POLITEKNIK

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AUTOMATIC WIRE CUTTER AND WINDER MACHINE

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JABATAN KEJURUTERAAN ELEKTRIK

JUNE 2022

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This report submitted to the Electrical Engineering Department in fulfillment of the requirement for a Diploma in Electrical Engineering

JABATAN KEJURUTERAAN ELEKTRIK

JUNE 2022

CONFIRMATION OF THE PROJECT

The project report titled "Automatic Wire Cutter and Winder Machine" has been submitted, reviewed and verified as a fulfills the conditions and requirements of the Project Writing as stipulated

Checked by:

Supervisor's name :

Supervisor's signature :

Date :

Verified by:

Project Coordinator name :

Signature of Coordinator :

Date :

"I acknowledge this work is my own work except the excerpts I have already explained to our source"

1. Signature :

Name : **ADLINA SOFIAH BINTI MOHD FAHMI**

Registration Number : **08DEP20F1041**

Date :

DECLARATION OF ORIGINALITY AND OWNERSHIP

TITLE : AUTOMATIC WIRE CUTTER AND WINDER MACHINE

SESSION: SESI 2 2021/2022

I, **ADLINA SOFIAH BINTI MOHD FAHMI (08DEP20F1041)** is a final year student of **Diploma in Electrical Engineering, Department of Electrical, Politeknik Sultan Salahuddin Abdul Aziz Shah**, which is located at **Persiaran Usahawan, 40150 Shah Alam, Selangor**. (Hereinafter referred to as 'the Polytechnic').

2. I acknowledge that 'The Project above' and the intellectual property therein is the result of our original creation /creations without taking or impersonating any intellectual property from the other parties.

3. I agree to release the 'Project' intellectual property to 'The Polytechnics' to meet the requirements for awarding the **Diploma in Electrical Engineering** to me.

Made and in truth that is recognized by;

.....

ADLINA SOFIAH BINTI MOHD FAHMI
(020614-10-0048)

In front of me,

.....

PN. ZARINA MD AMIN
(740505-01-5712)

As a project supervisor, on the date:

ACKNOWLEDGEMENTS

I have taken efforts in this Project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them. I am highly indebted to Puan Zarina Bt. Md Amin for their guidance and constant supervision as well as for providing necessary information regarding the Project & also for their support in completing the Project.

I would like to express my gratitude towards my parents & member of DEP4C for their kind co-operation and encouragement which help me in completion of this Project. I would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

My thanks and appreciations also go to my colleague in developing the Project and people who have willingly helped me out with their abilities.

ABSTRACT

Wire cutting is essential in the electrical industry. Smaller organizations usually cut and wind wire manually as the machines available in the industry to do so tend to be very expensive. This project is focused on reducing the use of manpower to cut, measure and wind wires as well as making an affordable alternative to cut wire. This will reduce the chances of mistakes being made. This project is designed to automatically cut a specific measurement of wire as well as automatically winding wire. This machine will take the input from the keypad, sending them to the machine to start pulling the desired measurement of wire if the option to cut wire is chosen . The wire cutter will then cut the wire and this process will repeat for the amount chosen. If the option to wind wire is chosen, the machine will turn the wire spool until the key to stop is pressed. This project is realized using Arduino as the microcontroller and 4x4 keypad as the input. For the output, a 16x2 LCD is used as a display, a stepper motor is used to pull the wire as well as turn the wire spool, and a servo motor is used to move the wire cutter.

Commented [FAP1]: The abstract must be simple, written in one
paragraph and not more than 200 words in one page.
The abstract should be written in single spacing.
The abstract should contains, an introduction, problem statement, research objectives, results and conclusion (optional)

