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# ZIGBEE AND GSM BASED SECURE VEHICLE PARKING MANAGEMENT AND RESERVATION SYSTEM

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**ABSTRACT**

Wireless technology is an emerging technology. This paper discuss about the secure car parking and reservation system using wireless technologies. The system includes three modules, parking lot vacancy monitoring module, parking lot reservation module, and security module. Parking lot vacancy monitoring module includes infrared sensors and Zigbee modules which are interfaced with PIC Microcontroller. Vacancy monitoring module detects the presence of vehicle in the parking areas and provide the status to the users in real time. Reservation module includes GSM modem which is interfaced with a coordinator system. The user can book their parking spots through SMS. Security module includes set of rules which ensures the security of user's vehicle parked in their reserved parking spots. Security is one of the main concerns in this paper. If user's vehicle has been accessed by an unauthorized person, SMS based indication will be provided and also the system will not allow the vehicle to exit from the parking bay .This system suits well for multilevel and closed underground car parking systems.

**Keywords-***Smart Parking, Security, Zigbee, Xbee, GSM, SMS, Parking Reservation.*

## 1. INTRODUCTION

As the number of vehicles increasing day by day, the vehicle theft is also getting increased on a same scale [5]. The main problems that the vehicle users facing every day are finding out empty parking lots for their vehicle and security for their parked vehicle. A statistical report says that most of the vehicles are stolen when they are placed in the parking areas. Security is the main issue that lacks in many of the parking areas. The security for vehicles can be provided by appointing watch person for the parking area but for a multilevel car parking area multiple watch persons should be appointed which is not cost effective. An automated parking lot management system will provide a solution for these issues which is clearly framed out in this paper. Present smart parking system uses camera and load cell based vehicle monitoring system, which is not cost effective and also does not provide full scale security to the vehicles. This proposed work will solve this issue by providing two way password securities, and the system will be very much cost effective. The block diagram of the proposed secure car parking management and reservation system is shown in the figure 1.

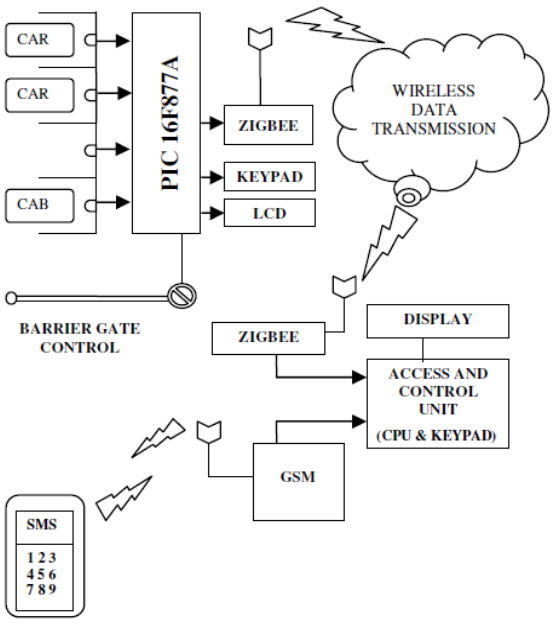


*Figure 1: Block Diagram.*

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## 2. WORKFLOW

### *2.1 Parking Lot Monitoring Module*

The flow diagram of vehicle detection module is shown in the figure 2. The parking lot is provided with infrared sensors and is allowed to sense the parking area continuously 24x7. If it detects any vehicle in the parking lot, it will indicate the presence of vehicle to the microcontroller to which it is interfaced. The microcontroller will in turn send the status information to the Zigbee node which is also interfaced with the microcontroller. The Zigbee node in turn transmits the status information to the end Zigbee node which is interfaced with a coordinator system at the entrance of the parking bay. Then the parking lot status is updated in the database system. Continuous update will take place as the system works continuously for 24x7. A display device is provided at the entrance of the parking bay which helps the users to identify whether the parking lot is available or not. This scenario suits well for single level parking system.

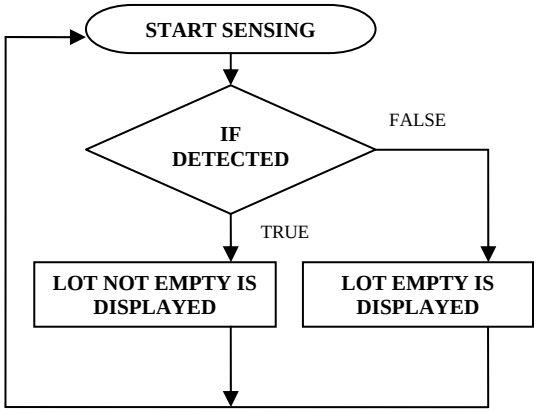


*Figure 2: Vehicle Detection Flow Chart.*

For multilevel parking system multiple Zigbee nodes will be used one for each level and a network is formed between the Zigbee nodes. In this proposed system, PIC 16F877A series controller and Digi International's Xbee nodes are used [4].

