A Smart Vehicle Parking Management Solution

GGYU Gunasekara#, ADAI Gunasekara and RPS Kathriarachchi

General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka

#yashikaudayani@gmail.com

Abstract— With the increase in vehicle production and world population, more and more parking spaces and facilities are required. In world context, many approaches were suggested and implemented based on sensor technology, image processing and character recognition technology. Most of the parking areas today in Sri Lanka currently operate without or with a small computerized system using a small database. They usually require vehicle owners to walk around and manually check the occupancy of individual spots. The owners are concerned that they are not maximizing profit due the inefficient managements of parking slots. This study aims to examine the development of vehicle parking management system using programmable chip for signal processing and infrared sensor technology to detect the entering and leaving of the vehicle. In the system, low-cost infrared sensors will be 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. Features of this system include vacant parking space detection, display of available parking spaces, payment facilities and different types of parking spaces namely vacant, occupied and reserved. The solution consists of a web application which is connected to the hardware circuit. Customer can reserve a parking slot through the web application. This system would be tested in the shopping complex environment with vehicle owners. The research has been conducted through quantitative and qualitative methodology within an overall inductive framework through observing the problem. The feasibility of the proposed model has been analysed through financial, technical and operational perspectives and it will be discovered that infrared sensor technology based solution has the possibility to rationalize the vehicle parking management.

Keywords— Infrared Sensor Technology, Occupied, Vacant

I. INTRODUCTION

Due to the technological innovations man is leading to a comfortable life. But at the same moment these advancements have at times become troubles. With the growth of economy, vehicle has become a necessity in our daily life making the vehicle quantity increase dramatically. Vehicle brings convenience to people, yet parking causes serious problems because of poor management at the same time. For drivers and managers, traditional parking management hasn't met their needs in efficiency, security and performance. Parking problems are becoming ubiquitous and ever growing 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. Difficulty in finding vacant spaces, improper parking, and poor management are some of the parking lot problems.

According to Kianpisheh et al., (2011) 86% of drivers face difficulty in finding a parking space in multilevel parking lots. Finding spaces during weekends or public holidays can take more than 10 minutes for about 66% of visitors. Arenas or shopping malls are crowded at peak periods and difficulty in finding vacant slots at these places is a major problem for customers. Insufficient car park spaces lead to traffic congestion and driver frustration. Improper parking can happen when a driver is not careful about another driver's rights. Sometimes improper parking occurs when a driver parks on or a bit outside of the lines of a parking space. Poor management about parking availability in areas of high demand lead to large amount of traffic circulating looking for a parking space, contributing to congestion and pollution.

This research is an attempt to develop a generic application and architecture for vehicle parks. The main benefits of this research are cost effectiveness, time saving and proper management.

II. LITERATURE BEHIND THE ANALYSIS

Recent advancement in the automobile industry has opted many people to use their own vehicle for travelling. But at the same moment these advancements have become hard at times. The number of people using their own vehicle has increased exponentially in the past ten or fifteen years with the growth of economy.

According to Kianpisheh et al.,(2012) a new parking system called Smart Parking System (SPS) is suggested to support drivers to find vacant spaces in a car park within a shorter time using ultrasonic sensors. Ultrasonic sensors detect car park occupancy or improper parking actions. For each individual car park, one sensor is fixed in each parking space which is worked based on echo-location. The sensor transmits a sound, hits the car or ground and it is reflected back to the sensor. The time between the sent pulse and the returned echo is used to evaluate distance. The time among transmitted sound and reflection is lengthier in a vacant space than in an occupied space, hence the sensor can detect when a space is occupied. Figure 1 demonstrates how it works.

Figure 1. Ultrasonic Sensor Detection Area
Source: Kianpisheh et al. 2012, p.55

Waraich (2012) proposed RFID-Based Automatic Vehicle Parking System as shown in the figure 3 diagram. The system consists of a vehicle counter, sensors, display board, gate controller, RFID tags and RFID reader. Firstly the vehicle owner has to register the vehicle and get the RFID tag. The RFID tag is located near the RFID reader, which is installed near the entry gate of the parking lot. When the RFID tag is read by the reader, the system automatically takes the specified amount from the RFID tag and the entry gate boomer opens to take the car inside to the parking area. Simultaneously, the parking counters increments by one. Likewise, the gate is opened at the exit and the parking counter decremented. The system also offers the facility to recharge the amount for each RFID tag. No manual processing is involved. In addition, the system provides security.