ABSTRAK

Pemotongan wayar adalah penting dalam industri elektrik. Organisasi-organisasi kecil biasanya memotong dan menggulung wayar secara manual kerana mesin yang tersedia dalam industri untuk melakukannya cenderung sangat mahal. Projek ini tertumpu kepada mengurangkan penggunaan tenaga kerja untuk memotong, mengukur dan menggulung wayar serta menjadi alternatif yang lebih berpatutan untuk memotong wayar. Ini akan mengurangkan kemungkinan kesilapan dibuat. Projek ini direka bentuk untuk memotong secara automatik ukuran dawai tertentu serta penggulungan wayar secara automatik. Mesin ini akan mengambil input daripada pad kekunci, menghantarnya ke mesin untuk mula menarik ukuran wayar yang dikehendaki jika pilihan untuk memotong wayar dipilih . Pemotong wayar kemudiannya akan memotong wayar dan proses ini akan berulang untuk jumlah yang dipilih. Jika pilihan untuk menggulung wayar dipilih, mesin akan memusingkan kili wayar sehingga kekunci untuk berhenti ditekan. Projek ini direalisasikan menggunakan Arduino sebagai mikropengawal dan papan kekunci 4x4 sebagai input. Sebagai output, LCD 16x2 digunakan sebagai paparan, motor stepper digunakan untuk menarik wayar serta memutar kili wayar, dan motor servo digunakan untuk menggerakkan pemotong wayar.

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Commented [FAP2]: if not relevant, can remove this page

LIST OF ABBREVIATIONS

Commented [FAP3]: if not relevant, can remove this page

CHAPTER 1

1 INTRODUCTION

1.1 Introduction

This chapter will explain the background research done for this project, as well as the problem statement, research objectives, scope of research and project significance.

1.2 Background Research

Commented [FAP4]: This section contains the introduction to the issues which the research/project is concerned

Electrical wire is used in a lot of different settings. It is one of the most important components used in the electrical industry. Due to this, the demand for wire cutting and spooling is always high. This is traditionally done manually with a wire cutter or a manual spooling caddy but as new technologies continue to exist, the traditional method is now considered a slow method in approaching wire cutting and spooling. Thus, innovations were made to solve this issue. Unfortunately, a lot of them do not cater to smaller organizations where floor space and budget is limited.

1.3 Problem Statement

Wire cutting tends to require a lot of attention as it is very easy to make mistakes. Cutting wires manually also takes a lot of time if done frequently. This will lower the productivity rate as a lot of time is wasted to carefully measure and cut wires to avoid uneven measurements.

While there are options such as industrial wire cutting machine, they tend to be very expensive and comes in big sizes. This will cost smaller organizations a lot of money which will be hard for them to gain back due to them being a smaller organization. Apart from that, these machines are usually big and will take up a lot of space. For many smaller organizations, this may not be a good option to take.

When it comes to wire winding, although most wires are bought in spools, after handling them there may be a lot of excess wires which will be needed to wind as to maintain a neat working space. In other occasions, wire spools may also get accidentally dropped causing the wires to get unraveled. To wind them

manually will take up a lot of time and it needs to be done carefully as too much tension on the wire can lead to possible wire damage.

There is also industrial wire spooling machine but like the wire cutting machine, they are expensive and big which is not suitable for small organizations.

1.4 Research Objectives

The objectives of this project are ;

1) To design a machine that can cut a specific measurement of wire
2) To build an automatic wire winder

1.5 Scope of Research

Commented [FAP5]: This section contains clear scopes and limitations that you have considered in the project.

This project is aimed to develop a more affordable option to measure, cut, and wind wires all within one machine. This product is aimed to be used by the electrical industry. This product is expected to be able to measure up to 1000cm of wire and cut a maximum of 99 pieces at a time. This product does not measure the wire while spooling therefore it will only stop spooling when the stop key is pressed.

This project will be constructed with these measures :

1. 9V battery will be used to power the system
2. Arduino Nano is used for the system's microcontroller

1.6 Project Significance

Commented [FAP6]: This section contains the significance of the proposed project/research. You should cite previous research in this area. You should cite those who had the idea or ideas first, and should also cite those who have done the most recent and relevant work. You should then go on to explain why more work was necessary (your work, of course.)

This project is developed to help the electrical industry save time and manpower when it comes to measuring, cutting and winding wires. This will greatly benefit those in the electrical industry to improve productivity while not spending a huge amount of resource to use industrial wire cutting machine.

1.7 Chapter Summary

This chapter explains the background research done for this project, along with the problem statement which inspired the innovation of this project that is the unnecessary use of extra manpower to cut and spool wire when it could be directed towards other more productive activity. Another problem is the high cost and low mobility of industrial machines.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

Commented [FAP7]: This section contains the introduction of this chapter. Briefly tell the reader what are the important matters will be reviewed during the project/research development.

