PROJECT OUTLINE

FARNESS DETERMINATION SYSTEM

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Introduction

Over time, technology has gone through an evolution phase and hence has changed our living style significantly. In today's era, most people prefer using the latest technologically advanced gadgets to perform their daily life activities. The drastic improvements in the world of technology have undoubtedly made life more convenient and enjoyable. Surely, you must have observed that the latest technological innovations have brought comfort to not only our standard of living but also in the ways we carry out business routine tasks.

1.1 | Motivation

Technology also allows doing business easier. Back in the days when we had to do things manually, doing business was harder as you had to capture data and other documents manually. And when you need to review the information you need, you'd still have to go over a pile of physical files. This eats so much time and effort before.These technologies include different types of embedded systems, operating systems and processing units.Embedded System has become an integral part of human lives though they are designed to function with minimal or no human interference. Aspects like low cost, compressed size, and simple design make them very popular. These systems, today, play a vital role in many devices, equipment instrumentation and home appliances and is likely to continue in the recent future.

1.2 | Aims and Objectives

Generally, the embedded systems are explained as the collection of hardware and software components. But just saying this is not the proper explanation of embedded systems. Because it is the system with hardware devices, software integration, and all those embedded together to perform the specified task. There are several purposes and work for developing the embedded system.This paper revolves around one such project which is based on use of embedded systems.The professions relating to construction, such as architecture, surveying, carpentry, masonry, locksmiths, etc require a very important system which can calculate distance and proximity between an object and a target. This distance can be in form of height, sorting, diameter, positioning, dimensioning and many more. One such application where distance needs to be calculated is of object detection system. In this, objects can be detected for security, counting, inventory or robotic obstacle avoidance. A sensor which can be used for farness determination is ultrasonic sensor. Thus, in this project we calculate distance using ultrasonic sensor and a micro-controller.

1.3 | Research

There are many components used in this project while designing the system.Prior to design of any system a thorough analysis and study is required for accurate outcome of project. The primary goal of the research is to guide action, gather evidence for theories, and contribute to the growth of knowledge in data analysis.The research is important in business decision-making because it can assist in making better decisions when combined with their experience and intuition.Analysis is the process of analyzing data in various formats. Even though data is abundant nowadays, it's available in different forms and scattered over various sources.The analysis helps to clean and transform all this data into a consistent form so it can be effectively studied. One such method of research is SWOT Analysis.

1.3.1 |SWOT Analysis

A SWOT analysis is an incredibly simple, yet powerful tool to help develop a project.SWOT stands for Strengths, Weaknesses, Opportunities, and Threats.

