. Now when the user reaches the parking slot, the OTP is required to be entered on the console.

This entered OTP is then verified with respect to correctness as well as reservation time limit and indicated to the user appropriately. On verification, the server checks for the available parking space and allocates it to the user and displays the allotted slot's location on the provided display. After getting the location, the user parks the car and the corresponding occupancy status is updated on the server using the proximity sensors.

As seen from the Figure 4, the central controlling and processing unit of the system is the server which performs multiple functions such as interfacing with the console, that is, display and keypad, connecting to the sensor controller to update the status of the parking slots, that is, whether empty or reserved or occupied and lastly as a server so as to receive requests from the client side, that is, smart phone connected to the network to check availability as well as book parking slots. Server also checks for the correctness of the entered OTP and gives the corresponding indication. The sensors with sensor controller, at each of the parking slots check for the occupancy of their parking spaces and give the corresponding status to the server which then updates its database. Then the smart phone on the user's side is used to check the availability status of the parking spaces at parking lot and if available book a space. Each slot is provided with ultrasonic sensor(HC SR-04) with 8-bit MCU(microcontroller unit) and each MCU is connected to the embedded server having TDMA type of multiplexing [4].

4. EXPERIMENTATION

Ultrasonic sensor (HC-SR 04) is interfaced with the sensor controller as shown in the Figure 2 below. The ultrasonic sensor works on the principle of SONAR (Sound Navigation and Ranging), that is, sending a pulse of ultrasonic waves of frequency 44 kHz when a signal of pulse width more than 10 ms is applied at the trigger input of the ultrasonic sensor. From an obstacle, the ultrasonic waves get reflected and are sensed by ultrasonic sensor which in turn generates a pulse at the Echo pin of the ultrasonic sensor. The width of this pulse at the echo pin is measured in order to find the distance.

Algorithm

1. Create Main Activity.
2. Create Book Activity and download the updated availability file from the server and if available go to next screen. If parking slot is not available then display the appropriate message on screen.
3. Create Payment options Activity and select payment mode and go to next screen.
4 .Create Payment details activity and accept details.
5. Generate OTP and send user's name and OTP to the server.
6. Save OTP on user's mobile. Update the status of slot to reserved.
7. When user reaches to parking, check the correctness of OTP entered by user with respect to digits as well as reservation timing.
8. If OTP is correct, then search the database for available parking space and allot the available slot to user.
9. When user parks the car, turn the status to occupied.

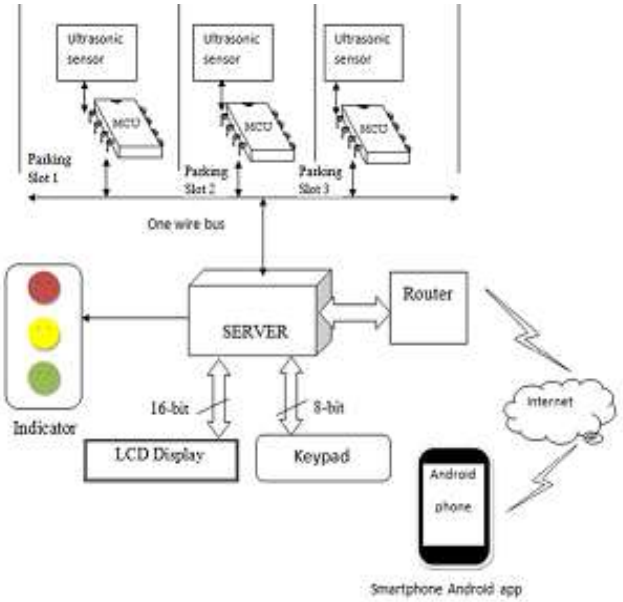


Fig 4 Block Diagram of Smart Parking System

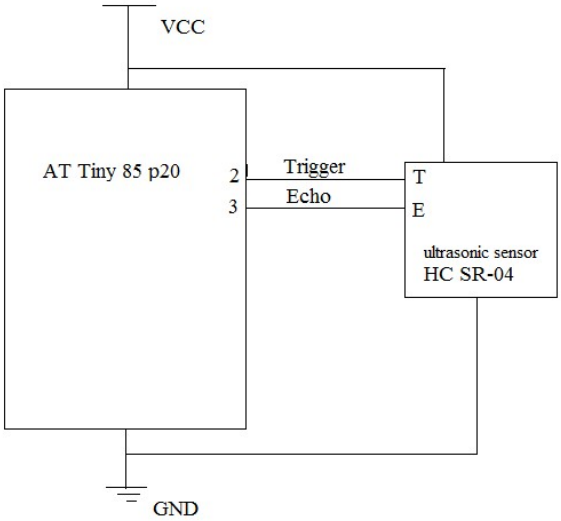
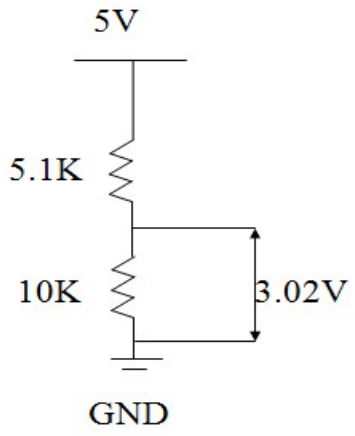


