International Journal of Computer Communication and Information System (IJCCIS)
– Vol2. No1. ISSN: 0976–1349 July – Dec 2010

A Prototype Parking System using Wireless Sensor Networks

Mr.P.VIJAY KUMAR ,SIDDARTH T.S
Asst. Prof. (Sr.G) ECE DEPARTMENT , SRM UNIVERSITY ,Chennai, India
vijay_at23@rediffmail.com
M.tech Embedded System Technology, SRM UNIVERSITY, Chennai, India
siddarthts@gmail.com

Abstract

With the rapid proliferation of vehicle availability and usage in recent years, finding a vacant car parking space is becoming more and more difficult, resulting in a number of practical conflicts. Parking problems are becoming ubiquitous and ever growing at an alarming rate in every major city. Wide usage of wireless technologies with the recent advances in wireless applications for parking, manifests that digital data dissemination could be the key to solve emerging parking problems. Wireless Sensor Network (WSN) technologies have attracted increased attention and are rapidly emerging due to their enormous application potential in diverse fields. This field is expected to provide an efficient and cost-effective solution to the effluent car parking problems. This paper proposes a Smart Parking Management System based on wireless sensor network technology which provides advanced features like remote parking monitoring, automated guidance, and parking reservation mechanism. The paper describes the overall system architecture of our embedded system from hardware to software implementation in the view point of sensor networks.

This paper also shows that the pre existing security surveillance (CCTVs) will be used as a sensing nodes to identify vacant parking space. The captured image will be processed through the ARM7 Microcontroller and the processed data will be transmitted via ZigBee to a central computer to store and update the occupancy status of available parking space vacancies in the database. The performance of this WSN based system can effectively satisfy the needs and requirements of existing parking hassles thereby minimizing the time consumed to find vacant parking lot, real time information rendering, and smart reservation mechanisms.

Index Terms—Wireless Sensor Networks (WSN), Smart Parking, Remote Monitoring, Automated Guidance, Lot Reservation, CCTV.

I.INTRODUCTION

Recent increase in the growth of automotive industry coupled with the perpetual demand of commuters urged the need for better and smarter parking mechanisms. Though lot of researches were conducted in this area, most of the existing parking management systems rarely address the issues of parking space management, vehicle guidance, parking lot reservation etc. Majority of these systems Have control at the entrance & exit and use vehicle detectors as an essential element to provide smart parking. Though inductive loop is one of the most widely used detectors today, it includes various problems in installation and maintenance which might disturb the normal operations of parking. The widespread use of wireless technologies paired with the advancement in wireless applications for parking implies that digital data dissemination could be the key for resolving the growing parking challenges. WSN have a great potential towards providing an easy and cost effective solution to this credible application for various reasons. Ease of deployment in existing parking lots without excavation and expensive cable installations has increased our attention towards wireless sensor network technology. Flexibility to couple with sophisticated but cheap sensors that can accurately detect vehicles makes WSN a natural candidate to solve the emerging car parking problems. Wireless sensor network usually consists of a large number of nodes that are deployed in the sensing area and are equipped with different kinds of sensing, computation and communication units. These functional units enable WSN nodes to cooperatively collect, process, and transmit information to the communication subsystem. Compared with the existing parking management systems, this paper proposes a Smart Parking solution based on wireless sensor network technology. Our choice was motivated by the need for an automated, cost-effective, real time and easy-to-use system for car parking. The proposed system is capable of monitoring & managing individual parking spaces, providing automated guidance and advanced reservation services as well. In the remainder of this paper, we present the complete overview of Smart Parking Management System, including the design and implementation of the developed prototype model as part of the project. We begin with a detailed discussion of related works on various parking management systems using WSN. We describe the system architecture of our proposed system and its functional components. Discusses the subsystem level interactions and user interfaces to the system. As a proof of concept, we present a full-fledged prototype deployment and give some preliminary experimental results in this. Finally we conclude the paper in section 5.

II.RELATED WORKS

In this section we review the literature on existing and proposed parking lot applications based on WSN. Lee, Yoon and Ghosh proposed a hybrid approach

[1] For an intelligent parking system using a combination of ultrasonic and magnetic sensors. They demonstrated promising results through various real world experiments and showed that these hybrid solutions are more practical and accurate. Though the main goal was to count the number of vehicles on each floor and provide a cheap and accurate solution, the scope of their work restricts itself to vehicle detection using WSN than providing a smarter parking management solution. D-Systems Project

[2] Presented various issues for a reliable WSN system using magnetic sensors. As part of this project an implementation of a car-park management system using a tiered architecture is detailed using magnetic sensor boards. of dynamic & robust routing, delayed retransmissions, etc. Jatuporn et al.