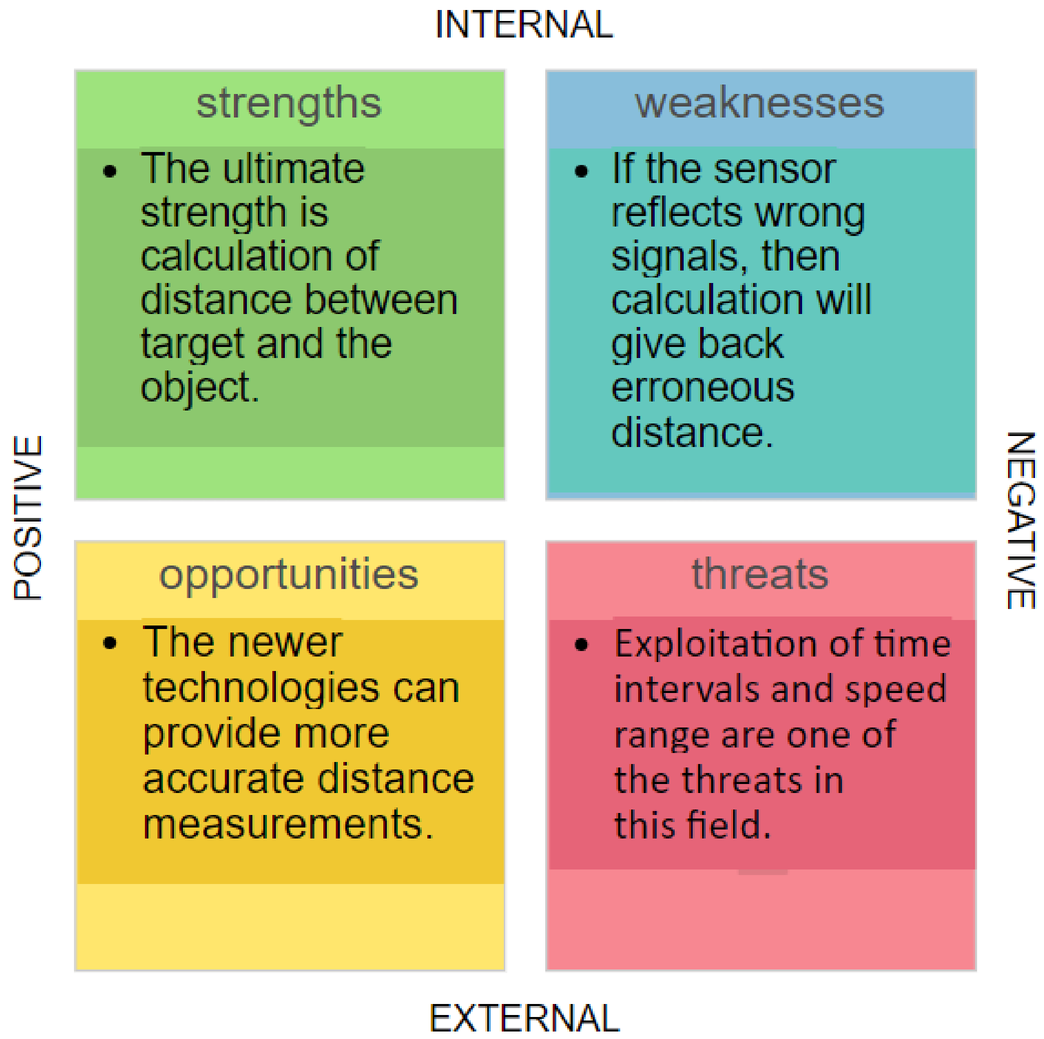

Figure 1.1: SWOT Analysis for given project.

2

Design Requirements

Project design is an early phase of the project life-cycle where ideas, processes are planned out. This involves clearly defining the design requirements so as to form a sound foundation for the design process. There are different types of requirements.A good requirement states something that is necessary, verifiable, and attainable.A bad requirement is where the specifications aren't well defined and consists of much rework.This portion of the paper explains about requirements considered while designing the project.It includes two different levels of requirements.

HIGH LEVEL REQUIREMENTS: -

ID	DESCRIPTION	CATEGORY
HLR01	User should be able to calculate accurate distance.	Mathematical
HLR02	Distance calculation should be contactless.	Technical
HLR03	The range of sensor should be minimum of 400cms.	Mathematical

LOW LEVEL REQUIREMENTS: -

ID	DESCRIPTION	CATFORY
LLR01	The system should be cost effective.	Technical
LLR02	Sensor should use sonar waves for reflection.	Technical
LLR03	Distance should be displayed on LCD	Technical

Figure 2.1: Design Requirements

3

Architecture

This section includes about architecture of the project. It is in form of basic block diagram, flow chart and the working principle of project.

3.1 | Working Principle

The project works on certain principle.To calculate a certain distance in any medium we need the speed and the time component of that medium.So in this project we consider frequency pulse and time for reflection as speed and time components respectively.Thus the source will generate a wave of certain frequency which will be obstructed by the object in it's path.The same is reflected back in form of echo signal. This is distance which is of concern.