This chapter will discuss further on the problem statement. This chapter will also discuss a few similar projects in how they were executed, the difference in the hardware as well as the software used, to be compared and observed. A comparison between different types of a component is also discussed. This will help to be able to make improvement for this project.

2.2 Overview

From the research done, there appear to be many parties who have looked into the issue with manual wire cutting and wire winding and created a project to solve the issue. Most of them uses similar main components to create a machine to cut or wind wire such as Arduino as the microcontroller and stepper motor.

2.3 Previous Research

2.3.1 Industrial Wire Cutting Machine

This system uses Arduino Mega 2560 for the microcontroller as well as a 24-V power supply to power the machine. They also used a recycled stepper motor to draw the wire and a servo motor to cut the wire. For the input, they use buttons and 16x2 LCD. This system is innovated to solve the issue with manual wire cutting. This product appears to be made in a bigger scale which may affect its mobility.

2.3.2 Automatic Pipe-Wire Cutting Machine

Another similar project that was done is Automatic Pipe-Wire Cutting Machine by Mr D. G. Gahane, Prachi Katole, Priyanka Naidu, Ruchita Dhoke, and Sushama Kore in 2020. This project uses stepper motor to draw the wire for the desired length and pull the wire towards the cutter assembly. The cutter is then controlled by the servo motor by having the servo motor attached to the blade to cut the wire perfectly. The product also uses LCD to show current status of on-going work to help the operator know the progress of the task. Buttons are used to set the measurements and amount to be cut. For the microcontroller, they used Arduino Nano .

2.3.3 Improvement in Spooling of Wire Rope

This project focuses on the spooling of wire rope, Rack and pinion mechanism is used to convert rotation into linear motion. The wire will first be attached to the drum to provide tension. Then, switch is pressed which start the motor which will rotate the drum and actuate the gear mechanism. The speed of the motor is maintained to provide uniform layer of wire on the drum. When the wire reaches the end the second pinion gets engaged to the rack and starts winding the second layer or wire in reverse direction. The machine will stop once the clearance limit is reached which can be achieved by using a limiting sensor.

2.4 Hardware

2.4.1 Microcontroller

Microcontroller is a self-contained computer-on-a-chip that can be used as an embedded system. There are many options when it comes to microcontroller with each slightly different than the other. Microcontrollers are characterized by bus-width, instruction set, and memory structure. The types of microcontrollers are PIC microcontroller, ARM microcontroller, 8051 microcontroller, AVR microcontroller, and MSP microcontroller.

2.4.2 Stepper Motor

Stepper motors are a type of DC synchronous motor. Whereas the rotation of an induction motor is largely uncontrollable, the rotation of a stepper motor can be precisely controlled. Stepper motors can generate full, instantaneous torque even when at rest. This makes them ideal for motion control applications requiring precision, repeatability and power.

There are three main types of stepper motors, the permanent magnet stepper which create rotation and torque by interacting with the electromagnets of the stator. Another is a variable reluctance stepper. They are built with plain iron and resemble a gear. This type has a high degree of angular resolution but lower torque.

Lastly is the hybrid synchronous stepper. This stepper motor has the features of both the permanent magnet stepper and variable reluctance stepper. Due to this, this type has both high angular resolution and high torque.

2.4.3 Servo Motor

Servo motor is a rotational or translational motor to which power is supplied by a servo amplifier and serves to apply torque or force to a mechanical system. Servo motor allows for precise control in terms of angular position, acceleration, and velocity. There are three basic types of servo motor, positional rotation servos, which rotate 180 degrees, continuous rotation servos motor which does not have a range of motion limit and linear servos which use a rack and pinion mechanism.

2.5 Chapter Summary

Commented [FAP8]: Each chapter must include the summary of the chapter as its final subsection. In this subsection, you must summarize the contents of the chapter in solid sentences.

This chapter discussed the previous research that was done to create this project. From the research, it is found that most projects done focuses on either wire cutting or wire spooling. Most projects also use buttons for the input rather than other form such as a keypad. Next, A research for the different types of microcontrollers, stepper motor and servo motor are done. From the research, an AVR microcontroller Arduino Nano is found to be the most suitable microcontroller as it is small and easier to use compared to other microcontrollers. As for the stepper motor, NEMA 17 is chosen which is a hybrid stepping motor. The servo motor that was chosen is MG996r servo motor which is a digital positional rotation servo.

