# TRADE PROJECT

**TITLE** : **AUTOMATIC ROOM LIGHT CONTROLLER WITH BIDIRECTIONAL VISITOR COUNTER**

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## DECLARATION

I, Dancan Kibet, confirm that this report and the work presented in it are my own achievement. I have read and fully comprehend the consequences of plagiarism.

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SUPERVISOR CONFIRMATION

This project has been submitted to the Department of Electrical and Electronic Engineering, RVIST, with my approval as the supervisor:

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## CERTIFICATION

This is to certify that this thesis is fully adequate in scope and quality as a diploma project work for the award of Diploma in Electrical & Electronics Engineering (Telecommunication Option).

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Name and Signature of Supervisor Date

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## DEDICATION

This project is dedicated to the almighty God who provided us with sound health and safety throughout the course of tertiary education and this thesis.

## ACKNOWLEDGMENT

At this point, I would like to express my undying gratitude to individuals who have contributed to the realization of my thesis and to the success of my academic endeavors at this junction. My thanks go to my parents for their relentless effort to my progress.

## ABSTRACT

Arduino.cc created the Arduino Uno, an 8-bit open-source microcontroller board. The board has a number of digital and analog input/output pins that can be used to connect to other circuits. A visitor counter is a device that measures visitor traffic entering and exiting institutions, recreationalcenters, malls, etc. with the incorporation of an energy-saving lighting system in a bid to minimize energy consumption whilst providing crowd control and crowd traffic information. With the emergence of the Covid-19 pandemic and the need to enforce social distancing guidelines, the importance of the digital counter increases daily. The primary idea behind this project is to calculate and show the number of people entering any environment, such as a lecture hall, a conference room. The LCD monitor shows the number of individuals in the room. This counter is said to be bi-directional since if a person enters the room, the counter will be increased and decreased if a person exits the room. The counter is fitted with two ultrasonic sensors each at the exit and entrance of the enclosed room that generates a 40 kHz sound wave which when obstructed reads as an individual entering or leaving the environment. In various enclosed settings, such as seminar halls, where space capacity is limited and should not be exceeded, implementations of these systems are important. The device will show the exact number of people inside the room and potential system upgrades include adding a voice warning system to signify when the room limit is exceeded and people can no longer enter inside compared to the buzzer already included. The counter is fitted with a relay system which powers

the lighting system. The counters system project achieved crowd control to enable social distancing whilst implementing small-scale energy conservation.

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## LIST OF ABBREVIATIONS

Vcc- Collector Supply Voltage

Vss- Voltage Source Supply

PWM - Pulse Width Modulation

LCD- Liquid Crystal Display

GPIO - General Input/output

ICSP- In Circuit Serial Programming

USB- Universal Serial Bus

DC- Direct Current

# CHAPTER ONE

## 1.0 Introduction

The world is fast becoming a digital hub as manual and time-consuming tasks are readily being digitalized. Looking back in the 90s, individuals made use of crude meanings to count visitors by manually counting them or they used a manual tally counter. But with continual developments and rising needs and challenges such as the covid-19 pandemic which required social distancing and crowd control, load control for buildings, room temperature control, sense trespassers, and several others. The demand for electronic devices that can control crowds and room facilities has risen to the point where they could be used in a variety of real-time applications such as hotels and living rooms. As a result, an automated counter system has emerged as a cost-effective way to count the number of people entering or exiting a room. It uses simple sensors such as IR sensors or ultrasonic sensors to intelligently find and count the number of people and is coded using an Arduino development board.

The ultrasonic sensors will detect people entering the room through the door, and the signal will be sent to the Atmega328p microcontroller for processing and regulating the count in the room, as well as specifically monitoring the lighting system in the room. [1]. It also provides crowd monitoring information and accuracy. The ultrasonic sensors will detect people entering the room through the door, and the signal will be sent to the Atmega328p for processing and regulating the count in the room, as well as specifically monitoring the lighting system in the room.

## 1.1 Background of Study

Measurement, counting to be exact plays an important role in nature and human existence. It is a broad discipline in both engineering and science encompassing the areas of detection, acquisition, control, and analysis of different data. Measurement provides means of describing natural, human, and artificial activities in quantitative terms. It comprises the precise and accurate measurement and recording of physical and non-physical parameters that play a vital role in every branch of scientific research and industrial processes.

Recent advancement in science and technology, has led to the development of several sophisticated and high precision measurement and counting devices. Among the devices developed, are those for counting the number of people present in a particular place (up/down counters). These devices are essential because of the role it plays virtually in all aspects of life. Visitor counting is simply a measurement of the number of visitors entering and exiting conference rooms, malls, sports venues, etc. With the rise in the standard of living, there is a growing sense of urgency to create circuits that will make life easier.

An ancient memory aid system used to record and register numbers, amounts, or even texts, was a tally (or tally stick). Pliny the Elder makes historical reference to the best wood to be used for tallies, and Marco Polo discusses the use of tallying in China. Tallies have been used to the point of being reliable for various purposes, such as messaging and scheduling, and particularly in person counting, financial and legal transactions. The mechanical tally counter was the replacement for the tally stick, it's a mechanism used in counting anything incrementally. Counting people, animals, or objects that are quickly entering and leaving a location is one of the most common uses for tally counters.

In the last two decades visit estimations and counting were done using; trial logs, examination of footprints, various permits and best estimates made by staffs working in institutions [3]. As time went on, an electronic counting counter with an LCD screen to display the count and a push-button to advance the count was added. In the mid-1990s, some still had a button to reduce the count in case of a miscalculations. Different types of people counters have now been introduced as a result of technological advancements to automatically count the number of people entering and leaving a building at a specific time. Laser beams, thermal imaging, video

cameras, and infrared sensors are just a few of them. All of these sensors serve as visitor detectors in their own right.

These devices are very reliable and accurate in terms of performance as compared to the mechanical tally counter used previously. The counter gives statistics on the number of actual visits to a region that have been made. It is possible to estimate the number of visitors and monitor this information, combined with data obtained from visitor surveys.

Electricity has become a necessity for everyone; without it, daily life tasks and activities come to a halt. Energy conservation has become mandatory because of the depletion of nonrenewable resources, and we can also reduce electricity bills by doing so. We all know that renewable energy sources like wind, solar, and hydro are used to generate, conserve, and renew energy, which is advantageous because it is pollution-free, long-lasting, and has no negative environmental consequences. Many environmental impacts and the daily depletion of energy reserves are signals for us to conserve energy, necessitating the development of an automatic energy conservation system.

In recent times, there is an increasingly popular need for automatic appliances. With the increase in the standard of living, there is a sense of urgency to create circuits that will make life easier. In order to avoid congestion, the counters also contain information about the number of people in a room.

### 1.1.1 Importance of Crowd Counters

To provide a workable approach for counting people in offices or a place where the intensity of people is moderate to high, to ensure social distancing and energy conservation. These counters also provide importance crowd traffic data useful in marketing and coordination.

## 1.2 Research Problem

Hiring human auditors to stand and manually tally the number of visitors who enter or pass by a particular area is the most common method for counting visitors. Human auditing software, also known as human-based data collection, was unreliable and expensive. For example, in situations where a lot of people enter and exit buildings, such as meeting rooms, federal buildings, libraries, plaza, and stadiums, human auditors manually counting the number of visitors may gather incorrect information. Many organizations have sought to find ways to minimize the inaccurate

problems of traffic monitoring for this purpose. This digital bidirectional visitor is something we want to design and build. This circuit will provide executives with information on the density and movement of people in a building.

For this research, the general thrusts are to address the following important issues

- To replace the old practice of counting the number of people entering and exiting the room one by one, this project can be used to keep track of the number of people present.
- Crowd control to enable social distancing
- Implementation of small-scale energy conservation.

## 1.3 Motivation of Research

From the year 2020 until now 2022 has been a torrid time with the coronavirus pandemic affecting the whole world. Two of the major emphasis was on social distancing and crowd control. The need to return things to normal has put governments under pressure to relax lockdown protocols. This project aims to aid institutions, offices and large establishments in crowds' control and energy consumption. Reduction in energy consumption could be achieved through automatic switching off of electrical appliances such as air coolers and fans after the end of programs, and meetings, once the device senses he absence of people.

All these problems gave me the perspective that concise analysis on the number of people entering and leaving halls can be conducted. This encouraged the concept of a Bidirectional Visitor Counter from which we can monitor the number of individuals entering or leaving and enable all individuals to exit every building before sealing it. Visitor counts could be carried out to evaluate individuals' feedback on any case. And most notably, all electrical equipment would be switched off automatically in the event of all people leaving the premises, resulting in energy conservation.

## 1.4 Aim

This research project is aimed at designing and constructing Automatic Room Light Controller with Bidirectional Visitor Counter. Making use of Ultrasonic Sensors and Atmega328p microcontroller programmed using Arduino Uno as core components.

