Cloud Based Smart Parking System

Rishi Gupta, Sharvil Pradhan , Abhijit Haridas , D.C. Karia
Department of Electronics Engineering
Sardar Patel Institute of Technology, Mumbai

Abstract—One of the major problems faced by Smart cities is that of traffic congestion. The rate at which number of vehicles are increasing greatly surpasses that at which new parking places are made available. This paper proposes a solution of Smart Parking System by leveraging Internet of Things technology. The IoT application monitors the availability of parking slots with real-time data being stored in cloud, with the provision for users to access this data via an android application. The status of each parking slot in the parking enclosure is indicated by wireless technology using ultrasonic sensors. Pre-booking of the parking slot is also possible through the app developed. The intention of presenting this paper and also implementing the system is to help reduce the worsening traffic and parking issues faced in cities.

Index Terms—IoT;ultrasonic sensors; wireless; Internet of things

1 Introduction

Traffic congestion, an alarming problem at a global scale has been growing exponentially over the years. One of the major reasons for this is scarcity of parking areas. The increasing number of automobiles further adds to the traffic congestion problem. Finding a parking place is a major issue, mainly in urban cities. As the global population continues to urbanize, the current situation will worsen unless there is a proper efficient car parking utility. Currently, the conventional method of finding a parking space is completely manual where the driver himself/herself searches for a vacant parking slot at or near his/her destination. This is not only a waste of time but also fuel which in turn increases carbon footprints. Hence, booking of available parking spaces based on reservation is the need of the hour.

Recent research conducted towards improvement of smart parking systems use various wireless technologies such as Radio Frequency Identification (RFID), Infrared (IR), Zigbee. This study aimed to provide information to the user about nearby available parking spaces. The advent of Internet of Things (IoT) revolutionized many fields of technology including the Smart Parking System. IoT plays a vital role in providing connectivity by using devices and systems to collect data and communicate via a network.IoT applications provide methods for solving issues faced by smart cities. Integrating the features of IoT, we can achieve development of smart cities. [5]

The present day solution to parking management involves an effective cloud-based Smart Parking provision based on the Internet of Things. The system proposed in this paper presents an over-all parking system utility for the people by providing information related to available parking areas and a booking facility via android application. Our research implements a system prototype based on Raspberry Pi and Cloud MQTT.

2 Related Work

There are applications that provide information about available parking slots to the users. An interface has to be developed that enables users to monitor the parking availability information and allows users to book an occupied slot. Majority of existing apps focus on finding nearby parking space but do not provide details about availability of the slots. [1] implements IoT technology by using Pi camera to detect the number of vacant slots in the area. This data is sent to the server. The stored data is accessed by the users via application. The number of slots available for booking/parking are checked using RFID in [2]. The main disadvantage of RFID implementation is high cost due to use of RFID tags and scanners. Another approach includes the use of image processing techniques as done in [3]. A camera captures the number plate of the car entering the enclosed parking area, and the image is processed prior to character recognition. The obtained car number is matched with the stored valid car numbers in the database of that parking area and the result information is displayed to the user. If the number matches any one of the stored numbers then the car can be parked at the designated parking slot.

[4] uses Raspberry Pi as an IoT device that stores collected parking slot related data directly to the cloud.In one approach,IR sensors are used to sense availability of the slot parking and this data is converted to text format and sent to users via GPS and GSM technology. [6]In another innovative approach, Arduino is used to directly send ultrasonic sensor data(availability or non availability) of the slot to a central cloud server. [7].Also in one more paper,the author in [9] an automatic car parking Monitoring called (CPMMS) with help of automatic number plate.Finally,in [10] the author's proposed system consists of an on chip micro controller along with sensor and LCD display integrated to it.the availability of the slot is sensed by the sensor and accordingly the output is displayed on LCD.

3 Proposed System

3.1 System Overview

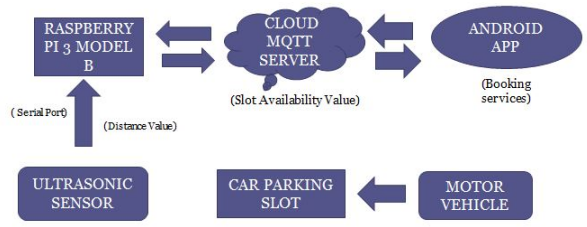

Fig. 1: Proposed System

The system makes use of ultrasonic sensors to monitor parking slots information. Each slot has one ultrasonic sensor that gives information whether that particular slot is occupied or vacant at any given instant of time. This method facilitates implementation of a large-scale system at low cost. The data is serially transmitted from Arduino to Raspberry Pi which acts as a client for CloudMQTT. Parking slot availability information is updated real-time and continuous data is stored in the cloud instance. The user can access real-time car parking scenario via an Android application developed that subscribes data from the cloud. The application also has the facility to book a desired parking slot prior to arrival at the destination. The idea is to reduce wastage of time in search for a parking place. Parking charges can be decided mutually as per the hourly tariff of the enclosed area parking where this system is implemented.