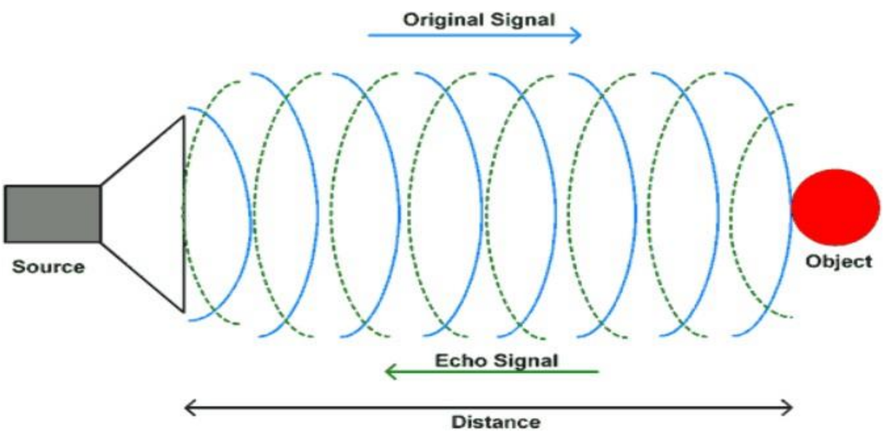

Figure 3.1: Working Principle

3.2 |Work Flow

3.2.1 |Part 01

The work flow represents the checking and verification while calculating the distance. This verification can be understood by use of flowchart.If the wave is reflected back then calculate the distance and display it on the LCD display.If the wave does not reflect back then go in loop and wait until it is reflected back.

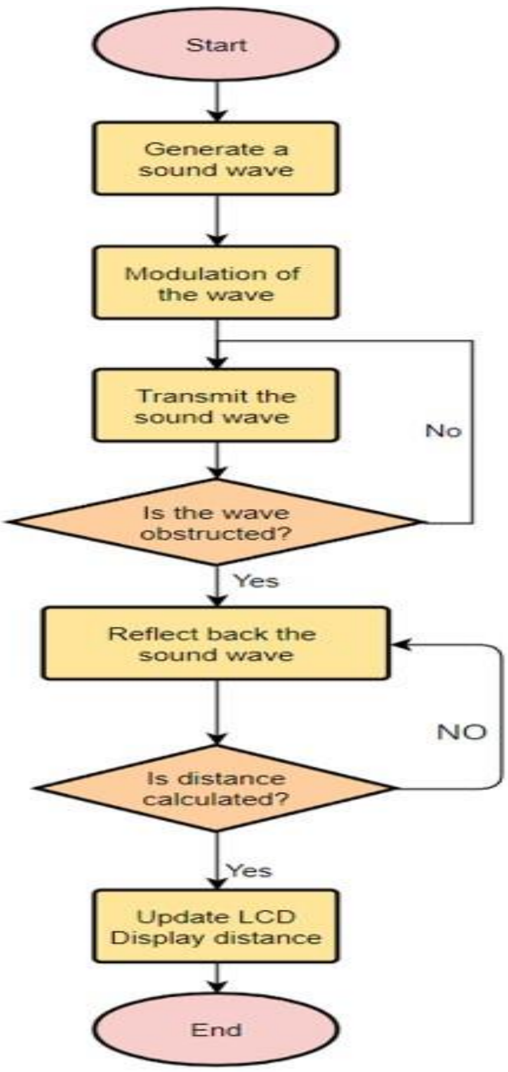

Figure 3.2: Working Principle

3.2.2 |Part 02

The work flow represents the displaying of the distance. This process can be understood by use of flowchart.If the distance is in centimeters then convert it into inches and display it on the LCD display.If it is not in inches then go in loop and wait until it is converted into inches.

