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A Novel Approach towards Car Parking with Space Conservation

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***Abstract* — With the tremendous increase in human population and the cars on road in the last few decades, has led to an existing and growing parking problem. This paper presents our work on automatic smart parking system that relies on sensors and vision to estimate free parking slots. The proposed system not only locates empty parking lots but also estimates the parking space required considering the size of the vehicle thereby reducing any space wastage.**

***Keywords* — Intelligent Car Parking System, Wireless Sensor Network, Parking Management, Parking Guidance.**

II. INTRODUCTION

The ever growing vehicular traffic in most cities has lead to a major problem of parking. This problem is a major one especially in the congested areas of the cities which often are the most visited and important trade centres. Further considering the increase in vehicle sizes in the luxury segment and confined parking spaces in parking lots and cities, often leading to traffic jams and gallons of fuel wastage and an unnecessary increase in pollution levels. Further these situations often cause stress & fatigue for the car driver. So an efficient and intelligent utilization of parking space is the need of the hour.

Most of the developed western countries have installed elevated or underground multilevel car parking systems as shown in Figure 1. Such parking systems require less space, but have very high constructional cost and often consume large electricity, thereby have high maintenance cost and can only be thought of in specific locations of a city. However in a country a developing country like India with congested cities such a system is often impractical considering their huge costs except in metros.

The intelligent car Parking System is a system designed to reduce the number of problems associated with parking cars. Most of the intelligent car parking systems suffers from one or more of the following problems:

- Locating empty spaces
- Directing driver to search vacant space for park.
- Congestion in car parks.
- Combine traffic monitoring.
- Indiscriminate parking.
- Reduce search time, which in turn reduces congestion on the surrounding roads.

Fig.1. Multilayered Car Parking System

II. LITERATURE REVIEW

Wireless Sensor Networks (WSN) has attracted a great amount of attention in recent years [1]. A WSN consists of a large number of low-cost sensor nodes which can be self-organized to set up an ad hoc network via the wireless communication module equipped on the nodes. Taking the advantages of wireless communication and sensing, WSNs have already found many civil and military applications. With the imminent demand of the automobiles and the demand on intelligent parking systems, the use of WSN in these systems has caught the eye of the researchers more so in the last few decades. In this section some of the recent work in this area is presented.

Some of the initial studies focused on the applications of car parking system using sensor technologies adopted video sensors/cameras to collect the information in car parking field [2]. However the use of sensors has certain disadvantages, of which the two main disadvantages includes; a video sensor is energetically expensive, and a video sensor generate a very large amount of data which often poses difficulty in transmission in a wireless network.

Bi Yan-Zhong, Sun Li-Min, Zhu Hong-Song and Yan Ting-Xin [3], have designed a system which includes three kinds of nodes and a management station for central control. Each kind of nodes plays a different role in the system, and communicates directly or indirectly with other kinds of nodes. They collaborate with each other to accomplish topology formation, route establishing, parking space status sensing and reporting and command processing.

Vanessa W.S. Tang, Yuan Zheng and Jiannong Cao, in their work [4] proposed a WSN-based intelligent car parking system which used low-cost wireless sensors 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. They have

implemented a prototype of their system using crossbow motes. The system evaluation demonstrated the effectiveness of our design and implementation of the car parking system.

Rakesh Kumar, Naveen K Chilamkurti and Ben Soh [5], presented a valuable comparison data for different sensors using different type of software functions and hardware components. The main goal of their work was to present a simple, automated analysis and comparison of power management, communication efficiency and threshold times using different sensors and a corresponding prediction of the above features. The results show a clear difference in various parameters by using different types of sensors for vehicle detection.

Xiaolong Li and Uma Kanth Ranga in their work "Design and Implementation of a Digital Parking Lot Management System" [6], designed a digital vehicle management system using radio frequency identification (RFID) technology. This digital vehicle management system will enhance the utilization of parking space and help user check the availability of the parking space remotely since the system is connected to the Internet.

Nayab Suhail Hamirani, Imdad Ali Ismaili, Asad Ali Shaikh, Faheem Ahmed and Azhar AliShah, in their work, have used ATMEL microcontroller as the main processor along with LCDs and motors as complimentary components for display and rotation [7]. Their model is based on circular mechanism giving low cost, less space and optimum performance. Password locking system is used to verify the object and detects number of free spaces available in the parking lot.

Mingkai Chen and Tianhai Chang, in their work [8] have designed an efficient parking systems using WSN concepts. They used three kinds of nodes namely monitoring nodes, routing nodes and sink node. The monitoring nodes would detect the status of every parking space, and transmit the information through routing nodes hop by hop to the sink node. The sink node connects to the information and management centre through RS-232 interface. After processing the data, the information and management centre will send the message to all the nodes and update the information in LED screen at the entrance of the parking lot.

Mingkai Chen, Chao Hu and Tianhai Chang, have presented a space choice decision parking model to help PGIS in the parking lots choose the optimal parking space for drivers [9]. Based on the specific situations of the parking lots, the habits and preferences of the drivers are also considered in this modal.

One of the most significant factors in designing an efficient and intelligent car parking system or any other transportation system for that matter is to accurately detect the mobility of automobiles, particularly when vehicles move in a high speed. There are some studies using magnetic sensors. In [10] vehicles are detected by measuring the change in the Earth's magnetic field caused by the presence of a vehicle near the sensor. Two sensor nodes placed a few feet apart can estimate speed. This work describes the algorithms and presents experimental results comparing the accuracy of such a wireless sensor network with loop detectors and video. However, these sensors can be energy intensive and widespread deployment of these sensors is still a challenging problem in WSNs considering the energy constraint.

