

**Technical University of Mombasa**

**Faculty of Engineering and Technology**

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

**Bachelor of Science in Electrical and Electronic Engineering**

**AUTOMATED BASEMENT PARKING SYSTEM FOR MOTOR VEHICLES**

**by**

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**Project report submitted in partial fulfilment requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering**

**Supervisor: Mr. Ungai**

**Date submitted \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

# DECLARATION

I, Eric Munuve Masila, declare that the contents of this project proposal represent my own unaided work, and that the report has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Technical University of Mombasa.

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| --- | --- | --- |
|  |  |  |

**Signed Date**

I certify that Eric Munuve Masila worked this project under my supervision and all the contents in this project report represent his own work.

**Name of Supervisor Sign and date**

# ABSTRACT

With the rapid proliferation of vehicle availability and usage in recent years, finding a vacant car parking space is becoming more and more difficult, resulting in a number of practical conflicts. Parking problems are becoming ubiquitous and ever growing at an alarming rate in every major city. Lot of research and development is being done all over the world to implement better and smarter parking management mechanisms. Most vehicle users have resorted to parking their vehicles on the road side which has led to congestion in most cities and some streets might end up being impassable until the vehicles have been removed. Location of empty slots for parking by vehicle users has been a major concern in the cities especially to visitors in the city.

The system will be designed to minimize the area and/or volume required for parking cars. It will be designed for optimum utilization of parking space by utilizing vertical space rather than horizontal space by providing parking for cars on multiple levels stacked vertically to maximize the number of [parking spaces](https://en.wikipedia.org/wiki/Parking_space) while minimizing land usage. Car is driven up to the entry point of the automated storey parking system and the driver and passengers exit the car. The car is then moved automatically to its parking space. The project when implemented will be designed to occupy the basement of storey buildings while they are under construction so as to be included in the design of the building. In already existing buildings the structure will be able to be implemented on the already existing parking lots while maximizing the available space. The project when implemented will enable vehicle users to check the available parking. The project intends to use ultrasonic sensors to automate the parking and a microcontroller through stepper motor will use chain and sprocket mechanism is used for driving the parking platform.

When implemented the project aims to develop automated car parking system with a minimum cost for reducing congestion within the cities to help ease of movement of motorists within a city. The project when implemented will help the vehicle users to easily locate the available parking lots to avoid being stranded while trying to locate an empty parking space. This in the end will result in the reduction of wastage of time and fuel finding free space around the parking ground.

# ACKNOWLEDGEMENT

First of all, praise and thanksgiving to God for the blessing of mind and health to do my proposal and project. I pay tribute to the myriad contributions of my supervisor and mentors and the support of my family and friends. To my supervisor MR. UNGAI: thankyou for your continued guidance and endless patience as we continue with this journey. I wouldn’t be this far without your insights and guidance. To the TUM staff of the department of electrical and electronic engineering, thank you.

# DEDICATION

For my beloved family

For my better friends VINCENT MUYA AND KENNEDY NGURE

For my beloved KENYA

For my beloved supervisor MR. SAMSON UNGAI

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# GLOSSARY

ABPS Automated Basement Parking System

APS Automated Parking System

MLCPS Multi-level Car Parking System

PIG Parking Information guidance

1: INTRODUCTION

## Introduction

Currently, the existing parking space relegated for cars in every institution isn’t enough to manage the number of cars that require to be parked. In addition to that existing problem, most of the car parks are manually managed with very little or no efficiency at all. There is an ever-growing need for faster commute mostly in the city and this has brought about an unforeseen problem of parking. The problem that always occur is that the number of cars surpass the volume provided for parking [1]. This results in some people parking their vehicles at road sides and hence causing congestions in the streets or blocking walking paths as they try to find a parking solution. This problem mostly occurs in urban areas where the number of vehicles is higher as compared to the availability of parking spaces. Also, in areas where they try to provide a larger parking area, one may end up circling the parking area for a longer time trying to find a parking space [2]. This ineffectiveness is caused by the lack of implementation of modern technologies available in the market. Parking inside a building is also user friendly as it prevents the car from extreme exposure of direct sunlight [3]. For years now the government has tried its best to construct roads for quicker commute but the question remains, are we also giving the vehicles enough space to park? While residential projects escape with designated parking, the real problem lies within commercial spaces. Before industrialization took over, this could be tackled by expanding the parking space but unfortunately that is not an easy option currently and hence the need for my project.

