DESIGN AND IMPLEMENTATION OF AN AUTOMATED PARKING LOT SYSTEM

BY

OYEDOKUN FOLAKEMI FLORENCE

(CPE/14/1681)

SUBMITTED TO

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CERTIFICATION

This project with the title

DESIGN AND IMPLEMENTATION OF AN AUTOMATED PARKING LOT SYSTEM

Submitted by

OYEDOKUN FOLAKEMI FLORENCE

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Has satisfied the regulations governing the award of degree of

BACHELOR OF ENGINEERING (B.Eng.) in COMPUTER ENGINEERING,

Federal University Oye-Ekiti, Nigeria.

Dr. (Engr.) O. M. Olaniyan

Supervisor

11/4/19.

Date

Dr. (Engr.) O. M. Olaniyan

Head of Department

Date

DECLARATION

I hereby declare that this project report entitled "DESIGN AND IMPLEMENTATION OF AN AUTOMATED PARKING LOT SYSTEM" submitted by me Oyedokun Folakemi Florence to Federal University Oye-Ekiti in partial fulfillment of the requirement for the award of the degree of Bachelor in Engineering in Computer Engineering Department was carried out by me and supervised by Dr. (Engr.) O.M. Olaniyan.

I also confirm that this project work has not been copied from any other source except from quotations which have been duly acknowledged.

Student's Name: Oyedokun Folakemi Florence

Student's Matric Number: CPE/14/1681

Student's Signature and Date: 1st April, 2019

DEDICATION

This project is dedicated to God the true source of knowledge and he made it possible for me to complete my degree program and to compile the necessary information present in the report of this project work.

ACKNOWLEDGEMENT

My profound gratitude goes to God for his grace and abundant blessings he has bestowed on me, I would like to thank my parents for their unconditional love and support. Special thanks to Ogunye Adeoluwa Philip for the support he extended in difficult times and for being there for me through out. And my heartfelt thanks to my sister and brother for their encouragement and love and to my friends for their best wishes.

I also acknowledge my project supervisor and my head of department, may GOD continue to be your source of wisdom.

ABSTRACT

Due to the increase in the number of vehicles caused by rapid population growth in urban areas, the demand on parking infrastructure for the general has increased significantly (Polycarpou & protopapadakis, 2013). As (Polycarpou & protopapadakis, 2013)further points out, finding a free parking space in urban areas like hospitals, hotels, shopping malls, event centers especially during peak hours is more or less impossible, in many cases. Drivers have to drive round looking for free space to park which is estimated to be responsible for about 35% traffic congestion, air pollution, fuel consumption and sometimes accidents (when drivers are trying to drag for a particular free spot). To alleviate the problems, smart parking system were implemented. With the implementation of the smart parking infrastructures, drivers can easily locate and secure a vacant parking space at any car park deemed convenient to them. The objectives of this project work which is to design and implement a hardware prototype of smart parking lot using a microcontroller based system was achieved, and the components were verified.

This project work was designed majorly using a microcontroller and other components like the sensors, liquid crystal display, jumper wires, Vero board. These components work hand in hand in the operation process of the design work, for instance, if a car is parked at slot1 of the parking lot the signal is received from the receiving signal of the sensor, then transmitted to the transmitting signal of the sensor to the microcontroller, then from the microcontroller to the LCD to display that parking slot1 is occupied, zero "0" is the value that shows for an occupied slot.

At the end of this project work, a microcontroller based parking lot system was implemented, the parking lot system was able to identity which slot was occupied or not which helps in solving the traffic congestion, air pollution and hazardous situation problems.

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CHAPTER ONE

INTRODUCTION

1.1 Preamble

Due to the increase in the number of vehicles caused by rapid population growth in urban areas, the demand on parking infrastructure for the general has increased significantly (Polycarpou & protopapadakis, 2013). As (Polycarpou & protopapadakis, 2013)further points out, finding a free parking space in urban areas like hospitals, hotels, shopping malls, event centers especially during peak hours is more or less impossible, in many cases. Drivers have to drive round looking for free space to park which is estimated to be responsible for about 35% traffic congestion, air pollution, fuel consumption and sometimes accidents (when drivers are trying to drag for a particular free spot). To alleviate the problems, smart parking system were implemented. With the implementation of the smart parking infrastructures, drivers can easily locate and secure a vacant parking space at any car park deemed convenient to them.

The project design an automated parking lot system which can effectively help drivers identify a free parking spot, (pemag, 2014)and reduce the cost of roaming around the garage trying to find a place to park, and also to reduce traffic congestion and air pollution. This application gives information about occupancy status of the number of spaces available in the parking lot equipped With sensors that detect the presence of a vehicle. It also helps us in having a more organized community/parking lot as each driver get to park at a particular spot available to him/her.

1.2 Problem Statement

Urban areas are faced with issues concerned about parking system in which drivers have to roam around a parking lot before he finally gets a place or no place to park, which in turn causes pollution and traffic jam. However, drivers are still finding it difficult to find an available parking slot to park their vehicles. The process of looking for a parking lot is time consuming, confusing and wasting fuel as well and sometimes causes accidents whereby drivers are trying to drag a particular spot. At this point of time, someone may miss or go for their important event late. This might cause frustration for the drivers.

This project designs an automated car parking system with the use of sensors, actuating systems, and networking systems as a solution to addressing the problem, the system can be used in allocating an available parking lot in a parking lot system , which in turn reduces traffic, air pollution, accidents ,time consumption and this solution also increase safety to commuters.

1.3 Aim and Objectives

The project aim is to design and implement a microcontroller based automated parking lot.

The objectives are:

- To design a smart parking lot using sensors and microcontroller
- To implement a smart parking lot using hardware prototype
- To evaluate the effectiveness of the developed system

1.4 Significance of Study

- Allows the driver to locate available parking spaces, which saves time, resources and effort.
- Reduced Traffic: It eliminate the hassle of circling a parking lot in search of a place to park which in turn causes traffic.
- Reduced Pollution: Searching for a park causes serious air pollution in the environment. A smart parking solution will significantly reduce driving time and air pollution
- Increased Safety: Parking lot employees and security guards contain real-time lot data that can prevent parking violation, fast location of illegally parked vehicles and suspicious activity.

1.5 Scope of Work

The scope of work in this project is to develop a parking lot, the design and implementation of an automated parking lot system with the use of sensors, microcontroller, and networking systems. The system induces parking vehicles, in which a driver enters in a parking lot, with LCD displaying if there are available space in the parking lot, if there are available space then the driver park in the right space of parking lot, it takes care of information gathering of parking vehicles there, hence if the LCD displays all value as '0' the driver turns back to use another available parking lot elsewhere.

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Background

2.1.1 Parking Lot System

A parking lot is a clear area set aside for parking of vehicles, in the time past and presently we park our vehicles in car parks without the use of internet, sensors, ultrasonic, API, payment system and other technologies of sort. But now technology has evolved and made parking easier with the use of sensors, access control systems, and networking technology which makes parking safe, easier and convenient it helps us saves times, conserves fuel, reduces air pollution and also traffic congestion.

The smart parking system was implemented mainly in the Europe, United States and Japan (Shaheen, Rodier, & Eaken, 2005)is developed with the incorporation of advanced technologies and researches from various academic disciplines. With its deployment in the car park, it is hoped that it would solve the aforementioned problems faced by the patrons within the car park.

The project addresses the need for aggregation of data and information from different sensors and records, but these sources must be connected to the internet to make that data accessible through Application Programming Interfaces (API). The sharing and utilization of data between the interconnected sensors and data sources, through the internet, areas similar characteristics to the concept of The Internet of Things (IoT). The physical objects are equipped with hardware and Software that permits them to collect and exchange data and/or execute control commands to drive actuators.

2.2 Related works

2.2.1 Smart parking systems based on Global Positioning Systems GPS

Global Positioning Systems (GPS) technology is used to determine and track a vehicle's precise location. In this domain, it is used to offer information about the location and availability of parking spaces at the destination. This technique proposed in ((Pullola, Atre, P., & Saddik., 2007) (Chon, Agrawal, & El Abbadi, 2002) . Chon et al presented a location-based system called NAPA. The server in the system associates buildings on the campus with parking lots in the order of distances to the building. After locating the nearest available parking lot, the user sends the NAPA server a message that he/she has parked. Then the server updates the information about the lot accordingly. When the user leaves the parking lot, the NAPA server can automatically charge the appropriate parking fee if necessary. (N, M, Badiozaman, & Daud, 2010)Proposed a new smart parking system using SMS services. This system is capable of finding parking spaces in specific car park areas. A parking reservation system is developed in such a way that users can book their parking spots over short message services (SMS) using the GPS. The SMS is processed by a wireless communication instrumentation device called a micro-RTU (Remote Terminal Unit). The proposed prototype have the following specification; the circuit has a simple design, the reliability level is high, and the system accuracy is excellent.

