An Najah National University
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Automatic Water Line production

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A Graduation Project submitted to the Department of Electrical and Computer Engineering in partial fulfillment of the requirements for the degree of B.Sc. in Computer Engineering

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Acknowledgment

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Chapter 1

Introduction

Contents

In our pursuit of addressing the increasing global demand for bottled water, we've embarked on the creation of a simple yet impactful automatic water production line for our graduation project. In an age where accessibility and quality are paramount, our project takes center stage as we explore the efficient, precise, and technologically sophisticated production of bottled water. With a focus on providing a convenient source of hydration, our project signifies a dynamic interplay between innovation, regulatory compliance, and environmental sustainability.

1.1 General background

Automatic water production lines are essential in efficiently manufacturing bottled water to meet the growing global demand for a convenient and safe hydration source. Leveraging advanced technologies, these lines ensure precision and consistency in the production process. Key factors include adherence to strict regulatory standards, a focus on environmental sustainability, and the competitive drive for innovation. As consumers increasingly prioritize health and convenience, automatic water production lines play a crucial role in providing a reliable supply of quality bottled water to the market.

1.2 Objectives

For our graduation project, we aim to create a straightforward and efficient automatic water production system. Our key goals are to improve the production process, maintain high water quality, and control costs. We want a system that adapts easily to different production needs without the need for complex monitoring. Safety is a priority, so we're automating risky tasks and ensuring an easy-to-use interface. Our project also focuses on being environmentally friendly and meeting all necessary regulations. Our goal is to integrate smoothly with other processes and maintain a reliable supply.

1.3 Significance or importance of your work.

Our project to improve the water production line is crucial because it makes things better. By creating a simple and effective system, we aim to make water production easier and keep the water always good. Our work is important because it makes the process smoother and can adapt to different needs.

1.4 Organization of the report

Our report is thoughtfully divided into key sections to guide you through the Automatic water line production experience. Begin with the Introduction and Background and Previous Work for context, followed by the Methodology detailing our approach.

Transition to the Results and Analysis for empirical findings and interpretations. The Discussion section places results in a broader context, while Conclusions and Recommendations summarize achievements and suggest future directions.

The report concludes with References, acknowledging our sources.

Chapter 2

Constraints and Earlier Coursework

Contents

2.1 Constraints & Limitations

1-The October War imposed challenges on movement, travel, time, and access to equipment, creating difficult conditions and negatively affecting mental health.

2-The process of designing and getting the 3D printed part's was a difficulty , because of lack of time and the 7/October War which made communicating with industrial companies hard.

3-Dealing with some tools and equipment and parts which we never used before , like Drills , pipes , wrenchs .

4-The mechanism of capping the bottles was a difficulty as it must be accurate and done by a motor .

5-Doing pretty much work on the Project , Report , and Demo on the final exams period was making a lot of pressure which makes us don't think with a lot of creativity and peace of mind .

2.2 Earlier Coursework

1. Electronics course that provides instruction in various aspects of electronic systems and technologies.

2. Microcontrollers Course covering their fundamental principles and practical applications.

3. Microcontrollers Lab which includes hands-on experience with Arduino and its functionalities, and topics like controlling stepper motor and dealing with analogs.

4. Critical thinking and scientific research teaching students skills such as reading scientific publications and utilizing modern technologies like LaTeX to produce research papers. 5.Engineering drawing which helped with imagining the project and it's details to use 3D printing for the items used .

Chapter 3

Methodology

Contents

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3.1 Introduction

This chapter outlines the methodology adopted for the design and implementation of the water production line hardware project, with a specific emphasis on the design process, tools and technologies utilized and details of usage .

3.2 System Architecture

3.2.1 Conveyor Belts

(a) Conveyor Belt

Figure 3.1: Conveyor Belt Figure.

A flat belt conveyor, shown in figure a, supports the bottles as a placement structure and carries them forward sequentially onto the water pump to be filled , and then onto Star wheel, where containers will be capped. The conveyor belt arrangement consists of wood frame, a motor, two rollers, and a belt. The frame has low friction with the belt made of leather. Consequently, only two rollers in either side can facilitate the movement of the belt well. we used 2 conveyor belts , one for the way in and one for the way out .