3.2 System Architecture

3.2.1 Ultrasonic Sensor HC-SR04

HC-SR04 is a general purpose ultrasonic sensor that is used to detect obstacles at a distance by emitting sound waves from the trigger input and receiving the bobbed back sound waves at the echo input.In order to calculate the distance at which the object is present,the time duration passed between the creation of sound wave and it ricocheting back from the object is the parameter that is actually perceived by the sensor apparatus. Using the expressions for speed of sound in air(i.e 344 m/s or 1129 ft/s),distance of the obstacle from the sensor is easily computed using the relation between speed,distance and time as the time for the wave to travel this distance twice is what is perceived by the sensor(Round-trip time).

3.2.2 Arduino UNO-R3

The Arduino is a microcontroller which has Dual inline-package (DIP) ATmega328 microcontroller used for education on a large scale . Arduino is a miniaturized scale controller that is incredible for equipment prototyping. A smaller scale controller is somewhat similar to your brain â it forms inputs and conveys yields. A miniaturized scale controller is a little PC on a solitary incorporated circuit made up of memory units,user and system programmable I/O peripheral devices and ports and an on-board microprocessor as well.Arduino programming IDE (Integrated Development Environment) is a cross stage application that can be utilized to compose program for Arduino's.The controller consists of 20 advanced I/O pins which can be used as six PWM OUT pins as well as six ANALOG IN pins. Arduino was interfaced with ultrasonic sensor to get continuous data in this project.

3.2.3 Raspberry Pi

The Raspberry Pi is a cheap PC that can fit some light medium-duty tasks. It is based on a Broadcom SOC (System on a Chip) that includes an ARM7 core, a Videocore in GPU and USB controller. It has either 256MB or 512MB on the board and an SD card slot for storage.The Raspberry Pi is a miniaturized Personal Computer(PC) which can be used in a wide variety of applications that large scale PC's also do such as web browsing,document creation and basic computational functionalities as well.Also it supports exceptional quality video streaming.In this task, we made a serial communication amongst Arduino and Raspberry Pi which exchange key data by sending information one bit at any given moment. [8]Serial interchanges are fundamental for each Micro-controllers to convey between Micro-controllers and another gadget. The Micro-controller sends these 1 and 0 (bits) that contain

important data one by one, or Serially. These bits shape together and transform into bytes (contain 8 bits).

3.2.4 CloudMQTT

CloudMQTT are overseen Mosquitto servers in the cloud. Mosquitto executes the MQ Telemetry Transport Protocol, MQTT, which gives lightweight techniques for doing informing utilizing a distribute/buy in message queueing model.MQTT is the machine-to-machine convention without bounds. It is perfect for the ”Internet of Things” universe of associated gadgets. Its insignificant outline makes it ideal for worked in fraMessage lines gives an asynchronous communications protocol that is both the parties,sender and the receiver of the published message are not required to connect to the message line simultaneously at a single time. Messages set onto the line are put away until the point that the beneficiary recovers them or until the point when the messages times out. MQTT acts as broker in our project.MQTT and Mosquitto are for good use by transfer speed delicate applications.CloudMQTT lets you center around the application as opposed to investing energy in scaling the merchandise or fixing the stage.

4 METHODOLOGY

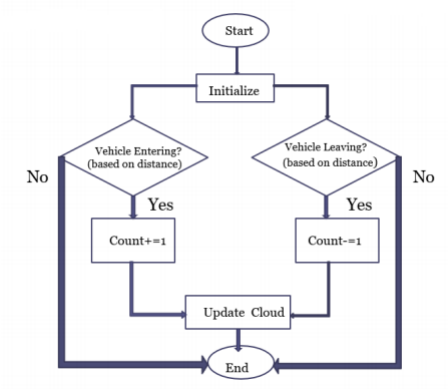

Fig. 2: Flowchart of proposed algorithm

The android application interface displays the real-time status of the parking slots to the user. The user can book a slot by clicking the âbook a slotâ button. On booking a slot, a QR code is generated which has the relevant data about the booking time, booking date. The user should show the QR code at the car parking entry. The app displays the real-time status of the individual slots - empty, booked or full. The counter decreases the available parking slots number and this updated data is stored in the cloud. Cloud MQTT instance acts the broker between Raspberry Pi (client) and Android application (subscriber). When the car leaves the parking slot, the counter increases the vacant parking slot number.