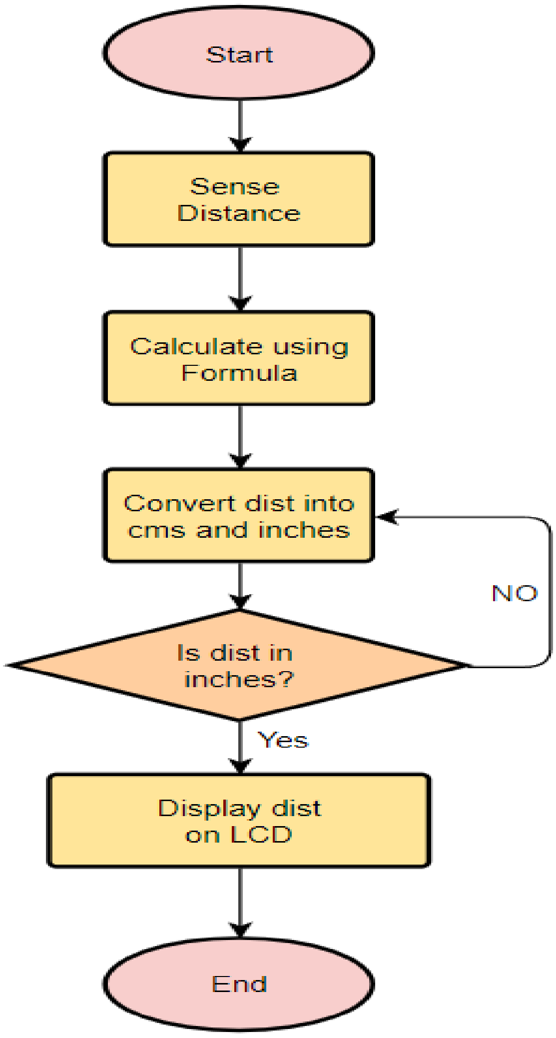

Figure 3.3: Working Principle

3.2.3 |Part 03

The work flow represents the block diagram of the overall system.It takes sound signal pulse as input,processes it with help of micro-controller and displays the distance between target and the object on the LCD Display. The fixed power supply is required for powering up of the micro-controller and the switch is for controlling on off for the system.

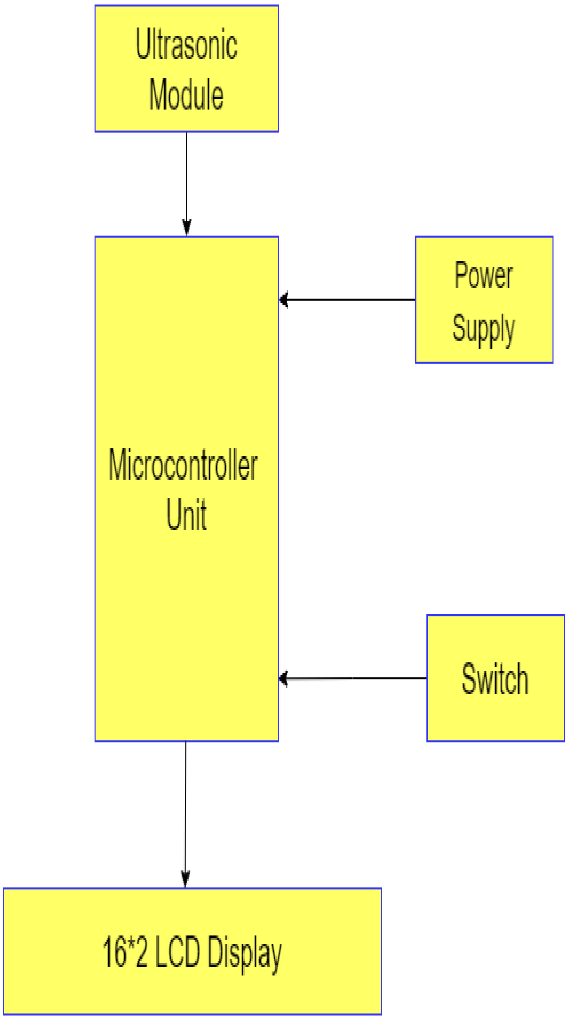

Figure 3.4: Working Principle

4

Electronic Components

This part describes about the equipments used for building this project.The implementation proposes of 2 different approaches.So for each approach the components used are described in this chapter.