### *2.2. Parking Lot Reservation Module*

The flow diagram of parking lot reservation module is shown in the figure 3. When the user wants to reserve a parking lot in advance, user has to send a reservation SMS. When the coordinator system receives the SMS from the user, it will start to check whether there is any vacancy in the parking lot. If lot is available means the control unit will send an acknowledgement message along with the entry password to the respective user who has requested for parking lot reservation. A timer will be started for that reservation. Before the timer expires the user has to reach and enter the password, if not means the reservation will get expired and the expiration message will be sent to the user. If lot is not available means lot not available SMS will be sent to the user. If user reaches on time means, he has to enter the entry password in order to access the parking lot. An access system which is available at the entry of the parking bay is used to provide the password. If the password is correct means the barrier gate will get open and allow the user to enter the parking level. Once the user parked the vehicle in the respective parking lot allotted, the user has to press a key, which is available in the parking lot which enables the security monitoring of the vehicle.

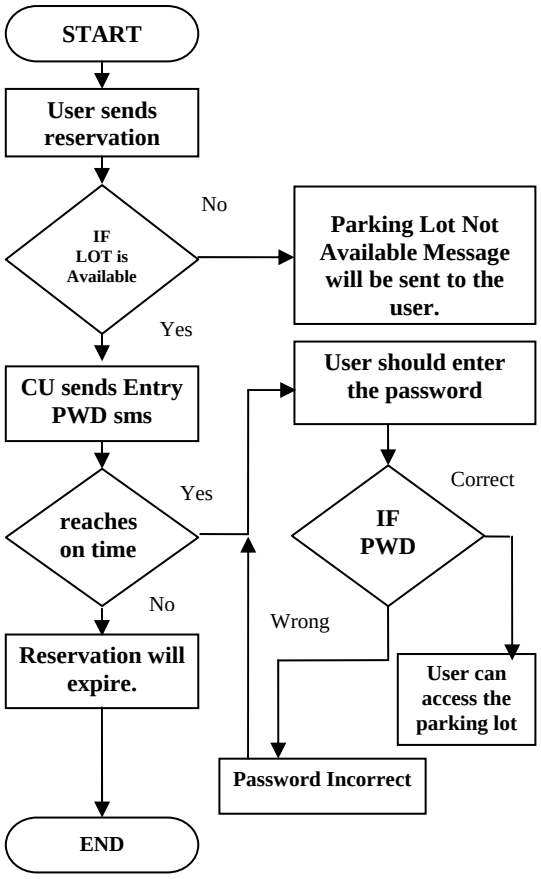


*Figure 3: Reservation Flow Chart.*

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*2.3. Security Module*

The flow diagram of security module is shown in the figure 4. When the user park their vehicle in their respective reserved parking lot means, that particular parking lot number and user's phone number will be stored in the database system for that particular lot and the sensor will sense the presence of vehicle in the parking lot. If the vehicle is taken out from the parking lot means the infrared sensor will indicate the controller and the controller will in turn indicate the coordinator system through Zigbee nodes. The coordinator system will in turn send an exit password to the user's mobile phone which is stored in the database system. If the vehicle is taken out from the parking lot by the user means the user has to enter the exit password which he will be receiving once he takes out the vehicle from the parking lot.