2.2.2 E-parking

E-parking provides an alternative for patrons to enquire the availability and/or reserve a parking space at their desired parking facility to ensure the availability of vacant car park space when they arrive at the parking facility. The system can be accessed via numerous methods such as SMS or through the internet. Some of the additional benefits of using the E-parking system aside

from those collectively gained by smart parking system are that it can be extended easily to incorporate the payment mechanism of smart payment system whereby payments by the patrons are made hassle free using the technologies discussed previously. Customized information can also be provided to the patrons either before or during their trip to the car park (Shaheen, Rodier, & Eaken, 2005)

In a study by (Inaba, M. Shibui, Ogiwara, & Yoshikai, 2001)reservations can be made through the utilization of mobile phones or any reservation centers convenient to the patrons. On the other hand, the study by revealed options of using the internet via Wireless Application Protocol (WAP) enabled mobile phones, Personal Digital Assistants (PDAs) and even conventional computer in addition to SMS service for the drivers in accessing the information as well as making reservations. (Teodorovic & Lucic, 2006) takes the implementation a step further by incorporating **fuzzy logic** in decision making whereby the parking reservation request can either accepted or rejected. It also facilitates the enforcement of tariff classes to enable the maximization of revenue for car park operators. The system discussed in (Idris & E.M. Tamil, 2007)is one of the systems integrating PGIS with E-parking system, where the patrons are able to reserve parking slots after reviewing the status of the car park and its proximity to the patron's current location.

2.2.3 Smart parking lot using RFID

The utilization of RFID as a method for vehicle detection was discussed in (Mouskos, Boile, & Parker, 2007). It is a universal, useful secure and efficient technology (Pala & Inanc, 2007) which consist of 3 units which are: transceiver, transponder and antenna. The transceiver is used to send and read information from the transponder unit which contains the coded information

through the antenna. Active transponders are also re-programmable through wireless connection, while passive transponders have an unlimited lifetime. Radio signals eliminates the need for contact, no line of sight operation and are able to penetrate opaque structures. By using RFID sensors, it provides the means for low cost installation and maintenance as well as possible detection at high speed. The complication actually lies with the need to place transponders in every vehicle as well as privacy issues with the patron's personal details.

2.2.4 Smart parking lot using Ultrasonic sensors

This project aim is to help drivers to locate the vacant spaces in a parking lot in a short period of time. This system is using the ultrasonic sensor as detector to detect the car park availability. The project also as known as Smart Parking System contain few features such as vacant car park detection, improper parking detection, display available parking lot and directional indicators toward the vacant car park space, payment facilities and different types of parking spaces by using LED indicator. Ultrasonic sensors transmits, pulse waveforms between 25 to 50 kHz to the road by detecting transmitted energy which are reflected back the sensor. Together with a signal processing module, the reflected ultrasonic energies are analyzed to detect occupancy in a roadside controller. Its utilization brings the advantage of detecting vehicles that exceed certain height limit as well as multiple lane operation. The ultrasonic sensors are also easy to install without the need for facility closure. Degraded occupancy measurement on freeways with vehicles traveling at moderate to high speeds due to large pulse repetition period are one of the shortcomings of the sensor. Besides that, temperature changes and extreme air turbulence affects the sensor performance, although temperature compensation has been built into some model

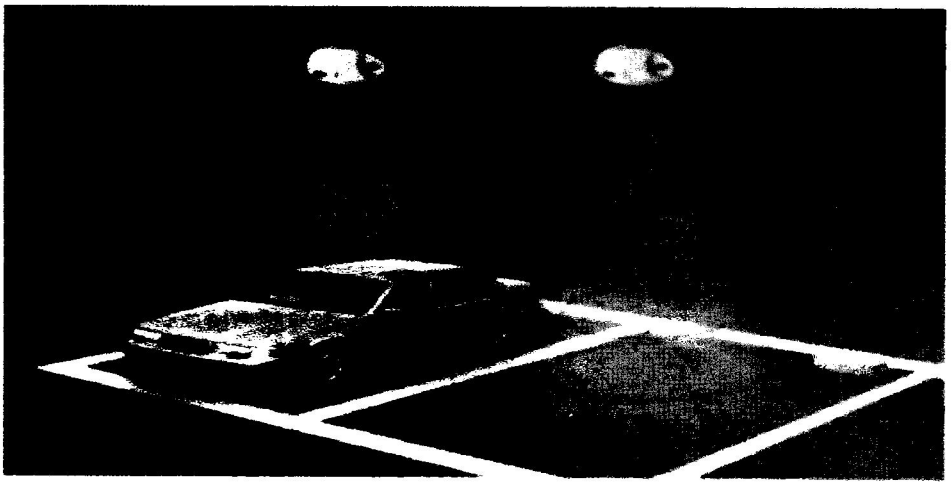

Fig 2.1 showing the diagram of ultrasonic sensor detection

2.2.5 Wireless sensor networks-based systems

These types of systems have generated increased interest in researchers since 2005. They are the most popular technique in the last decade with researchers, as wireless sensor networks have various advantages, such as flexibility, intelligence, reasonable cost, rapid deployment, and sensing, as it usually consists of sensor nodes. The following papers discuss WSN-based parking systems (Yan, C, & Olariu, SmartParking: A secure and intelligent parking system using NOTICE.., 2008) (Yan, C, & Olariu, A novel parking service using wireless networks, Service Operations, Logistics and Informatics, 2009) (O'Flynn, C, M, J, U, & Sreenan, 2005) (Kumar, N., & Soh, 2007) (Lee, D, & Ghosh, 2008) (Boda, A., & Howitt, 2007) (Cheung & Varaiya, 2005) (Wenzhi & Bai, 2006)6 (Agarwal & Chandramouli, 2009) This type of system, which utilizes sensors to monitor environmental conditions, is widely used, especially in academia, due to the ease of installation and configuration, and the reasonable price. (Zheng & Cao, 2006) developed a system using crossbow products, which have a low unit cost. This system enables a car to detect entry to the car park, and it efficiently guides the driver to an empty parking space

through signs displayed to the driver. (Kianpisheh, Mustaffa, & Keikhosrokiani, 2012)Presented a new smart parking system using an ultrasonic detector. For each individual car park, one sensor is fixed on the ceiling above each parking space. Ultrasonic sensors operate based on echolocation. The sensor transmits a sound, which hits a solid object (car or ground) and is reflected back to the sensor. (Mathur & Trappe, 2009)Discussed the research challenges relating to parking technology and proposed some possible solutions. In the centralized solution, some cars are equipped with ultrasonic sensors as well, which drive past the parking spaces to collect occupancy data and upload the data to the centralized database. The cars that need to park simply query the centralized database. (Lee, D, & Ghosh, 2008)Proposed the use of a combination of magnetic and ultrasonic sensors for the accurate and reliable detection of vehicles in a parking lot and described a modified version of the min max algorithm for the detection of vehicles using magnetometers.