## 1.5 Objectives

- Provision of a concise literature review on Arduino Bidirectional Counters Systems.
- The use of Arduino droid app to program the Atmega328p with the help of a USB connection.
- To analyze consumer traffic whilst designing a user-friendly and safe counter system.

# CHAPTER TWO: LITERATURE REVIEW

This chapter provides a literature review on the innovations and challenges of the visitor counter system with smart power management. A summary of past and present research was provided for this reason in three sections: early innovations, modern trends, and future challenges.

## 2.1 Early Developments

Counting of visitors passing through a location was previously performed manually using of finger or tally methods which was time consuming and inaccurate. Other room appliances such as light switches are still mainly operated manually in most regions of the world invariably leading to power waste, human recourses and time. With technological innovations, many electronic technologies such as bidirectional visitors' counters and automatic appliance controllers, have been created as a result of technological advancements to keep count of the number of visitors entering a hall and control the lighting in that environment. These technological developments led to the development of counters using Atmega328p microcontroller

### 2.1.1 Atmega328p

Although we have many controllers ATMEGA328P is most popular of all because of its features and cost. ARDUINO boards are also developed on this controller because of its features.




With program memory of 32 Kbytes, atmega328p applications are many.
With various power saving modes it can work on mobile embedded systems.
With watchdog timer to reset under error it can be used on systems with minimal human interference.
With advanced architecture, the controller executes programs quickly.
Also, with in chip temperature sensor the controller can be used at extreme temperatures.
These all features add together promoting atmega328p further.
Below is the pin mapping between Arduino Uno and ATmega328P chip:

## ATMega328P and Arduino Uno Pin Mapping

| Arduino function | | | | | Arduino function |
|---|---|---|---|---|---|
| reset | (PCINT14/RESET) PC6 | 1 | 28 | PC5 (ADC5/SCL/PCINT13) | analog input 5 |
| digital pin 0 (RX) | (PCINT16/RXD) PD0 | 2 | 27 | PC4 (ADC4/SDA/PCINT12) | analog input 4 |
| digital pin 1 (TX) | (PCINT17/TXD) PD1 | 3 | 26 | PC3 (ADC3/PCINT11) | analog input 3 |
| digital pin 2 | (PCINT18/INT0) PD2 | 4 | 25 | PC2 (ADC2/PCINT10) | analog input 2 |
| digital pin 3 (PWM) | (PCINT19/OC2B/INT1) PD3 | 5 | 24 | PC1 (ADC1/PCINT9) | analog input 1 |
| digital pin 4 | (PCINT20/XCK/T0) PD4 | 6 | 23 | PC0 (ADC0/PCINT8) | analog input 0 |
| VCC | VCC | 7 | 22 | GND | GND |
| GND | GND | 8 | 21 | AREF | analog reference |
| crystal | (PCINT6/XTAL1/TOSC1) PB6 | 9 | 20 | AVCC | VCC |
| crystal | (PCINT7/XTAL2/TOSC2) PB7 | 10 | 19 | PB5 (SCK/PCINT5) | digital pin 13 |
| digital pin 5 (PWM) | (PCINT21/OC0B/T1) PD5 | 11 | 18 | PB4 (MISO/PCINT4) | digital pin 12 |
| digital pin 6 (PWM) | (PCINT22/OC0A/AIN0) PD6 | 12 | 17 | PB3 (MOSI/OC2A/PCINT3) | digital pin 11(PWM) |
| digital pin 7 | (PCINT23/AIN1) PD7 | 13 | 16 | PB2 (SS/OC1B/PCINT2) | digital pin 10 (PWM) |
| digital pin 8 | (PCINT0/CLKO/ICP1) PB0 | 14 | 15 | PB1 (OC1A/PCINT1) | digital pin 9 (PWM) |

Digital Pins 11,12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

## 2.2 Modern Trends

Earlier attempts of counter Systems were harder to program and larger complex circuits. These designs were not completely automated as a user is required to manually increase or decrease the values by pressing the buttons, and this serve as a great limitation to the system.

Recent counter systems using Arduino and Raspberry Pi are equipped with improved architecture which includes; smart sensors and more advanced distributed control technology.

### 2.2.1 Arduino

Arduino is simply an open hardware development board used by tinkerers, software developers, innovators, and inventors to design and build devices that communicate with the real-time situations. It was originally developed in Ivrea, Italy [1].

Arduino boards can convert inputs like light on a sensor or a finger on a button and convert them to outputs like triggering an engine or turning on an LED. Boards are programmed by giving a series of commands to the board's microcontroller.

### 2.2.2 Advantages of Using Arduino

- This model can be implemented as an automated switch to increase energy efficiency. The counter detects zero people in a room and automatically put off the power supply. Thus, promoting electricity and energy conservation.
- Easily operated and not complex like micro-controller.
- Compared to microcontrollers which are limited to Windows, while Arduino is supported with all operating systems, including Linux, Macintosh, and Windows.
- Arduino boards are inexpensive when compared to other microcontrollers available on the market. For as little as Ksh.1000, you can get a pre-assembled Arduino board.
- Easy to program




*Figure 2.2: Arduino Uno*

### 2.2.3 Raspberry Pi

Raspberry Pi is a series of small single-board computers built on 29 February 2012 by the Raspberry Pi Foundation in association with Broadcom in the United Kingdom [10].

The Raspberry Pi was first released in 2012, and various versions and variants have been released since then. The first Raspberry Pi had a single-core 700MHz CPU and only 256MB Memory, while the most recent model has a quad-core 1.4GHz CPU and 1GB RAM. People all over the world use Raspberry Pi to learn programming, develop hardware projects, automate their homes, and even use it in automotive purposes. The Raspberry Pi is a cheaper computer that runs Linux and has a set of GPIO pins for tracking physical computing components and experimenting with the (IOT) technology [11].

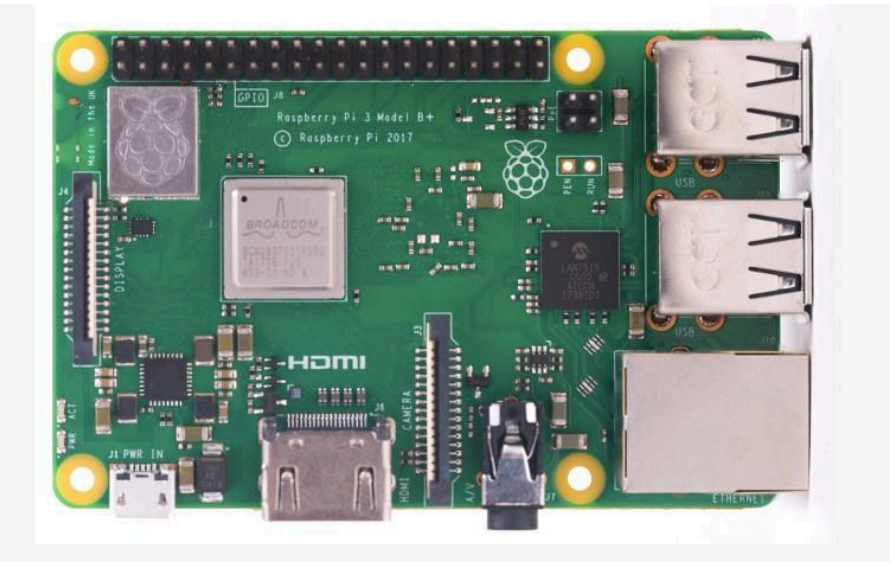



*Figure 2.3: Raspberry Pi 3 Model B+*

## 2.3 Related Works

Technique transfer, protocol, and future challenges have all been addressed thus far. The literature review found a number of unsolved issues with Arduino-based counting systems, including accuracy, productivity, and reliability.

*Table 2.1: Summary of literature of Arduino-Based Counter System*

| Researcher | Technology used | Key benefits | Limitations |
|---|---|---|---|
| | | | |

| | | | |
|---|---|---|---|
| Bruno F. Carvalho | ultrasonic sensor | Identifies objects and determines the distance between the sensor and the objects with precision. | This technique was unable to detect over one individual at a time. If multiple individuals go through the system at the same time, only one of them will be detected. |
| Jeong W. Choi | IR-UWB radar sensors using ARM Cortex-M4 and Raspberry Pi 2 modules | The system is capable of detecting several individuals at a time. | As the sensors on the market are highly expensive, the system is not cost-effective. |
| Jothibasu M and Aakash B | IR sensors | This method is a bidirectional counter whilst possessing the ability to regulate home appliances and helps in consuming less electricity. | This technique is only capable of detecting one person at a time. |

| | | | |
|---|---|---|---|
| Jingwen Li | Bag- Of-Features (BOF) model | This system keeps track of the number of people. The system can also automatically select pedestrian and non-pedestrian samples and update the algorithm in real time to make it more appropriate for particular situations. | Pedestrians must be monitored in real time by the system, which necessitates the use of extremely expensive camera modules. |
| Kartik Madhira and Aditya Shukla | Image processing | Used in specific areas, such as ATMs, retail stores, malls, to count humans. Around 80-93 percent precision was achieved by the method. | The scheme includes real-time monitoring of people using very expensive camera modules. |
| Shubham Mathur | image processing with sensor feedback using Raspberry Pi fitted with a RaspiCam | An efficiency of 83% is achieved using this method. | In this method, the equipment used is very costly. Apart from the camera module and Raspberry Pi, sensors add additional costs to the device. |

Furthermore, on the comprehensive literature review, some problems need to be discussed with adequate solutions provided in further research. According to Table 2.1, regardless of numerous solutions being available for crowd control, they are rather expensive. The development of a low-cost remedy has therefore become important.