[3], proposed optical WSN as a vehicle counting system in smart parking garages. Their proposed solution is to add another optical sensor head to the wireless sensor node. Two sensor heads were used to classify the objects of different sizes thereby distinguishing and identifying different vehicles.

III. OUR SYSTEM ARCHITECTURE

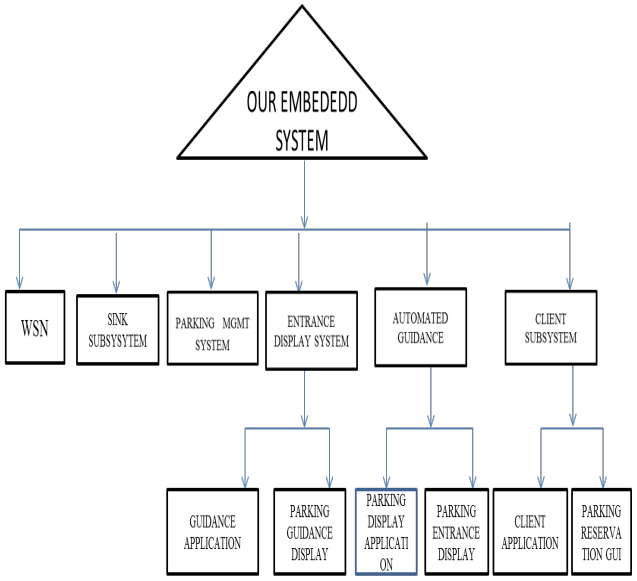

Fig. 1: System Architecture

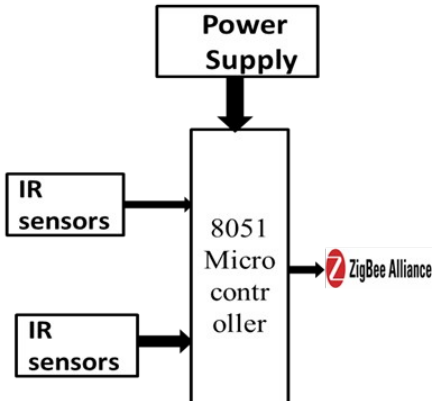

Fig 2: Transmitter

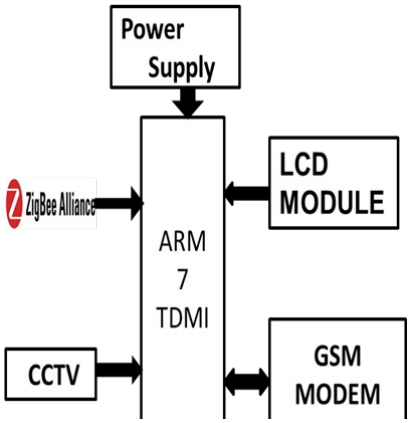

Fig. 3: Receiver

In this section, we describe the design of Smart Parking management system which consists of WSN, communication subsystem, Parking Management, Automated Guidance, Entrance Display and Client Reservation subsystems. At a glance, the system shall be able to graphically display real time information related to the availability of parking lots to the users and would also enable users to reserve parking lot from remote locations. The system will also be capable of guiding users to efficiently locate vacant parking spaces so as to park their cars quickly and safely. Figure 1 details the system architecture of our system. The overall architecture is divided into six major subsystems as mentioned. The functions of each subsystem are as follows.

A. WSN Subsystem

WSN subsystem mainly deals with monitoring of parking status. This subsystem detects the status of parking space with hybrid sensing techniques and transmits status information through RF. It also receives commands from parking management subsystem to carry out various procedures. The subsystem internally consists of four major

modules which include sensing, routing, dissemination and status modules. System Architecture of our embedded system.

B.Communcation Subsystem

This subsystem collects the parking status report from WSN subsystem and delivers them to the parking management subsystem. It acts as a gateway between wireless sensor network and external networks. This subsystem also forwards the information regarding the change in parking status received from management subsystem to the guidance subsystem through Wi-Fi/Bluetooth/RF interfaces.

C.Parking Management Subsystem

This subsystem acts as the heart of entire our system. Whenever communication subsystem sends data to the parking management subsystem, the gateway transceiver module associated with the subsystem receives the data, processes it and forwards to the database module and vice versa. The database module stores the event based sensor data and the health information of the sensor nodes. The sensor & guiding node information from the database will be collected by the parking guidance module and displays the corresponding information on the parking lot GUI. It also takes the health information from sensor health monitoring module & displays on GUI. Parking entrance display module existing on this subsystem gets consolidated status information from the database and then processes the information to be sent to the parking entrance display. Whenever the client reserves a parking lot, the reservation message will be forwarded to parking reservation module running on the management subsystem. It will further retrieve data from the sensor database and based on the availability of parking lots will forward an acknowledgment to the client.