2.2.6 Smart parking systems -based on Fuzzy logic

Since 1965, when fuzzy logic was introduced by Professor Zadeh (1996), it has played an outstanding role in design and production in industry. Actually, fuzzy control systems are control systems based on the fuzzy logic system, which analyses analog input values in terms of logical variables that take on continuous values between 0 and 1, while digital logics operate on discrete values of either 1 or 0. Nowadays, fuzzy logic has become a standard technology, which is applied in data and sensor signal analysis. Fuzzy code is designed to control something, usually something mechanical. Some proposed systems based on this technique are selected as follows. This type of system is proposed in (Sharafi & Nikpoor, 2010) . The following proposals as examples are chosen in order to clarify the principles of this technique proposed a system that

depends on an FPGA-based fuzzy logic controller (FLC). The benefit of using an FPGA-based FLC compared to software FLC is that takes less time to process the information. First, a Fuzzy Control System is chosen. Then, the implementation of the fuzzy rule-based system takes place upon the neural network architecture. It is the main reason for learning and adapting from the training data: "The neuro-fuzzy system has the ability to reason like human beings as well as it has expert knowledge". (Benson, et al., 2006) proposed that an RF transceiver and antenna with an ATMega 128 L micro-controller system could operate by monitoring the availability of car-parking spaces and send this information to customers and facility administrators. (Sharafi & Nikpoor, 2010) presented a fuzzy approach for the control of the backward movement of trucks and trailers in a dynamic environment. This method was then expanded to circumstances in which there are obstacles in the truck's pathway. In the first scenario, it is assumed the obstacles are constant. The second scenario assumed by the authors is that there are moving obstacles which can mean the truck must be directed to the parking facility. The parking process is completed due to the intelligence of fuzzy logic. The proposed ultrasonic sensor identifies objects and obstacles longitudinally. (Zhao & Collins, 2005)Developed and demonstrated a robust automatic parking algorithm for parking, using a genetic algorithm's learning ability for space detection errors by employing a Kinematic model for a skid steering autonomous ground vehicle.

2.2.7 Machine Vision Parking lot System

A visual camera can be used for license plate recognition or identifying parking lot occupancy using machine vision. The camera should be placed near the entrance of a closed parking lot for license plate recognition (LPR). Based on the number of vehicles entered and exited it can help to get the count of vacant parking spaces. However, occupancy status of parking spaces cannot

be attained using this system. Video processing of parking lot using a camera is not ideal as it requires continuous transfer of large bandwidths. Therefore, a video should be broken to images at regular intervals and frame rates to facilitate continuous monitoring of the parking lot (Enriquez, 2017). For parking spaces occupancy detection, a camera can be installed overhead to a parking lot and relevant image detection algorithms can be used to segment vehicles and detect occupancy of parking space. A camera is suited for open parking lots as it can cover large number of parking spaces (Ichihashi, 2009). However, it is susceptible to limitations such as; occlusion and shadow effects, distortion and lightning change. These limitations can be removed with the use of 3-D scene information (Huang, 2013). Since limited number of cameras can cover large number of parking spaces the expenditure is considered minimal.

2.2.8 Multi-Agent Parking Systems

These kinds of systems make use of multiple mediums such as sensors, mobile, algorithms, visual camera, etc. These systems are also capable of incorporating aspects such as user preference, importance, etc., in finding a vacant parking space for the driver. Multi-agent systems are considered as foundation for automation of smart parking systems. A user can select a parking space using a mobile or web application and based on the user importance and Preference, a parking space will be selected. The user will also receive navigational information to reach the parking space. Java tools such as JaCaMo and environment such as Cartago can be used in the architecture (Bilal, 2012). Machine vision systems or VANETs can be used instead of using sensors. Usage of multiple systems is supported in this architecture. These systems are suitable for both open and closed parking lots. The expenditure would be dependent on the usage of technology to identify occupancy status of parking spaces.

2.2.9 Neural Networks Parking System

Neural network is a data processing system which is inspired by brain nervous system. Neural networks have evolved over the years and various types of neural networks were developed such as; fuzzy, neural network, fluid neural network, feed forward and convolution neural network. Neural networks can be combined with machine vision to achieve automation. Neural networks were used in efficient recognition of license plates in real time videos (Rahman, 2003). In one of the study, images from morning and night were taken separately to train the neural network and a two layered feed-forward network with hidden sigmoid is used to produce accurate results in detection of available parking spaces (Jermsurawong, 2012). Deep learning is a branch of machine learning which uses neural networks in object detection and classification. There is another evolving technology such as convolution neural networks which would take images as input and is more efficient in analyzing images. In a recent study, convolution neural networks were used along with machine vision to capture parking occupancy information efficiently (Amato, 2017). This technology would function as an efficient tool in data processing while it is not involved in real time data capturing. Therefore, it is suitable for open and closed parking lots with minimal expenditure.

2.2.10 Vanet Parking System

This system uses wireless communication devices to provide services such as; smart parking and antitheft. Road side unites (RSUs) would be widely placed across parking lots and vehicles should be installed with on-board units (OBU). A Trusted authority will be responsible for registrations of OBU and RSUs. (Lu, 2010).Therefore, once a vehicle approaches the parking lot installed with RSUs navigational information to the vacant parking space will be provided to

OBU. These devices are not sensitive to environment and are suitable for closed and open parking lots. However, installation and maintenance of RSUs in the parking lot would be expensive. In order to achieve accurate parking occupancy data and navigational information all the vehicles must install OBU. Parking occupancy data is prone to errors if there are vehicles without OBU are parked.

2.2.11 Parking Guidance Systems

Parking guidance systems is another smart parking system which provides information about number of parking spaces available on display screens and these are usually placed near the parking lots as the driver can see and decide the parking space to occupy. (Waterson, 2001) (Idris M. T., 2009)Inductive loop detectors or visual camera can be used at the entrance and exit of a parking lot to know the count of the vehicles in a parking lot which would be displayed on the screens. However, they do not guide the driver to a particular parking space which is found empty. Therefore, there is every possibility that the driver would cruise for several minutes before finding an empty space to occupy. The driver can make a decision about the parking lot only after viewing the display screens (Kianpisheh A. M., 2012). Since sensors or visual cameras would be deployed only to get the count of vehicles the expenditure for installation and maintenance would be minimal making them suitable for open parking lots.

2.2.12 Robotics Parking System

Robotic Parking Systems creates space for design, development and the community. The company's automated parking technology enables parking from hundreds up to several thousand cars in half the area of a conventional ramp-style garage. Architects and developers can use less

space for parking and more space for green areas, retail, residential or office space or combinations of these.

The high-speed efficiency of the Robotic Parking System and fast retrieval times ensure rapid throughput (the number of cars in and out per hour) and a satisfying user experience.

Robotic Parking Systems has designed the automated parking structures and built the machinery, electronics and automation for thousands of parking spaces. The modular Robotic Parking System can be built above ground, underground, inside a building, on top of a building or under a building.

Additionally, the facade is completely flexible and can be designed to blend in with neighboring buildings with a look that is contemporary, historic, traditional, etc. Any type of material can be used — concrete, wood, brick, stone, aluminum, etc. It is completely up to the imagination of the owner and his architect.

Fig 2.2 showing the diagram of a robotic parking lot system

2.2.13 Automated parking lot using a tower system

Tower systems typically consist of a vehicle elevator with a parking space either side of the elevator shaft. This configuration is repeated over a number of levels to complete the parking tower. Typically there is a parking module located on the ground floor, where the vehicle is turned, and the vehicle elevator simple raises to one of the parking levels of the tower and deposits the vehicle sideways into a parking space. This process is reversed to retrieve a vehicle. As there is a single mechanism to park and retrieve vehicles system redundancy is an issue with tower system

Fig 2.3 showing the diagram of a parking system using a tower system

2.2.14 Automated Parking lot using a Crane System

Crane parking systems utilize a single mechanism to simultaneously perform the horizontal and vertical movements of the vehicle to be parked or retrieved in the parking system. The simultaneous horizontal and vertical movements allow the vehicle platform to move to and from one parking spot to another very quickly. The crane mechanism moves horizontally on rails, typically located on the floor and ceiling of the parking system, and has a vertical elevator platform fitted where vehicles to be parked and retrieved are placed. This means that a floor-to-ceiling opening in the center of the system is required for the crane(s) to operate. The crane mechanism can move in line with the normal direction of a vehicle (a longitudinal system) or orthogonal to it, i.e. sideways (a transverse system) depending on the site constraints. If higher throughput or redundancy is required, crane systems can also have two cranes running parallel to one another should the site constraints allow it. As there is typically only one mechanism for the parking and retrieval of vehicles the system redundancy is potentially low but back-up motors, switches, etc. can be installed to increase the system's redundancy. Turning devices can be fitted under the vertical elevator platform should this be required.

