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IoT Based Sensor Enabled Smart Car Parking for Advanced Driver Assistance System

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Abstract— Smart parking systems typically obtain information about available parking spaces in a particular geographic area and process it in real-time to facilitate vehicle parking at available positions. One of the key issues that smart cities relate to is car parking facilities and traffic management systems. Internet of Things (IoT) enables the connectivity between surrounding environmental things to internet and makes easy to access those things from any remote location. The effective use of an IoT technology can ease human life in some aspects. The proposed work is one of the applications of combination of IoT and cloud computing technology. The objective of this work is to design, analyze and implement "IoT based sensor enabled car parking system", this enables the user to pre reserve parking slot from remote place with the help of mobile application. Authentication of the valid booking is incorporated to benefit valid user. This system is implemented using low-cost IR sensors, Raspberry-Pi model 3b for real-time data collection, E-Parking mobile application. E-Parking mobile application is developed using android studio having baseband version of android 4.3.

Keywords— *IoT; Raspberry pi; ADAS;E-parking application; User authentication.*

I. INTRODUCTION

More than half of the world population lives in the urban areas so the cities have reached its full occupancy. As a result number of vehicles in the cities is also increased. Due to this most of the people spend their valuable time on searching parking slots to park their vehicles. It is hectic job to find parking space to park their vehicles. Work proposed in this paper is an attempt to solve above mentioned problem. The system developed here is an integration of internet of things (IoT), cloud technology, android application and user authentication for ADAS system. Internet of things is the internetworking of physical device embedded with electronics that enables those physical devices to connect to internet. IoT was first introduced in 1999 at auto ID center and first used by Kevin Aston. In this system IoT technology is used to connect parking slots in parking area to the internet. Here cloud technology is related to creating, updating and deleting database which is maintained at central server and android application provides user interface, allows user to get real time status of parking slots, to book parking slot and also displays parking charge which has to be paid. User authentication is accomplished by using unique ID which adhaar card number. The system not only provides ease to user for car parking but also reduces traffic which occurs due to dead locking of cars while parking and also saves fuel consumption of car by avoiding unnecessary traveling through filled parking lots which in turn reduces carbon dioxide emission in atmosphere. The many efforts have made to solve the above mentioned problem and are explained as follows:

IoT based smart car parking system in paper [1] ultrasonic sensors are used for detecting the availability of parking slot. Each sensor is attached with a Wi-Fi chip. The gateway comprises raspberry pi board which updates the cloud using MQTT protocol. Mobile application is provided for user interface. Implementation cost of system is high as every sensing node has its own Wi-Fi chip.

Parking availability prediction for sensor-enabled car parks in smart cities in paper [2] the waiting time is predicted based on the variable parameters such as time of the day, day of week , weather, temperature ,humidity. The algorithm used for prediction is Regression tree, Support vector regression, and neural network.

Parking is easier by using context information of a smart city in paper [3], The system defines four parking states which are Available parking space, Reserved parking space, In use parking space, load/unload parking space. The NFC technology is used here for wireless payment. Geomagnetic sensors are used for detecting presence of car. Major disadvantage of geomagnetic sensor based vehicle occupancy detection is sensor response is prone to magnetic interference

A cloud based intelligent car parking services for smart cities in paper [6] the entire system developed with three layers sensor, communication, and application layer. The server finds the best available car parking lot for the user based on his preference and driving direction is returned to him.

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Intelligent parking lot application using wireless sensor networks [17] proposed the use of a combination of magnetic and ultrasonic sensors for accurate and reliable detection of vehicles in a parking lot, also describing a modified version of the Min-max algorithm for detection of vehicles using magnetometers.

All the above discussed works are not considered a valid authentication and the cost effectiveness of the system and this proposed work considered

- User authentication
- Eliminating false charge that occurs when user parks car in parking slot other than his booked slot
- System is developed by using low cost IR sensors to reduce overall cost.