3.2.2 Star Wheel

The star wheel plays a crucial role in our bottle capping system. Its main job is to receive filled bottles, guiding them for the capping process. Once a bottle is filled, the star wheel moves it forward, positioning it correctly for the cap taking step off the slider. The capping motor then securely tightens the cap on the bottle .

To achieve controlled rotation, we use a stepper motor connected to the star wheel's rod through two gears and a chain. One gear is attached to the stepper motor, and the other to the star wheel's rod. This setup ensures that the star wheel turns precisely as needed for efficient capping.

(a) Star Wheel

Figure 3.2: Description of the star wheel.

3.2.3 3D Printed Capping Mechanism And Cap Slider

(a) Cap Slider

(b) Capping Motor

Figure 3.3: 3D Printed Capping Mechanism And Cap Slider.

The 3D-printed Cap Slider and Capping Motor (Motor Mount) are essential elements in our capping process. Designed for simplicity, cost-effectiveness, and ease of use, they streamline the operation.

When the star wheel receives a filled bottle, it turns to the Cap Slider to pick up the cap accurately. Then, it rotates to the Capping Motor, a 3D-printed Motor Mount housing a small DC motor. The DC motor turns the cap, closing the bottle securely while held by the star wheel.

After capping, the Capping Motor releases the bottle, and the star wheel, driven by the Stepper Motor, guides it to the next conveyor belt for packaging. These 3D-printed components ensure an efficient and straightforward capping process in our project.

3.3 Tools and Technologies

Our water production line project came to life with the help of essential tools and technologies. These key resources, such as sensors and motors, played a vital role in turning our ideas into a functional product. They enabled the smooth coordination of hardware and software, making our water production line a successful reality. In the following sections, we'll highlight the core tools and technologies that were the building blocks of our project's accomplishment.

Arduino Mega

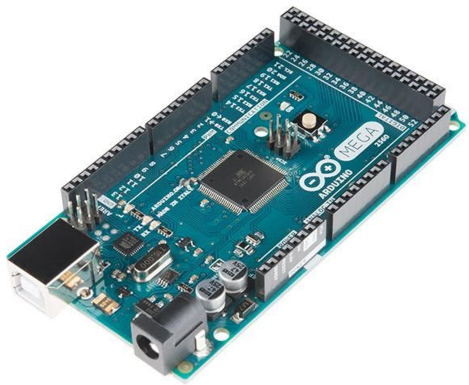


Figure 3.4: Arduino Mega.

Absolutely! At the core of our hardware project is the Arduino Mega, a microcontroller packed with 54 digital I/O pins, 16 analog inputs, and 256 KB of memory. These pins serve as the connectors for our Project components – buttons,motors, and Sensors.implementation Through the Arduino Inte- grated Development Environment (IDE), we craft intricate code,to make the accuracy and efficiency work at the highest level. The IDE also facilitates real-time Communication with the Arduino Mega, allowing us to upload and execute code seamlessly. This dynamic interaction between hardware and software forms the backbone of our project, where the Arduino Mega's adaptability and memory contribute to a responsive and intelligent experience, truly showcasing the fusion of technology.

NEMA 17 stepper motor 17HS4401

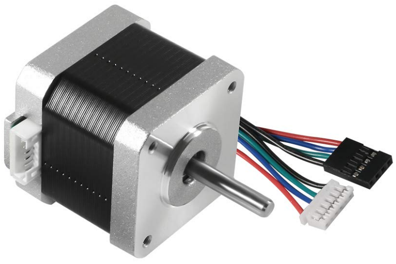


Figure 3.5: NEMA 17 stepper motor 17HS4401.

NEMA 17 stepper motor, such as the 17HS4401 model, is renowned for its precise control. It adheres to NEMA 17 standards with a 1.8-degree step angle (200 steps per 360-degree rotation). This motor boasts considerable holding torque—its static position maintenance force. It's widely used in precise positioning tasks like CNC machines, 3D printers, gimbals, and robotics.

Regarding its electrical needs, the 17HS4401 has specific current and voltage ratings for optimal performance. It adheres to NEMA 17 dimensions—42mm by 42mm faceplate, 5mm shaft. It comes in unipolar and bipolar coil setups, influencing wiring and control methods. Its popularity in maker and engineering communities stems from its versatile compatibility and integration ease.