As per a 2020 survey, 1.2 billion cars are running on road. 97% of urban lands are either occupied commercially or under construction which only leaves about 3% for parking. The above survey unveiled a serious problem of the scarcity of parking spaces. It is also estimated that by the year 2035, 2 billion cars will be running on the road. There is need for an efficient parking system that tackles both the availability and volume issues.

The existing storey car parks comprise of some deadly curves and ramps which have proven very difficult to manage especially for learners. Automated car parking systems are becoming common but they are not perfect. We still need to eliminate the shortcomings of the existing systems by focusing primarily on energy and space utilization.

This is sufficient to imply that it is essential to develop some robust car parking system which is:

1. Efficient in terms of energy and space utilization.

2. Safe, attractive and easy at the customer end.

3. Which also has a future scope for substantial expansion without demolishing the existing structure and which can be erected on a very short notice in case of more demand.

This project aims at satisfying all these basic needs in the most efficient way by making optimum use of the modern architectural traits combined with the concept of green and clean energy, securing the system by using centralized monitoring, making it safe and reliable. The system is also pliable in terms of the design which connote that more parking lots can be added afterwards which also makes it futuristic.

## Objectives

Overall objectives

This project aims to design, construct, simulate, implement and test an automated underground parking system for motor vehicles.

Specific objectives

1. To design an automated parking system.
2. To construct a circuit showing the automated parking system.
3. To simulate the automated parking system using SOLIDWORKS to show how it works.
4. To implement and test the automated parking system.

## Problem statement

In urban areas, the number of vehicles is increasing everyday while the urban land scarcity grows. This situation has led to insufficient utilization of the available parking space [1]. Road congestion caused by space-searching traffic [2]. Access problems and safety hazards caused by illegal parking and environmental strains [3]. The unavailability of a parking information and guidance (PIG) system in many countries means that most vehicle users do not have any knowledge on where the best parking locations are situated, the duration of the operating hours, costs and availability of the parking space.

This project aims to achieve its objective and filling in the gap in the market of balancing the ratio of number of cars and available parking space. It will help to reduce congestion in the cities and also it will increase the efficiency by a very big margin.

## Scope of work

The scope of this project will be limited to the design, simulation and construction of an automated underground parking system for busy cities and institutions which have a challenge of parking space due to reduced urban land and increased ownership of motor vehicles.

## Problem justification

The important aspects that motivate this project are: there is need to maximize the available urban land and one of the ways is to avoid allocating so much land for parking land which would otherwise be put into other use, there is also need to reduce congestion in busy cities due to poor parking system or no parking systems at all and also, there is need to for cheap and reliable parking systems which can be easily adopted. Many studies have clearly shown that parking time for conventional cars is around 95% (Shoup, 2005)

When implemented the project will be of great help to busy cities especially in promoting order and organized parking and also it will be secure for vehicle owners to park their vehicles.

## Significance and motivation of study

The motivation of this study results from rapid increase need of parking spaces in the recent years due to the increase of vehicle ownership. Depletion of land as an important natural resource forces urban city to develop effective strategies to solve future parking crises.

The project will be of great importance to busy cities. Efficient and effective parking system will encourage maximization of land use. The AUPS for motor vehicles can be implemented in available parking spaces and also it can be incorporated in the basement design of the new buildings to create an efficient parking system.

When implemented the project can significantly contribute and enrich the body of knowledge in addressing problems related to car parking management systems. The creation of this model for a car parking management system can act as a point of reference to other car parking management system developers.