II. METHODOLOGY

A. *Proposed System Block Diagram*

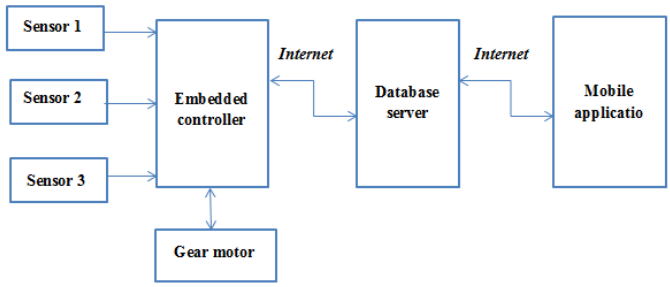

Figure 1. System block diagram

Fig. 1 shows the system block diagram of proposed work it major constituent of it are:

Embedded controller: The input from parking lot sensor is given to embedded system. Upon any changes in input embedded system updates the information collected from sensor to database server and it also used to drive geared DC motor. In this proposed work Raspberry pi model 3b is used as embedded system.

Database server: Information regarding registered users, status of the parking slot, and time duration of parking is maintained in server. The information regarding availability of parking lot is shared among all users who use mobile application. Database server is updated from two terminals. One is from sensors and embedded system. Another one is from user. Amazon web server is used to host PHP files and maintain database.

Mobile application: It is an android application running on user mobile device. It facilitates user to check availability status, to book parking lot and also integrated with adhaar card for unique authentication of user. Android application is developed using android studio IDE.

Sensing nodes: Information regarding status of parking lot is collected by using IR sensors attached to parking lot. Advantages considered while selection of IR sensor for vehicle occupancy detection are

- Sensor response is not dependent upon color, transparency of object
- IR sensors can work in critical conditions such as dirt and dust
- The output is linear with the distance between sensor and target
- Accurate detection even of small object
- Adjustable detection range up-to 30cm

DC gear motor: It is used for opening and closing of parking area main gate. Gate will open when user enters valid booking ID otherwise it will be closed by doing this it enforces user authentication. It is controlled by embedded controller.

B. *System Flow Diagram*

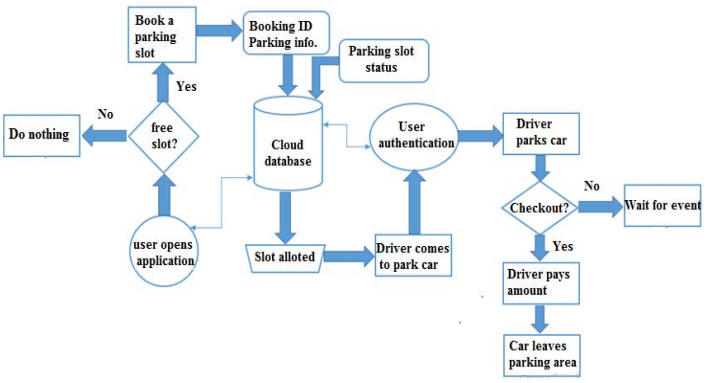

Figure 2. System flow diagram

Fig. 2 is a system flow diagram depicts complete process flow and is explained as fallows.

Step1: User accesses the mobile application and check for the status of parking slot. The status of parking slots is known through data base server which is updated by raspberry pi embedded with sensors in real time placed at the parking area through internet.

Step2: If any parking slot free, the user books slot by entering user ID, Slot number along with date and time, then this information is updated to cloud.

Step3: In response to the user request, the corresponding slot will be allotted to the respective user and that slot will be locked for other users.

Step4: When driver reaches parking area to park the car, the driver and the vehicle is authenticated by using unique booking id which is generated at the time of booking and the corresponding slot is provided to the user to park their

vehicle.

Step5: The algorithm validates the parking time and charges based on the presence of the vehicle at the parking slot. When driver selects checkout button, the temporary charge is displayed in his application, though actual parking charge is calculated by taking input from sensor.

Step6: Once the car vacates parking slot the user will be charged for the calculated amount of time and status of slot is updated as free in server database.