## 2.4 Summary

This chapter presented a detailed literature review on the Automatic Room Light Controller with Bidirectional Visitor Counter. We discussed the various solution to crowd control over decades that have persisted in the literature. Manual methods were first used in solving crowd control problems. Eventually, the use of microprocessors and sensors started evolving to improve the solution. Technological advancement also played an important role, as the increment in easily programmable processors and energy-saving circuits. Leading to the development of more sophisticated crowd control devices.

# CHAPTER THREE: MATERIALS & METHODOLOGY

## 3.0 Introduction

This chapter examines the theoretical background of the major systems components as well as the design and implementation of the whole system. The system has sub-units: like power supply unit circuit, switching circuit, sensor unit, and liquid crystal display. These sub-units are also made of some components and all those components have their individual specifications based on datasheets, like current rating ratings, voltage ratings, and power ratings. On that account, proper design calculations and implementation of the designs have to be carried out on each of these sub-units to ensure that the system as a whole function properly and expected.

## 3.1 Methodology

The methodology implemented was divided into software and hardware method. The software involves a simulation of the project using proteus while the hardware involved bread boarding and soldering.

## 3.2 System Block Diagram

Block diagram representing the principle units and components of the Arduino counter system.

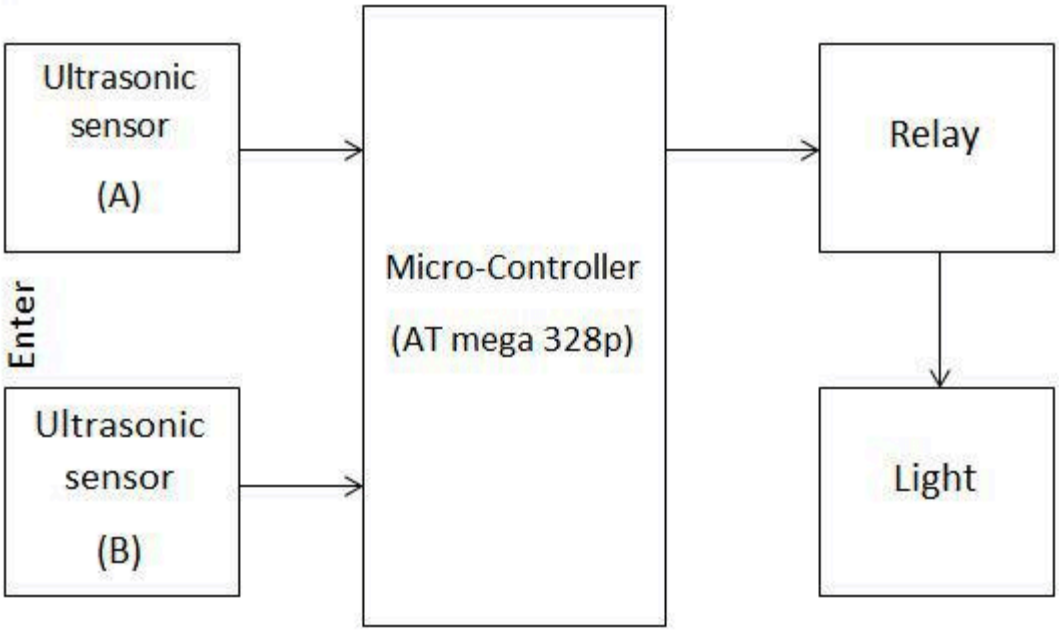



*Figure 3.1: System Block Diagram*

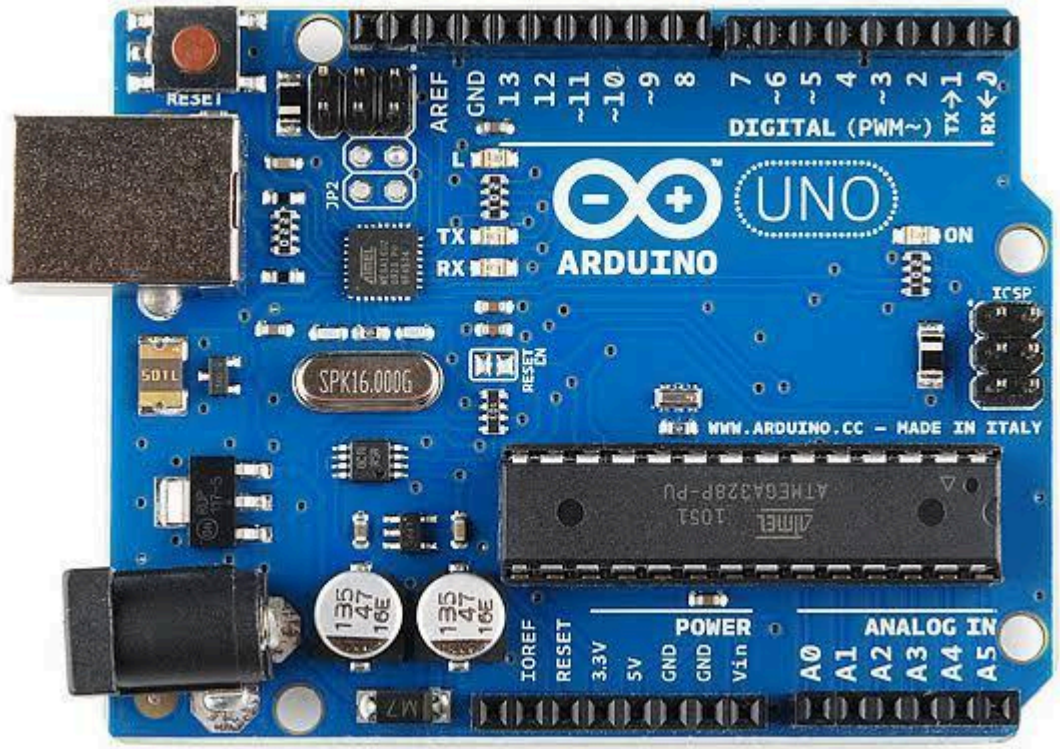
## 3.3 Materials

This section outlines the list of materials used in the execution of this project. The hardware and software components used are listed below.

### 3.3.1 Arduino Uno Board

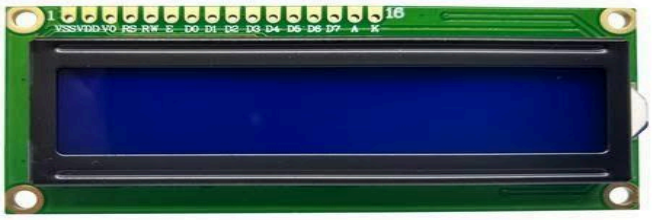
The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 22 digital input/output pins, including 6 pulse width modulation output pins, 8 analog inputs, 16 MHz resonator, a USB connection, a reset button, and an ICSP header. It includes everything you

need to get started with the microcontroller; all you have to do is connect it to a computer with a USB cable or power it with an Alternating Current-to-Direct current adapter or battery.




## 3.3.2 Liquid Crystal Display (LCD)

The LCD is a solid-state device that uses liquid crystals to modulate light. It can be either a computerized visual display or a display screen. LCDs do not emit light directly, so they can be used to display any image (as in a general-purpose computer display).



### 3.3.2.1 LCD Design

This design makes use of a "16 x 2" LCD. It has input ports D0, D1, D2, D3, D4, D5, D6, D7, a cathode "K," anode "A," allow "E," reset "R/S," read and write "R/W," as well as a Vdd supply pin, a variable resistor pin for setting the LCD contrast, and ground Vss. The liquid crystal display is used to view the unit's status.