## Assumptions and Delimitations

Assumptions

1. It is assumed once the entrance bar is lifted, the vehicle must enter.
2. It assumed once the exit button is actuated the vehicle must leave the system
3. It is assumed there will be no people to in the slot to interfere with the ultrasonic sensor operation
4. It’s assumed once the barrier opens the vehicle will not stop while the barrier has been lifted.
5. It is assumed that all components will be fully functional
6. It is assumed that during the research the research materials will be readily available and the researcher will get all the assistance they require.
7. It is assumed that occupants in the vehicle will take a given time frame to alight from the vehicle as set by the system while taking into account the aspect of time usage economy.

Delimitations

1. The complexity of the design may be a very big challenge.
2. It might be time consuming to adopt the new parking system especially for existing buildings.
3. In some instances, it might be difficult to incorporate the new parking system in the basement of already existing buildings.
4. The design will be for small vehicles and not large vehicles such as trucks.

2. LITERATURE REVIEW

# 2.1 Introduction

Automated storey parking systems have been implemented in countries like china and Germany which means there have previous studies on the field. In this chapter, we will focus on the previous works and show the gap that constituted the need for my work. The concept for the automated parking system was and is driven by two factors: a need for parking spaces and a scarcity of available land. We will approach this chapter from 4 different perspectives;

1. Multilevel parking techniques
2. Mode of access techniques
3. Mode of parking vehicles
4. Available slots monitoring techniques

2.2 Multilevel parking techniques

Multilevel generally means that the vehicles are parked in a vertical structure arranged in levels. A few scientists have written papers discussing the above approach as shown below:

(Mala Aggarwal, 2012), This Automatic Car Parking enables the parking of vehicles-floor after floor and thus reducing the space used. Here any number of cars can be parked according to requirement. These make the system modernized and even a space-saving one. This idea is developed using AVR Microcontroller. Here program is written according to this idea using AVR ATMEGA 16 microcontroller. This Automatic Car Parking enables the parking of vehicles-floor after floor and thus reducing the space used. Here any number of cars can be parked according to the requirement. These make the system modernized and even a space-saving one. Mathematical modeling is also done to identify the least car parking space available among the difference parking places in a city. The system has been provided with three floors of a building for car parking. Maximum storage capacity of each floor is given as ten. Storage capacity can be changed according to the requirement. When the lift reaches the first floor, the processor compares the filled amount to that of the already fed capacity of that floor, and if it finds that the first floor is fully filled, it goes to the second floor and thus the procedure stops here. As soon as a car is placed in a particular floor, the display counter at the ground floor increments as to indicate the floor capacity has decreased by one. After the lift places the car in a particular floor, it comes back to its normal position and that time, the motor that drives it, also stops. This project has a shortcoming of consuming time because the lift checks floor by floor.

(Katik D. Bhujade, March-April 2016), In this paper, the essential multi-level auto stopping framework with three stories is considered to demonstrate the utilization of control frameworks in stopping frameworks. The present undertaking work is expected to add to a decreased working model of an auto stopping framework for stopping 6 to 24 autos inside of a stopping territory of 32.17 m². It is an amalgamation of the officially created stopping frameworks with the additional favorable position of lessened space inhabitance by the configuration of a more straightforward and smaller stopping framework that is revolving and involves vertical parking spot. This project had a major shortcoming of not utilizing free space. It was designed for a small-scale parking.

(Prof. Yatin Jog, 2015), Multi-level car parking system (MLCPS) is one such technology which is implemented in India. It is used for optimum utilization of parking space by utilizing vertical space rather than horizontal space. Some of the benefits of MLCPS are optimum utilization of space, low construction cost, low working and maintenance cost to name a few. Smart parking uses sensors, wireless communication technology, data analytics etc. to solve parking issues. Smart parking solutions can be used to locate available parking space with the help of sensors. This saves customer’s time as well as minimizes wastage of fuel. Various technologies are being used to ease parking problems in public places. In automated multilevel car parking, the car is lifted and placed at the available slot. This is done with the help of robotics and a lot of software programming. However, this project did not tackle the issue of pollution occurring from having many vehicles packed in the same area.