C. Application flow Chart

Fig. 3 depicts developed mobile application flow chart

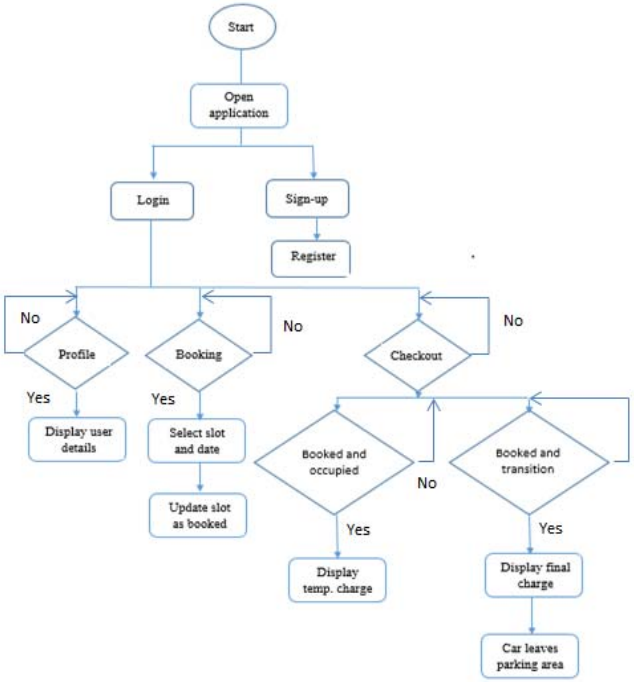

Figure 3. Mobile application flow chart.

In step1 user opens mobile application and application ask for login and signup. In step2: If user is using the application for the first time, user need to complete registration by entering required information including valid ID preferably ADHAAR then user will be provided with unique user name and password. In step4: after successful login, there will be three options available to users which are profile, booking, and checkout. User will choose any one of these option based on requirement. In step5: on selecting profile, user details are displayed which is given at the time of registration, which includes name, email, address and image. In Step6: On choosing booking button, user has to select slot number, booking date, booking time and unique ID and book a slot. In Step7: During checkout, there are two activities, one is display temporary charge and other is display final charge. Final charge is displayed only when user removes his car from booked slot and temporary charge is displayed when user wants to know interim charge when car is parked.

III. WORKING OF MOBILE APPLICATION

In this section the working of E-parking mobile application with the help of screen shots is explained in detail.

User login: This layout facilitates user to login and registration for new user. During login user has to mention preregistered username and password. For registration user has to provide name, password, unique ID address etc.
Fig. 4 shows login window of E-parking mobile application which has two text fields one for username, password and sign-up button.

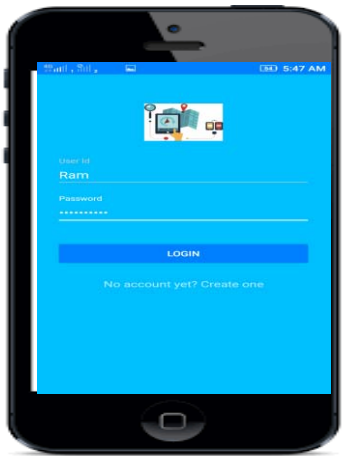

Figure 4. Login window

Main: After successful login there will be a drawer window at the left most corner of main window. When user selects drawer window there will three options available to him which are profile, booking and checkout as shown in Fig. 5

Figure 5. Main window

View profile: By clicking profile button in drawer window of application user can view information entered while registration such as user name, email ID, address and image as shown in Fig. 6

Figure 6. Profile window

Slot Booking: Fig. 7 shows the booking window. Booking of parking slot is done with the help of this window of application. To book the slot user has to select slot number, from time and has to enter valid booking ID

.

Figure 7. Booking window

Checkout: As shown in fig. 8, User can choose checkout option. Once the user selects checkout option, the algorithm validates the reality of checkout by taking inputs from the sensor and the user will be charged based on check in and checks out time difference and the same will be sent to user.

Figure 8. Checkout window

IV. RESULTS AND COMPARISIONS

A. *Hardware prototype*

Fig. 9 represents the prototype of the proposed system. The prototype is consists of 3 slots, each slot is monitored by IR sensor and all the slots are connected to central node raspberry pi which is in turn connected to cloud using IoT. Each slot also contains status LEDs which indicates either green or red signal depending on parking slot occupancy. The system also contains geared DC motor controlled by raspberry pi to enforce user authentication. Geared motor controls the opening and closing of parking slot gate. Also there is one vehicle detection sensor included in system to prompt enter booking ID message.

