Design and implementation of Parking System using Zigbee

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***Abstract*— Due to the rise in the number of vehicles on the road, traffic control system is one of the major problems in the current world. Parking problems is increasing at an alarming rate in every major city. Lot of research and development is being done all over the world to implement better and smarter parking management mechanisms. In this project we have designed parking system using wireless sensor network. The state of parking system is decide by IR sensors, and is reported periodically to master controller via slave controller. This information is sent to desktop server via Zigbee device and also to android phone through internet, vehicle driver find vacant parking lots using this android mobile device. The driver can also do reservation in particular vacant slot using his android mobile phone device.**

Keywords-Infraredsensors(IR),Mastercontrolle(LPC2148),Slave controlle(89C4051),desktop server

I. INTRODUCTION

In metropolitan areas, most vehicle drivers have the daily concern of finding a vacant parking space especially during the rush hours. It is time-consuming and it is leading to more traffic congestion, air pollution and driver frustration. A recent report [1] presents that the traffic congestion is generated by vehicles searching for parking spaces takes up to 45% of the total traffic. So, many parking management systems have been deployed in order to reduce such traffic congestion and improve the convenience for vehicle drivers. A few systems focused on the applications of vehicle parking system using video camera sensor technologies [2], [3] to collect the information in vehicle parking field. However, a video camera sensor is expensive, and can generate a large amount of data that can be difficult to transmit in wireless network. In recent years, wireless sensor networks technologies [4], [5] have a great potential method for providing a low-cost solution in order to implement vehicle-parking service with respect to easy deployment in existing parking lots without having to install new components (e.g. expensive line or cabling), and the flexibility to connect with sophisticated but cheap sensors for accurately keeping track of vehicles.

This paper introduces a parking system using Zigbee and mobile application for the drivers. We have designed and implemented a prototype system of smart parking services that allows vehicle drivers to effectively find the vacant parking spaces, in indoors environment. The proposed system consist of sensor circuit which has IR transmitter and receiver as sensor to detect vehicle presence in parking slot, slave controller (89C4051), master controller (LPC 2148), Pair of Zigbee devices, desktop server on which we have Graphical User Interface (GUI) running to display parking slot information, Database to store parking slots information and reservation requests and we have also designed android application running on android phone which is present with driver. In this system IR sensor circuit is present in each parking slots. The state of the parking slots is detected by sensor(IR transmitter and receiver). Whenever driver from mobile phone ask for slots information from his android phone, the request goes first to desktop server. The desktop server and android phone communicate with each other through web server. Now desktop server will give command to the master controller (LPC 2148), through Zigbee device which is interfaced with this desktop server. This Zigbee device will send this information in form of packet and transmit this packet wirelessly. Now another Zigbee device is interfaced with master controller (LPC 2148).This Zigbee device will receive this packet retrieve the command information and give it to LPC 2148 controller. Now master controller (LPC 2148) will give query command to slave controller (89C4051).The slave controller (89C4051) will take slot information from sensor circuit and transmit it to master Controller (LPC 2148).The serial ports of slave controllers and LPC 2148 are interfaced with each other. We have also interfaced LCD with slave controller (89C4051) to display parking slots information. The master controller will receive this parking slots information and give it to Zigbee device. Now Zigbee device will make packet of this information and send it to Zigbee device which is interfaced with desktop server. Desktop server's Zigbee device will retrieve this information and display this information in GUI. We have made database in SQL server to store this parking slots information. Thus server will update this information in database and also display it on GUI. The GUI is made in Microsoft Visual Basic Studio 2008.Now desktop server will transmit this information to android phone application through web server. Thus drivers will get parking slots information. If the driver wants to do reservation in particular parking slots he will send reservation request. Now android application will transmit this reservation request to desktop server through web server. Desktop server will validate the driver's information such as his money balance to park his car in parking slots, his password from database. Now

desktop server will validate from database if any other car or reservation is done in requested parking slot. If there is no reservation or any vehicle present in that parking slot it will make reservation in that parking slot. Now desktop server will send reservation confirmation message to android application on android phone through web server.

II. RELATED WORK

Some related works for the parking space management system based on WSN are reviewed in this section.

