IoT based Vehicle Parking Manager

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***Abstract*—The main objective of this project is to design a solution for overcoming the parking issues that exist in public places such as malls, multiplexes etc. especially on weekends. The aim is to achieve this by using the concept of Internet of Things (IoT), wherein an Android Application is created for the customer, whose details are constantly updated by the hardware/server at the location. The features include unique identification for each vehicle, display of available parking slots on the mobile application, possibility of making reservations for the same, maintenance of a database (for the management).**

Keywords—QR Code, Internet of Things, Android Application

I. INTRODUCTION

Nowadays, a problem of finding parking slots for vehicles is observed in malls mostly on public holidays and weekends. It has been observed that a considerable amount of time gets wasted while trying to find a vacant spot at large public parking spaces, and if no parking slots are available, then the parking has to be done elsewhere, thus resulting in more time being wasted. Vehicle Parking Manager is a concept where technological solutions are designed to overcome these issues. They can be avoided if a person is enabled to book the parking slots in advance. The cost-effective technology used in this project enables customers to check if parking slots are available at a specific location such as a mall or a movie theatre and also to book an available slot for a specific period for their vehicle using the same. This can be done on a mobile phone using an android application. This application can be managed by an administrator at the malls and multiplexes. The customer information and the booking details are stored on a continuously-updating central server. The payment for the booked slot can be done via deduction of the amount from the customer's account which can be refilled online itself. The vehicle can be parked at the booked slot after verification, for which hardware is used. This project primarily makes finding parking systems more efficient and less time-consuming, and also eliminates the need of a large staff to be employed for such purposes at these places, thus increasing the profit margins.

II. PROBLEMS FACED IN EARLIER PARKING SYSTEMS

In the earlier systems, presence of a person was necessary for the management of parking slots i.e. for checking available parking slots, occupied parking slots, allotment of slots for new incoming vehicles etc. As this is done manually, this may sometimes be erroneous in nature and also quite a lot of time-consuming. There are many problems faced by the customers with the earlier systems. Some of them are the customers have to wait for a long time for the allotment of parking slots, when parking traffic increases manifold. This may increase outside traffic as well which can be chaotic. The other problem being no proper parking charges. Detailed database of vehicles entering and leaving the parking place is also not available with the parking place staff. This causes inconvenience to the customers as well as the staff managing the system.

III. FEATURES

Features of the proposed project for a customer are:

- Display of total parking slots in the parking lot, number of parking slots, available, occupied parking slots and the reserved parking slots.
- Assigning of a unique identification to a customer/car in the form of a QR code through which a user can view the balance, view the transaction/records of the earlier parking done by them in the parking place, make reservations along with the timings.

Features of the proposed project for the managing staff ofthe parking system are:

- A QR Code reader at the entry of the parking system to identify the unique ID associated with the vehicle and do the corresponding transactions (entry time, rate deduction etc.)
- An LCD at the gate to display the car number and the parking slot selected by/allotted to the user.
- Parking slots status (full/reserved, total time slots)
- Earnings -Total/Per Customer/per week
- View database of all the cars which entered the parking system along with the timings and the slots occupied.
- Recharge the customer's ID at the entry if required.
- Special reservations for VIP's (no time limit)
- Allow one time entries for vehicles without any unique ID.

IV. QR CODE SCANNER

The QR (quick response) bar code is a 2D bar code used for easy access to the information through a smartphone. It is used for product tracking, item identification, time tracking, document management, and general marketing etc. QR code has white background on which black squares are arranged in

a grid which can be scanned or read by an imaging device such as a camera, and processed until the image can be appropriately interpreted. Then the data is extracted from the patterns that are present in horizontal and vertical direction. The square code is distinct and easily visible on any surface that it is printed on. As a result, people do not have to be notified separately about the existence of a QR code; they can see it with their own eyes.[1] However, the same is not true for RFID. People have to be notified that a device is RFID capable or contains a transmitting RFID chip. It is a substantially cheaper and easier to get QR codes than RFID. For RFID, special RFID chips have to be deployed that transmit the relevant code. For using QR code one just have to print and stick it on a surface. Even generating a QR code is cheaper and easier as compare to RFID. One can generate a QR code on their smartphone itself. High cost goes into generating RFID tags. For most small and medium sized businesses, QR codes are a much more financially viable option. [2]In our project the details such as the name of the customer, the vehicle number, their contact number & other details are used to generate a QR code.The QR code generated can either be stuck on the wind shield of the car or an image of the same in the customer's mobile phone application can be shown at the entry gate of the parking system. This is scanned by the Raspberry Pi camera module & the details of the customer corresponding to the QR code will be retrieved. (Obtained by the person at the entry gate). Further decisions will be made on the basis of information obtained.