The LCD pins have the following functions;

- Pin 1 and Pin 2, are $V_{ss}$ and $V_{dd}$ respectively (Power supply)
- Pin 3 is $V_o$ (Contrast adjust)
- Pin 4 - R/S, pin 5 - R/W and Pin 6 - E (Control line) select either instruction or character.
- Pin $D_0$……D7 (Data line) Transfer data or instruction.
- Pin 15 is A and Pin 16 is K (Back light) LED

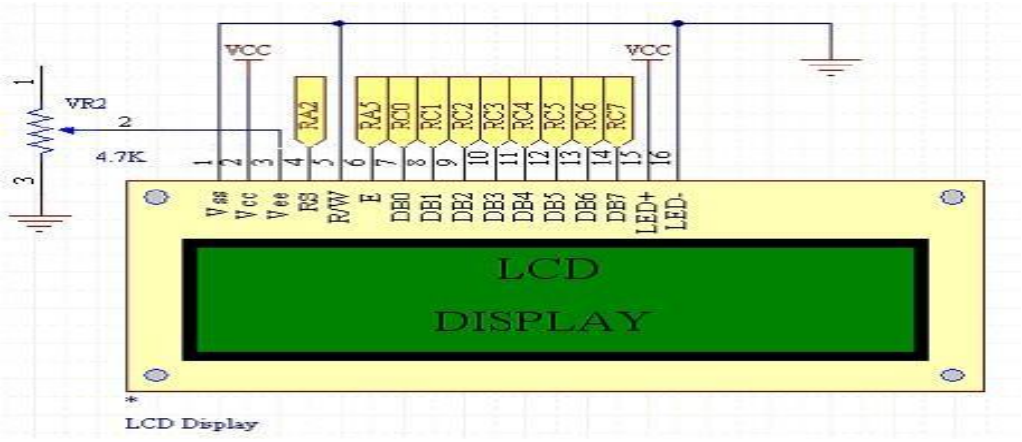



*Figure 3.4: Display Unit*

### 3.3.3 Buzzer

A buzzer or an alarm is an audio device that converts audio signals into sound signals. These devices usually serve as a safety device and for the purpose of this project provide a beep sound when a person enters or leaves the room. It also provides continuous sound when a person stands at the door and does not enter nor leaves.





### 3.3.4 Capacitor

A capacitor is a two-terminal electrical component that stores electrical energy in an electric field. Capacitance is present between any two electrical conductors in close proximity in a circuit. A capacitor is primarily designed to provide and improve this effect for a variety of practical applications by considering the size, shape, and positioning of tightly packed conductors, as well as the dielectric material between them. The capacitance of an ideal capacitor is defined by a single constant value. The ratio of each conductor's electric charge Q to the potential difference V between them is known as capacitance. The SI unit of capacitance is the Farad (F), which is equivalent to one Coulomb per volt (1 C/V). Capacitance values typically vary from about 1 pF (1012 F) to about 1 mF (103 F).




### 3.3.5 Transistor

A transistor is a semiconductor device that amplifies or switches electronic signals and power. It is made of semiconductor material and has a minimum of three terminals that connect it to an external circuit. A voltage or current implemented to a pair of transistor terminals controls the current through the other pair. A transistor can amplify a signal because its controlled (output) power is greater than its controlling (input) power.

Generally, transistors have three leads and normally consist of a chip of silicon or germanium inside a plastic or metal case. A transistor can behave like a control valve where a small input current controls a large output current. It can therefore amplify a signal. In many circuits, a transistor is used as a switch, where a small input current switches on its output. A transistor is made up of two P-N junctions that are manufactured in a single sheet of semiconductor crystal. Emitter, base, and collector are the three regions formed by these two junctions. Thus, a Bipolar transistor (BJT) can be NPN or PNP as shown below:

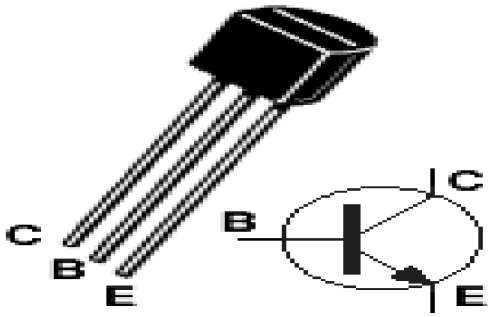



*Figure 3.8: Transistor*

Significance of the Three Leads

- Emitter:

The transistor's left-hand section, or area, is made up of it. Because its main purpose is supplying the base with the majority of charges, it is more heavily doped than all of the regions (either electrons or holes).

- Collector:

It is the right-hand region of the transistor, and its primary function is to gather majority charge carriers coming from the emitter passing through the base (as implied by its name).

- Base:

It forms the middle portion of the transistor. The base is very thin in comparison to either the emitter or the collector, whilst being heavily doped.

### 3.3.6 Relay

A relay is a switch that is powered by electricity and is used to close and open circuits. Although other operating concepts, such as solid-state relays, are regularly used, many relays use an

electromagnet to mechanically regulate a switch. When a circuit's regulation requires a separate weak signal or when multiple circuits is always operated by a single signal, relays are used.




### 3.3.7 Ultrasonic Sensor

Short and high-frequency signals are emitted by the ultrasonic sensor. These signals travel at the speed of sound in the air. It can bounce back to the module if it encounters an object or obstacle on its way. The multi-vibrator that makes up the ultrasonic sensor is connected to the base. The multi-vibrator is a combination of resonator and vibrator. An ultrasonic wave is generated by the vibration is supplied by the resonator. Actually, the ultrasonic sensor made up of two parts: the emitter that generates a 40 kHz sound wave and a 40 kHz sound wave detector that sends an electrical signal back to the Arduino microcontroller.




Ground, VCC, trig, and echo are the four pins on the HC-SR04 ultrasonic module used in this project. The module's Ground and VCC pins should be connected to the ground and 5 volts pins on the power supply, and the trig and echo pins should be connected to any digital I/O pin on the Atmega382 microcontroller. Set the Trig to a High State for 10 µs to produce the ultrasound, as shown in figure 3.12. This will generate an 8-cycle sonic burst that will travel at the speed of sound and be received by the Echo pin. The Echo pin will output the time it took for sound waves to travel in microseconds.

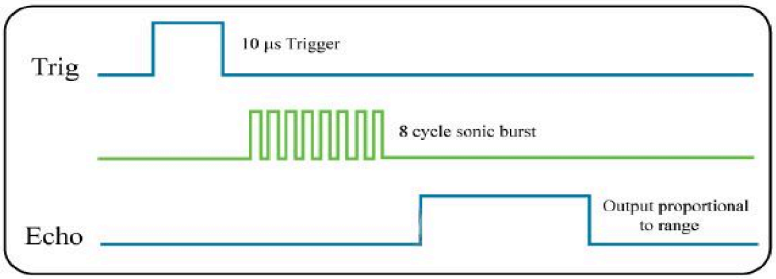



*Figure 3. 11: HC-SR04 Timing Diagram*

### 3.3.7.1 Distance Measurement for Ultrasonic Sensor

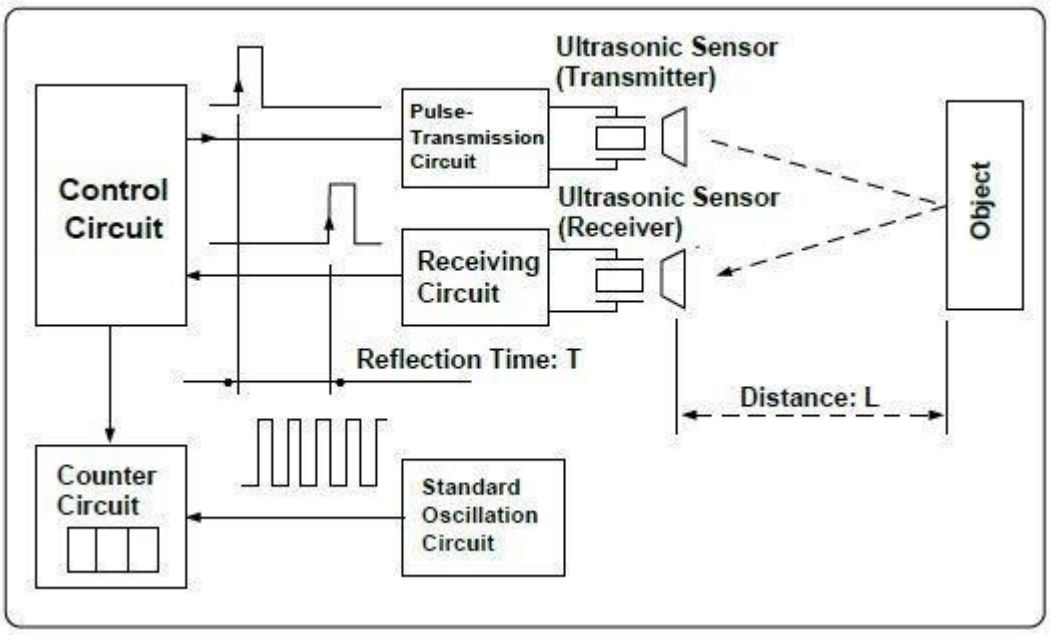



*Figure 3.12: Principles of Measuring Distance*

The "pulse reflection method," which allows you to count the number of reference pulses, is depicted in the diagram above. This technique is used to determine the time between the transmitting and receiving pulses of an ultrasonic wave up to the object. The following formula expresses the relationship between the distance up to the object L and the reflection time T: L=S T/2, where S is the sound speed. That is, the distance to the object can be determined by calculating the time it takes for the reflection to reach the object. If the object is 10 cm away

from the sensor and the sound speed is 340 m/s (0.034 cm/s), the sound wave would travel for approximately 294 seconds. However, since sound waves must travel forward and backwards, the amount you get from the Echo pin is twice as much. To calculate the distance, multiply the obtained travel time value from the echo pin by 0.034 and divide it by two in cm. Speed of sound = v = 340 meters per second.