2.2.15 Automated Parking lot using Puzzled System

PLC control automated puzzle parking system is the popular mechanical parking equipment. The equipment is designed with 2-levels and multi-rows and ground level is designed with space as an exchanging space. All spaces can be lifted automatically except the spaces in the first level and all the spaces can slide automatically except the spaces in the top level. When a car needs to park or release, all spaces under this car space will slide to the empty space and forms a lifting

channel under this space. In this case, space will go up and down freely. When it reaches the ground, the car will go out and in easily. The Lift Sliding parking system is a 2-level customizable solution for storing cars in vertical and horizontal arrays. The hybrid stacking system consists of a self-supporting structural framework and independent platforms for self-park storage and retrieval.

The advantages of puzzle automated parking system:

- Custom Dynamic Arrangement
- Direct Access for self-parking
- Cost Effective Multi-layered parking system

Often nicknamed the puzzle system, this system can have more than two levels of parking. Its design has a structure that enables the use of all parking entrances and exits on ground level. The parking pallet moves left, right, upward, and downward and has always a minimum of one empty slot for movement. Car parker can have multiple levels above, pit style below, or a combination of both.

CHAPTER THREE

DESIGN METHODOLOGY

3.1 Overview on the Automated Parking Lot System

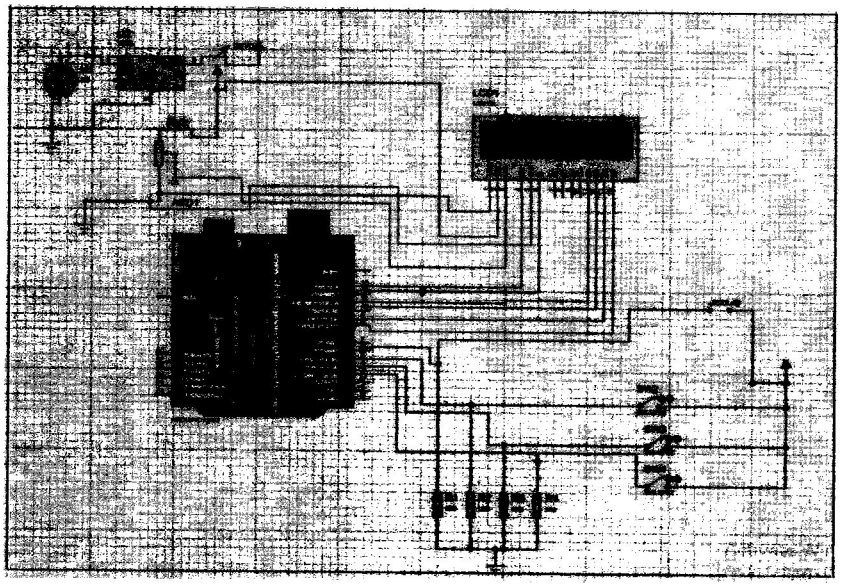

Fig 3.1 showing the circuit design of an automated parking lot system.

From the above circuit diagram, the arduino which is the heart of the design work is used to control the operations of all components when coupled together as a unit. The R1, R2, R3 & R4 from the circuit design are the pull up resistors are used for the sensors, the SW2, SW3 & SW4 represents the sensors. The pull up resistors ensure a known state of a signal, in other words it stops unused inputs from floating about randomly and also to ensure that inputs to the arduino settle at expected logic level. The first two wires from the sensor are connected to the positive and ground respectively while the third wire is connected to pin 3, 4 & 5 on the microcontroller board at the digital input session of the board which is used for signal transmission. The LCD first two wires are connected to the positive and ground respectively at the power session of the

board while the last two wires are connected to pin A4&A5 on the microcontroller board at the analog session of the board for the display of information sent from the microcontroller

This project aim is to help a driver locate a vacant space in a parking lot. This system made use of a microcontroller, sensors and LCD system to detect the car park capability. In the design of this project, microcontroller (Arduino), LCD, IR sensors was used.

At the entrance of the parking lot, the LCD would be displaying what slot is free to be used then the driver drives in to park on the allocated space left, then the IR sensor receives a signal that a car is parked at lot 'one' for instance then transmits the signal to the microcontroller which then transmits the signal to the LCD to display the value '0' which means parking lot 1 is occupied

An IR sensor shall be placed side by side at each parking spot, one of the IR sensor is to receive signal and the other is to transmit signal, the IR sensor receiver, receives a signal that a car has been parked while the IR sensor transmitter transmits a signal to the LCD that a particular car is parked at a particular slot. LCD shall provide the display information about the total number of cars that can be parked and the place free for parking. Also the LCD shall indicate the maximum capacity of parking space in this project.

Now the microcontroller shall decrement the count whenever a car is parked and displays it on the LCD. When all spaces on the lot are occupied the LCD would display the value '0'.

3.2 Components Used

3.2.1 IR sensor

Infrared sensors are the sensors which can detect infrared radiation. IR is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat

of an object as well as detects the motion. Infrared waves are not visible to human eye. It has wavelength greater then visible light, visible light has the wavelength in the range of 0.4 to 0.7 micro meters. Infrared ray has wavelength greater than 0.7 micro meters. The IR sensors are the reverse biased diode made up of suitable band gap material, when infrared radiation falls on the detector electron hole pairs are generated in the depletion region which is swept by the large electrical field available in the depletion region. Thus a current gets established. Since infrared radiation has less energy compare to visible light (because it has low frequency compare to visible light and the energy of incident photon =hv where v is the frequency, h is Planck constant) so material with suitable band gap should be chosen.

There are two types of an IR sensor

- IR transmitter
- IR receiver

3.2.1.1 IR Transmitter

The emitter is simply an IR LED and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

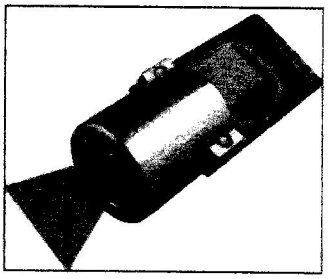

Fig 3.2 showing the diagram of an IR transmitter

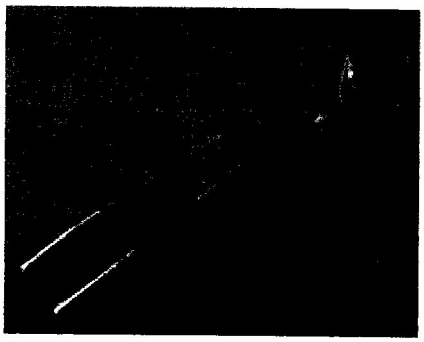

Fig 3.3 showing the diagram of an IR transmitter

3.2.1.2 IR Receiver

An infrared receiver is hardware that sends information from an infrared remote control to another device by receiving and decoding signals. In general, the receiver outputs a code to uniquely identify the infrared signal that it receives. This code is then used in order to convert signals from the remote control into a format that can be understood by the other device. It is the part of a device that receives infrared commands from a remote control. Because infrared is light, it requires line-of-sight visibility for the best possible operation.

Fig 3.4 showing the diagram of an IR receiver

Functions of an IR sensor

- It is used in imaging devices
- It is used in sorting devices
- It is also used in remote sensing
- For detecting flame
- It is used in night vision devices

3.2.2 Microcontroller

A microcontroller is an embedded programmable computer present in single integrated circuit which is dedicated to perform and execute a specific task. It contains memory, programmable input/output peripherals as well a processor. Microcontrollers are mostly designed for embedded applications and are heavily used in automatically controlled electronic devices such as cellphones, cameras, microwave ovens, washing machines. Also microcontrollers operate at a

low clock frequency, usually four bit words and are designed for low power consumption and programs are stored in the ROM also microcontrollers are used in situations where computing functions are needed. They also have dedicated input and often display their output and are usually embedded in other equipment which is used to control features or actions of the device.

In this project the type of microcontroller to be used is an **Arduino**

An Arduino is an open-source platform used to carry out electronics design. It consists of both a microcontroller and a part of the software or Integrated Development Environment (IDE) Arduino are able to read inputs-light on a sensor and turn it into an output, its able to activate a motor, turn on an LED etc…

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Advantages of an Arduino

- **Simplicity:** Arduino paintings are designed to suit the needs of all engineers, designers, professors, students and interactive electronics enthusiasts around the world.
- **The price:** The Arduino plate is less expensive than any microcontroller.
- **Self-Assembly:** Arduino board is very easy to deal with and easy to connect circuits.
- **Multi-platform:** The Arduino program has the ability to work with all the different operating systems of Windows, Mac and Linux while most other boards run on Windows only.

- **Easy and simple software environment:** The programming environment is designed to be easy for beginners and professionals and its programming language "Arduino C" is easy to learn.