2.3 Available slots monitoring techniques

(Mr. Vedant Chikhale, June 2017), The paper proposes the use of LCD displays to show the availability of the space, the counter keeps the check of the number of cars entering and exiting the parking space, the servo motor helps as gate for the entry and exit of the cars. The ultrasonic sensors detect the availability of the parking space. Object counters IC 555 and IC 4026 monitor the availability of the remaining slots. This project does not offer remote update thus when a person is driving up to the parking, they have no idea if they will find a space.

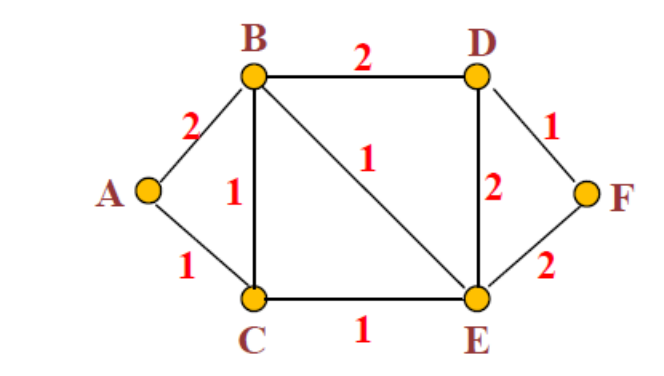
(Abhishek Singhal, March-2016), In this paper, the parking system incorporates Infrared sensors, Wireless communication and Radio Frequency Identification technology. Sensors are utilized to find the accessible parking spot. GSM empowers the Short Message Service that gives the charging data alongside the parking duration to the drivers. The empty slots are available in the main control unit. ATMEL AT89S52 microcontroller has been used as the fundamental handling framework. This project does not offer remote data for checking the availability of parking space from a distance.

(B. Ramya Sri, 2017), the paper proses the use of IR sensors to monitor empty parking slots. At the entrance an IR pair is placed is place to monitor the entrance of the vehicles and this provides the information of the remaining empty slots. The information of the available parking slots is displayed on an LCD screen. Whenever a car comes in front of the gate, the IR signal gets disturbed and the microcontroller will open the gate by rotating the stepper motor. The gate will be closed only after the car leaves the second IR pair since the microcontroller should know whether the car left the gate or not. Now the microcontroller decrements the value of the count and displays it on LCD. In this way, the microcontroller decrements the count whenever the car leaves the park and displays it on LCD. If the count reaches ‘0’, i.e. if the park is completely filled, the microcontroller will display “NO SPACE FOR PARKING” on LCD. The system uses AT89C52 microcontroller to coordinate the events in the system. In this project, the sensor might be disturbed by something different causing the system to run empty.

(Mala Aggarwal, 2012), this paper proposes use of image processing technology to monitor vacant slots. Security surveillance (CCTVs) will be used as a sensing node to identify vacant parking space. The captured image will be processed through the AVR Microcontroller and the processed data will be transmitted via ZigBee to a central computer to store and update the occupancy status of available parking space vacancies in the database providing real time information rendering, and smart reservation mechanisms.

**2.4 Mode of access techniques**

(R. Jeyabharath, Mar-Apr 2016) The paper proposes the use of RFID reader interfaced with the PIC microcontroller connect between multilevel vehicles parking system. RFID reader is placed in front of the vehicle parking system, PIC microcontroller controls the vehicle parking system using Dijkstra’s shortest path algorithm. Dijkstra's algorithm computes length of the shortest path from the source to each of the remaining vertices in the graph. It repeatedly selects from the unselected vertices, vertex v nearest to sources and declares the distance to be the actual shortest distance from s to v. Dijkstra’s algorithm works on priority-based search between edges and vertices. Priority queues dictate a different order based on priority of their elements. The element with the smallest distance is the one that has the highest priority. This project had its major shortcoming in the approach. RFID sensors can be activated by materials such as metals and liquids. RFID readers are also very expensive.