CHAPTER 3

3 RESEARCH METHODOLOGY

3.1 Introduction

To realize this Project as a product that is ready to use with safety characteristic, a very comprehensive plan is taken. A step by step procedure is done so that the Project can be completed in time.

Commented [FAP9]: This section contains the introduction of this chapter. Briefly tell the reader what are the methods and techniques will be used in the project. This is important as it informs the readers on the methods used to achieve the objectives of the project that lead towards collecting the data and generate the findings reported

3.2 Project Design and Overview.

This project is initially designed and simulated on Proteus using Arduino Nano as the microcontroller.

Commented [FAP10]: In this section, you can describe and explain the research methodology used in the study. The subsection may include the research design/research procedures adopted in terms of block diagram and flow chart. Note that all previous works must be cited according to APA (American Psychological Association) style.

3.2.1 Block Diagram of the Project

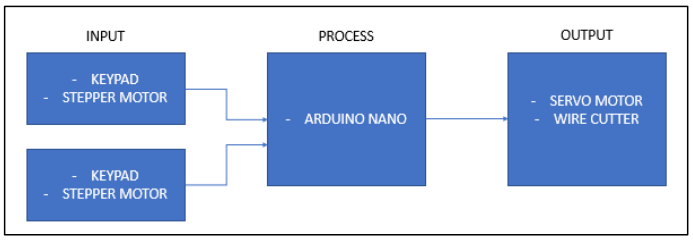

Figure 3. 1 shows the block diagram of the project

3.2.2 Flowchart of the Project

Figure 3. shows the circuit diagram of the whole system. The project will start by displaying the options for the user such as option A : to cut wire and option B : to wind wire. If the user picked the first option, the machine will ask for the desired measurement of wire the user wish to cut. After pressing next, the machine will ask for the amount of wire to be cut. Then, the machine will begin to cut the wire according to the selected measurement and amount. The machine will need to be reset to begin the process again or to choose other option. If the second option is chosen, the machine will ask the user to start

winding by pressing a key. The machine will then ask the user to press the stop key to stop winding.

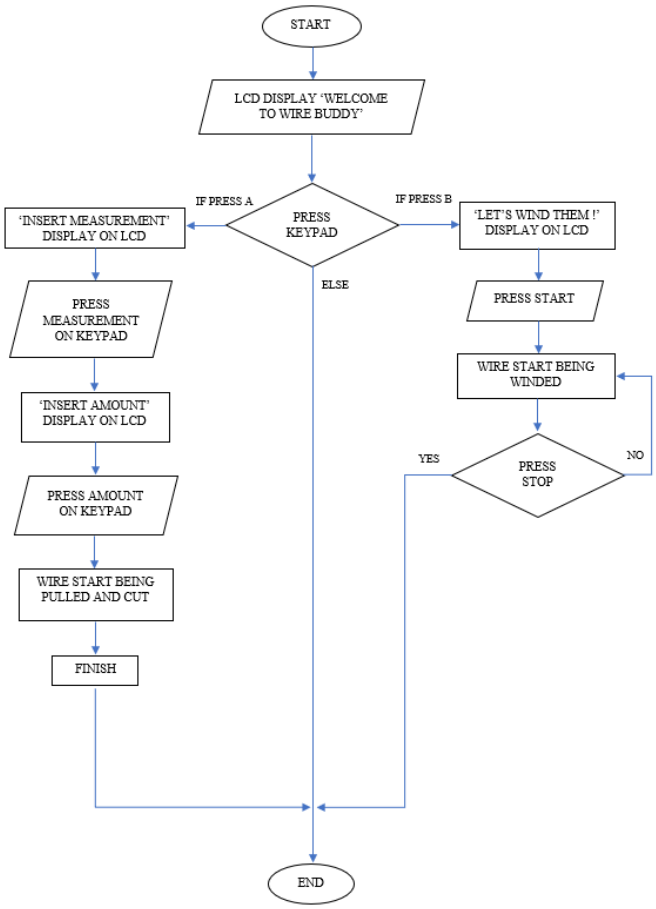

Figure 3.2: Flow chart of operation of the system

*Images may be subject to copyright

3.2.3 Project Description

This project requires both hardware and software to be able to function properly. For the hardware, the circuit is first designed and simulated on Proteus then the prototype is built to test the machine. As for the software, the program for this project is done on Arduino IDE to process the input.