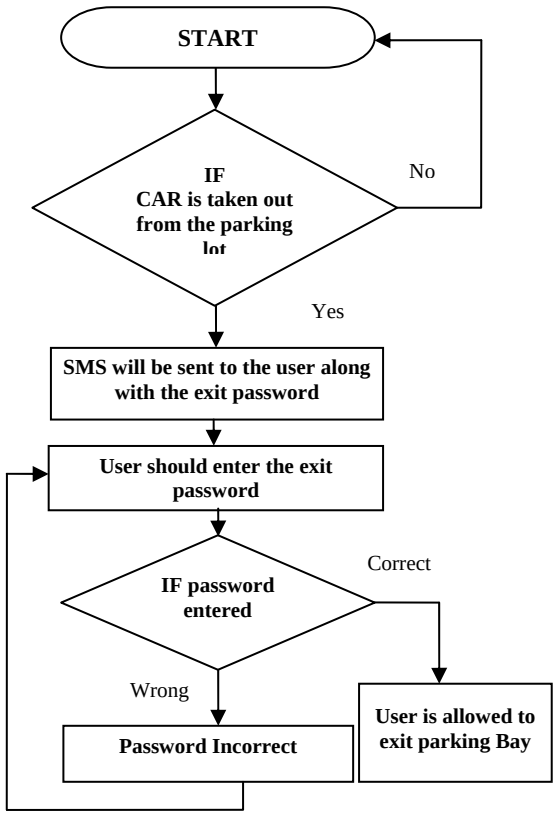


*Figure 4: Security Module.*

If the vehicle is taken out from the parking lot by an unauthorized person, (He/she may think that the entry password and exit password will be the same but not so.) he/she is not allowed to get out of the parking bay as the barrier gate will not get open until correct exit password is entered. At the same time the original user will receive an exit password in his mobile, and he will come to know that some unauthorized person is trying to access his/her vehicle.

## 3. DESIGN OVERVIEW

The secure car parking reservation and management system includes access control unit (normally a PC), PIC 16F877A series microcontroller, Zigbee nodes, keypad, barrier gate, and display unit. As mentioned earlier this system has three modules; parking lot monitoring module, lot reservation module, and security module. Each parking lot will be provided with infrared sensor, whose function is to monitor the parking field 24x7. The infrared sensors are interfaced with the PIC microcontroller to which Zigbee node is also interfaced. The lot status is continuously transmitted to the coordinator system where the database is maintained. A barrier gate is provided to each level of parking bay. Each level may have number of parking lots. UART communication is carried out between Zigbee node and the microcontroller. On the other hand the access control system (coordinator system) will have Zigbee node and GSM modem interfaced with it. Dot Net framework is used to construct the access system.

*3.1. Zigbee.*

Zigbee is a low power radio frequency node which operates on a license free frequency band. Digi International's Xbee node is used in this system. It operates on 2.4 GHz frequency band [4]. Here Xbee nodes are used to transmit the lot status to the coordinator system and also for handling the barrier gate control.

*3.2. PIC Microcontroller.*

PIC (Peripheral Interface Controller) is an 8 bit Microcontroller used in this system. PIC16F877A series controller used here seems to be efficient and cost effective for this parking management system.

*3.3. GSM.*

GSM (Global System for Mobile communication) is a wireless communication device used to receive the user's request for reserving the parking lot and also for sending the entry and exit password to the user for accessing the parking lot. SIM300 V7.3 version modem is

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used in this system. AT command sets were used to access the GSM modem [3]. GSM modem is interfaced with the coordinator system using RS-232 COM connection.

*3.4. LCD.*

LCD is a display device interfaced with the microcontroller which is placed at the parking level. The LCD is used to display the value entered by the user.

## 4. RESULTS AND EXPERIMENTS

Experiments were conducted and it proves to be very successful. The screenshots of the front end access system and the prototype of the parking lot management system are shown in the figure below.

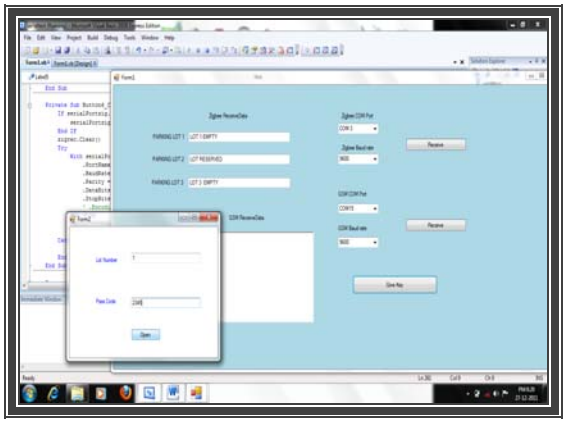

*Figure 5: Access Form.*

The figure 5 shows the front end access form with number of fields. The front end access system is constructed using VB.Net. It consists of number of user friendly fields which can be easily accessed by the users.

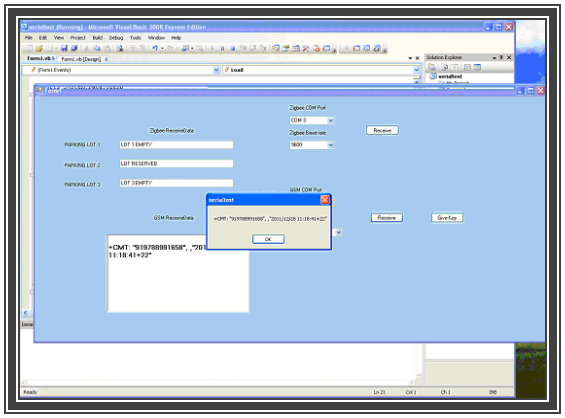

*Figure 6: Access Form in Windows XP Showing User's Message Validation.*

Figure 6 shows the reception of the users request for lot reservation. Figure 7 shows the prototype of the lot monitoring and management system for single level vehicle parking system. Figure 8 shows the coordinator setup which consist of front end system to which aigbee end node and GSM modem are interfaced.