Soh Chun Khang [4] proposed a Wireless Mobile-based Car Parking System using low cost SMS service. The implementation of SMS service into the car parking system, enable the drivers to receive information regarding the availability of car parking spaces. In this system, the drivers can resend SMS to request for new assignment of car parking spaces if they fail to get the previous assigned destination. However this system did not included the concept of central web server. First, the driver arrives at entrance and takes the parking ticket. Then, the driver may follow the assigned parking spaces (with parking lot ID) that printed on the ticket to park his vehicle. If there is available, means there is an empty parking space, driver may park their vehicle and proceed to the shopping mall. However, if the driver arrive at the assigned parking space and found out the parking space is already occupied, driver may send a SMS to WMCPS (Wireless Mobile-based Car Parking System) to get a new assigned parking spaces. Within a short period of time, driver may receive a SMS with a new parking lot ID. Then, driver may proceed to the new parking space to park their vehicle.

Vanessa W.S. Tang, Yuan Zheng, Jiannong Cao[5] developed a WSN-based intelligent car parking system. In the system, low-cost wireless sensors are deployed into a car park field, with each parking lot equipped with one sensor node, which detects and monitors the occupation of the parking lot. The status of the parking field detected by sensor nodes is reported periodically to a database via the deployed wireless sensor network and its gateway. The database can be accessed by the upper layer management system to perform various management functions, such as finding vacant parking lots, auto-toll, security management, and statistic report. They have implemented a prototype of the system using crossbow motes. The system evaluation demonstrates the effectiveness.

Sangwon Lee, Dukhee Yoon, Amitabha Ghosh [6] developed intelligent parking lot using WSN. They propose the use of a combination of magnetic and ultrasonic sensors for accurate and reliable detection of vehicles in a parking lot. They described a modified version of the minmax algorithm [7] for detection of vehicles using magnetometers, and also an algorithm for ultrasonic sensors

Rushikesh, Sagar, Sanjay, Trupti, Rahul proposed Parking Space Searching & Reserving With Mobile Using Bluetooth Technology [8]. This system has a main graphical user interface on client's mobile which enables him to search and reserve the parking space .The overall transaction takes place between client's mobile and server via Bluetooth modem .The Bluetooth modem is another mobile device. The heart of the system is the microcontrollers that are actually responsible for all the process being executed. It will monitor and control all peripheral devices or components connected in the system.

III. BLOCK DIAGRAM OF PARKING SYSTEM

Fig 1 shows block diagram of the system. The whole area of parking slots is divided into different areas. Each area has three minimum parking slots. In a parking slot the presence of vehicle is detected by sensor circuit.