$$Time = distance/\ speed \qquad \text{Equation 3. 1}$$

$$s \qquad 10$$

$$t = = = 294\mu s v\ 0.034$$

The obtained distance will be twice the actual distance since it gives to and fro distance of the object as per the to and fro time equated to the equation:

$$Distance = time{*}speed \qquad \text{Equation 3. 2}$$

$$l = t{*}v = 294 * 0.034 = 10cm$$

Therefore, the distance obtained divided by 2 gives the real distance of the obstacle.

$$\text{Distance} = (\text{time*speed})/2d \qquad \text{Equation 3. 3}$$

$$= \frac{t * s}{2} = 294 * \frac{0.034}{2} = 5_{cm}$$

### 3.3.7.2 Measurement Scenarios

Figure 3.14 shows three typical ultrasonic sensor measurement scenarios.

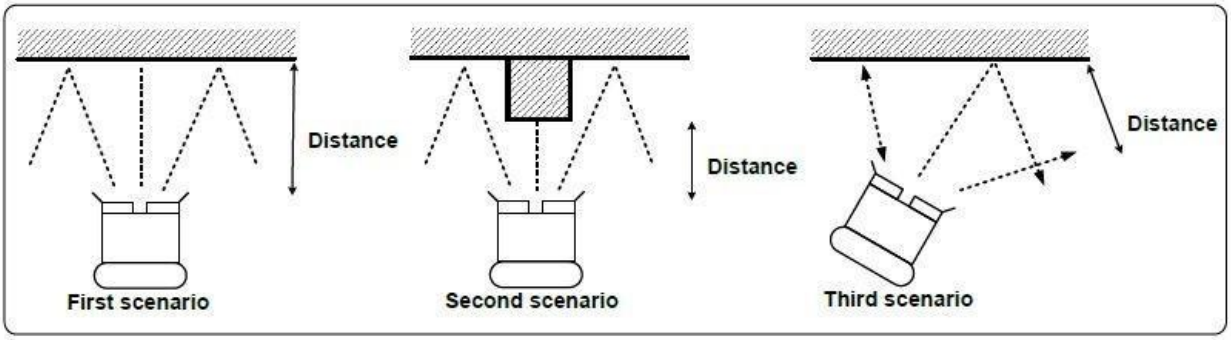



*Figure 3.13: Typical Ultrasonic Measurement Scenarios*

The first scenario in figure 3.14 will obtain an accurate measurement because the ultrasound sensor is parallel and perpendicular to the hurdle or obstacle. The second case would produce an accurate measurement as well as a "view" of the obstacle directly across from the ultrasound sensor. The last situation, on the other hand, would result in an incorrect measurement since the measurement is taken on the left side of the ultrasound sensor. If it's going to be used to make maps, it's important to learn more about the ultrasound sensor's beam structure. When it comes to avoiding obstacles, this is less true.

## 3.4 Circuit Diagram

The circuit diagram entails the connections and interfacing of each component device to each other. The ultrasonic sensor module, transistor, switch, and LCD are connected to the microcontroller. The bulb is attached to the relay pins.

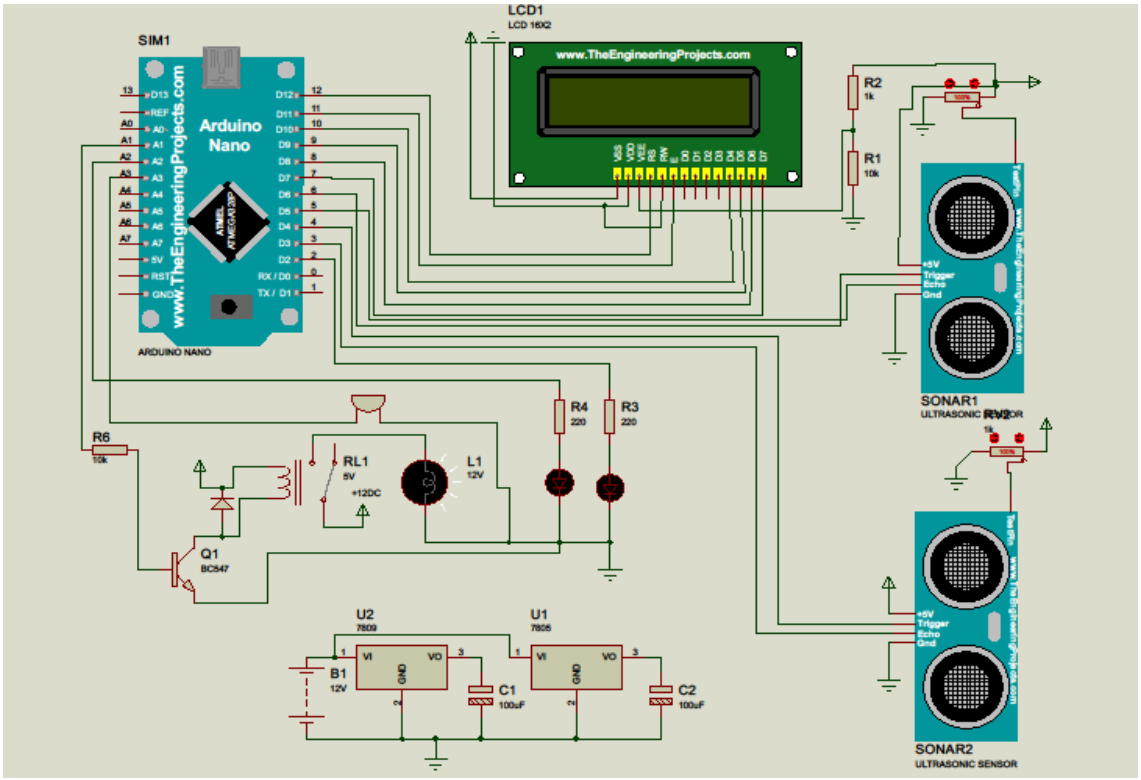



Figure 3. 15: System Circuit Diagram

Figure 3.15 shows the complete circuit diagram of the system. The aforementioned diagram was sketched using Proteus 8.6 simulation software in order to simulate the system before bread boarding and soldering. The circuit is discussed below;

The Circuit consists of;

- Liquid Crystal Display (LCD)
- Ultrasonic Sensor (HC-SR04)
- Microcontroller (ATMEGA328)
- Power Supply Unit
- Switching circuit
- Liquid Crystal Display (LCD): liquid crystal display has fourteen pins (14) which range from $V_{SS}$ to D7. In this circuit, four-bit mode interfacing of LCD with a microcontroller is employed to reduce the number of LCD pins being used. Pins $V_{ss}$, RW (Read and Write pins), D0, D1, D2, and D3 are all connected to the ground through a 10KΩ RVI resistor. Pin 5

(Read/Write pin) provides easy communication between the microcontroller and LCD while pin 3 ($V_{EE}$) of the LCD gives maximum contrast to the LCD. Pin 4 (Reset pin) and pin 6 (enable pin) of the LCD are connected to Pin 12 and pin 11 of the microcontroller and pins D4, D5, D6 and D7 are connected to pin 10, 9, 8, and 7 of the microcontrollers. It is through these pins (D4 – D7) that data are been sent to the LCD from the microcontroller. Pin $V_{DD}$ of the LCD is connected to the $V_{CC}$ for the LCD to operate.

- Ultrasonic sensor Module (HC-SR04)**:** Pin 1 of the HC-SR04 is connected to (5.0) VCC while Pin 4 is connected to the ground in order for the MODULE to be powered so that it can operate. Pin 2 (Trigger pin) and pin 3 (echo pin) of the HC-SR04are connected to pin 6/3 and pin 5/4 of the microcontroller. These pins provide serial communication between the microcontroller and the Ultrasonic module.
- Buzzer: The buzzer has two pins, pin 1 of the module is connected to A3 of the microcontroller, and pin 2 is connected to the ground for the module to be powered so that it can operate.
- Power Supply: The output of the power supply unit circuit is connected to the (Vcc) pin 7 of the microcontroller. This provides the 9V voltage supply required by the microcontroller (Nano) to operate.
- Relay: Pin A1 of the microcontroller was connected to the bases of the transistor through base resistors. The base resistors are used to have the quantity of current required by the transistor to operate. When power is applied to the relay coil (RL1) through the collector due to transistor 1's switching action, the coil's dc resistance causes a maximum current to flow, as explained by Ohm's law(I=V/R). The magnetic field of the relay coil contains a fraction of this electrical energy, which results in the ON bulb switching. When the transistor is turned " OFF ", the current flowing through the relay coil decreases and the magnetic field collapses. The stored energy in the magnetic field, on the other hand, has to go somewhere, so reverse voltage is generated across the coil and the current in the relay coil is maintained. This action creates a high voltage spike across the relay coil that, if allowed to build up, can damage the switching NPN transistor. So, a flywheel diode is wired across the relay coil to avoid damage to the semiconductor transistor.