3.3 Project Hardware

Commented [FAP11]: Continue your chapter 3 with the discussion and explanation of your circuit diagram. Provide clear pictures of the circuit used in your project and explain your circuit operation.

3.3.1 Schematic Circuit

Figure 3 shows the overall circuit diagram of this Project. From the diagram, the LCD, keypad, stepper motor and servo motor are connected to the Arduino as well as the power source.

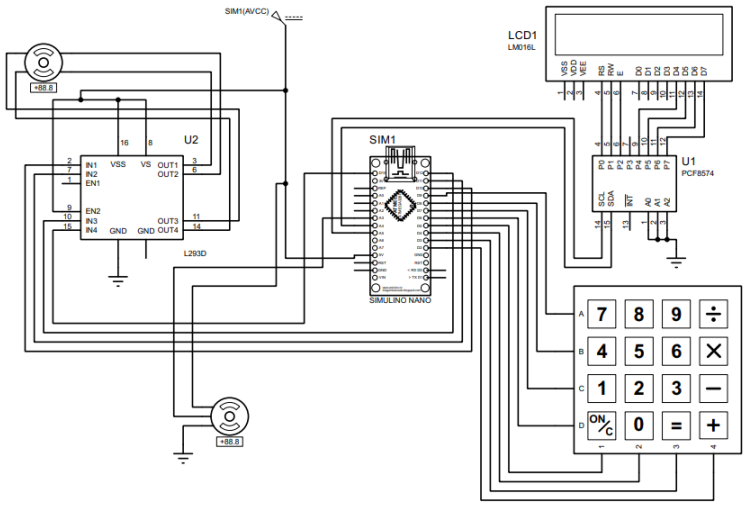

Figure 3.3: Circuit Diagram

*Images may be subject to copyright

3.3.2 Description of Main Component

3.3.2.1 Arduino Nano

Arduino Nano is a small, complete, flexible and breadboard friendly microcontroller board, based on ATmega328P. It has 14 digital pins, 8 analog pins, 2 reset pins and 6 power pins. This Arduino is used to process the input from the keypad and move the stepper motor and servo according to the input.

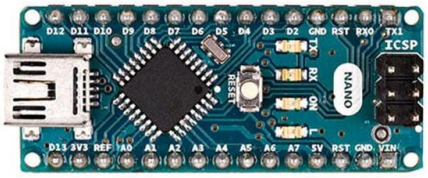

Figure 3.4 Arduino Nano

3.3.2.2 Stepper Motor

Nema 17 stepper motor is a hybrid stepping motor with a 1.8° step angle (200 steps/revolution). Each phase draws 1.2A at 4V, allowing for a holding torque of 3.2 kg-cm. Nema 17 stepper motor is generally used in printers, CNC machines and laser cutters. This stepper motor is used to move the wheel that is used to pull the wire as well as to move the wire spool for winding purposes.

Figure 3.5 NEMA 17 Stepper Motor

3.3.2.3 Servo Motor

The MG996r servo motor is a metal gear servo motor with a maximum stall torque of 11 kg/cm. This motor rotates from 0 to 180 degree based on

the duty cycle of the PWM wave supplied to its signal pin, weight 55g, This servo motor is used to pull one leg of the wire cutter to cut automatically cut the wire.

Figure 3.6 MG996r Servo Motor

3.3.2.4 Timing Belt and Pulley

A timing pulley is a type of pulley configuration that features teeth and pockets on the outside diameter of the pulley's body. These teeth and pockets mate with a timing belt having the same pitch in a synchronous drive, preventing pulley-belt misalignment and ensuring smooth power transmission. The timing pulley and belt will connect to the stepper motor to move the wire spool and the wheel to pull the wire.