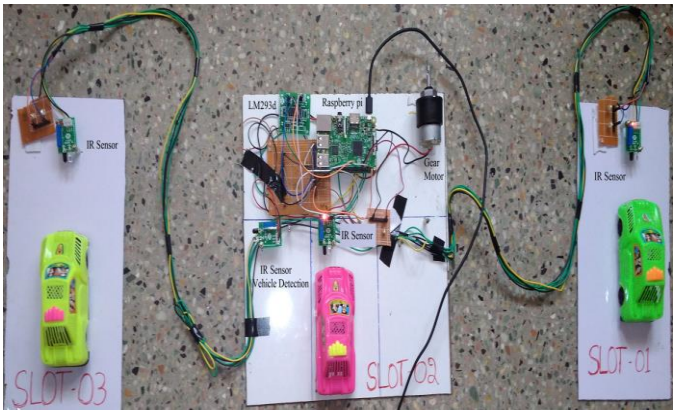

Figure 9. Hardware prototype

B. *Slot booking through E-parking application*

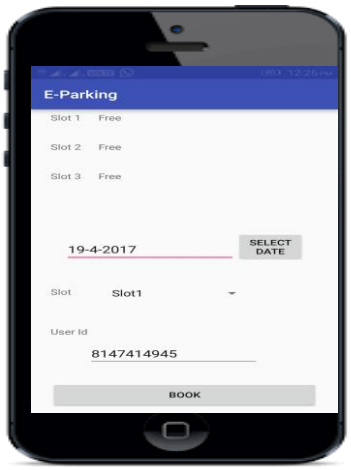

Figure 10. Slot-1 status before booking

User can book parking slot by making use of android application. Initially status of all three parking slots is free as shown in fig. 10.

Fig. 11 shows that the user has booked slot-1 on date 30-04-2017 with unique id 386778336378. After booking, status of parking slot-1 is changed from 'free' state to 'occupied' state. After the booking slot-1 will reserved to user.

Figure 11. Slot-1 status after booking

Fig. 12 shows the updated database showing current status of the parking lots. The sensors at each slot will be monitoring the status and updating the database in real time. The database also updates the status of the parking slots by using colors that is r = Books and g = Not Booked.

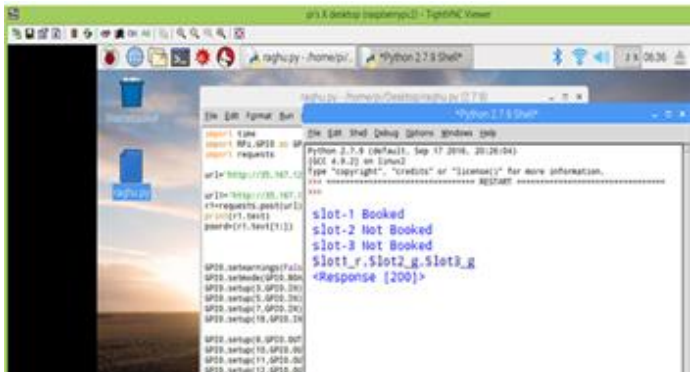

Figure 12. Updated data base

Fig. 13 shows the parking area status. From the figure it can be seen that car has been parked at slot-1 of parking area. now the status of IR sensor of slot 1 will be changed to booked.

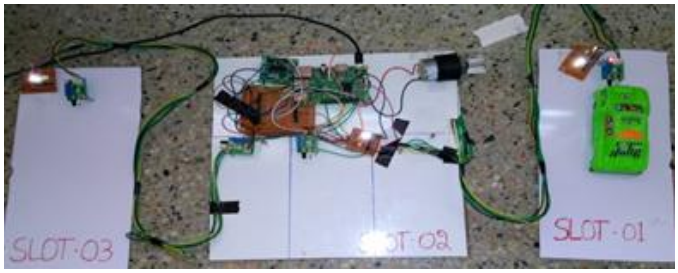

Figure 13. Parking area status

C. *User authentication*

Fig. 14 shows the vehicle detection done at parking area. When system detects vehicle it will ask user to enter preregistered booking ID in on-site computer.