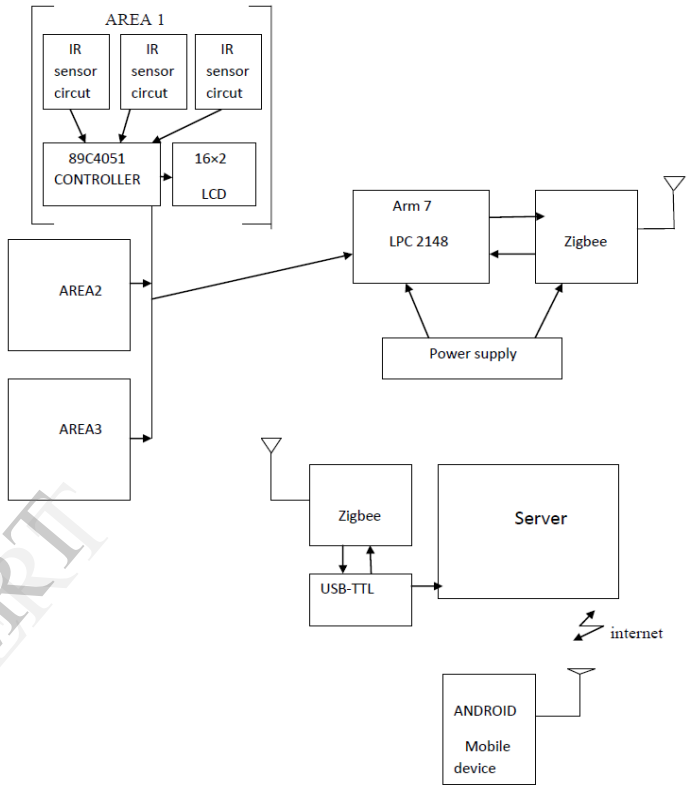

Fig-1: Block Diagram of Parking System

The sensor circuit consists of two main components IR transmitter and IR receiver and comparator IC LM358.IR transmitter transmits the IR light, if vehicle is present, the infrared light is radiated back and received by IR receiver. These signals are compared by operational amplifier IC LM358 which will act as comparator, if there is radiated pulse received by IR receiver it generates high output and if there is no radiation then it generates low output pulse. The comparator output signal is given to 20 pin controller (slave controller) IC 89C4051.The comparator output are given to the port 3 of IC 89C4051. The LCD is interfaced with the controller to represent state of parking slots in that particular area. The sensors information is then transmitted to master controller's serial bus UART 1. The serial port of slave controller (89C4051) and master controller (LPC2148) UART 1 are interfaced. Now Zigbee device is interfaced to UART 0 serial bus of master controller (LPC2148). This Zigbee device is used to transmit sensor data wireless to another Zigbee device which is interfaced to server through USB-TTL circuit. The work of this server is to display sensor data information in Graphical User Interface (GUI).Thus we get live sensor data. We have to make GUI using Visual basic

software. The database to store live sensor data is generated in SQL. The android application has to be developed in ADT JAVA for android phone. The android phone is present with the driver of the vehicle. This android phone is connected with server through internet (web server).Thus live parking slot information is present with the driver. The driver can also make reservation in particular slot which is free by making reservation request through his phone.

IV. HARDWARE COMPONENTS

The main components used in project are

- Master controller(LPC2148)
- Slave controller(89C4051)
- IR sensors
- Zigbee

A. Master controller(LPC2148)

The LPC2148 microcontrollers are based on a 32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support that combine microcontroller with embedded high speed flash memory of 512 KB [9]. We have used LPC 2148 because it has 2 serial ports UART O AND UART 1.On UART 0 we have interfaced Zigbee device which transmits slave controller data to another Zigbee device which is interfaced with server. On UART 1 we have interfaced serial communication port of slave controller (89C4051) to get parking slots status of particular area.

B. Slave controller(89C4051)

The AT89C4051 is a low-voltage, high-performance CMOS 8-bit microcontroller with 4K bytes of Flash programmable and erasable read-only memory [10].

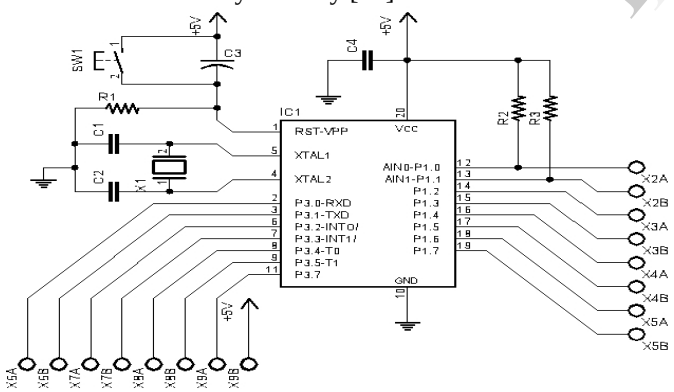

Fig-2: Slave controller circuit

FIG 2 shows slave controller circuit. We have interfaced LCD to port 1 of 89C4051and IR sensors data to port 3 of 89C4051.The sensors data is transmitted through serial port of 89C4051 to UART 1 of LPC2148.Thus serial port of 89C4051 is interfaced with UART 1of LPC2148.We have also interfaced LCD to port 1 of 89C4051 to give live parking slot status of that particular area.

C. IR Sensors circuit

Fig 3 shows circuit of IR transmitter and receiver with op amp IC LM 358 which will act as comparator.IR transmitter transmits IR light continuously. If the vehicle is present in front of IR transmitter the IR light bounces back and received by IR receiver. But this variation cannot be analyzed therefore the output of IR receiver is given to LM 358 op amp which will act as comparator. Now when vehicle is not present in parking slot IR waves transmitted by IR transmitter pass away straight and IR receiver does not receives reflected waves. Now due to this IR receiver output is zero, due to this inverting input of comparator goes higher than non inverting input of comparator thus output of comparator goes low and LED glows.