4.1 | Ultrasonic Sensor

Ultrasonic Sensors measure distance to target objects or materials through the air using “non-contact” technology that does not touch or damage the target. They are easy to use and reliable, and used in hundreds of applications around the world in all industries.The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (like a tiny speaker), the other receives them, (like a tiny microphone). The speed of sound is approximately 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object. It uses the following mathematical equation:
Distance = Time x Speed of Sound divided by 2

4.1.1 | HC-SR04

The sensor used in this project is **HC-SR04**.It is used to measure distance in range of 2cm-400cm with an accuracy of 3mm. The sensor module consists of an ultrasonic transmitter, receiver control circuit.The working principle of ultrasonic sensor is as follows:

- High level signal is sent for 10us using Trigger.
- The module sends eight 40 KHz signals automatically, and then detects whether pulse is received or not.
- If the signal is received, then it is through high level. The time of high duration is the time gap between sending and receiving the signal.

4.2 | LCD 16x2 Display

LCD stands for Liquid Crystal Display. It is a flat panel display technology, mainly used in TVs and computer monitors. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols.

4.2.1 | HD44780-4 LCD display

The LCD used in this project is HD44780 LCD display.displays alphanumerics,Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. It is one of popular LCD used worldwide.

4.3 | Micro-controller

A micro-controller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical micro-controller includes a processor, memory and input/output (I/O) peripherals on a single chip.They run one specific program and are dedicated to a single task. They are low power devices with dedicated input devices and small LED or LCD display outputs. It is easy to use, troubleshooting and system maintenance is straightforward. At an equivalent time, many tasks are often performed therefore the human effect are often saved. Processor chip is extremely small and adaptability occurs. Cost and size of the system is less.Since this project has 2 different proposed solutions so two different micro-controllers are used.

4.3.1 |AVR ATMEGA 8 Micro-controller

The Microcontroller includes the Harvard architecture that works rapidly with the RISC. The features of this Microcontroller include different features compared with other like sleep modes-6, inbuilt ADC (analog to digital converter), internal oscillator and serial data communication, performs the instructions in a single execution cycle. These Micro-controllers were very fast and they utilize low power to work in different power saving modes. The Atmega8 microcontroller consists of 28 pins where pins 9,10,14,15,16,17,18,19 are used for port B, Pins 23,24,25,26,27,28 and 1 are used for port C and pins 2,3,4,5,6,11,12 are used for port D.

4.3.2 |Arduino Micro-controller

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button and turn it into an output - activating a motor, turning on an LED, publishing something online. Arduino code is written in C++ with an addition of special methods and functions, which we'll mention later on. C++ is a human-readable programming language. When you create a 'sketch' (the name given to Arduino code files), it is processed and compiled to machine language.

5

Implementation

This chapter of the paper focuses on the implementation part of the project. The coding and algorithm used for completion of the project is explained here.The chapter proposes two different solutions.After the analysis of both solutions ,one solution will be finalised for the simulation.

5.1 | Proposed Solution 01

This solution uses AVR Atmega8 as the micro-controller.The code can be implemented in many ways. One such method is including all the library functions and function declarations in one header file .This header file will be used in coding as one single library required.The coding will interface the LCD on port D and sensor on port c with the micro-controller.The functions will initialise sensor and LCD both for respective transmissions.A function is defined for calculating a pulse width of the wave.This will be further used for measuring the distance.For sending commands to LCD and clearing the display of LCD there is need to define functions accordingly.Since the project is being simulated using software, so to capture outputs we define a cursor function.This function will measure the distance whenever the cursor is used .Using the pulse width the distance will be calculated and would be displayed in centimeters on the LCD.