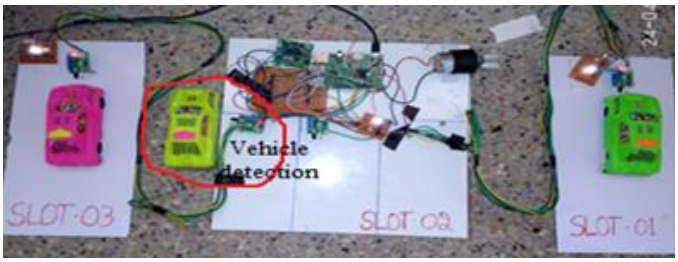

Figure 14. Vehicle detection

The Fig. 15 shows invalid booking ID message. This message is displayed when user enters incorrect booking ID. At the entry level of parking area, user is authenticated by verifying the valid user ID. If unauthorized user enters a wrong ID, the database is immediately shows the warning message that is “Not Valid Booking” and user will not be allowed to enter parking area thus parking area gate will be remained in closed state.

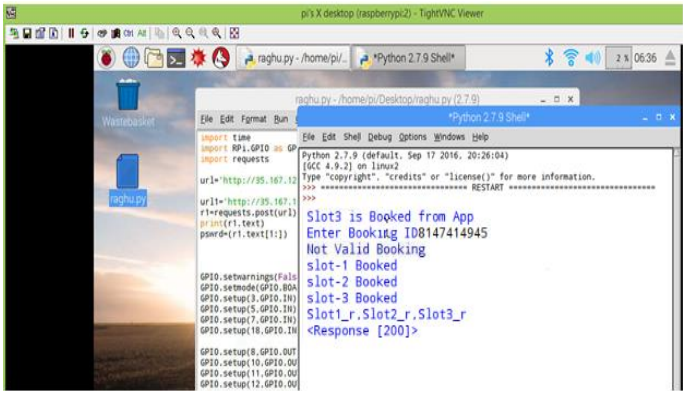

Figure 15. Invalid booking

The Fig. 16 shows the valid booking ID and message. If the user enters a valid booking ID the database will be updated as “Valid Booking”.

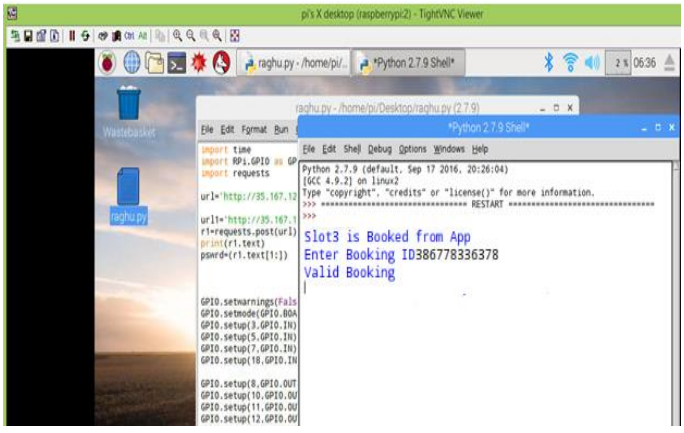

Figure 16. Valid booking

V. CONCLUSION

Work proposed in this system addresses an issue of parking in smart cities. The system is implemented using low cost IR sensors, Raspberry pi model 3b for real time data processing, E-parking mobile application and Geared DC motor. The developed system provides real time information of availability of parking slots in parking area and allows users to book parking slot from remote locations by using mobile application and also provides user authentication. The developed system is tested for different cases such as single user booking, multiple users booking, user trying to book reserved slot and user authentication. The proposed system is designed for 3 parking slots each having single IR sensor with adjustable sensing range of up-to 30cm. Proposed work not only reduces the traffic congestion, it is also providing authentication of the user, cost effective, real time and helps in reducing carbon footprint.

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