V. Parking Slot Status

One of the main purposes of this project is to provide assistance to both the customer as well as the management of the parking system to view the current status of the system. For this purpose, each parking slot in the system is assigned a particular status. One of the parking slot status is 'Available' which indicates that the slot is neither booked by any customer nor is it occupied and hence can be reserved if required. The other slot status is 'Reserved' wherein the parking slot has been reserved by a customer but is not yet occupied. The last type of parking slot status is 'Occupied' wherein a vehicle has occupied the parking slot. The status of the parking slots will be updated with the help of ultrasonic sensors present at the place of the slot.

VI. Implementation

The current design of the parking system model works on a local modem where all the components, the Raspberry Pi 3 and the server (administrative machine) are connected on the same network as shown in Fig.1. The values of all the sensors are updated constantly and sent to the central machine where the main decision making takes place and implementation of the same is done using a Raspberry Pi 3.

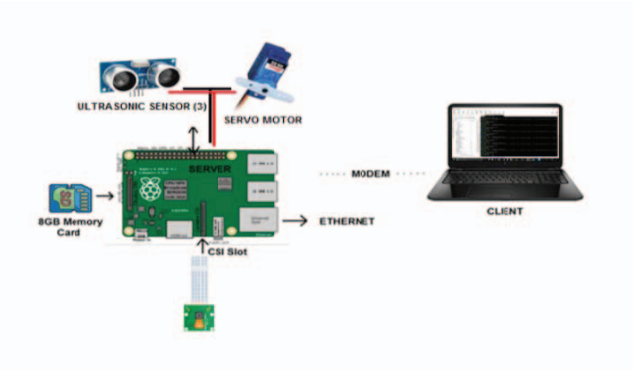

Fig.1 Basic Design of IoT based Vehicle Parking Manager

VII. Operation

i. The Raspberry Pi camera module scans the QR code containing registration details of the car entering the parking slot and after scanning the QR code, checks if there are any reservations for the same.

ii. If reservations have been already done, then the account of the customer is checked for proper balance.

iii. If all the above conditions are fulfilled, then the gate (Servo Motor) at the entry opens and car is allowedinsidealong with deduction in the amount as per to the time forwhich the parking slot has been reserved.

iv. Once the car enters the parking slot, the ultrasonic sensor gives an indication of the same and thus the status of theparking slot is updated.

VIII. System Block Diagram

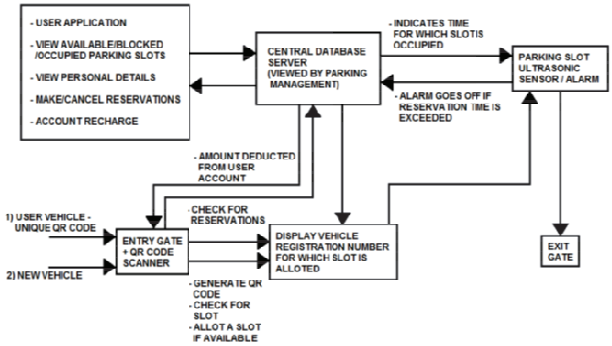

Fig.2 Block Diagram of IoT based Vehicle Parking Manager

Fig.2 describes the working of the proposed IoT Based Vehicle Parking Manager. It gives us a brief idea of the main functions of all the major parts of the system and the direction of data flow among these parts.It shows how all the main components of the project i.e. the gate at the entry of the parking system, the android application in the user's mobile phone and the sensors at the parking slot are connected to a central server, which not only gets updated by them but also provides information to them such that the Raspberry Pi can take a proper decision based on the available data and hence work successfully and efficiently.

IX. Hardware Used

A. Raspberry Pi 3

The Raspberry Pi is a series of credit card-sized single-board computer which in this project has been used as a microcontroller.