5.1.1|Atmega8 Code

```
#include<avr/io.h>
#include<util/delay.h>
#include<stdlib.h>

#define lcd_port PORTD
#define lcd_data_dir  DDRD
#define rs PD0
#define en PD1

#define US_PORT PORTC
#define US_PIN  PINC
#define US_DDR  DDRC

#define US_TRIG_POS      PC0
#define US_ECHO_POS      PC1
#define led1 PC2
#define led2 PC3
#define led3 PC4
#define led4 PC5
#define led5 PD2

#define US_ERROR         -1
#define US_NO_OBSTACLE   -2

int distance, prev_distance;

void HCSR04Initialise();
void HCSR04Trigger();

void lcd_command( unsigned char );

void HCSR04Initialise()
{
        US_DDR|=(1<<US_TRIG_POS);
}

void HCSR04Trigger()
{
        US_PORT|=(1<<US_TRIG_POS);       //high

        _delay_us(15);

        US_PORT&=~(1<<US_TRIG_POS);      //low
}
```

```
int main()
{
        initialize_lcd();

        char numberString[4];

        while(1) {

                uint16_t r;

                _delay_ms(100);
                HCSR04Initialise();


                DDRC |= (1 << led1) | (1 << led2) | ( 1 << led3) | ( 1 << led4);
                DDRD |= (1 << led5);
                PORTC |= 1 << led1;
                while(1)
                {


                        HCSR04Trigger();
                        r=GetPulseWidth();
                        if(r==US_ERROR)
                        {
                                lcd_CursorSet(1, 1);
                                lcd_output("Error!");
                        }
                        else
                        {

                                distance=(r*0.034/2.0);


                                        if (distance != prev_distance)
                                        {
                                                lcd_clear();
                                        }

                                        lcd_CursorSet(1, 1);
                                        lcd_output("Distance = ");
                                        lcd_CursorSet(12, 1);
                                        itoa(distance, numberString, 10);
                                        lcd_output(numberString);
                                        lcd_CursorSet(14, 1);
                                        lcd_output(" cm");

                                prev_distance = distance;
                                _delay_ms(30);
                        }
                }

        }
}
```

5.2 |Proposed Solution 02

This solution uses Arduino as controller.The algorithm will interface LCD and the ultrasonic sensor with the controller.The language used in Arduino is C++.Thus inbuilt keywords can be used for programming of the project.For the transmission and reception of the wave,several pins are enabled in the micro-controller.Once the distance is sensed it will be converted to inches and displayed on to the LCD.The outputs can be captured via change in the voltage which is operated by a knob.

5.2.1 |Arduino Code

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(7, 8, 9, 10, 11, 12);

float cm;
float inches;

long measureDistance(int triggerPin, int echoPin)
{
          pinMode(triggerPin, OUTPUT);  // Clear the trigger
          digitalWrite(triggerPin, LOW);
          delayMicroseconds(2);
          digitalWrite(triggerPin, HIGH);
          delayMicroseconds(10);
          digitalWrite(triggerPin, LOW);
          pinMode(echoPin, INPUT);
  return pulseIn(echoPin, HIGH);
}

void setup()
{
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.print("--> Distance <--");
  delay(3000);
  lcd.clear();
}