Figure 3.7 Timing Belt and Pulley

3.3.2.5 16 x 2 I2C LCD

LCD (Liquid Crystal Display) 16x2 is an electronic device that is used to display data and message. It includes 16 columns and 2 rows allowing it to display 32 characters in total and every character will be made with 40 pixel dots. The LCD will display the input inserted from the keypad and tell the user what process is currently on-going.

Figure 3.8 LCD 16x2

3.3.2.6 4 x 4 Matrix Membrane Keypad

This is a keypad with 16 buttons. It is made of a thin, flexible membrane material with an adhesive backing. This keypad is used to insert the desired measurement and amount to the Arduino.

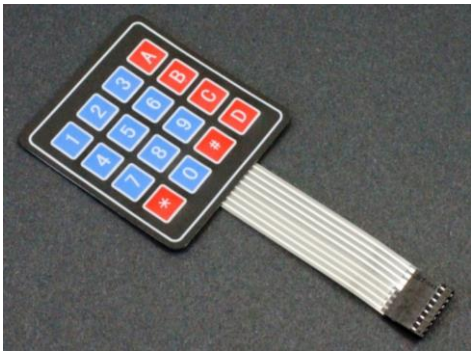

Figure 3.9 4 x 4 Matrix Membrane Keypad

3.3.2.7 Wire Cutter

Wire cutter is a handheld tool designed to cut wire ropes and cables. It will be used to automatically cut wire by connecting it to a servo motor.

Figure 3.10 Wire Cutter

3.3.2.8 Wheel

The wheel is used to pull the wire to the desired measurement.

Figure 3.11 Wheel

3.3.2.9 Shock Absorber

Shock absorber is a mechanical device designed to absorb and damp shock impulses. The shock absorber is used for the top wheel to keep the wire from moving around.

Figure 3.12 Shock Absorber

3.3.3 Circuit Operation

3.4 Project Software

Commented [FAP12]: Provide clear pictures of the circuit and software used to simulate the circuit connection.

3.4.1 Arduino IDE

Arduino IDE is an open-source software, designed by Arduino.cc and is mainly used for writing, compiling and uploading code to almost all Arduino. The main code, also known as a sketch, created on the IDE platform will generate a Hex File, which is then transferred and uploaded into the board's controller. For this project, this software is used to write and upload the code intro the Arduino Nano.

3.4.2 Flowchart of the System

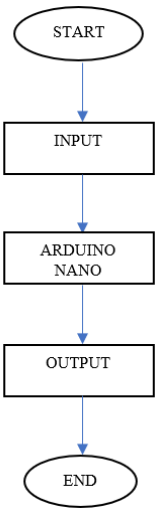

Figure 3.13 System Flowchart

3.4.3 Description of Flowchart

The input will come from the keypad. User will be asked to choose whether to cut or to wind, and if the option to cut is picked, the user will be asked to key in the desired measurements and amount.

The Arduino will then process the input .

If the option to cut is chosen, the stepper motor will turn and pull the wire according to picked measurements and the servo motor will then pull the cutter leg to cut the wire. If the option to wind is chosen, the stepper motor will turn and move the wire spool and wind the wire.

3.5 Prototype Development

Commented [FAP13]: It is good to provide the early sketch/diagram of how your project will look when it is completed. You may use software like Solidworks, 360Fussion, SketchUp, AutoCAD or even technical hand drawing etc to provide the 3D or 2D modelling of your project.

3.5.1 Mechanical Design/Product Layout

Figure 3. and Figure 3.4 shows the design of the product from the top view and from the front view

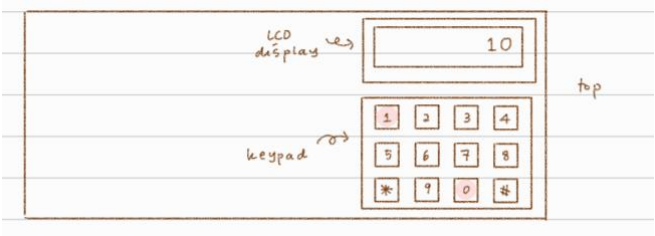

Figure 3.14 Top View of the Project

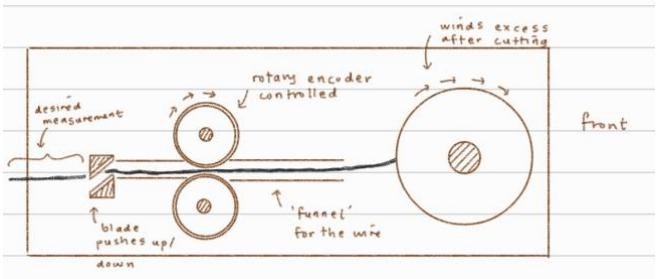

Figure 3.15: Front view of the Project

3.6 Sustainability Element in The Design Concept

For this project, it is expected to be able to be used with a rechargeable battery therefore the waste of battery can be reduced. This product is expected to be compact, affordable and portable which can help a lot of people be able