D.Automated Guidance Subsystem

Guiding nodes divide their managing areas into several sections according to the turn offs of the parking layout. This subsystem helps vehicles to find idle parking spaces within less time. It consists of 2 modules which are as follows:

a) Guiding Application

If there is a change in the status, the management subsystem processes the information and forwards it to the sink subsystem. The processed data is then forwarded by sink subsystem to the guiding application running on the guidance subsystem, which is later depicted on parking guidance display.

b) Parking Guidance Display

This module collects the information from the guiding application and displays it to the users. It shows the availability of the parking lots in all the directions (Left/Right/Ahead) which shown figure 7.

E.Entrance Display Subsystem

As the name suggests, this subsystem is placed at the entrance of the parking. It shows the status of the parking lots to the users before entering the parking area. This subsystem is divided into 2 modules as follows

a) Entrance Display Application

Whenever there is a change in the status, the parking entrance display module on the management subsystem processes the information and forwards it to the parking entrance display subsystem. The entrance display application running on this subsystem receives and processes the data. The processed data is then forwarded to the parking entrance display for displaying the status

b) *Parking Entrance Display*

This module displays the parking status information to the users received from the entrance display application. It shows the complete status of the whole parking layout (Total lots occupied/vacant) which shown figure 8.

F. Client Subsystem

Client Subsystem is the one which allows the clients to remotely interact with our system. This subsystem consists of 2 modules which mainly run on the clientele devices. They are

1. Client Application

This mainly runs as a background process which processes the inputs given by the user through the parking reservation GUI and sends the information to the parking management subsystem.

2. Parking Reservation GUI

parking reservation GUI is a front-end application running on the clientele devices allowing the users to give their parking details (License Number + Time of parking) in order to reserve a parking lot. This information is later processed by client application and sent to the parking management subsystem to allocate a parking lot which is shown in figure 6.

G. *Sensing Technique*

To detect an event we evaluate (Base light - Sn) > Threshold, where Base light is calculated through reference motes deployed in the parking lot. This value will eliminate the disparity in light readings due to environmental variations. Sn is the averaged light readings for a predefined period of time (1 second in our case). If the

difference in readings exceed the set threshold, then we assume that the lot is occupied with a car, else, we consider that the lot is vacant.

```
while(1)
{
do
{
temp= rx();
}
while(temp!='A');
        //printf("\b%c",temp);
                        temp = rx();
                        cmd_lcd(0x8e);
                        dat_lcd(temp);
 temp1 = 0x39-temp;
 temp2 = temp1+0x30;
cmd_lcd(0xCe);
 dat_lcd(temp2);
            printf("Vehicles Parked  :%c\n ",temp);
             printf("Vacancy Slots: %c\n\n",temp2);
             }
}
```

6. PROTOTYPE OF PARKING LAYOUT

Fig 4: prototype of parking GUI

Fig 5: LED

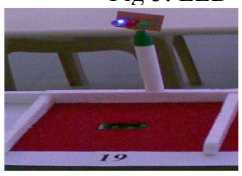

Fig 6: Reservation Slot

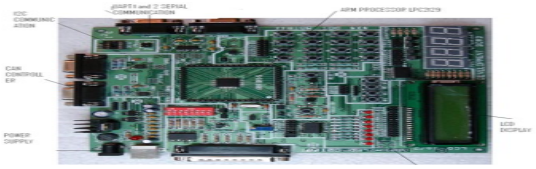

Fig7:ARM7-TDMI

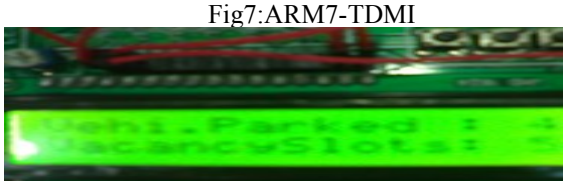

Fig8: Entrance Display

Fig9: GSM Device

IV System Evaluation

Our prototype system is developed as a proof of concept to meet the real time requirements of parking management systems. We have carried out preliminary experiments to evaluate the functionalities and features provided by our prototype system. In our initial experiment we have modelled this prototype for 4 parking lots which is shown in figure 4.