Sensor IR

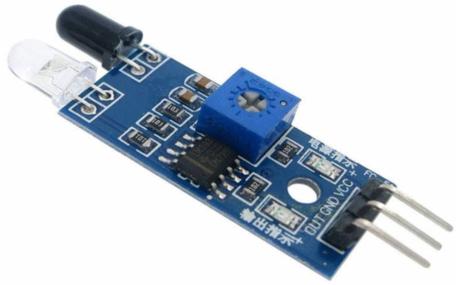


Figure 3.6: (IR) sensor.

An infrared (IR) sensor is a versatile component that detects infrared radiation in its surroundings, converting it into electrical signals. Commonly used in various applications, IR sensors can sense heat emitted by objects or detect motion based on changes in IR radiation. They find application in remote controls, proximity sensors, and security systems, among others. Depending on the specific type, IR sensors can detect objects, measure temperature, or capture movement, making them integral to a wide range of devices and systems.

l298n motor driver

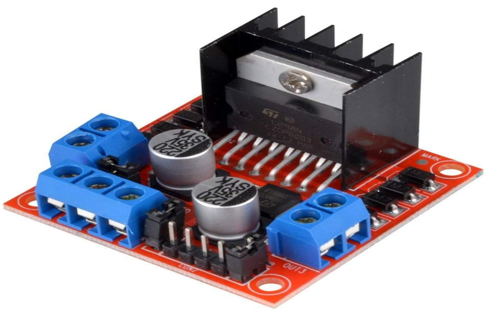


Figure 3.7: l298n motor driver.

The L298N motor driver module is a widely used dual H-bridge motor controller that enables the control of two DC motors or a single stepper motor. It is capable of driving motors with higher current and voltage requirements, making it suitable for various robotics and automation projects. The module offers both forward and reverse control for each motor and can handle peak currents, contributing to efficient motor operation. The L298N's compatibility with microcontrollers and ease of integration have made it a popular choice for driving motors in applications such as mobile robots, CNC machines, and remote-controlled vehicles.

LCD Display

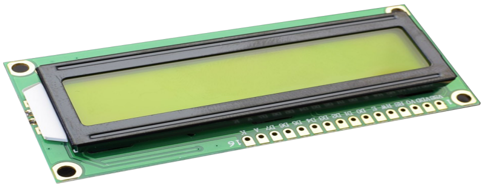


Figure 3.8: LCD Display.

An LCD (Liquid Crystal Display) is a flat-panel display technology that uses liquid crystals to modulate light and create images or text. LCD displays are commonly used in electronic devices such as televisions, computer monitors, smartphones, and digital clocks. They offer high-quality visual output with sharp images and a wide range of colors. LCDs consist of pixels that can be individually controlled to display different colors and patterns. They are energy-efficient and come in various sizes and resolutions, making them suitable for diverse applications including information displays, user interfaces, and visual output in electronic devices.

Keypad

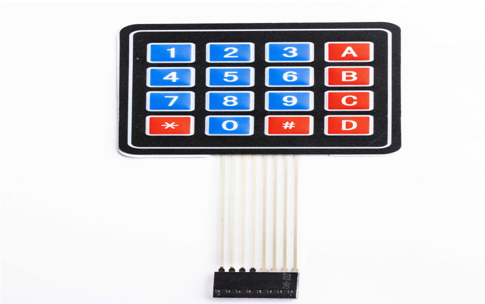


Figure 3.9: Keypad.

keypad, short for "keypad entry system" or "keypad input device," is a user interface component that consists of a set of buttons arranged in a grid or array. Each button typically represents a specific character, digit, or function. Keypads are commonly used for entering numerical data, text, or commands into electronic devices, security systems, and other applications. They can be found on devices like calculators, remote controls, security alarm panels, and ATM machines. Keypads provide a convenient and tactile way for users to input information, and they are often used in combination with other display technologies like LCDs to create user-friendly interfaces.

Power Supply

Figure 3.10: Power Supply.

A power supply is an essential electronic component that converts input voltage from a source, such as a wall outlet or a battery, into the required output voltage and current needed to operate various electronic devices. Power supplies provide the necessary energy to run everything from small gadgets to complex systems. They come in various forms, including AC-DC adapters for household devices, DC-DC converters for voltage regulation, and power distribution units (PDUs) for data centers. Power supplies ensure stable and reliable operation of electronics by delivering the appropriate and consistent electrical power for their functioning.