Zhang et al. (2013) suggested Street Parking System (SPS) based on wireless sensor networks can monitor the state of every parking space by deploying a magnetic sensor node on the space. For accurately detecting a parking car, a vehicle detection algorithm is suggested. Sensor nodes are deployed along the roadside and each node is mounted on the centre floor of a parking space. Each sensor node distinguishes the earth's magnetic field periodically. When a node detected a car entering or leaving, it transmits a message to the router. The router forwards the packet to a base station that is one or more hops away. In the base station, information from different nodes will be combined, and parking guidance information will be transferred to LED board and remote server.
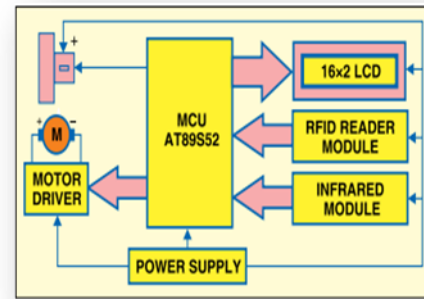

Figure 2. Block diagram of RFID-based automatic vehicle parking system
Source: Waraich 2012, p.11

Rashid et al. (2012) discussed on automatic parking system and electronic parking fee collection based on vehicle number plate recognition. The system used image processing of recognizing number plates for operation of parking and billing system.

III. METHODOLOGY

As the chosen methodology for the research, a mix of quantitative and qualitative methodologies was used within an overall inductive research paradigm. The characteristics of the quantitative and qualitative methodologies and the variables of the research necessitate a rational synthesis between these two methodologies.

The main stimulus behind using such a combination is that the research demands the predictive generalization of the feasibility of developing a comprehensive solution covering all the aspects of vehicle parking procedure.
Primary data were gathered from the world trade centre of Sri Lanka to identify the relevance of the vehicle parking management. Primary data are the basic details which were used to develop the application such as users, process, access levels etc.

Several vehicle parking locations are selected to collect essential information required to develop the solution.

Data gathering techniques such as interviews, questioners and observations were used in the data collection process in order to gather quality quantitative and qualitative data required for designing the requirement specification for the new system.

IV. HYPOTHESIS

Technology is now sinking in our lives and launch to remodel our standard way of living. From simple cellular phones to multimedia gadgets to super computers, that enables a person to make traditional processes become automate. Advances in technology such as the World Wide Web are one of the major media used by people nowadays to access information. Therefore web based solution with using infrared sensors can address the existing parking issues and it more helpful to do the work in an efficient and effective way. An infrared sensor is an electronic device that emits and/or detects infrared radiation in order to sense some aspect of its surroundings. Through this technology it will be possible to detect parking slots to increase the customer efficiency & satisfaction.

V. DATA ANALYSIS

The data which was gathered during the data collection phase described were analysed and presented in this section. This research was highly based on gathering data using the techniques explicitly interviews, questionnaires, and observations. The interviews were conducted using face to face with the people who handling the current parking process. The conversations were going through the existing parking process, pros and cons, features and new suggestions regarding the process. Observations were facilitated to identify the existing process of the parking and the issues related to manual parking. Questionnaires were distributed among staff of the parking areas and vehicle owners regarding process of the current procedure, limitations, and suggestions so on. Through those techniques several parking issues are identified as shown in figure 3.