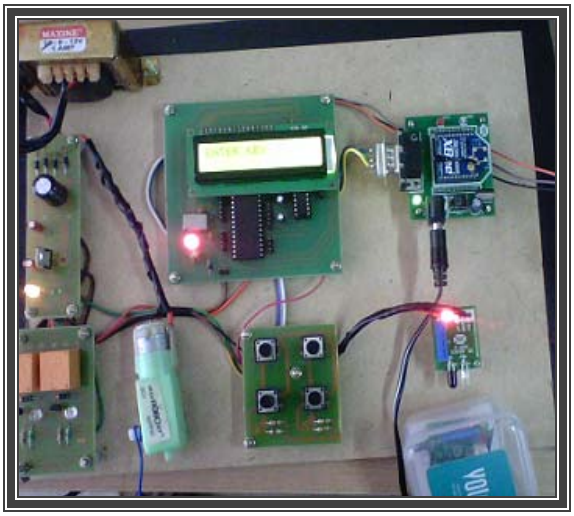

*Figure 7: Prototype of Parking Lot Monitoring System.*

SIM 300 type modem is used in this system and Digi International's Xbee nodes were used. Xbee nodes are configured using X-CTU software [4]. AT commands for Zigbee will vary according to the manufacturers. Figure 9 shows the controller circuit diagram of the lot monitoring module.

*Figure 8: Coordinator Setup.*

It includes LCD, MAX232, PIC16F877A controller, four infrared sensor modules and a D-type 9-pin connector.

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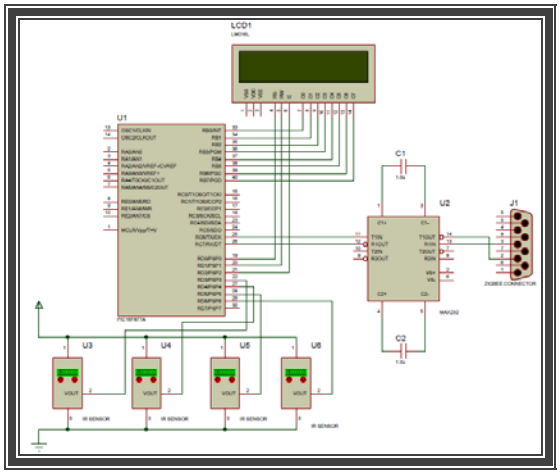

*Figure 9: Microcontroller Circuitry For Lot Monitoring.*

On the whole, this system provides security to the parked vehicle, reduces the unnecessary time taken for finding the empty space in parking area, and also reduces the traffic and unnecessary mess inside the parking area.

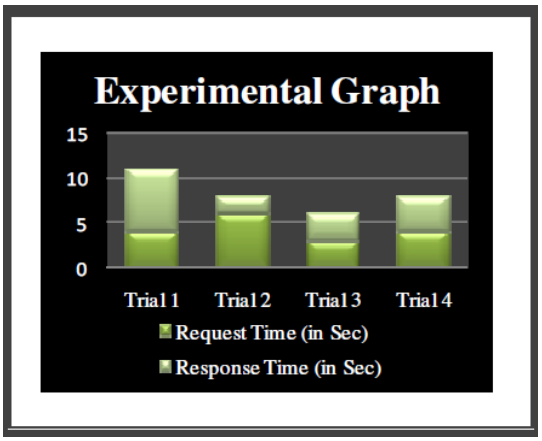


*Figure 10: SMS Request and Response Time Graph.*

Figure 10 shows the graph between request time (time taken for the message to reach the coordinator) versus the response time that the coordinator takes to validate and reply.

## 5. CONCLUSION

This system holds good for smart parking system, as it provides higher level of security for the vehicles parked in the respective parking spots. This system also reduces the traffic and congestion in finding the available parking spots. The two way password protection module ensures the security of the vehicle and the experimentation result proves that the system provides higher level security for the parked vehicles and is easily implementable in real time. This system holds a working rate of 9.5 out of 10. On the whole this system proves to be cost effective and highly secure.

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