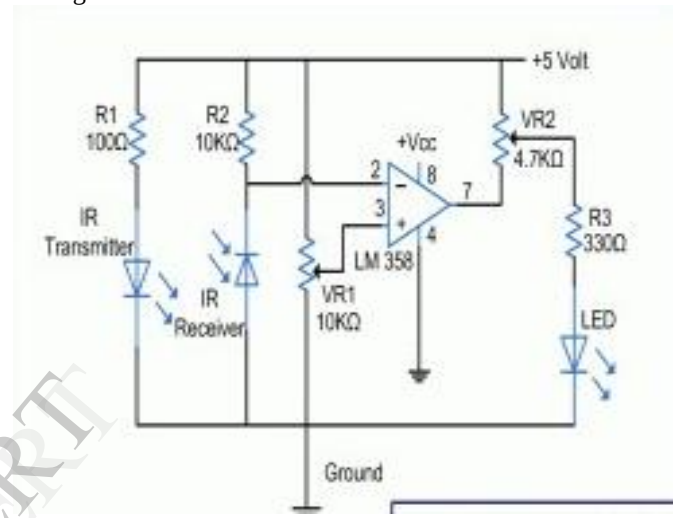

Fig-3: IR sensor circuit

If the vehicle is present in front of IR transmitter the IR light bounces back and received by IR receiver. Due to this inverting input goes low than non inverting input of comparator the output of comparator goes high and LED stops glowing. This output of comparator is then given to port 3 of slave controller 89C4051. ResistorsR1, R2,R3 are used to ensure that minimum 10mA of current flows through IR transmitter, IR receiver and LED.VR1 is used to adjust sensitivity of circuit.VR2 is used to adjust output.

D. Zigbee

We have used Zigbee series 2 module as shown in fig 4. The Zigbee Series 2 OEM RF Modules were engineered to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks.

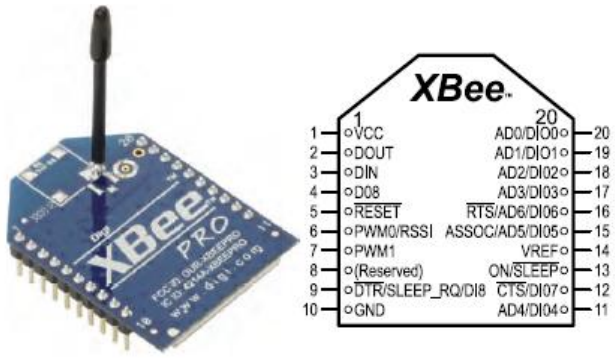

Fig-4: IR sensor circuit

We have configured two Zigbee modules with X-CTU software.

V. SOFTWARE DESIGN

The programming of LPC2148 and 89C4051 is done in Embedded C. We have used Keil micro vision integrated development environment (IDE).The micro Vision IDE is the easiest way for most developers to create embedded applications using the Keil development tools [11]. The micro Vision editor and debugger are integrated in a single application that provides an embedded project development environment. The graphical user interface (GUI) is developed in Microsoft visual basic studio 2008.The android application for mobile is programmed in JAVA using Eclipse 4.3.2 software. The system flowcharts are given in coming sections. The software flow are divided as