By analysing the gathered data most of people waste their valuable time to search a parking slot. And also they face with lack of free spaces, less availability of car parks, minimum security and maximum parking fees.
And also most of the people are willing to use an automated system to save their time and money rather than wasting their time to search a vacant slot manually as shown in figure 4.
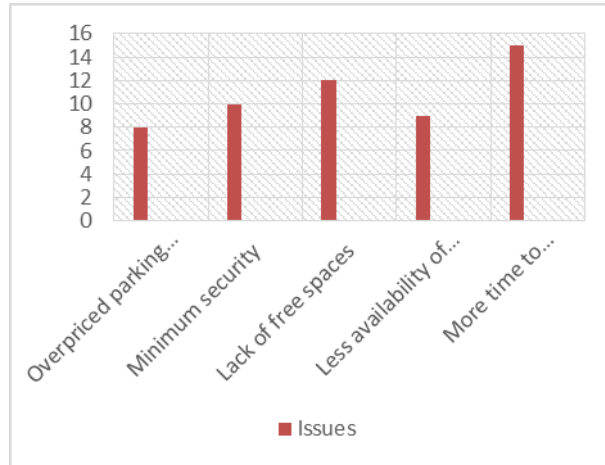
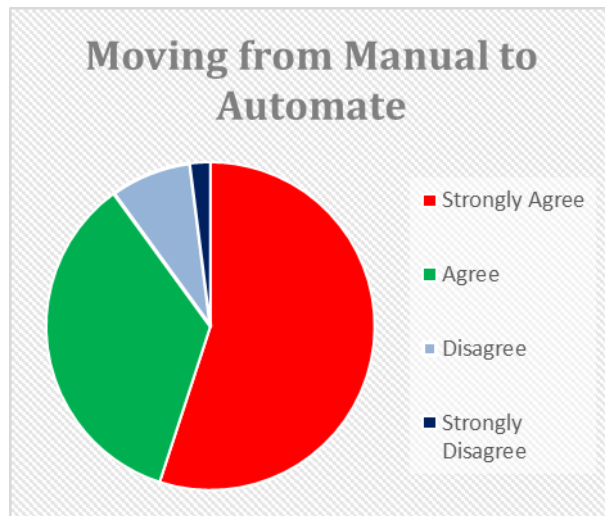

Figure 3.Issues related to vehicle parking
Source: Author

Figure 4. Moving from Manual to an Automate System
Source: Author

VI. EXPERIMENTAL DESIGN

The major motives for using a vehicle are saving time and convenience. A manual vehicle parking system is unreliable, time consuming and inconvenience. Employing a guard to track all vehicles is not practical and lead to number of problems since it is difficult to memorize all the details of vehicles with respective of user. This research paper represents the best solution for the above problems.

A. Hardware Architecture

Infrared sensors were used to detect availability of parking slots and used to open the gate automatically. This unit has two items namely, IR LED and photo sensor. Server motor is used for control the gate to open and close automatically. Each parking slot contains states named: Occupied, Reserved, Vacant. Reserved state will be mainly controlled through a computer application. The

hardware architecture consists of set of infrared emitters and infrared receivers. The signal is generated when the vehicle is entered to particular slot and the signal is transmitted to the arduino 2560. Arduino 2560 is a microcontroller board based on the ATmega2560 as shown in the figure 5.
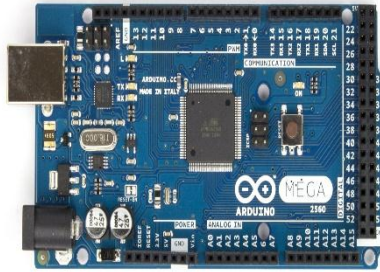

Figure 5: Arduino Mega 2560 R3 Front
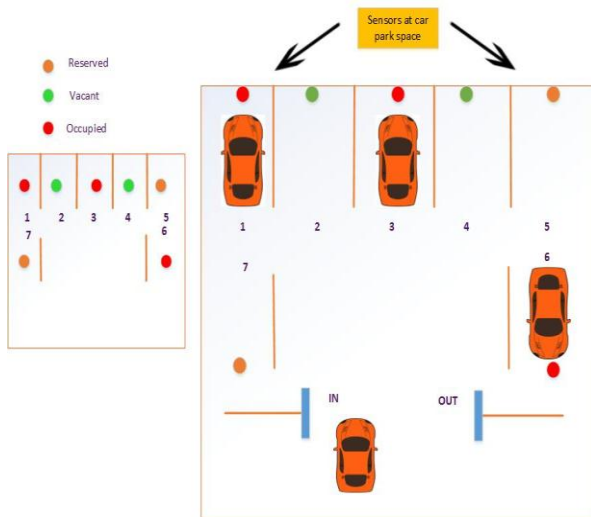Source: Arduino.cc

Figure 6: Detection of
Parking Slots
Source: Author

It simply connects to the computer via USB cable. Arduino Ethernet shield connects the arduino to the Internet via RJ45 cable. In the vehicle park, LCD display can used to represent the availability of the vehicle park on site. Keypad can be used to enter customer PIN number to confirm his arrival. Figure 6 shows the parking areas with IR sensors.

B. Software Architecture
Overall system architecture is based on the three layers namely presentation layer, data link layer and application layer. According to the software architecture customer can reserve a parking slot through the web application before he gets into the parking area by using his or her username and password as shown in the figure 7. After confirming the reservation PIN number will be generated. When he arrives to the parking area he enters the PIN number to confirm his arrival. At that time entering time is recorded. At the departure exit time is recorded. After that the total time that he parked is calculated. Once he enters to the parking slot IR sensor detects the vehicle by emitting IR radiation. Subsequently state of the parking slot changed from reserved to occupy. When leaving the parking slot IR sensor change the state from occupy to vacant. In the data link layer all the relevant data such as reservation details, payment details etc. are stored in the database.