to afford and use this product without needing a lot of floor space at the same time be able to move the product around easily.

3.7 Chapter Summary

This chapter discusses about how the product will run from the hardware to its software. How the product functions is explained using a block diagram, a flow chart and schematic diagram. The use of the main components are also explained in this chapter.

CHAPTER 4

4 PROJECT MANAGEMENT AND COSTING

4.1 Introduction

This chapter will show the management of this project via a Gantt chart and the expected total budget for this project.

4.2 Gantt Chart and Activities of the Project

No.	Activity	Implementation	WEEK													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Briefing	Plan														
		Actual														
2	Project Title Proposal	Plan														
		Actual														
3	Logbook Preparation	Plan														
		Actual														
4	Block Diagram and Objectives	Plan														
		Actual														
5	Title Finalization	Plan														
		Actual														
6	Product Market Studies	Plan														
		Actual														
7	Project Sketches and Draw	Plan														
		Actual														
8	Project Circuit	Plan														
		Actual														
9	Project Programming	Plan														
		Actual														
10	Investigation Report	Plan														
		Actual														
11	Idea Development	Plan														
		Actual														
12	Project Assembling	Plan														
		Actual														
13	Project Testing	Plan														
		Actual														
14	Project PCB Etching and Soldering	Plan														
		Actual														

4.3 Cost and Budgeting

No.	Items	Unit	Price (RM)
1.	Arduino Nano	1	37
2.	Nema 17 Stepper Motor	1	45
3.	A4988 Motor Driver	1	4.50
4.	MG996r Servo Motor	1	17
5.	I2C LCD 16x2	1	13
6.	4x4 Membrane Keypad	1	3.50
7.	9V Battery	1	5
8.	Touring Wheel	3	26.50
9.	Timing Pulley	2	14
10.	Timing Belt	2	10
11.	Shock Absorber	1	9
12.	Wire Cutter	1	10
13.	Other materials		50
		Total	**244.50**

4.4 Chapter Summary

In conclusion, this project is designed to be halfway finished within 14 weeks. The making of this project is also expected to cost about RM250 which makes this project feasible and affordable.

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5 APPENDICES

APPENDIX A- DATA SHEET

APPENDIX B- PROGRAMMING

Commented [FAP14]: Put relevant data sheet that you are referring while doing your project