A. Flowchart to knows status of parking slots

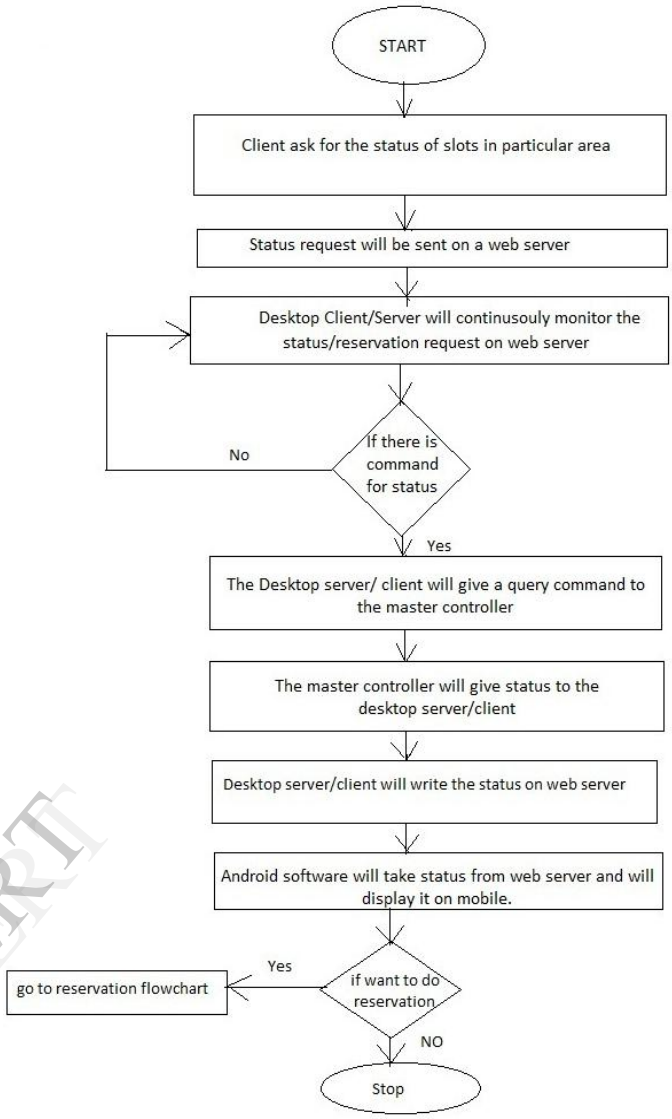

Fig-5: Status flowchart

As in fig 5 client (driver) will ask for particular parking slots status in particular area through his android application running on android phone. Android phone will send this status request on web server as we know desktop server and android phone will communicate through this web server. Now desktop server will continuously monitor for status request on web server. If it receives status request on web server it will send request to master controller through pair of Zigbee devices.

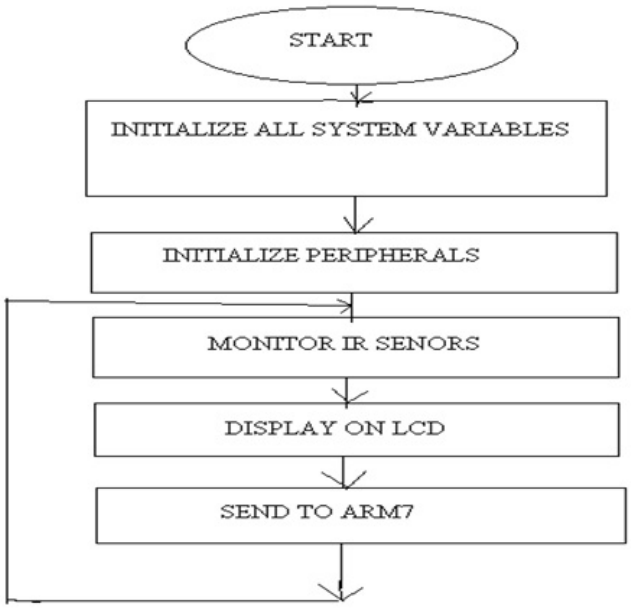

Fig-6: slave controller flowchart

Now as shown in fig 6 shows slave controller (89C4051) flowchart. Now master controller will give command to slave controller to get parking slot status. So as in fig 6 slave controller will get IR sensor circuit status and display on LCD simultaneously it will send these parking slots information to ARM 7 controller(LPC 2148) that is master controller. Now back to fig 5, the master controller will give this parking slots information to desktop server through pair of Zigbee devices. Desktop server will write this status on web server. At the same time desktop server will update database which we have designed in SQL. The android application will take status of parking slots from web server and display on android phone. Thus client (driver) will know status of parking slots. Now if driver wants to do reservation, we will see reservation flowchart.

B. Flowchart to make reservation in parking slots

Fig 7 shows flowchart to make reservation in parking slots of particular area. The client (driver) will send reservation request with his vehicle ID, area and parking slot in which he wants to make reservation and his password .The android application will send all this information on web server. Desktop server will continuously monitor web server for reservation request. If there is request for reservation then visual basic running on desktop will access database, now visual basic running will check in database if requested slot by client(driver) is reserved or not, if it is already reserved then it will send message “already reserved” on web server. Then it will check balance available in account of that particular client (driver), if balance is zero then it will send message “low balance” on web server, if balance is greater