*Figure 2-1 Path finding Graph*

(C. Mahalakshmi, Jan. – Feb. 2018) The paper presents project work which is to augment a car parking system, in which Programmable Logic Control (PLC) is used for performing overall operations. The Internet of Things (IoT) concept is implemented in this car parking system which makes it highly advantageous as it provides a reliable and secured parking system. In juncture with this, a mobile application is introduced that is interfaced with PLC through which vehicles can be easily located. For security reasons an electronic identity chip is used that is interfaced with the mobile application. The chip includes a unique ID no for each vehicle that is read by the RF card reader. The user can access the entire parking zone with the help of the mobile app only if he/ she enter the exact OTP. By usage of proximity sensors, the entry and exit path is properly synchronized to avoid the parking attendant. At the entry end of the parking zone, the user can select the vacant parking slots with the help of mobile app. In this project, it presents a hazardous situation where drivers use their mobile phones. This could cause accidents.

(Alam, 2017), The paper proposes use of an LCD to display the number of available slots and a RF Receiver Module to get updates about the parking slot. The system will have an operator who sends instruction through Arduino microcontroller to open gate using RF Transmitter Module and update the LCD display at the entrance. DC motor helps the gate to open up when it gets the signal from Arduino, Arduino will only get the signal to DC motor using RF Receiver Module. The operator will send a SMS containing a code to the user’s mobile phone using Arduino and GSM Module. The stopwatch will be started as soon as the gate opened. The shortcoming of this project is that it is not fully autonomous. It needs an operator to be employed.

(Janhvi Nimble, Mar-2016), their proposed system presents an Autonomous car parking that regulates the number of cars that can be parked in a given space at any given time based on the parking space availability. When a car arrives at the entrance, it will be stopped at the main gate and the driver alights the car. If the availability of Parking space is confirmed, the user commands the car to get parked to the designated slot. The car traces its path to the entrance of the parking area. Here, it waits and the details required for parking of car at the proper slot are communicated to the Car Control Unit. On receiving the information, the car will further trace its path to free parking spot. On successful parking, the data on the LCD will be updated automatically. Their system uses Microcontroller AT89S52.This system depends on vehicles having a car control unit and many vehicles do not have one.

2.5 Mode of parking vehicles

(Katik D. Bhujade, March-April 2016), The paper proposes, chain and sprocket component are utilized for driving the stopping stage and a one fourth horse power brake engine should be actualized for fueling the framework and indexing the stage. The platform is fabricated to suit the working model. By testing and analyzing the working model, the view to develop the parking lots at difficult and busy commercial places can definitely be designed. The shortcoming of this system is that it produces vibrations and they are not suitable for an underground system.

(R. Jeyabharath, Mar-Apr 2016), In this paper, driver parking and leaving the vehicle in the system at the ground level. Once the driver leaves the incorporated safety zone the vehicle is automatically parked by the system rotating to lift the parked car away from the bottom central position. This leaves an empty parking space available at the ground level for the next car to be parked on. The parked car is easily retrieved by Down to ground level ready for the driver to enter the safety zone and reverse the car out of the system. The shortcoming of this system is that it doesn’t give the owner the privilege of choosing where their car should be parked.

According to (C. Mahalakshmi, Jan. – Feb. 2018) a servo motor along with servo drive to perform closed loop operation. The motor is coupled to a sensor, in order to acquire an exact position feedback. In the car parking system, the servo motor is responsible for the rotary motion of the entire mechanical setup. It is mainly used for positioning the appropriate slots according to the user’s request. The encoder feedback gives the information about the current slot to the servo drive. The servo drive compares the current slot with the requested slot which is informed by the PLC. Then the servo drive instructs the motor to bring down the requested slot by providing appropriate pulses. Thus, necessary torque and speed is obtained by tuning various parameters.