Commented [FAP15]: Put your coding here

```
//------------------------------ librarys ----------------------------------

#include <LiquidCrystal.h>
#include <Servo.h>

//------------------------------ lcd ---------------------------------
LiquidCrystal lcd(12, 11, 5, 4, 3, 2); // 2, 3, 4, 5

//------------------------------ stepper ---------------------------------
#define stepPin 7
#define dirPin 8

//------------------------------ servo ---------------------------------
Servo snippers;
#define servo 10
#define openAngle 180
#define closedAngle 0

//------------------------------ input ---------------------------------

#define leftButton 14
#define rightButton 9
#define upButton 15
#define downButton 6

//------------------------------ user settings ---------------------------------
unsigned int wireLength = 0;
unsigned int wireQuantity = 0;
```

```
//------------------------------ system settings ---------------------------------
int state = 0;
int incrementSpeed = 1;
int previousWireLength = 0;
int previousWireQuantity = 0;
float mmPerStep = 0.18096;


void setup() {
  Serial.begin(9600);


  lcd.begin(16, 2); //LCD columns and rows


  pinMode(upButton, INPUT_PULLUP);
  pinMode(downButton, INPUT_PULLUP);
  pinMode(leftButton, INPUT_PULLUP);
  pinMode(rightButton, INPUT_PULLUP);

  pinMode(stepPin,OUTPUT);
  pinMode(dirPin,OUTPUT);

  snippers.attach(servo);

  snippers.write(openAngle);

  delay(1000);
}


void loop() {
  if (!digitalRead(rightButton)){
    if(state == 5){
      state = 0;
    }
    else{
      state += 1;
    }
    delay(200);
    lcd.clear();
  }
  if (!digitalRead(leftButton) && state > 0 && state < 4){
    state -=1;
    delay(200);
    lcd.clear();
  }


  switch (state){
    case 0:
      homeScreen();
      break;
    case 1:
       chooseWireLength();
       break;
    case 2:
      chooseWireQuantity();
      break;
    case 3:
      confirm();
      break;
```

```
    case 4:
      currentlyCutting();
      break;
    case 5:
      finishedCutting();
      break;
  }

}


void homeScreen(){
  lcd.setCursor(0, 0);
  lcd.print("WIRE CUTTER");
  lcd.setCursor(11, 1);
  lcd.print("NEXT>");
  delay(100);
}


void chooseWireLength(){
  wireLength = changeValue(wireLength);

  //clear LCD if required
  if(previousWireLength != wireLength){
    lcd.clear();
    previousWireLength = wireLength;
  }


  //Display information on LCD
  lcd.setCursor(0, 0);
  lcd.print("LENGTH:" + (String)wireLength + "mm");
  displayNavigation();
}

void chooseWireQuantity(){
  wireQuantity = changeValue(wireQuantity);

  //clear LCD if required
  if(previousWireQuantity != wireQuantity){
    lcd.clear();
    previousWireQuantity = wireQuantity;
  }

  //Display information on LCD
  lcd.setCursor(0, 0);
  lcd.print("QUANTITY:" + (String)wireQuantity);
  displayNavigation();
}

void confirm(){
  lcd.setCursor(0, 0);
  lcd.print((String)wireLength + "mm x " + (String)wireQuantity + "pcs");
  lcd.setCursor(0, 1);
  lcd.print("<BACK");
  lcd.setCursor(10, 1);
  lcd.print("START>");
  delay(100);
}
```

```
void currentlyCutting(){
  lcd.setCursor(0, 0);
  lcd.print((String)0 + "/" + (String)wireQuantity);
  lcd.setCursor(0, 1);
  lcd.print("???s");
  int stepsToTake = (int)wireLength/mmPerStep;
  for(int i = 0; i < wireQuantity; i++){
    unsigned long timeForOneCycle = millis();
    digitalWrite(dirPin,HIGH);
    for(int x = 0; x < stepsToTake; x++) {
      digitalWrite(stepPin,HIGH);
      delayMicroseconds(500);
      digitalWrite(stepPin,LOW);
      delayMicroseconds(500);
    }

    lcd.setCursor(0, 0);
    lcd.print((String)(i+1) + "/" + (String)wireQuantity);

    snippers.write(closedAngle);
    delay(600);
    snippers.write(openAngle);
    delay(600);


    lcd.setCursor(0, 1);

    unsigned long timeRemaining = ((millis() - timeForOneCycle)*(wireQuantity - (i+1)))/1000;
    lcd.print((String)timeRemaining + "s    ");

  }

  wireLength = 0;
  wireQuantity = 0;
  state = 5;
}

void finishedCutting(){
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("CUTTING COMPLETE");
  lcd.setCursor(11, 1);
  lcd.print("NEXT>");
  delay(100);
}


int changeValue(int currentValue){
  if (!digitalRead(upButton)) {
    delay(100);
    currentValue += incrementSpeed;

  }
  if (!digitalRead(downButton)) {
    if(currentValue - incrementSpeed >= 0){
      delay(100);
      currentValue -= incrementSpeed;

    }
    else{
      currentValue = 0;
    }
  }
```

```
  if (!digitalRead(downButton) && !digitalRead(upButton)){
    incrementSpeed = 1;
  }
  return currentValue;
}

void displayNavigation(){
  lcd.setCursor(0, 1);
  lcd.print("<BACK");
  lcd.setCursor(11, 1);
  lcd.print("NEXT>");
  delay(100);
}
```

APPENDIX C- PROJECT MANUAL/PRODUCT CATALOGUE