Figure 7: Home page
Source: Author

VII. EVALUATION & CONCLUSION

The main contribution of this study is to introduce the most significant parking space problem (finding a vacant slot) and propose a solution. Infrared sensors can be used to detect the parking spaces. Customer can reserve a parking slot before his arrival. Parking operator can handle the customer data. The proposed architecture for a parking detection system would decrease searching time for vacant spaces by reserving a parking space online.

The number of people using their own vehicles has increased exponentially in the past ten or fifteen years. The vehicle parking has become an enormous matter especially in urban areas. In view of increasing vehicle quantity, the proposed solution introduces a smart vehicle parking management based on IR technology which makes parking much easier for drivers. The system has several advantages such as high efficiency, low cost, high security etc. It solves all the issues related to vehicle parking such as finding free parking slots, improved demand system and certainly the security issues. So the main objective of this project is to implement a system to find parking slots in great efficient manner. And in the Sri Lankan context most of the vehicle parking are conducted in the manually file base approach. Due to the difficulty of data handling process the proposed system will give a better solution for the all processing data which is integrated through a central server based database.

ACKNOWLEDGEMENT

REFERENCES

Idris, M,Yong, Tamil, L & Haron, Z 2008, Parking guidance system using RFID and image processing techniques in WSN environment. *Proceedings of the 4th International Colloquium on Signal Processing and its Applications*, March 7-9, 2008, pp. 1-6.

Kastrinaki, V, Zervakis, M & Kalaitzakis, K 2003, A survey of video processing techniques for traffic applications, *Image Vision Computing*., 21: 359-381, viewed 10 March 2015,

http://www.barcodesinc.com/articles/barcode-technology.htm

Khan, R, Shah, Y, Khan, Z, Ahmed, K, Manzoor M & Ali, A 2013, Intelligent Car Parking Management System On FPGA, *International Journal of Computer Science*, Vol. 10, Issue 1, no.3, 171- 174

Kianpisheh, A, Mustaffa, N, Limtrairut, P & Keikhosrokiani, P 2012, Smart Parking System (SPS) Architecture Using Ultrasonic Detector, *International Journal of Software Engineering and Its Applications*, vol.6, no.3, 51-56.

Lee, S., Yoon, D & Ghosh, A 2008, Intelligent parking lot application using wireless sensor networks, *Proceedings of the International Symposium on Collaborative Technologies and Systems*, May 19-23, 2008, Irvine, CA. pp: 48-57.

Waraich, B 2012, 'RFID-Based Automatic Vehicle Parking System', Electronics *for You,* 117-120, viewed 3 March 2015,

http://www.efymag.com

Zhang, Z, Li, X, Yuan, H & Yu, F 2013, A Street Parking System Using Wireless Sensor Networks, *International Journal of Distributed Sensor Networks*, vol.2013, viewed 10 March 2015,

http://www.hindawi.com/journals/ijdsn/2013/107975/

BIOGRAPHY OF AUTHORS

GGYU Gunasekara is a final year undergraduate following the degree BSc. (Hons) In IT in General Sir John Kotelawala Defense University. Currently she is working as an intern at Virtusa Pvt. Ltd.

ADAI Gunesekera is a Lecturer of Department of IT & Mathematics, KDU. He received his BSc in Computing & Information Systems from London Metropoliton University, UK with a 1st Class (Hons).He poses a Postgraduate Diploma in Computer Science from the University of Colombo and also he has acquired his master's from the same university. Presently he is reading for his PhD at General Sir John Kotelawala Defence University in Human Computer Interaction. He was a former manager of Academic programs at IDM Affiliated Campus and he has more than five year experience in Academic Program management. His research interests are E-Government, E-Health, Digital Divide, and E-Learning.

R P S Kathriarachchi received his Bachelor of Science with Honors in Computer Networks First Class from University of Wolverhampton UK. He also completed his masters in Information Technology Management (ITM) in the same university with Merit passes. His current research interests include Computer networks, Network security, Cloud computing, Multi agent systems and GIS. Presently he is a lecturer in Faculty of Computing of KDU and working as the Network Administrator of KDU.