I2C module for lcd

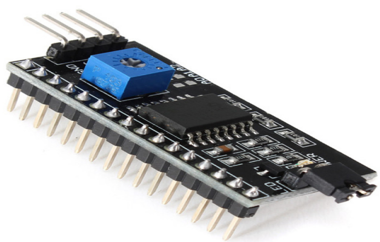


Figure 3.11: I2C module for lcd

An I2C module for LCD simplifies connecting and controlling an LCD screen using the I2C communication protocol. It reduces wiring by using fewer pins and is commonly used in projects with limited microcontroller pins. This module makes integrating LCDs into devices like IoT systems and robots easier and more efficient.

ESP32

Figure 3.12: ESP3

The ESP32 serves as a compact yet remarkable computer, adding an element of intelligence to your projects. With rapid processing and seamless Wi-Fi and Bluetooth connectivity, it stands as a versatile tool. Its pins allow you to integrate various components such as sensors and lights, while its robust memory effortlessly retains extensive data. By translating your instructions into action, the ESP32 transforms concepts into reality. Imagine crafting a plant watering system that communicates with your phone, autonomously nourishing plants when they require moisture. In essence, the ESP32 serves as an ingenious collaborator, amplifying your imaginative endeavors.

Single Channel Relay Module

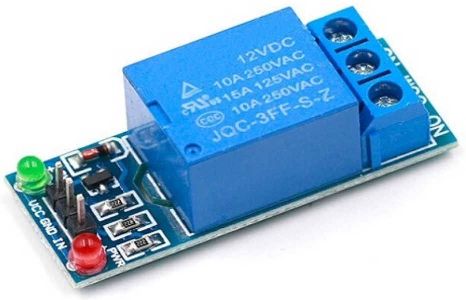
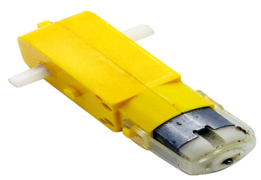


Figure 3.13: Relay

A single-channel relay is an electromechanical device used for switching or controlling electrical circuits. It typically consists of a coil, an armature, and a set of contacts. When an electrical current is applied to the coil, it generates a magnetic field, which attracts the armature and closes or opens the contacts. This action allows the single-channel relay to control the flow of electricity to a connected device or circuit. Single-channel relays are commonly used in a variety of applications, such as home automation, industrial control systems, and automotive electronics, to enable remote or automated control of electrical loads, such as lights, motors, or heaters. They are known for their simplicity, reliability, and versatility in providing an isolated switch for electrical circuits.

DC Gear Motor



(a) DC Wheel Motor

(b) DC Belt Motor

A DC gear motor is a compact electric motor with an integrated gearbox, designed for specific applications requiring controlled speed and increased torque. The combination of a direct current (DC) motor and precision gears enables precise and efficient motion control in devices such as robotics, electronic locks, and small appliances. These motors are known for their compact size, reliability, and versatility, making them ideal for applications where space is limited and precise movement is essential.

DC Water Pump

Figure 3.15: DC Water Pump

A 12-volt water pump for projects is a compact and lightweight device designed to efficiently move water using a 12-volt DC power supply. Ideal for small-scale applications such as DIY irrigation systems or water circulation in projects, this pump is portable, easy to install, and offers reliable performance. Its durable construction ensures longevity, making it a cost-effective solution for hobbyists and DIY enthusiasts seeking a simple and versatile water pumping solution for their projects.

3.4 How The System Works ?

Flow Chart

The Flow Chart given above illustrates the process of the project.