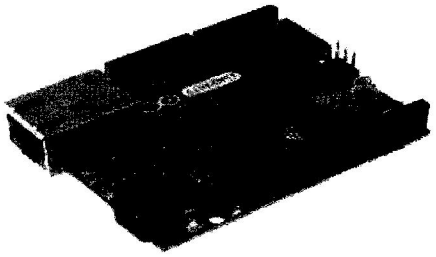

Fig 3.5 showing the diagram of an Arduino

3.2.3 LCD (Liquid Crystal Display) 16x2

An LCD display which simply means liquid crystal display. LCD is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome (Contributors, Liquid-crystal display, 2018)

An LCD is made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently;

improving the screen refresh time (your mouse will appear to move more smoothly across the screen, for example).

Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology.

Fig 3.6 showing the diagram of a LCD 16x2 display

3.3 Component's Principle of Operation

3.3.1 The IR Sensor

An infrared sensor is an electronic device that emits and/or detects infrared radiation in order to sense some aspect of its surroundings. Infrared sensors can measure the heat of an object, as well as detect motion. Many of these types of sensors only measure infrared radiation, rather than emitting it, and thus are known as passive infrared (PIR) sensors.

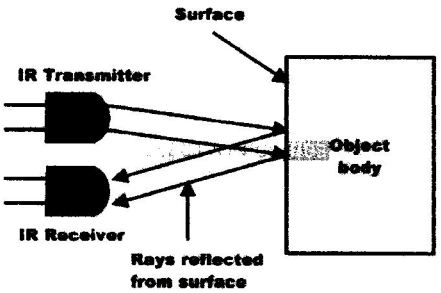

Fig 3.7 showing the object detection with IR sensor

The basic idea is to send infrared light through IR-LEDs, which is then reflected by the car in front of the sensor.

The sensor architecture is done in such a way that it is always ON, meaning that the IR led is constantly emitting light while the IR receiver is constantly waiting to receive infrared light. This design of the circuit is suitable for counting objects, or counting revolutions of a rotating object, that may be of the order of 15,000 rpm or much more. However, this design range can be from 1 to 10 cm, depending on the ambient light conditions and strength of the infrared (Satish V.Reve, July 2012). The sender is composed of an IR LED in series with a 470 Ohm resistor, yielding a forward current of 7.5 MA The receiver part is more complicated, the 2 resistors R5 and R6 form a voltage divider which provides 2.5V at the anode of the IR LED, this led is used as the sensor. When IR light falls on the LED, the voltage drop increases, the cathode's voltage of D1 may go as low as 1.4V or more, depending on the light intensity.

Parking Slot 1

If parking lot No. 1 is free, then this LED shows the value 1 to notify a driver that the parking slot is empty. Hence, a car can be parked in the slot 1. If parking lot No. 1 is filled up the LED shows the value '0' to notify a driver that the parking slot is filled.

Parking Slot 2

If parking lot No. 2 is free, then this LED shows the value 2 to notify a driver that the parking slot is empty. Hence, a car can be parked in the slot 2. If parking lot No. 2 is filled up the LED shows the value '0' to notify a driver that the parking slot is filled.

Parking Slot 3

If parking lot No. 3 is free, then this LED shows the value 3 to notify a driver that the parking slot is empty. Hence, a car can be parked in the slot 3. If parking lot No. 3 is filled up the LED shows the value 0 to notify a driver that the parking slot is filled. This system model provides the parking guidance mechanism in order to reduce the time of the driver for searching the parking space and also headache to drive the car inside the parking area and search the nearest parking lot.

The Smart Parking Lot System includes 3 sensor nodes, 3 parking lots, 1 exit gate and 1 entry gate Parking Status Display unit and a Controller, when the system starts functioning, all the sensor nodes form a network. These sensor nodes check the status of parking spaces and send the report to the Controller. The Controller transmits the status information to Parking Status Display Unit (LCD). The Controller changes the respective Slot on the display from 1 to 0 to indicate that the respective lot is not free. It only displays its respective number when any of the parking lots are free. When all the parking lots are full, the sensor nodes placed in the parking lots detect that there is no space available in the parking area for parking the vehicle.

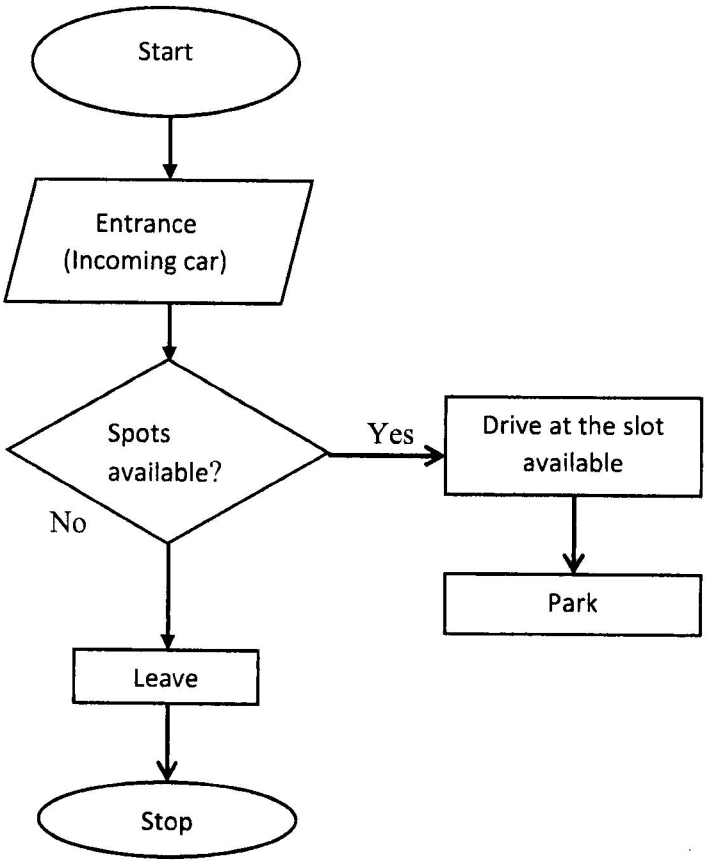

Fig 3.8 showing the flowchart diagram of the parking lot system

3.3.2 Liquid Crystal Display

An LCD display which simply means liquid crystal display. LCD is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome (Contributors, Liquid-crystal display, 2018)

In this project the LCD is used to display when the parking slot is empty or full. For instance, if parking lot 1 is empty it displays value1 but as so as its occupied it displays the value '0'. The LCD works hand in hand with the brain of the project design which is the microcontroller (Arduino) the microcontroller sends details to LCD from the IR sensor.

3.3.3 The Controller.

The heart of the system is controller which collects, monitor and displays the information collected from the IR sensor. This unit manages all the information necessary for the car driver. The Controller displays the processed information in the form of LCD Screen mounted at the entrance. Controller can be termed as a single on chip computer which includes number of peripherals like RAM, EEPROM, Timers etc., required to perform some predefined task.

The instructions used in programming the controller is written in C language. Libraries such as the standard C library, the string library, the wire library and the I2C library for liquid crystal display were used in the written instructions.

3.4 Materials Used

3.4.1 Straw Board

A straw Board is an engineered board that is made by splitting straw and formed by adding formaldehyde-free adhesives and then hot compressing layers of straw in specific orientations. It is coarse, yellow paperboard made of straw pulp, used in packing, for making boxes, etc. The strawboard also takes the place of wood-pulp for smaller paper boxes. Barrels or boxes of wood, or strawboard lined with water-proof paper, should be used in packing for

shipment. In this project the straw board is used as the surface layout of the design and implementation of a smart parking lot.