III. Requirements Analysis

This section discusses the basic requirements of designing a WSN-based intelligent car-park management system. Some of the conventional issues of modern day car parking systems have already been discussed in the first section. The common goal for all car parks is to attract more drivers to use their facilities from the business point of view. Hence some basic physical facilities required to be satisfied are:

a) Location of the car park should be easy to find in the street network.
b) Entrance of the car park should be easy to discover.
c) The number of parking lots should be abundance and a parking lot should obtain a large space enough to park a car in.
d) Easy to exit and to re-enter on foot.

Considering the basic physical and geographic facilities an intelligent car parking system should add to the automation of both business and customers and hence should satisfy the following requirements:

a) The system should provide proper and easy to understand instructions or guidelines to help drivers to find a available parking lot
b) The system should provide effective security measures to prevent the cars from being broken, stolen, etc.
c) The system should provide suitable auto toll methods to drivers.
d) The system should provide powerful functions to facilitate administrators and managers to manage a car park.

IV. Proposed Systems

Figure 2 below shows the prototype of the proposed intelligent car parking system. The proposed car parking system consists of following main parts:

- Ultrasonic wireless sensor
- Local Microcontroller
- Main Microcontroller
- Display Unit
- Management system
- RFID tag
- Euclidean Distance

In the Figure 2(a) below the red blocks indicate the wireless sensor nodes placed at appropriate distance depending upon the geographical area of the park. Here Euclidean Distance is used to calculate the minimum distance between the two adjacent nodes. The reduced number of nodes reduces the consumption of the whole system, can place the vehicles more efficiently and in lesser amount of time and would also lead to save petrol of the vehicles. As a car enters the parking lot it cuts the ultrasonic sensor and hence the main controller is

informed about the arrival of a new car. The car is assigned a RFID tag to identify the car later on. These RFID tag are used to lock while parking and unlock while leaving. The main controller assigns and displays an empty parking space to this car. The car when crosses the next WSN node it is instructed for the next move/turn and so on. In this way the car is guided to the allotted parking space.

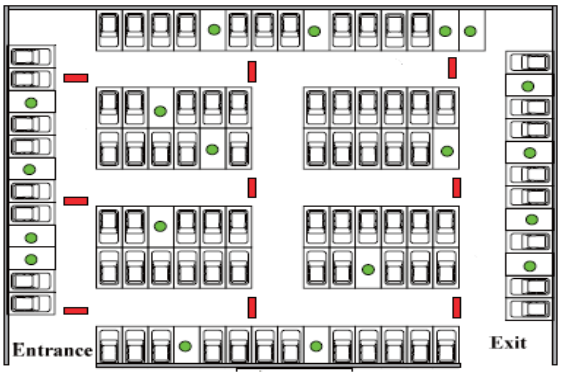

Fig.2. (a): Prototype of the proposed care parking system

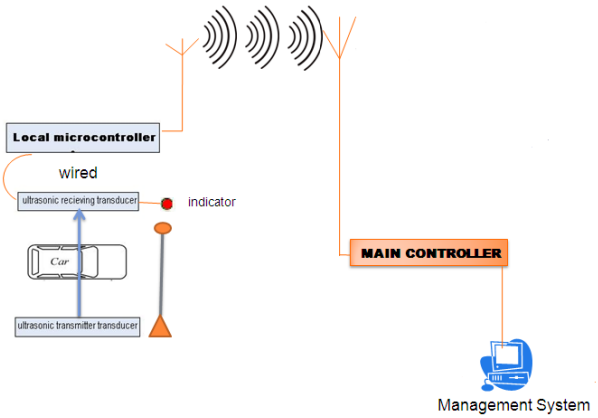

Fig.2. (b): Detecting a car at the entry.

As in figure 2(c), each parking space is companied by a WUS transmitter-receiver pair. When a particular space is getting filled then the sensor their responds to the local micro-controller about the space being filled up. On the other hand when a space is emptied the particular sensor doesn't detects an object and responds the same to micro-controller system using the WUS transmission to the WSN node.

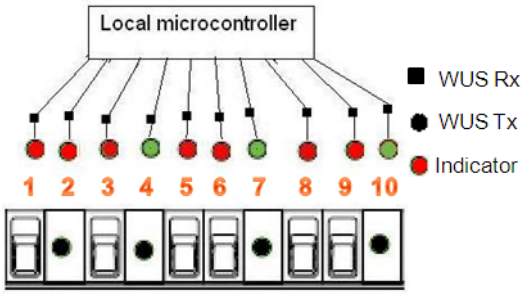

Fig.2. (c): Sensing empty spaces.

The proposed system employs the wireless ultrasonic sensors which are wired with AVR controller. These ultrasonic sensors are smaller, cheaper, and intelligent thus making the system cost effective and miniaturized. The Display System is a large LED screen at the entrance that shows available parking spaces in this parking lot and it also show the path to the optimal parking space. The Management System processes the data from the UWSN, optimal parking space, counts the parking fee, detects the status in a short time and controls the LED screen and locking system. The proposed system caters to all the requirements listed in the above sections and is designed using the following tools:

- AVR ATMega 16
- AVR Studio
- Matlab or Scilab 5.3(for PC display)
- GNU Compiled C (GCC)

V. Conclusions

In this paper, an intelligent and cost effective car park management system based on a wireless sensor network has been proposed. Firstly the actual requirements of modern day scenarios car park management systems were analyzed. Based on which we propose prototype WSN-based intelligent car park management system.

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