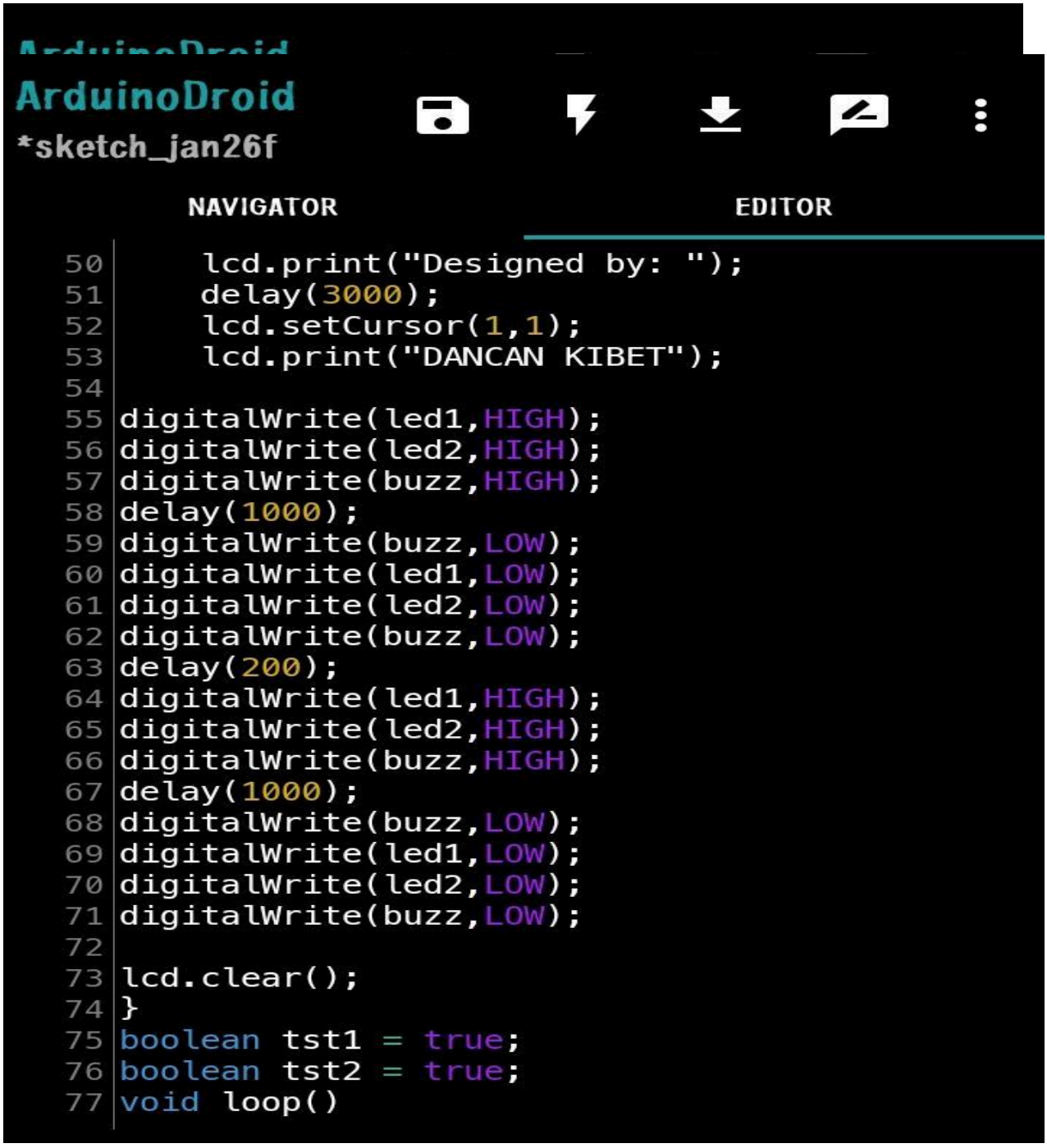
## 3.5 Writing the Control Program

This involves developing a program for the ultrasonic sensor, buzzer, display unit, and switching unit.

### 3.5.1 Program Development

For this project, a C programming language was used to write the system program. The preparation symbol which is the “START” begins the programming process. The system is then initialized, connecting the various units of the circuit. After this, the status of the ultrasonic sensor is checked to know the state of the device. Then a decision is made; if there is an object at the range of the first ultrasonic sensor (Entrance) the relay is triggered and then it displays on LCD the increment in the count and when the second ultrasonic sensor (Exit) has an object within its range, a decrement in the count is recorded as well as displayed. The bulb goes OFF when the counter reads ‘zero’.Refer to Appendix A for program code. The flow chart shows the flow of the program.

### 3.5.2 Arduino droid App


ArduinoDroid
*sketch_jan26f
NAVIGATOR
EDITOR
lcd.print("Designed by: ");
delay(3000);
lcd.setCursor(1,1);
lcd.print("DANCAN KIBET");
digitalWrite(led1,HIGH);
digitalWrite(led2,HIGH);
digitalWrite(buzz,HIGH);
delay(1000);
digitalWrite(buzz,LOW);
digitalWrite(led1,LOW);
digitalWrite(led2,LOW);
digitalWrite(buzz,LOW);
delay(200);
digitalWrite(led1,HIGH);
digitalWrite(led2,HIGH);
digitalWrite(buzz,HIGH);
delay(1000);
digitalWrite(buzz,LOW);
digitalWrite(led1,LOW);
digitalWrite(led2,LOW);
digitalWrite(buzz,LOW);
lcd.clear();
}
boolean tst1 = true;
boolean tst2 = true;
void loop()

The IDE (Integrated Development Environment) is a computer program that enables you to write sketches for the Arduino board in a plain language modeled after the processing (www.processing.org) language. It is designed to introduce artists and other newcomers to software development programming. It comes with a code editor that includes features like syntax highlighting, brace matching, and automatic indentation, as well as the ability to compile and upload programs to the board with a single click. A sketch is a program or code written for Arduino. C or C++ is used to write Arduino programs. The Arduino droid includes the "Wiring" software library from the original Wiring project, which simplifies many common input/output operations. The Arduino programming language has a simple structure and is divided into at least two parts. Blocks of statements are enclosed by these two necessary components or functions:

1. Void setup ()
2. Void loop ()

. The program can't run without both functions. The setup function should come after any variable declaration at the start of the program. It is the first function in the program, and it is used to set pin Mode or initialize serial communication and liquid crystal display. It only runs once. The loop function comes next, and it contains the code that will be run repeatedly - reading inputs, triggering outputs, and so on. This function is at the heart of every Arduino program and is responsible for the majority of the work.

### 3.5.3 Program Flowchart

Figure 3.16 depicts the control flow of the system. Beginning with (on start) the system will initialize the sensors and print the initials. The LCD will display the maximum capacity of the Room as well as the counter variable. Upon activation the ultrasonic sensor, it waits for an echo that indicates the presence of an object within the detection range (30cm). A simplified visual approach of the signal flow is depicted in the system flow chart.