(Vipul More, n.d.) In this paper, cars are parked by a forklift. The forklift places the car in the vacant space with the help of the pallets. After the admin starts the system, the driver is prompted to choose either to park or retrieve a car. On selecting the option for parking, the driver is then prompted to choose a vacant spot that is available, input given will be checked for accuracy and the spot will be made available to the user. The car is placed on the rotating platform, after that, the program sends the signals to the microcontroller to move the forklift to the designated space this will be accomplished by sending continuous movement instructions to make smooth movement. The shortcomings of this system is the proneness of forklifts to breakdown.

(Alam, 2017), The e paper proposes the use of trays to place vehicles at the designated empty slots. As soon as the vehicle enters the system a signal is sent to the car parking tray using RF Transmitter Module. The car parking tray will park the car & will come out to park the next car. The wheels of the car parking tray will be controlled by Arduino so that it reaches the particular slot. For parking out the user will have to give the provided code to the operator at the exit gate. In this system slots are located at a different place but the tray does the parking and retrieval of the vehicles.

## 2.6 General research gap

The parking systems discussed above have been found to be complicated, expensive or outdated. Some are time consuming during construction of the basic structure and others do not address the maximization of available land. Therefore, there is a need to introduce a parking system that is reliable, efficient and will tackle the availability of parking space.

## 2.7 Existing parking systems

Generally, there are two types of car parking systems: traditional and automated.

Traditional parking systems

This is the oldest form of vehicle parking where a car is allocated specific parking place which is designated by a white or yellow paint.

Automatic parking system

Automated car parking systems use a similar type of technology to that used for mechanical parcel handling and document retrieval. The driver leaves the car inside an entrance area and technology parks the vehicle at a designated area. Hydraulic or mechanical car lifters raise the vehicle to another level for proper storing. The vehicle can be transported vertically (up or down) and horizontally (left and right) to a vacant parking space until the car is needed again. When the vehicle is needed, the process is reversed and the car lifts transport the vehicle back to the same area where the driver left it. In some cases, a turntable may be used to position the car so that the driver can conveniently drive away without the need to back up. The automatic parking system has many types and some of these will be explained below.

1. Robot car parking – in this system, the vehicle is driven to aa central point where the driver exits, goes to the monitor to choose an empty slot and then swipes the card for payment. Automated lifts place it carefully to a shelving system. The operation of this system is governed by a computer.
2. Multi-level automated parking – this is essentially a building with multiple floors or levels for the cars to be parked. The different levels are accessed through external or internal lifts.
3. Crane automated parking system – a crane automated system utilizes a single mechanism to simultaneously perform the horizontal and vertical movements of the vehicle to be parked or retrieved from the system.
4. Puzzle automated parking system – this system offers the densest form of automated parking system. It typically utilizes around 95% of the floor area.
5. Shuttle automated parking – this system utilizes autonomous shuttles and elevators to park and retrieve vehicles. The number of shuttles in the system is typically flexible and is based around the client’s budgetary requirements.

3. METHODOLOGY

# 3.1 Introduction

To develop a reliable automated parking system, a lot of activities that include ground work, design, construction, testing and implementation have to be done. This chapter consists of three major sections:

1. Design
2. Simulation
3. Construction
4. Testing

In addition, the following supplementary issues will also be illustrated:

1. Project costing
2. Project time management
3. Bibliography/References
4. Appendix/Appendices

# 3.2 Block diagram

The block diagram of the automated storey building parking system is as shown below;

output

input

Parking process

feedback

Navigating system

Figure : the block diagram of the system

+12V DC

POWER SUPPLY

+5V DC

Servo motor

Motor driver

MICROCONTROLLER (Arduino Mega)

IR sensors

Stepper motor

OCR Input (labview)

DISPLAY (20\*4) LCD

**Controller**

The controller manages, commands, directs, or regulates the behavior of other devices or systems using control loops. Controller deals with the control of continuously operating dynamical systems in engineered processes and machines. The objective is to develop a control model for controlling such systems using a control action in an optimum manner without delay or overshoot and ensuring control stability. To do this, a controller with the requisite corrective behavior is required. This controller monitors the controlled process variable (PV), and compares it with the reference or set point (SP). The difference between actual and desired value of the process variable, called the error signal, or SP-PV error, is applied as feedback to generate a control action to bring the controlled process variable to the same value as the set point.