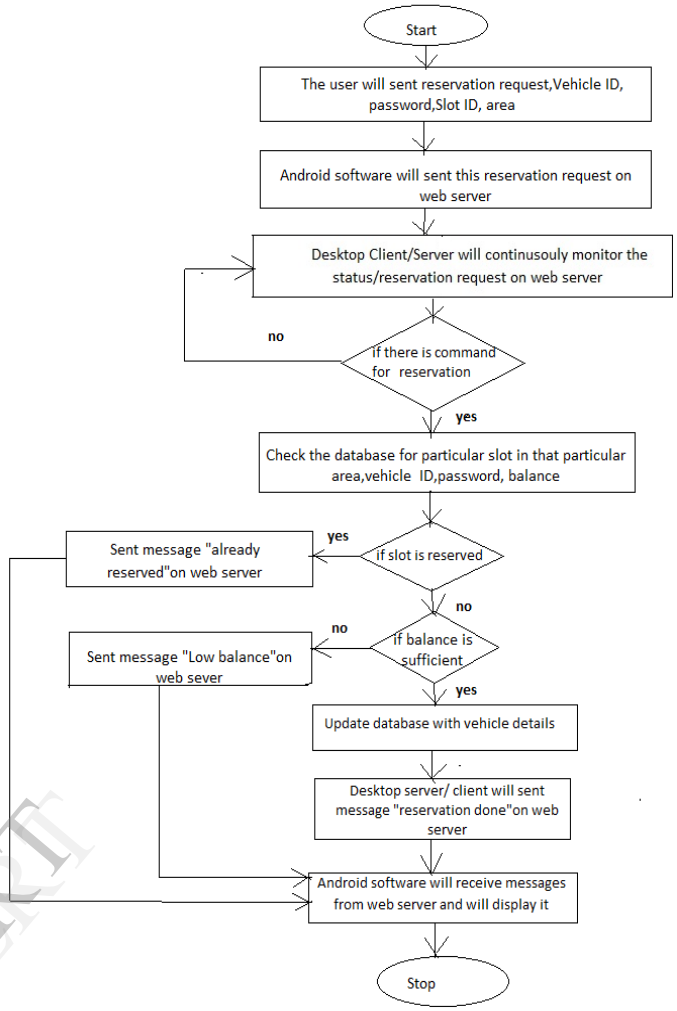

Fig-7: reservation flowchart

Than zero then visual basic will update the database with vehicle details. Then desktop server will sent message on web server “reservation done”. The android application running on android phone will take these messages from web server and display it on the client (driver’s) android phone.

VI. RESULTS

Fig 8 shows the actual circuit of master controller LPC 2148. As shown in fig 8 Zigbee is interfaced with UART 1 port of LPC 2148.Other two circuits are rectifier and adjustable voltage regulator

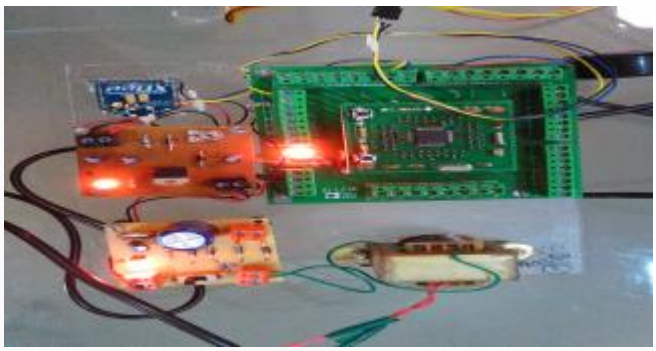

Fig 8: Master controller

Fig 9 shows circuit of one of the area whose serial port is interfaced with UART 0 of LPC 2148.

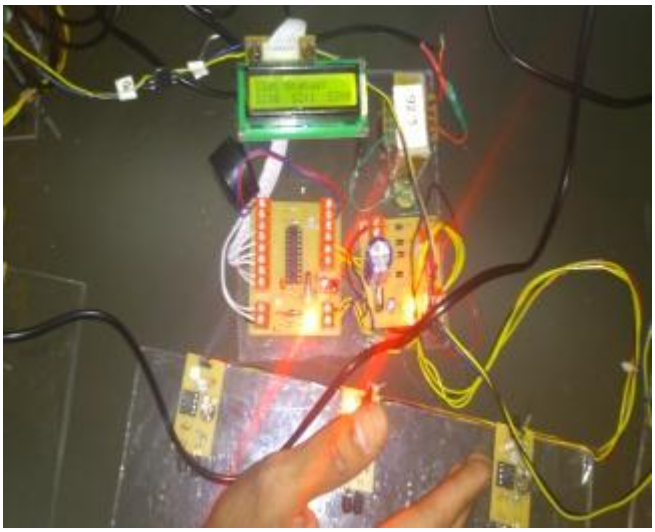

Fig 9: Circuit of area

As shown in fig 9 when we put hand in front of IR sensor circuit. The circuit senses it and gives high pulse to the slave controller (89C4051).The LCD is interfaced to Port 1 of 89C4051.Now accordingly 89C4051 will display the status of slots on LCD.