1 Parking Monitoring

a) *Scenario 1*: Total parking lots are vacant: When all the parking lots are vacant, the sensor nodes placed in the parking lots detect that there is no event generated. The entrance display shows total vacant lots as 4 and parking lot as 0 and GUI depicts the same as shown in figure 8.

b) *Scenario 2:* Two cars are parked: In this scenario we experimented by parking two cars in the parking lots. The sensor nodes detected the events and transmitted the report message to the communication subsystem. The communication subsystem in turn forwarded these messages to the management server. The management server processes this information and sends the status report to the respective guiding nodes and entrance display. The entrance display and parking lot GUI then, displayed the total no of vacant lots as 2.

2. Parking Reservation

The user interested in reserving the parking lot would submit his parking details on the client reservation GUI running on his mobile phone. This SMS Message is forwarded to the management server through the GSM interface. In this case the management server finds parking lot number 4 to be vacant and sends confirmation message, allocated parking lot number and start time of parking to the user. The management server will also send the status information to the WSN subsystem which will turn on the blue LED of parking lot 4 as shown in figure 6 and the parking lot GUI updates the parking lot number 4 as reserved.

3. Parking Guidance

We depict the feature of parking guidance provided by our prototype system in this case. The parking guiding nodes are deployed at the turn offs of the parking area these nodes depict the availability of parking lots in three directions (left/right/ahead) which is shown in figure 5.

V.CONCLUSION

In this paper, we described the Smart management system using wireless sensor networks. Based on the requirement analysis for existing car parking management systems, we designed the system architecture and its subsystem level components. We implemented a full-fledged prototype model as a proof of concept to realize and understand the real time scenarios in parking management systems. Through our prototype system we demonstrated that the proposed architecture can effectively satisfy the requirements of a car park management system and we believe that wireless sensor networks can be a promising technology to solve future parking hassles.

REFERENCES

[1] Sangwon Lee, Dukhee Yoon and Amitabha Ghosh, Intelligent Parking Lot Application Using Wireless Sensor Networks, Proceedings of IEEE conference, 978-1-4244-2249-4/08

[2] Barton, J., J. Buckley, B. O'Flynn, S.C. O'Mathuna, J.P. Benson, T. O'Donovan, U. Roedig, and C. Sreenan, The D-Systems Project – Wireless Sensor Networks for Car- Park Management, Proceedings of the 65th IEEE Vehicular Technology Conference, Dublin, Ireland, Apr 2007, pp. 170-173.

[3] IrisNet: Internet-scale Resource-Intensive Sensor Network Service, http://www.intel-iris.net

[4] Jatuporn Chinrungrueng, Udomporn Sunantachaikul, Satien Triamlumlerd Smart Parking: an Application of optical Wireless Sensor Network, roceedings of the 2007 International Symposium on Applications and the Internet Workshops (SAINTW'07)

[5] Tang, V.W.S., Y. Zheng, and J. Cao An Intelligent Car Park Management System based on Wireless Sensor Networks, Proceedings of the 1st International Symposium on Pervasive Computing and Applications Urumchi, Xinjiang, China, Aug 2006, pp. 65?70.

[6] BI Yan-Zhong, SUN Li-Min, ZHU Hong-Song, YAN Ting-Xin, LUO Zheng-Jun A Parking Management System Based on Wireless Sensor Network, ACTA AUTOMATICA SINICA, November 2006, Vol. 32, No. 6

[7] http://www.tinyos.net

[8] http://www.xbow.com

[9] Michelle Crowder, C. Michael Walton Developing An Intelligent Parking System For The University Of Texas At Austin, Research Report Swutc/03/167229-1

[10] Tapas, Dileep K Panjala, S V Srikanth System Requirement Specifications for SPARK, for Establishment of National Level Ubiquitous Research Resource Centre, C-DAC Hyderabad, 2008

[11] Jeffrey F. Paniati, Associate Advance Parking Management System : A Cross- Cutting Study, Taking The Stress Out Of Parking, January2007

[12] Gaurav Sehgal Monash Car Park SMS Project, School Of Computer Science And Software Engineering Monash University Research Proposal, 2005

[13] Tapas, Dileep K Panjala, S V Srikanth High Level Design Document for SPARK, for Establishment of National Level Ubiquitous Research Resource Centre, C-DAC Hyderabad, 2008

[14] http://www.amontec.com/lcd nokia 3310.shtml

[15] http://www.xbow.com/Products/Product_pdf_files/Wireless_pdf/ MTS MDA Datasheet.pdf

[16] www.xbow.com/Products/Product pdf files/Wireless pdf/ MICAZ Datasheet.pdf

[17] www.analogicgroup.com/Pdfs/datasheets/smart modem.pdf