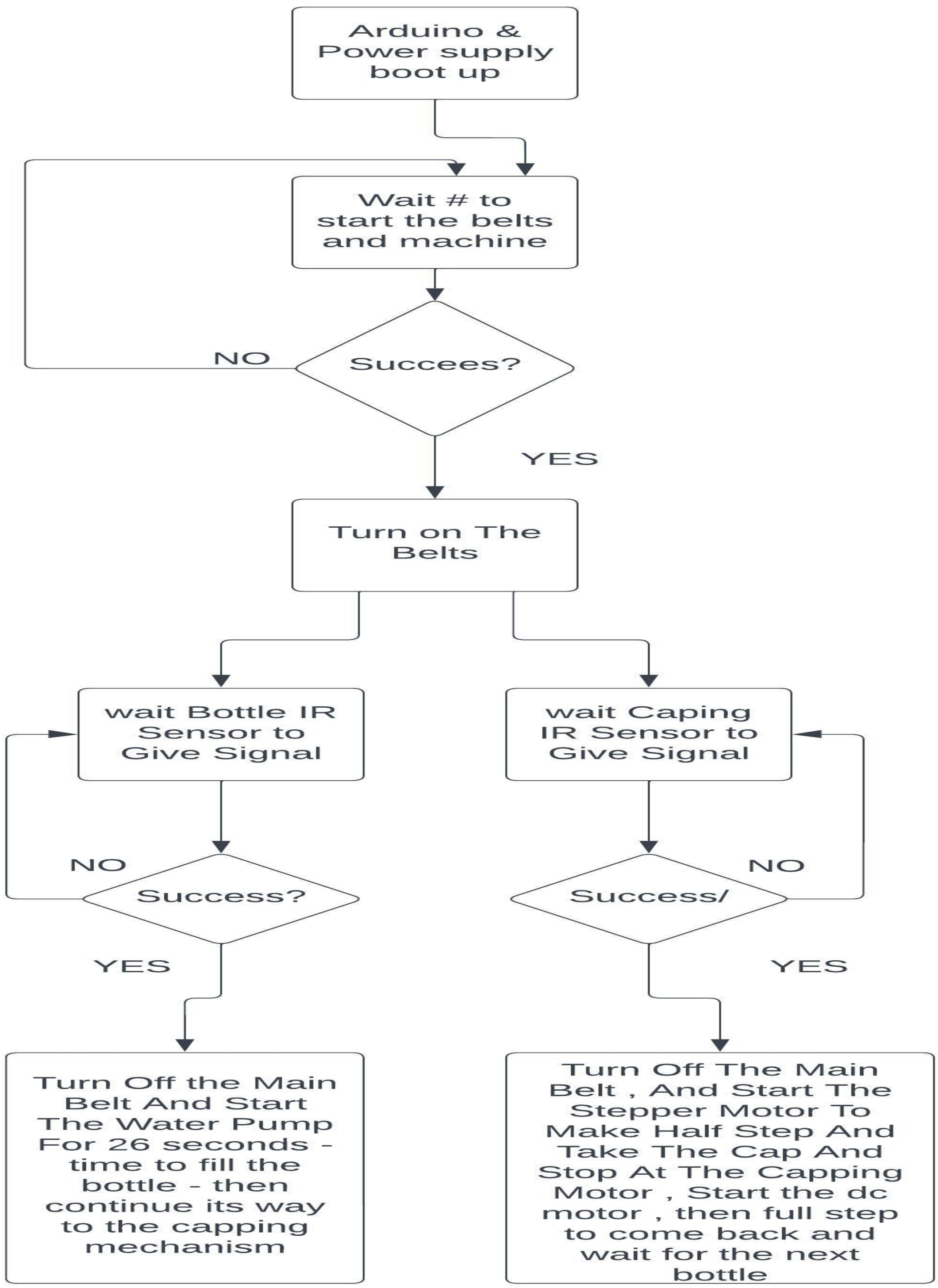


Figure 3.16: Flow Chart

3.5 3D printer links

Motor-Mount.stl

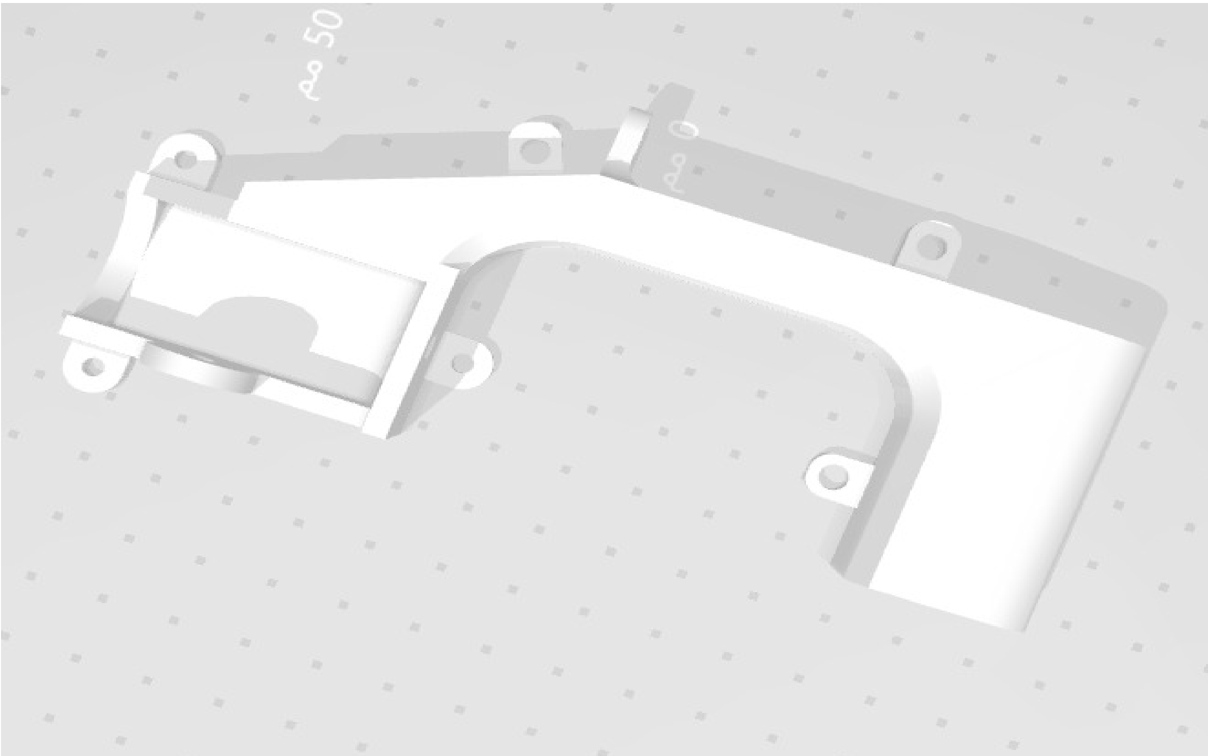