void loop()
{
  cm = 0.01722 * measureDistance(2, 3);
  inches = (cm / 2.54);
               Serial.print(inches, 1);
               Serial.print("\t");
               Serial.println(cm, 1);
          lcd.setCursor(0,0);
          lcd.print("Inches");
          lcd.setCursor(4,0);
          lcd.setCursor(12,0);
          lcd.print("cm");
          lcd.setCursor(1,1);
          lcd.print(inches, 1);
          lcd.setCursor(11,1);
          lcd.print(cm, 1);
          lcd.setCursor(14,1);
        delay(3000);
        lcd.clear();
}
```

5.2.2 |Circuit Diagram

This is the circuit diagram which can be implemented on the simulator software.The diagram is drawn according to ports and pins connection in the Arduino Code.

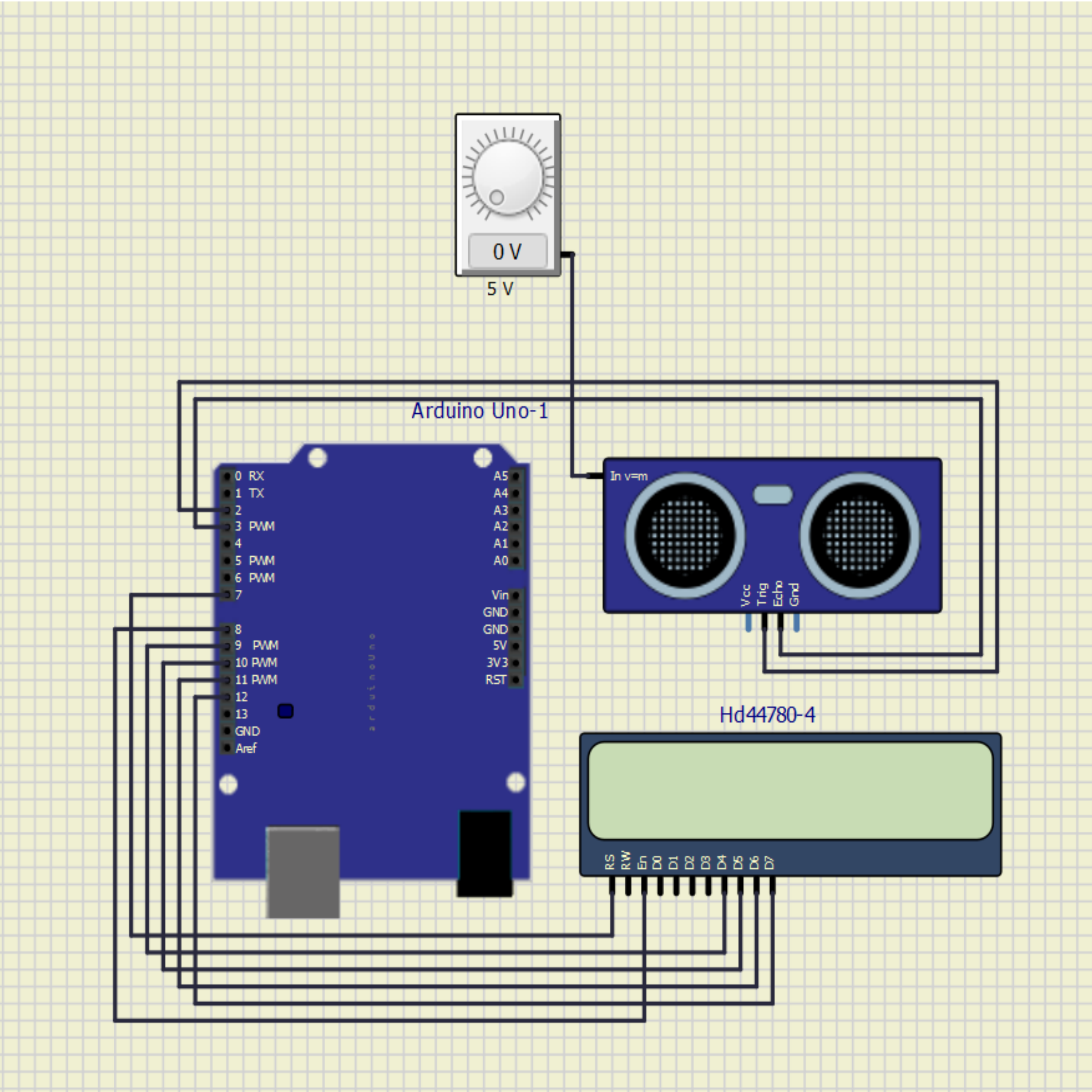

Figure 5.1: Circuit Diagram

6

Simulations and Output

This chapter will focus on simulation and output part of the project.For simulation of the project a software known as SimulIDE is used.SimulIDE is a real-time electronic circuit simulator with PIC, AVR, and Arduino simulation.From the two approaches listed in the previous chapter,Arduino code is simulated in the software.After running the codes of the respective programs HEX files are generated.These files need to dumped into software of simulation.

6.1 | Steps for simulation :

Same steps can be carried out for Atmega Program.

- Download, install, and start the software.
- Drag and drop the various components as described in the code.