Ultrasonic sensors are used in every slot to give information about that particular slot. Ultrasonic Ranging Module HC-SR04 calculates the time interval between the Trigger and Echo pulse. Code has been developed to calculate the distance between the vehicle and the sensor. If the distance is less than a fixed distance for car parking, the slot status is updated to parked. This information about the slot status is serially transmitted from Arduino to Raspberry Pi which stores the data in the cloud instance created via MQTT. Message Queuing Telemetry Transport (MQTT) is a publish-subscribe-based messaging protocol which publishes the data on the cloud from Raspberry Pi. The data is continuously updated on the cloud instance and visible on the Websocket UI. The android application developed subscribes to the data stored in the cloud by accessing the appropriate CloudMQTT ports. The app is designed to run on devices running Android OS 5.0 and above.

5 RESULTS

Sensing of parked vehicle using ultrasonic sensor is the first step. The ECHO pin of the HC-SR04 ultrasonic ranging module, which receives the sonic burst generated by the TRIG pin, works at a voltage of 5V. This pin cannot be directly connected to a GPIO pin of the Raspberry Pi 3 model B board as its voltage rating is 3.3V. So a voltage divider circuit needs to be used. Even after doing that it was observed that the output distance values generated were not extremely accurate and there was a garbage value displayed every time the obstacle distance was changed. This is represented in figure 3.

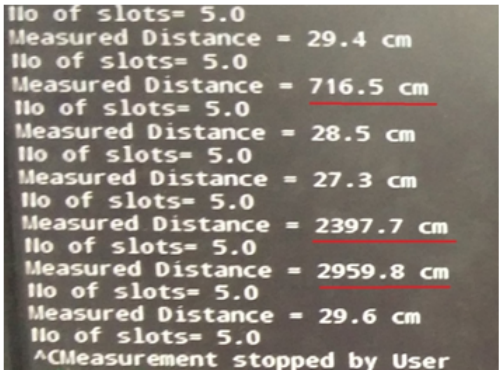

Fig. 3: Terminal Display

Furthermore, we observed that when the code was written in Python the delay between two values was greater (delay of 3-4 seconds) as compared to the case when the code was written in C language. This prompted us to interface ultrasonic sensors with Arduino board and was successfully achieved using Arduino Uno R3. Using this setup, the issue of stray distance values was totally eliminated and accurate real-time values were obtained with minimal delay (less than or equal to 1 second).

The data was transferred from Arduino to Raspberry Pi via serial communication between them. Baud rate needs to be set at 9600. The delay time of Arduino and the sleep time of Raspberry Pi were set to optimize the speed and reduce overall delay. This data received by the Raspberry Pi was stored on a cloud instance. One important observation made was the importance of KeepAlive time. It is the maximum time period for which the connection is open and active even if there is no data transfer from the client to the broker. The KeepAlive time was set to 60 seconds to get proper real-time results on the MQTT cloud instance which can be seen on the Websocket UI as shown in figure 4.

Fig. 4: MQTT Console

In the android application developed, a QR code is generated for every parking slot booked by a customer which is done by clicking 'Book a slot' on the front end dashboard shown in figure 7. QR codes can contain more information than bar codes. On scanning the generated QR code, the information about the booking is displayed which include the parking spot, date and time. This is shown in figures 5 and 6.

Fig. 5: QR code on clicking 'Book a Slot'

Fig. 6: Information displayed on scanning QR

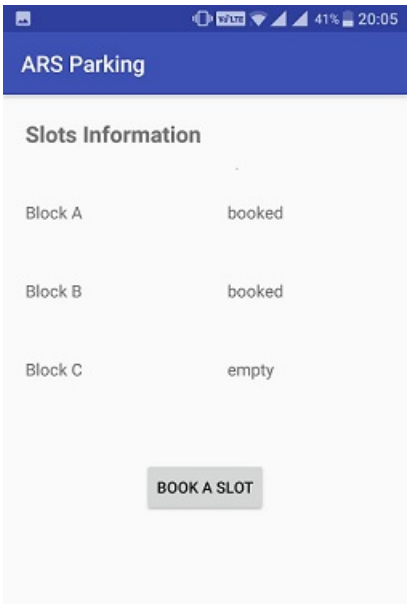

Fig. 7: Application Dashboard

6 Conclusion

The proposed Smart parking system based on reservation of slots is executed, utilizing an Android application.User is able to book and block a slot before actually traversing to the space based on the available number of slots displayed in the application.It is a straightforward, well managed and a financially sound solution to reduce carbon footprints.It takes out superfluous traversing across filled parking spaces in a city.Hence, it decreases time and is cost effective.The system is also scalable and robust as it potentially provides dynamic pricing based on real time parking information which therefore further adds a financial value to fulfill diverse requirements of drivers and parking service providers. It provides a seamless way for taking care of parking issues, which reduces traffic clogging.

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