The controller when the project is implemented will be able to adopt closed loop control since the feedback on the number of occupied parking compartments will be required.

**Infrared sensors**

A sensor is a device, module, machine, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics. They are always used with other electronics. Infrared sensor is used to sense certain characteristics of its surrounding. It does so by either emitting or detecting infrared radiation. They are also capable of measuring the heat being emitted by an object and detecting motion

**Process**

The process involves the movement of parking spaces through a belt and chain system which is rotated by a motor. The parking compartments will be attached on the chain so that as the chain moves so do the parking compartments.

**Motor**

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Motors operate through the interaction between the electric motor’s magnetic field and winding currents to generate force. Electric motors are used to produce linear or rotary force (torque).

**Gear and Chain system**

The gears and chain system will be an essential part of the process when the project will be implemented. Through the gear and chain system the parking compartments are able to be moved from one point to another. The length of the chain will determine the number of compartments that a given system will hold and thus the number of vehicles a system can hold.

A chain is made up of a series of links with the links held together with steel pins. This arrange makes a chain a strong, long-lasting way of transmitting rotary motion from one gear wheel to another.

**Disturbance**

Disturbances affect the control operation in a closed loop system. This disturbance affects the overall output of the system. For this project the disturbance will refer to the cars incoming into the system for parking.

**Feedback**

This negative feedback control system, the set point and output values are subtracted from each other as the feedback is out of phase with the original input. The effect of the negative feedback is to reduce the gain. The negative feedback produces a stable circuit response, improves stability and increases the operating bandwidth of the system. For this project the feedback will be the number of parking spaces already occupied. The sensors would monitor the actual number of slots occupied and compare it with set point.

**Error**

The error is the difference between the occupied slots and the total number of slots the system has. If the error is large it means most slots are not occupied thus more cars will be allowed into the system. However, if the error is zero it means all the slots are occupied and therefore no more vehicles will be allowed into the system. The error will increase if cars move out of the system.

**Output**

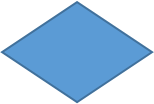
The actual output will be the number of compartments that are occupied by the vehicles. The output will be displayed on the 20 by 4 LCD display. The output will show the availability of a parking space and this will be available to the users. If there is no available slots, the system will let the user know so that they look for a different place.

**Programming description**

A program is a set of instructions. The basic platform used for programming in this paper is Embedded-C. Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems.



START

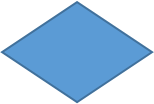


YES

NO

S1 = 1

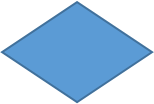
GATE OPENS



NO

YES

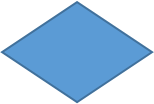
Slot1 = available



NO

YES

Slot 2 = available



YES

NO

Slot 3 = available



Have slot”…..”

Sorry! Parking full



STOP

*Fig 3.3: Overall Program flowchart*

**Software simulation stage**

To achieve my simulation objective, I used Proteus professional version 8.10 to show how different components connected will automate my parking process. The diagram shows the working of the simulated system in the proteus software.