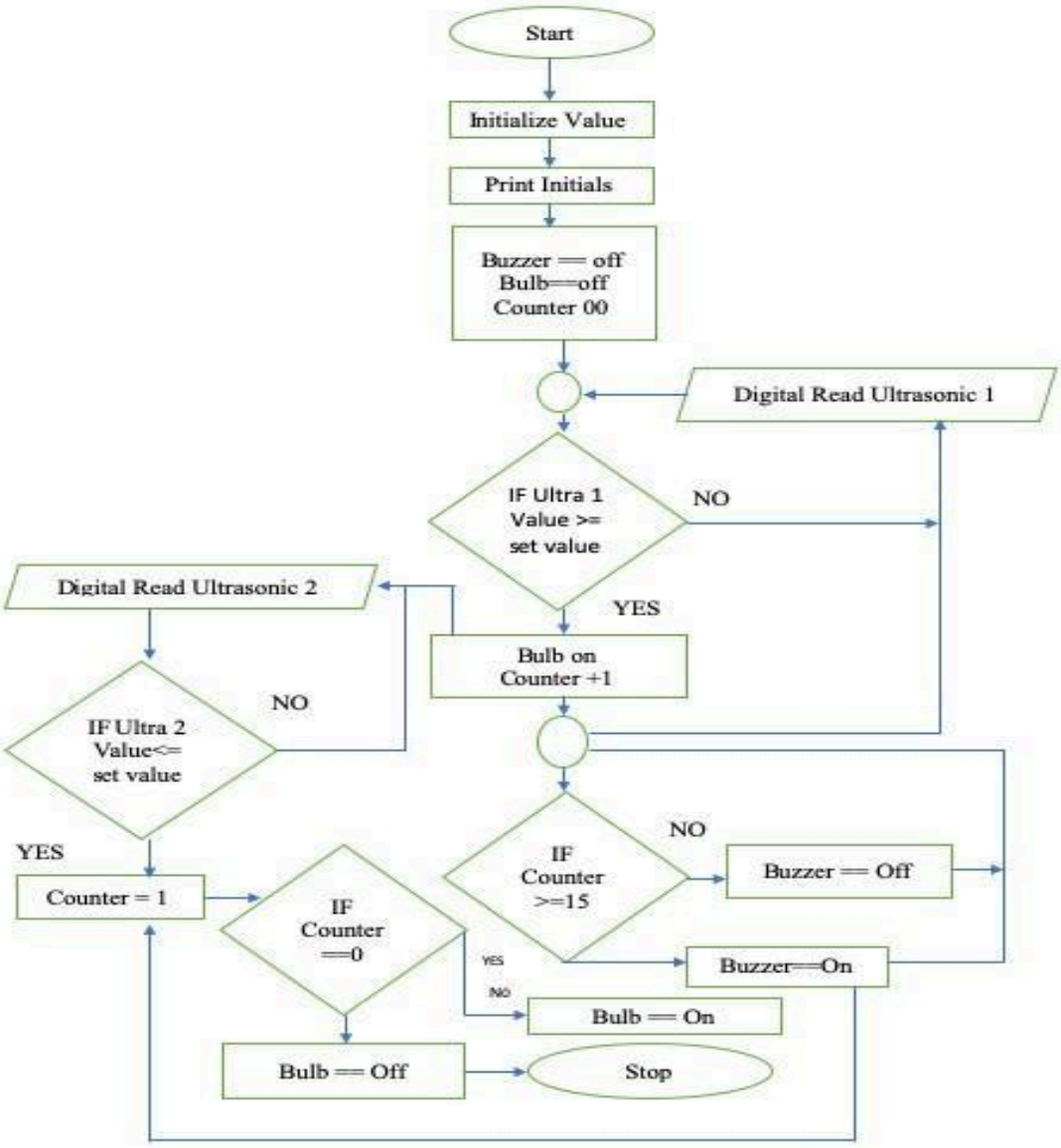



*Figure 3.17: System Flow Chart*

# CHAPTER FOUR
# RESULTS AND DISCUSSION

## 4.0 Introduction

This chapter provides a vivid discussion pertaining to; tests, results, limitation and/or problems encountered during the period of the project.

Testing was carried out on each component or section that makes up the circuit to ensure the proper satisfaction of the software design. The debugging was carried out using the Arduino droid. The step debugging was performed to ensure that each section of the code was correctly debugged to ensure proper functionality. This is a Proteus feature that allows you to step into the program while simultaneously viewing the registers and flag settings. Testing was also done to ensure that the system's capabilities, feedback, and response were all working properly.

## 4.1 Tests

The components used for the implementation of this project were tested on a breadboard for better performance and were later transferred to the Vero board and soldered. The heat applied during soldering was just moderate to avoid damage to the Vero and the components since most of the components have low heat resistance. The test equipment includes;

- Vero board-To assemble and test individual components
- Digital multimeter to measure voltage, current, resistance and check for continuity
- Light-emitting diodes
- Arduino sketch
- Proteus simulation software

### 4.1.1 System Overall Test

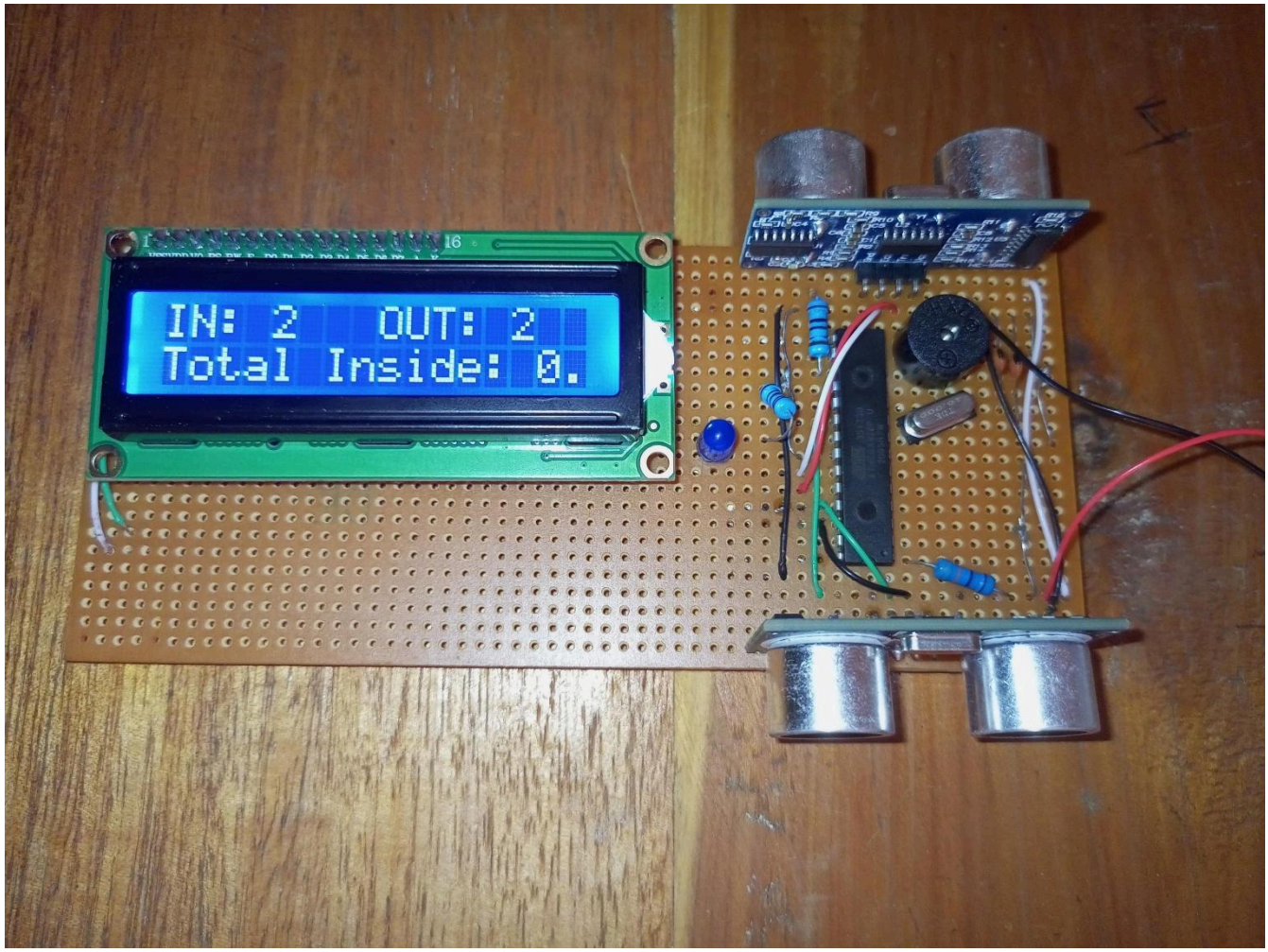
The overall systems test was conducted with the aid of the Arduino serial monitor.

- Ultrasonic sensor set distance = 30cm.

- Micro-controller frequency= 20MHz
- Crystal frequency= 16MHz

### 4.1.2 Vero Boarding Test

Figure 4.1 shows the system arrangement on breadboard. This is the first stage working of the project on the breadboard system. This was first implemented on the Vero board to make of its working before moving onto soldering.



### 4.1.3 System Under Test

This is the finished and packaged project ready for use by anyone. After ensuring its working then the components were soldered together and tested for working before the packaging. Figure 4.2 shows the system after soldering; testing the system after soldering is very important in order to be sure of its functionality before final packaging.