Specifications of Raspberry Pi 3:

- A 1.2GHz 64-bit quad-core ARMv8 CPU
- 802.11n Wireless LAN
- Bluetooth 4.1
- Bluetooth Low Energy (BLE)
- 1GB RAM
- 4 USB ports
- 40 GPIO pins
- Full HDMI port and implementation of the same is done using a Raspberry Pi 3.
- Ethernet port
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD memory card slot
- VideoCore IV 3D graphics core. [3]

B. Raspberry Pi Camera Module

The Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. It has a 5MP fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It is attached via a 15-cm ribbon cable to the CSI port on the Raspberry Pi. In this project, the camera module is being used to scan the special QR codes generated uniquely for each customer's vehicle. The camera module is connected to the Raspberry Pi at the gate of the parking system which scans the QR code of the vehicle, feeds the data encoded in the QR code to the central machine where the appropriate decisions are then taken. [4]

C. Ultrasonic Sensors

Ultrasonic sensors are used for distance measurement where a transmitter emits an ultrasonic wave in one direction, and starts timer when it is launched. This wave propagates through the air, and is reflected back when it encounters obstacles on the way. The receiver will then stop timer the moment it receives the reflected wave. As ultrasonic spread velocity is 340m/s in air, based on the timer record t, the distance(s) can be calculated between the obstacle and transmitter. In this project, these sensors have been utilized to detect the presence of a car in a parking slot. [5].

D. Servo Motors

A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. The servo motor blade can be moved to a desired angular position by sending PWM (pulse width modulated) signals on the control wire. In this project, servo motors are used in the gate mechanism. [6]

X. Results

The sensors, the servo motors and the camera module have so far been successfully interfaced with the Raspberry Pi to give us the proper functionality of the hardware side of the system. When ultrasonic sensor readings are below a certain threshold (distance between sensor and the ground surface) the presence of a vehicle is indicated. The servo motor acts as the gate mechanism for the slot, where the incoming vehicle is allowed to be parked after verification. The motor blade rotates 90 degrees back and forth which corresponds to the opening and closing of the gate. The camera module is efficiently able to scan the QR code where the registration details such as Customer name, contact number and vehicle registration number are successfully deciphered from the QR code in which they were stored, for the purpose of verification as can be seen in Fig.3.

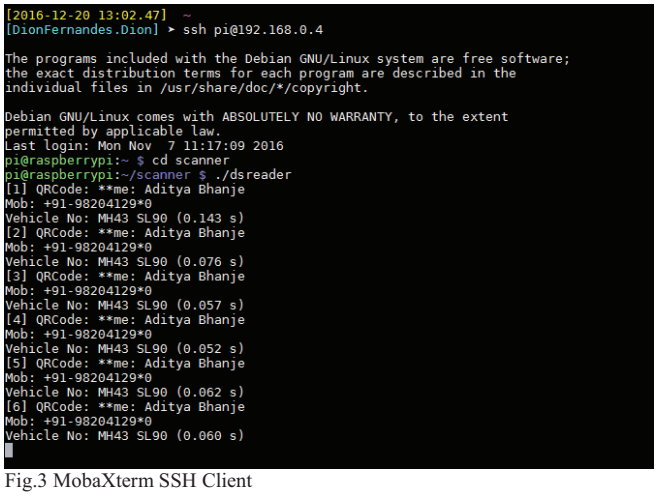

Fig.3 MobaXterm SSH Client

XI. Summary

The current model of the project is simply a prototype of a bigger-scale version which will be developed in due course of time. This model helps us to understand the basic working and interfacing of the various components used in the project, giving us an idea of how they work on a local network and to determine the flaws which must be overcome before being implemented on a larger scale.

Acknowledgement

It is with great pleasure that we submit this project entitled "IoT based Vehicle Parking Manager." We take this opportunity to thank those involved directly or indirectly with this project. Without their active co-operation, it would have not been possible to complete this project on time. At the outset, we keep on giving our deep sense of gratitude towards our project guide Mr. Jatin Desai and to Dr. Milind Shah, Head of Dept. (EXTC) at Fr. Conceicao Rodrigues Institute of Technology, Vashi, who gave us the guidance right from the

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