Fig 5 Ultrasonic sensor (HC-SR 04) interfacing

For interfacing Raspberry pi with sensor controllers a resistor divider is used to convert 5V to 3V. for this we have used resistors of 6k ohms and 10K ohms taking standard commercial available values. 5.1k and 1k in series to make 6.1k ohm. Voltage at output of following circuit is Vo=5*(10k/(6.1k+10k))=3.02V



5. RESULTS

The Android Application needs to connect to the network using username and password as shown in figure 6, and then request server to check for the availability and thus download availability information from the server as shown in Figure 7. The file is downloaded containing the current availability of the parking slots using Http URL Connection. If the available spaces are zero then, the "Book Now" button is freezes.

Then on the Bookspace screen, the payment mode is selected by the user, and followed by "Pay Now" button as shown in figure 8. User has to select either of the payment methods to continue. This is followed by Payment Activity wherein the user needs to enter the payment details which are then sent to the server as shown in figure 9. The final screen in the application is the OTP generation screen where on successful payment an OTP (One Time Password) is generated which is sent to the server along with the user details as shown in figure 10. The user then exits the App using the "Exit" button.

6. CONCLUSION

Searching for a parking these days is a difficult task and generally results in traffic congestion and loss of time and fuel. This project aims at alleviating such difficulties of the drivers by providing a reservation-based parking policy, thus reducing their problems and making the process of finding a parking place easier. This project provides a solution for reservation based parking by keeping a specific time limit for the cars to arrive to reserved parking. It also avoids underutilization of the parking space. This project also implements the online reservation application and payment facility so that there is assured parking available when driver reaches the parking. This system also provides online information of whether the parking if full or empty.

Fig. 6. Login Screen

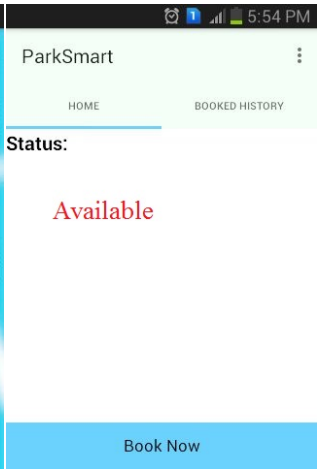


Fig. 7. Availability screen

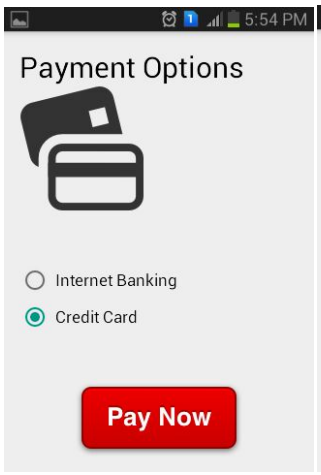


Fig. 8. Payment options

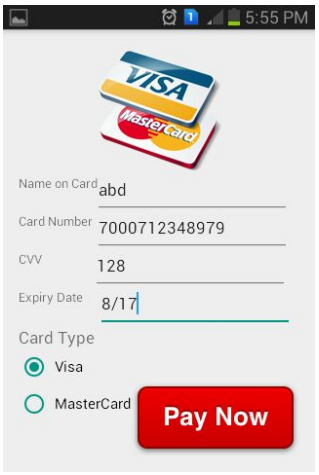


Fig. 9. Payment details

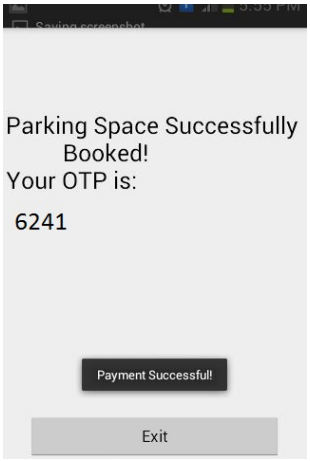


Fig. 10. OTP generation screen

The Android application developed is user friendly as well as found to be working on different android phones with different screen resolutions. The application does not require any other features except internet connectivity to run. This system uses a wired network of sensors to connect to the embedded server. This reduces overall cost of the system. It eliminates the need of additional hardware and software to be installed in cars. Ultrasonic sensors are used in this

project to detect the cars in each parking slot. This provides accurate as well as cost effective method to detect occupancy of the slot. The microcontroller based interface between server and sensors make the system reliable, robust, cost effective, and extendible if number of slots needs to be increased after installation. Since number of cars is increasing at a high rate but parking space does not increase to such an extent. There is need of such systems that require very less infrastructure for existing parking spaces. The future work is to provide the condition monitoring of electronics and implementation of solar based system [6]-[12].

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