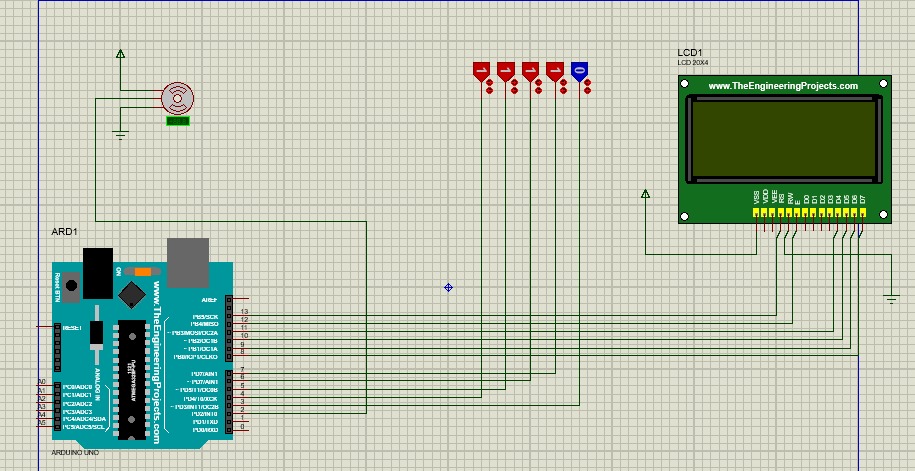


Figure 3.4: Connection of components on proteus

As the figure above shows, I connected Arduino uno to a lcd display output and logic states to represent the slots. Logic state, as the name suggests, has two states, HIGH and LOW. When the logic state is zero, it means that the sensor hasn’t detected anything and hence it is LOW. When the logic state goes to one, the sensor has detected a vehicle and hence it is HIGH. It stays on Vuntil the vehicle leaves the slot. Arduino is supplied with 5V DC. The DC 5V is used to power the servo motor, stepper motor and the ultrasonic sensor. The data is completely controlled by using the instructions given in the controller.

## **Estimated project costing**

*Table 3-1 Project Costing*

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Quantity** | **Cost in per piece (Ksh)** | **Total Cost (Ksh)** |
| Arduino Mega 2560 board | 1 | 1600 | 1600 |
| Micro Servo Motor S90g | 1 | 350 | 350 |
| Stepper Motor | 1 | 300 | 300 |
| HC-SR04 Ultrasonic Sensor | 1 | 200 | 200 |
| One digit 7 Segment Display | 1 | 50 | 50 |
| Limit Switch | 1 | 100 | 100 |
| Tactile Pushbutton | 6 | 5 | 30 |
| Jumper wires | 1 | 200 | 200 |
| LEDs | 6 | 5 | 30 |
| Resistors | 30 | 3 | 90 |
| Ball bearings | 2 | 100 | 200 |
| Sprockets | 2 | 50 | 100 |
| Chain | 1 | 200 | 200 |
| Strip board | 1 | 250 | 250 |
| Breadboard | 1 | 150 | 150 |
| Soldering Wire | 1 | 100 | 100 |
| Project Housing | 1 | 200 | 200 |
| Poster Printing | 1 | 450 | 450 |
| Internet |  | 500 | 500 |
| Document Printing and Binding |  | 500 | 500 |
| Miscellaneous/incidentals |  |  | 800 |
| **Total Cost** |  |  | **6400** |
|  |  |  |  |

## 3.4 Project Time Management

*Table 3-2 Gantt chart*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ACTIVITY** | **APRIL**  **2021** | **MAY**  **2021** | **JUNE**  **2021** | **JULY**  **2021** | **AUG**  **2021** | **SEP**  **2021** | **OCT**  **2021** | **NOV**  **2021** |
| **Documentation** |  |  |  |  |  |  |  |  |
| **Proposal Writing** |  |  |  |  |  |  |  |  |
| **Proposal Presentation** |  |  |  |  |  |  |  |  |
| **Research** |  |  |  |  |  |  |  |  |
| **Design and Data Collection** |  |  |  |  |  |  |  |  |
| **Simulation and modelling** |  |  |  |  |  |  |  |  |
| **Breadboard Stage** |  |  |  |  |  |  |  |  |
| **Circuit construction** |  |  |  |  |  |  |  |  |
| **Final Report Compilation & Presentation** |  |  |  |  |  |  |  |  |

### References

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