## 4.2 Discussion

### 4.2.1 Key Benefits

The Arduino-based Counter system offers a host of benefits by leveraging its technologies to do considerably more than merely “count heads.” People counting systems can provide statistics

that is useful for both fundamental business metrics like gross margins and more complex insights into areas like staff deployments, marketing program effect measurement, and energy conservation and control. These benefits include;

- **Deploying staff more effectively**: It is important to understand not only the cumulative number of workers at any given time in large companies and institutions with different divisions, but also where they'll have the greatest impact on customer service and sales. This becomes a simple task with the ability of bidirectional visitor counters to investigate traffic flows and identify concentration patterns.
- **Keeping a detailed record of the number of people in a particular area**: From a business standpoint, bidirectional people counters allow you to calculate how many people are in an environment from the start of the business day to closing time. It is important for gathering conversion rate data that can be linked to specific times of the day or activities, rather than the relatively uninformative periodic or weekly averages. Retailers can also calculate the optimum number of customers in a given location by measuring fluctuations in total people counts. More customers are definitely a plus, but too many customers can cause clogged aisles, an inadequate number of employees to serve them, and a higher risk of out-of-stock scenarios.

### 4.2.2 Limitations of The Bi-Directional Counter

- **Under or over counting:** situation where more than one-person enters the door at a time or even situation where some stands at the entrance for too long a time the sensor tends to record such situations incorrectly.
- **Sensor Performance:** The ultrasonic sensor is an important component. It is important because the performance of the Arduino-based Counter System is reliant on the accuracy of the ultrasonic sensor as over time sensors becomes less accurate and needs to be replaced.
- **Variations:** Some assumptions are made in the theoretical laws in order to achieve an ideal value of the Voltage source through measurement, such as constant pressure, temperature, mechanical strains, and so on. However, when the experiment is carried out and current passes through the conductor, the conductor heats up and the temperature does not remain constant, causing some errors.

# CHAPTER FIVE
# CONCLUSION, RECOMMENDATIONS & FUTURE CHALLENGES

## 5.1 Conclusion

After the design and implementation of the project, it is found that the project aims and objectives earlier stated had been successfully achieved. Hardware components of the system were tested and seen to be in good working condition. The microcontroller board was then independently interfaced and implemented with each unit. Thereafter the software is used in accordance with the application's requirements. The application was not tested immediately after it was finalized. Rather, each component of the app was checked separately. After the first unit yielded the expected result, the second unit was put to the test. After all of the units were found to be in good working order, they were connected and the system was tested. It's easier to figure out the bugs and the issues of the system as each unit of the system was tested separately. The entire program was written in C language and compiled with Arduino droid platform. As many approaches have been proposed for crowd management.

Many modules for crowd management have been suggested, some of which are visual sensing methods such as satellite imagery and infrared thermography, and others which are non-visual sensing methods such as smart watches or smartphone hotspot Wi-Fi. To take control of their advantages and circumvent their disadvantages, the striking approach relies on combining more than one of these modules. Construct Arduino Based Visitors Counter with its numerous attributes when implemented will be a better alternative to manual methods for visitors counting and automation. As, the aim and objectives of the project were achieved the technology comprises of high accuracy which enables real-time crowd control, visitor counting, and energy-saving capabilities.

Despite the sum of the job already performed, there are still a few problems or modifications that need to be accomplished before it is possible to complete a production run of the system for general use could be achieved. Some of these challenges include;

- The purchasing of necessary production components.
- Attaining ready capacities of using the Arduino program.

Finally, the knowledge gained through this project will be put to good use and applied in the face of this global pandemic to solve real-world problems.

## 5.2 Recommendations

The counter system although an effective technique in counting the number of visitors when a person or objects are detected, the system is incapable of interpreting the form, intent or purpose of the objects thus lacking a sizeable amount of sensitivity. Example, a cat or a passing pedestrian may unintentionally trigger the door and cause an erroneous opening operation. Frequent false actions are indeed inconvenient and waste energy resources, but they often shorten the life span of equipment.

The following measures can be carried out to enhance functionality and reliability;

- The application of raspberry pi should be factored for improvement in system speed and functionality.
- The use of a weight sensor should also be considered.
- The application of passive inferred sensors can also be factored.
- Facial recognition can likewise be included to improve security risks while performing crowd control.

## 5.3 Future Challenges

Researchers in accordance with the literature of crowd counter devices have suggested several methods and strategies to understand crowd behaviors in order to create a safe and secure environment to prevent crowd congestion, public riots or demonstrations, and terror attacks. In ability of individuals to abide by basic rule such as ‘enter from the entrance and leave from the exit’ has led to lack of accuracy in crowd control and counting pose a constant trait. Due to extreme occlusion and complex background scenarios, traditional image processing techniques are not suitable in a first-hand way. There are numerous computer vision algorithms for tracking, identifying, and evaluating crowded scene behavioral patterns. Although they perform well in low to medium population densities, dealing with a thick crowd remains a challenge.

# CHAPTER SIX
# REFERENCES


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## APPENDIX A-CODES

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,20,4); //
set the LCD address to 0x27 for 16
chars and 2-line display



Const int trig1 = A1, echo1= A0,
trig2=A2, echo2=A3;
// change set_distance = 0 to 400cm

Int state1 = 0, state2 = 0, count = 0,
set_distance = 200;
Long duration1, distance1;
Long duration2, distance2;
Int distance = 0;
Int buzz=6;
Int led1 =10;
Int led2 =11;
Int relay = 12; // Out for light
```

```
Void setup ()

{

 // initialize the LCD
Lcd.init(); // initialize the lcd

  // Print a message to the LCD.
  Lcd.backlight();



  pinMode (trig1, OUTPUT);
  pinMode (echo1, INPUT);
  pinMode (trig2, OUTPUT);
  pinMode (echo2, INPUT);
  pinMode (buzz, OUTPUT);
  pinMode (led1, OUTPUT);
  pinMode (led2, OUTPUT);
  pinMode (relay, OUTPUT);

  Serial.begin(9600);

  Lcd.setCursor(3, 0);
Lcd.print("SPECTATOR");
 Lcd.setCursor(4, 1);
Lcd.print("COUNTER");
    Delay (3000);
    Lcd.clear();
    Lcd.setCursor(1,0);
```

```
    Lcd.print(“Designed by: “);
    Delay (3000);
    Lcd.setCursor(1,1);
    Lcd.print(“DANCAN KIBET”);

digitalWrite (led1, HIGH);
digitalWrite (led2, HIGH);
digitalWrite (buzz, HIGH);
delay (1000);
digitalWrite (buzz, LOW);
digitalWrite (led1, LOW);
digitalWrite (led2, LOW);
digitalWrite (buzz, LOW);
delay (200);
digitalWrite (led1, HIGH);
digitalWrite (led2, HIGH);
digitalWrite (buzz, HIGH);
delay (1000);
digitalWrite (buzz, LOW);
digitalWrite (led1, LOW);
digitalWrite (led2, LOW);
digitalWrite (buzz, LOW);

lcd. clear ();
}
Boolean tst1 = true;
Boolean tst2 = true;
Void loop ()
{
```

```
digitalWrite (trig1, LOW);
delayMicroseconds (2);
digitalWrite (trig1, HIGH);
delayMicroseconds (10);
digitalWrite (trig1, LOW);
duration1 = pulseIn (echo1, HIGH);
distance1 = (duration1/2) / 29.1;



  if (distance1 < 40) {

    if (tst1 == true) state1++;
    tst1 =false;
    Serial.println(state1);
    digitalWrite (led1, HIGH);
digitalWrite (led2, HIGH);
digitalWrite (buzz, HIGH);
delay (200);
digitalWrite (buzz, LOW);
digitalWrite (led1, LOW);
digitalWrite (led2, LOW);
digitalWrite (buzz, LOW);

    }

  else {
```

```
  tst1 = true;

   Serial.println(state1);

 }

delay (100);

Lcd.setCursor(0, 0);
Lcd.print(“IN: “);
Lcd.setCursor(8, 0);
Lcd.print(“OUT: “);
Lcd.setCursor(0, 1);
Lcd.print(“Total Inside: “);


Lcd.setCursor(4, 0);
Lcd.print(state1);


digitalWrite (trig2, LOW);
delayMicroseconds (2);
digitalWrite (trig2, HIGH);
delayMicroseconds (10);
digitalWrite (trig2, LOW);
duration2 = pulseIn (echo2, HIGH);
distance2 = (duration2/2) / 29.1;

 if (distance2 < 40) {
```

```
    if (tst2 == true) state2++;
    tst2 =false;
    Serial.println(state2);
    digitalWrite (led1, HIGH);
digitalWrite (led2, HIGH);
 digitalWrite (buzz, HIGH);
delay (200);
digitalWrite (buzz, LOW);
digitalWrite (led1, LOW);
digitalWrite (led2, LOW);
digitalWrite (buzz, LOW);

    }

  else {

   tst2 = true;
    Serial.println(state2);

  }


Lcd.setCursor(13, 0);
Lcd.print(state2);

Int ins = (state1 – state2);
if (ins <0)
{ins=0;}
Lcd.setCursor(14, 1);
Lcd.print("…");
```

```
Lcd.setCursor(14, 1);
Lcd.print(ins);

if (ins >0) {
      digitalWrite (relay, HIGH);}
else {digitalWrite (relay, LOW);}



}
```