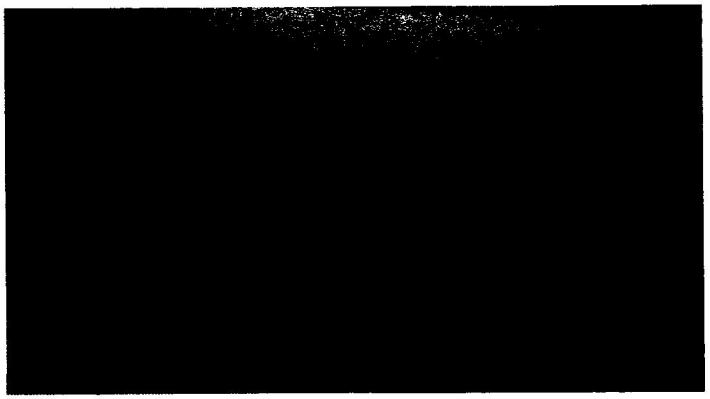

Fig 3.9 showing the diagram of a straw board

3.4.2 Asphalt

Asphalt also known aster paper is a heavy-duty paper used in construction. Tar paper is made by impregnating paper or fiberglass mat with tar, producing a waterproof material useful for roof construction and also used in prototype designs. In this project the asphalt serves as the tar road.

Fig 3.10 showing the diagram of Asphalt.

3.4.4 Cars

For the project prototype in place of real life cars for the implementation of the project.

3.4.5 Adhesive

For joining materials like the strawboard, asphalt together on the surface.

3.5 Implementation and Stages of Design

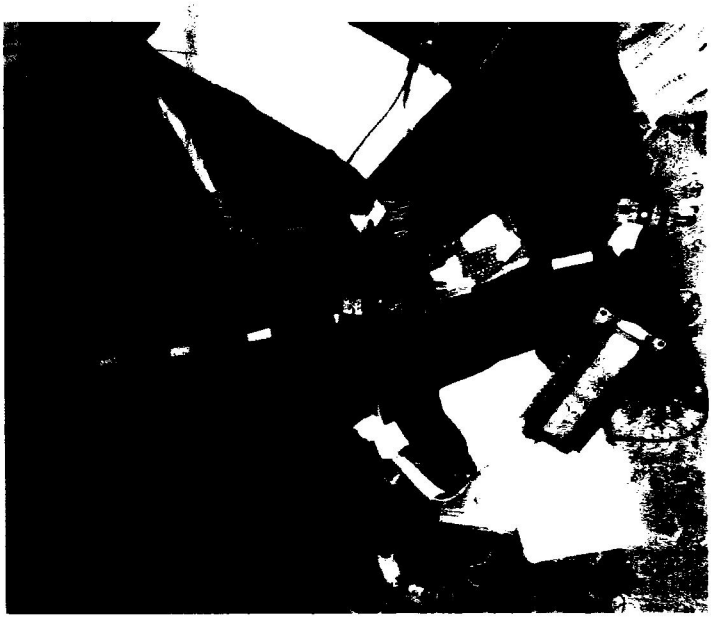

Fig 3.13 showing all components (controller, sensors and LCD) connected and working together before final construction on the board.

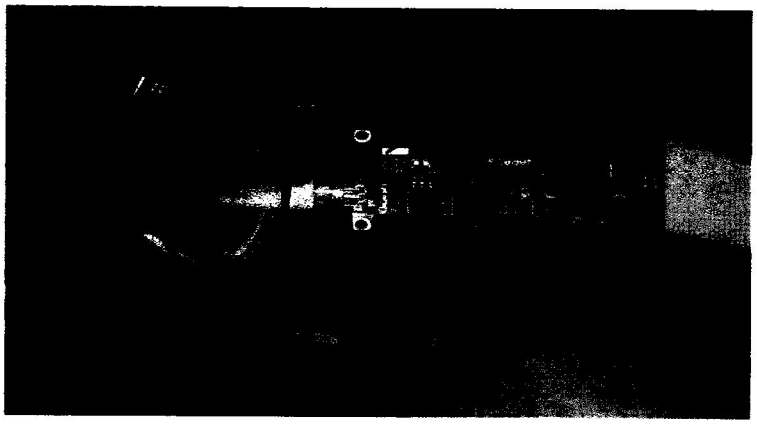

Fig 3.14 showing the connection of the wires to the LCD.

From the diagram above there are four wires connected to the LCD, the first wire is the positive the second wire is the ground while the last two (white and red) are connected to the microcontroller. This is because the controller tells it what to display, it sends information to the LCD from the sensor.

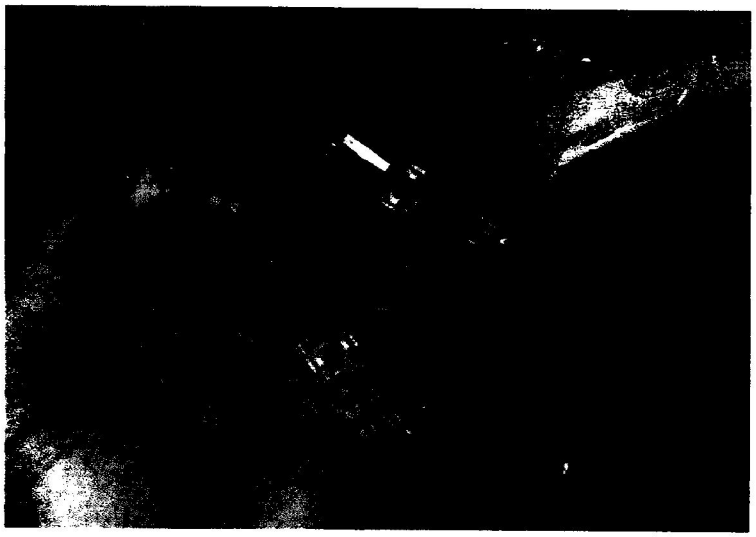

Fig 3.15 showing the diagram of the wires connected to the sensors

From the diagram above three connections are shown which are connected to the sensor the first wire (red) is the positive, the second (green) negative/ground while the third wire (blue) is for transmitting signals to the controller

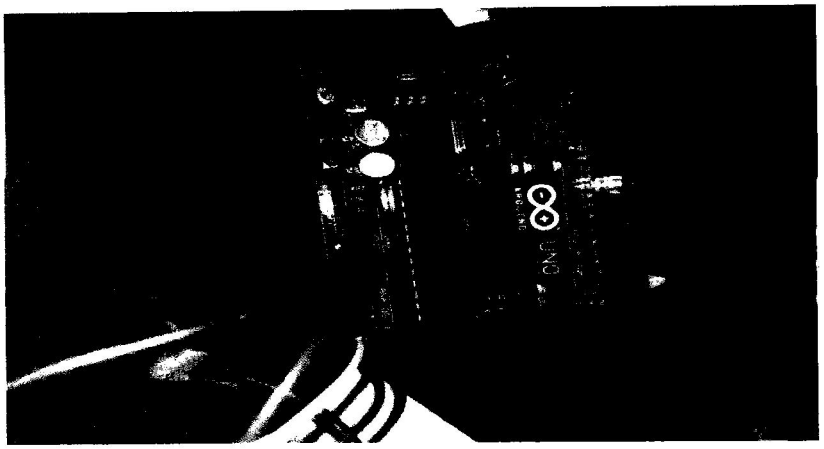

Fig 3.16 showing the diagram of an arduino board with wires connected to it

From the diagram above the last two wires (red and white) are connection wires coming from the LCD board; these are the wires use for the receiving of information from the controller and are connected on the port A4 and A5 on the controller on the analog in session on the board.

The first two (red and green) are the wires connected to the controller for powering up the controller , red wire is the positive it is connected to the 5v on the controller while the green wire is the ground and it is connected to the GND on the controller on power session on the board.

The blue wires at the other end are the third connection wires from the sensors, these wires are connected to the controller from sending of information to the controller and are connected to the port 4, 5 and 6 on the board.

Fig 3.17 showing the LCD on the board displaying the values 1'2'3, meaning there are empty spaces to park.