- Connect the ports and components respectively.
- Dump the HEX file generated into the Arduino micro-controller.
- Compile and run the circuit without any errors.
- Power up the circuit using the red button.
- To capture different outputs,change the voltage from volts display window.

6.2 | TestPlan and Output

Test case ID	Description of Test case	Input values	Expected Output	Actual Output
TC_01	Valid choice to start the system	Switch on	The system is switched on	System ready for detection
TC_02	Valid choice to Supply power	Fixed power supply	To power up the system	System and the peripherals are powered up
TC_03	Valid choice to start the generation of sound wave	Set trigger pin HIGH	Sound wave generated	Wave transmitted through air medium
TC_04	Valid choice to start the reception of sound wave	Set echo pin HIGH	Sound wave received	Wave received through air medium
TC_05	Valid choice to start the algorithm	Echo pin status and sound wave travel time	Pulse width	The distance is measured and displayed on LCD in inches

Figure 6.1: TestPlan Output

6.3 | Output and Results

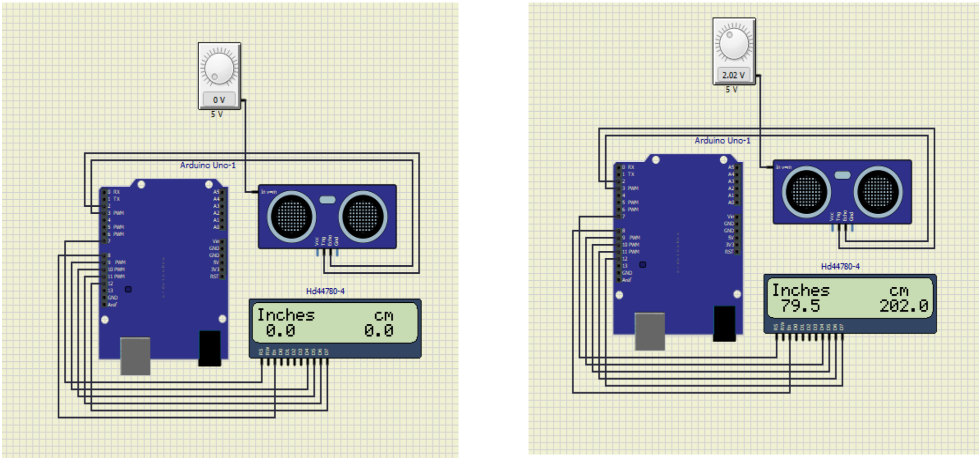

Figure 6.2: Output with discrete inputs

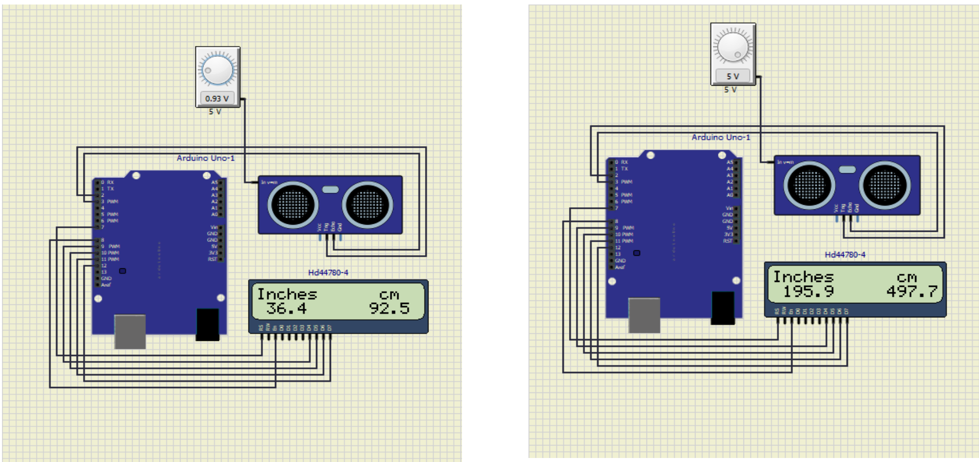

Figure 6.3: Output with discrete inputs

6.4 | Conclusion

Thus, Farness Determination System was completed with fulfillment of requirements, with use of different approaches and finalizing the best suitable method.