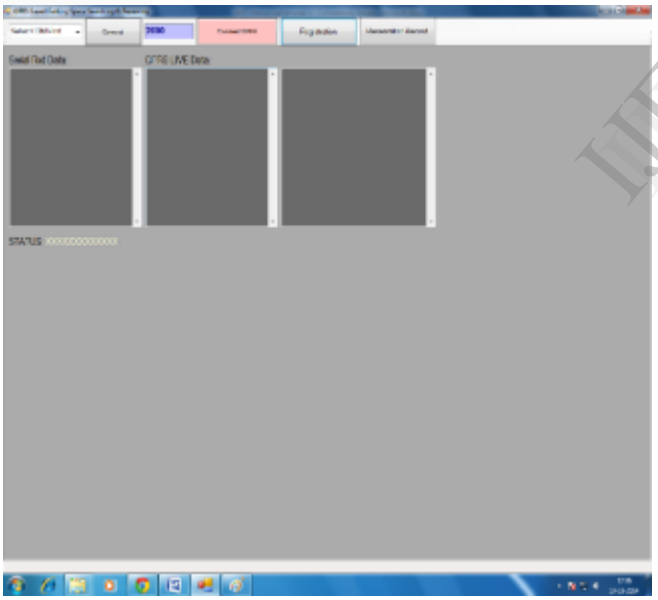

Fig 10: GUI running on server

Fig 10 is GUI running on server. It is designed in Microsoft visual basic studio 2008 software. This GUI is linked with SQL server database to store vehicle data. On GUI we have to select COM port to select Zigbee device, thus our server gets connected with Zigbee device and will get live status of slots in various areas. Connect GPRS button is used to connect our GUI with web server, thus android application can get live slots status in various areas.

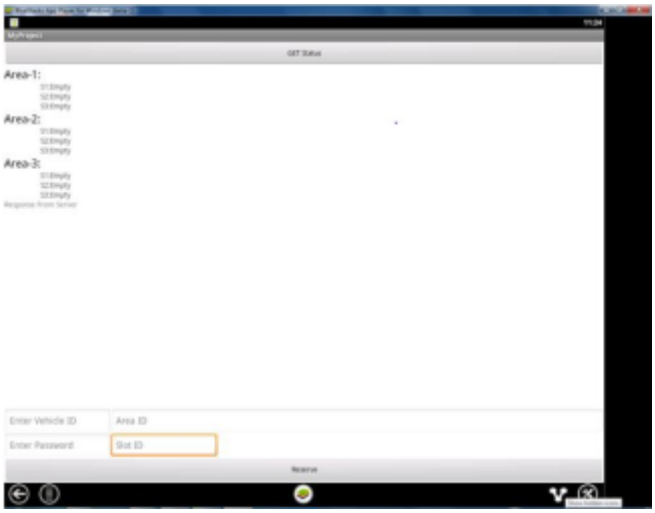

Fig 11: Android application running on android phone

Fig 11 shows the snapshot of android application which is running on android phone. We have created this android application in ADT java tool. The software used is Eclipse which is ADT Java tool.

VII. CONCLUSION

This paper proposes a set of smart parking services based on Zigbee. We designed and implemented a prototype system that allows vehicle drivers to effectively find the vacant parking spaces. The proposed system consists of slave controller, master controller, central server and android mobile phone application for android phone. In this system the state of parking slots is detected by IR transmitter and receiver and reported periodically to master controller through slave controller. The state of parking slot in particular area is also displayed on LCD. The state of parking slots is sent to central server by master controller through Zigbee device. Besides, the vehicle driver can find vacant parking lots using their mobile devices. The driver can also do reservation in particular slot using his android mobile.

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