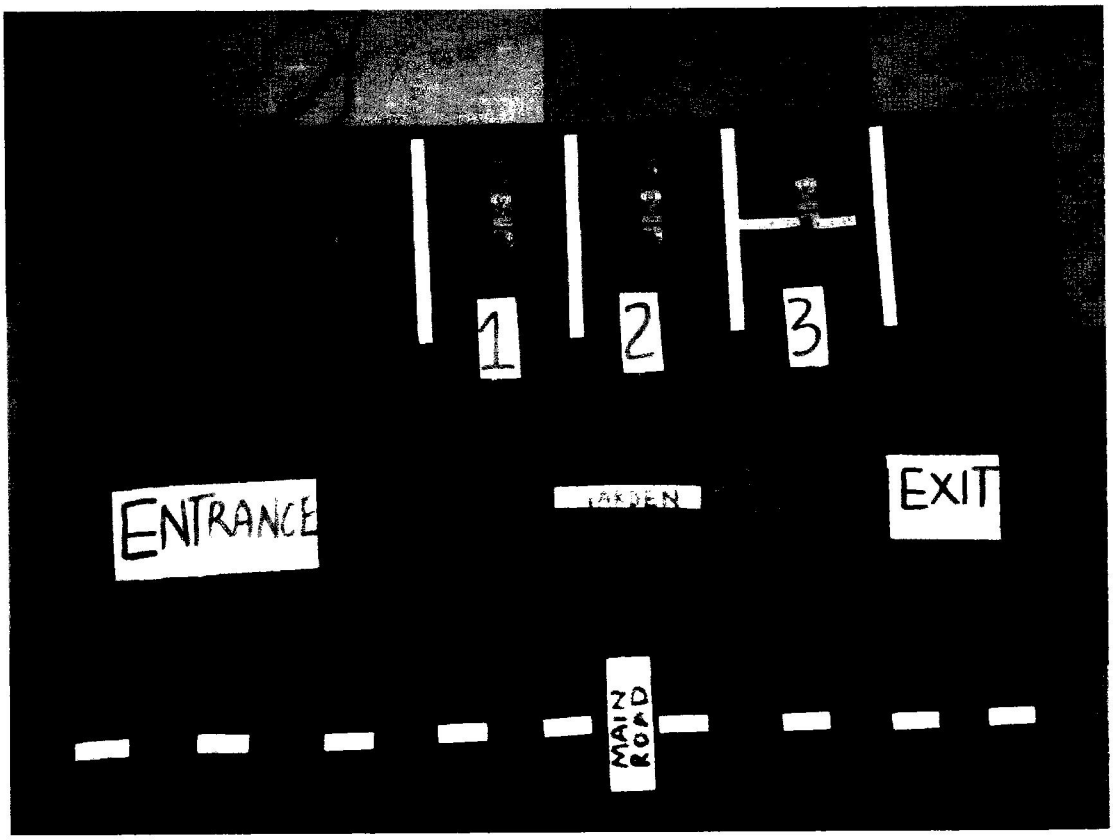

Fig 3.18 showing the final design of an automated parking lot system

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

The objectives of this project are to design and implement a smart parking lot using sensors and microcontroller. The main part of the system is the microcontroller, the LCD, and the sensors. This chapter covers the result of the design and development of the project. The smart car parking system is built for real-life applications. Thus, quality and consistency are mandatory.

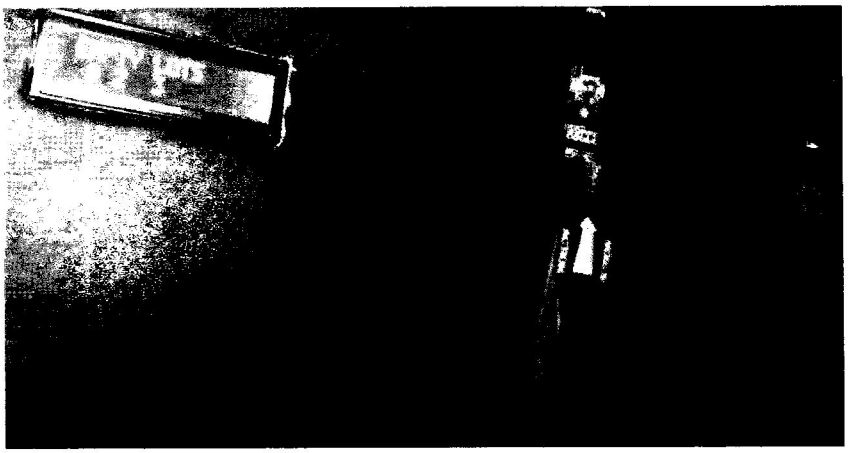

Fig 4.1 showing that parking slot 1 is filled

The figure above shows that a car is parked at slot one, the LCD indicates that slot one is occupied that is why the value '0' is showing at the portion of parking slot 1, if it were not occupied then it shows its original value which is '1'.

Fig 4.2 showing that parking slot 2 is filled.

From the diagram above which shows that a car is parked at slot one, the LCD indicates that slot one is occupied that is why the value '0' is showing at the portion of parking slot 2, if it were not occupied then it shows its original value which is '2'.

Fig 4.3 showing that parking slot 3 is filled.

From the diagram above which shows that a car is parked at slot one, the LCD indicates that slot one is occupied that is why the value '0' is showing at the portion of parking slot 3, if it were not occupied then it shows its original value which is '3'.

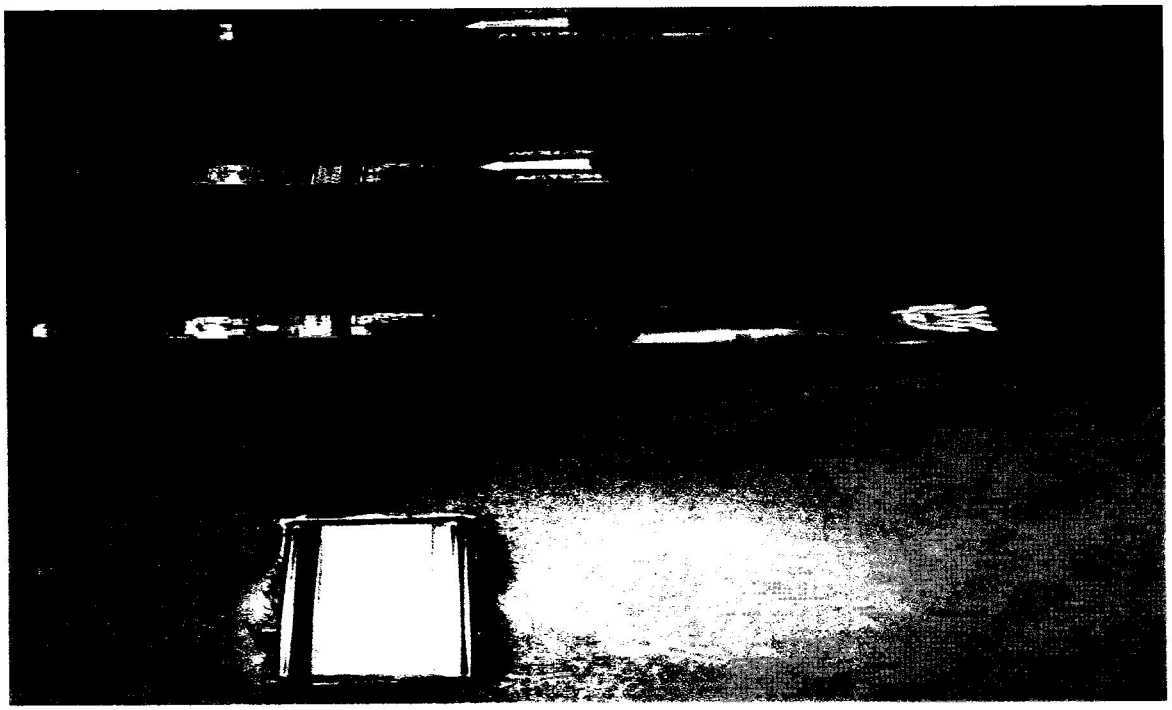

Fig 4.4 showing that all parking slot is filled up.

From the diagram above, the LCD displays the value "0" for the three slots because all the parking slot are used up.

4.2 Discussion of Result

The circuit where arranged and tested on a Vero board and implementation of the circuit was done. The diagram above from chapter three through chapter four shows us how each how each process was achieved ,from the description of the controller how it receives signals from the blue wire of the sensor then transmit the signals to the LCD, telling the LCD what to display if there are available space or not. For instance, if a car is parked at slot one the receiving end of the sensor receives the signal then the transmitting end sends the signal to the controller so that the

LCD would display the information that a car is parked at a particular slot which shows the value "0" but if it is empty it maintains its original value. The same theorem goes for the remaining slot. When the all slot is filled the LCD displays the whole value as "0", "0", "0" until someone leave the parking garage before the state can be changed.

4.3 Evaluation of System

One of the objectives of this project is to evaluate the effectiveness of the hardware prototype. In evaluating the system all necessary requirements were met. The evaluation was done in other to test the accuracy of the constructed system and the major metrics used in evaluating the system is by testing the hardware components independently.

4.4 Hardware Testing

All components were tested independently and as a unit with the use of a multi-meter to ensure that every component is in good working operation.

The components that were tested are the sensors, microcontroller and the LCD.

4.4.1 Testing of the IR Sensors

The IR sensors has a semiconductor\chip inside it and must be powered with 3-5v to function, a pull-up resistor was used to know the state of the signal which simply means to ensure the input to the microcontroller settles as expected and also to stop unused inputs from floating about randomly.

Pin 1-output (the pin that transmits information to the controller)

Pin 2-ground

Pin 3-vcc\positive (5v). Sensors also get 5v from the Arduino

4.4.2 Testing of the Arduino

The Arduino was tested by plugging the board into a USB port of a computer system and check if the green LED power indicator is illuminated, while the power is on an orange LED near the center of the board labeled "pin 13 LED" would flash on and off which means the chip on the board is working perfectly, if the light doesn't flash on and off then the factory code is not on the chip.

4.4.3 Testing of the LCD

The LCD was tested by plugging to a power supply, and when it's been plugged test the incoming flow of AC power by connecting the LCD to an independent power source like battery, ups, power bank because a direct current would damage the LCD. Also the LCD was tested with a multi-meter.

4.4.4 Testing the LCD with Arduino Board

To test the LCD and Arduino board as a unit, connect the power and the ground pins of the LCD which are pins 15 and 16 respectively to the board, connect the control pins for the LCD to the analog in on the board which are pin A4 and A5 respectively. After every connection has been made it was seen that the two components were working hand in hand perfectly.

Table 4.1 showing the table of the result of system evaluation

System Requirement	**Yes**	**No**
Response of sensors to cars	Yes	
Send correct signal	Yes	
Signal processed correctly by the controller	Yes	
LCD display of correct information	Yes	

4.3 Problems Encountered

- The use of a wooden board was a big problem because constructions on the board were difficulty so it was changed to a straw board which made construction easier and smooth.
- Availability of materials, especially the asphalt (which serves as tar road), grass and trees for beautification of the garage was not easy to get as well, only specific environment had the materials

4.4 Precautions

- The sensors should not be placed near any obstacle to avoid it sensing the wrong signals, it's should be positioned where not obstacle can reach.
- The power supply should be more than 5v because when it was it caused one of the sensors to burn.
- Avoid using wood for the prototype board to prevent difficulty in construction

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

Smart Parking is a parking system which can be defined as the use of technology for the efficient operation, monitoring and management of parking in an urban area. The increase in the number of vehicles on the road finding where to park during peak hours in most populated areas like shopping malls, universities, and event centers is difficult for the drivers.

Drivers searching for a place to park are estimated to be responsible for about 35% of traffic congestions in cities. The difficulty rises from not knowing where the available spots may be at that required time. Smart parking is a solution to solving this known problem to help reduce congestion, cut vehicle emission totals and save persons' time by helping them in finding a spot to park. So new approaches were made using smart parking systems to provide a more balanced view of parking that manages the relationship between demand and supply.

This project work made use of sensors, microcontroller and networking system, the system can be used in allocating parking slot. The system induces parking vehicles, in which a driver enters in a parking lot, LCD displays if there are available space in the parking lot, if there are available then the driver parks in the right space of parking lot,

Hence the driver would know where there is an available spot to park his vehicle in less time, reducing the energy consumption and air pollution.

5.2 Conclusion

Chapter one to four elaborates the design and construction of the design and implementation of a smart parking lot. The functionality of the system is tested and it is seen that the project design is working well. It is concluded that:

- The automated parking lot system is working reliably so far.
- The unit is fabricated using cheap, simple and available items. The construction and design process is quite simple thus can be reproduced and maintained locally.
- The major constraint of this project is power supply, if there is a shutdown of power supply during operation on the parking lot the parking lot would not work during the period of the power outbreak, unless there is a back-up support like an inverter or a solar system.

5.3 Recommendation

The project work has designed and implemented an automated parking lot. However further research can be carried out to improve the design, recommendation includes:

- A standby power supply can be incorporated to increase the efficiency of the system
- Ultrasonic sensors can be used to improve the performance of the system at night

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APPENDIX A: CODING

```
#include <stdlib.h>      // calloc

#include <stdarg.h>      // va_*

#include <string.h>      // strlen, strcpy

#include <Wire.h>

#include <LiquidCrystal_I2C.h>

//I2C pins declaration

LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);



/*

 * declaring variables to and initializing pins

*/

constint plot1 = 6 ;  //initializing pin 6

constint plot2 = 5 ;  //initializing pin 5

constint plot3 = 4 ;  //initializing pin 4

constint plot4 = 3 ;  //initializing pin 3



/*

 * declaring variables to monitor previous state
```

```
*/

int lastlot1 = 0;  // initializing states to OFF /DOWN / 0

int lastlot2 = 0;

int lastlot3 = 0;

int lastlot4 = 0;


void setup() {


pinMode(plot1,INPUT);    //initializing pin 6 as input

pinMode(plot2,INPUT);   //initializing pin 5 as input

pinMode(plot3,INPUT);  //initializing pin 4 as input

pinMode(plot4,INPUT); //initializing pin 3 as input


  // set up the LCD's number of columns and rows:

lcd.begin(16, 2);


}
```

```
void loop() {

 /*

 * Readinng the current states from input pins

 */

int lot1 = digitalRead(plot1);

int lot2 = digitalRead(plot2);

int lot3 = digitalRead(plot3);

int lot4 = digitalRead(plot4);


//(column , rows) means

lcd.setCursor(1,0);   // Setting cursor position for line 1

lcd.print("EMPTY LOTS"); // print a text on line 1


/*

 * Conditions to read state of different Pins. It checks if the state is HIGH or LOW

 */


/*
```

```
 * condition for parking lot 2
*/
if(lastlot1 != lot1){
if(lot1 == HIGH){
lcd.setCursor(2,1);
lcd.print("1");
        }
else{
lcd.setCursor(2,1);
lcd.print("0");
        }
      }
/*
 * condition for parking lot 2
*/
if(lastlot2 != lot2){
if(lot2 == HIGH){
lcd.setCursor(4,1);
```

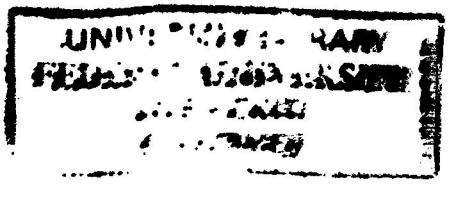
```
lcd.print("2");
}else{
lcd.setCursor(4,1);
lcd.print("0");
        }
    }

/*
 * condition for parking lot 3
*/
if(lastlot3 != lot3){
if(lot3 == HIGH){
lcd.setCursor(7,1);
lcd.print("3");
}else{
lcd.setCursor(7,1);
lcd.print("0");
        }
```

```
    }


/*
 * condition for parking lot 4
*/
if(lastlot4 != lot4){
if(lot4 == HIGH){
lcd.setCursor(9,1);
lcd.print("4");
}else{
lcd.setCursor(9,1);
lcd.print("0");
      }
    }


/*
 * setting variable for the previous state of Pins
*/
```

```
    lastlot1 = lot1;

    lastlot2 = lot2;

    lastlot3 = lot3;

    lastlot4 = lot4;

}
```

APPENDIX B: COST OF PRODUCTS USED

S/N	COMPONENTS/MATERIALS DESCRIPTION	QUANTITY	UNIT COST(N)	TOTAL COST(N)
1	ARDUINO	1	5000	5000
2	LCD(16X2)	1	1000	1000
3	SENSORS	3	1500	4500
4	JUMPER WIRE BUNDLE	1	1000	1000
5	VERO BOARD	1	100	100
6	STRAW BOARD	2	1500	3000
7	ASPHALT	1	1000	1000
8	ARTIFICAL GRASS	1	500	500
9	ARTIFICAL TREES	2	200	400
10	ADHESIVE(UHU)	1	1000	1000
11	ADHESIVE	1	100	200
12	CARDBOARD	1	100	100
13	PAPER TAPE	1	100	200
14	TOY CARS	1	1500	1500
15	POWER CORD	2	500	1000
16	CHARGE HEAD	2	700	1400



17	SCREWS	5	20	100
TOTAL				22,000