Figure 3.17: Motor Mount

Star-Wheel-example.stl

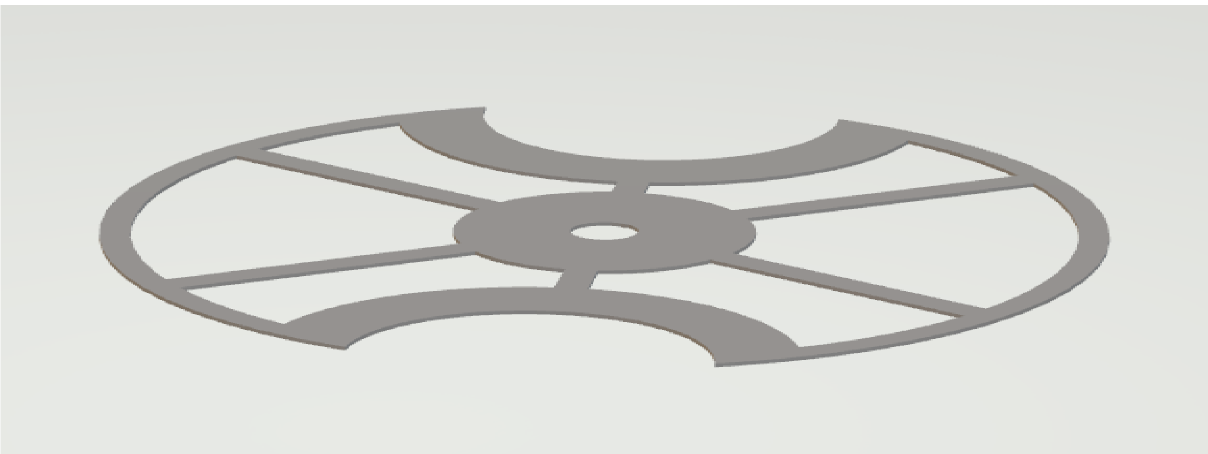


Figure 3.18: StarWheel-Layer

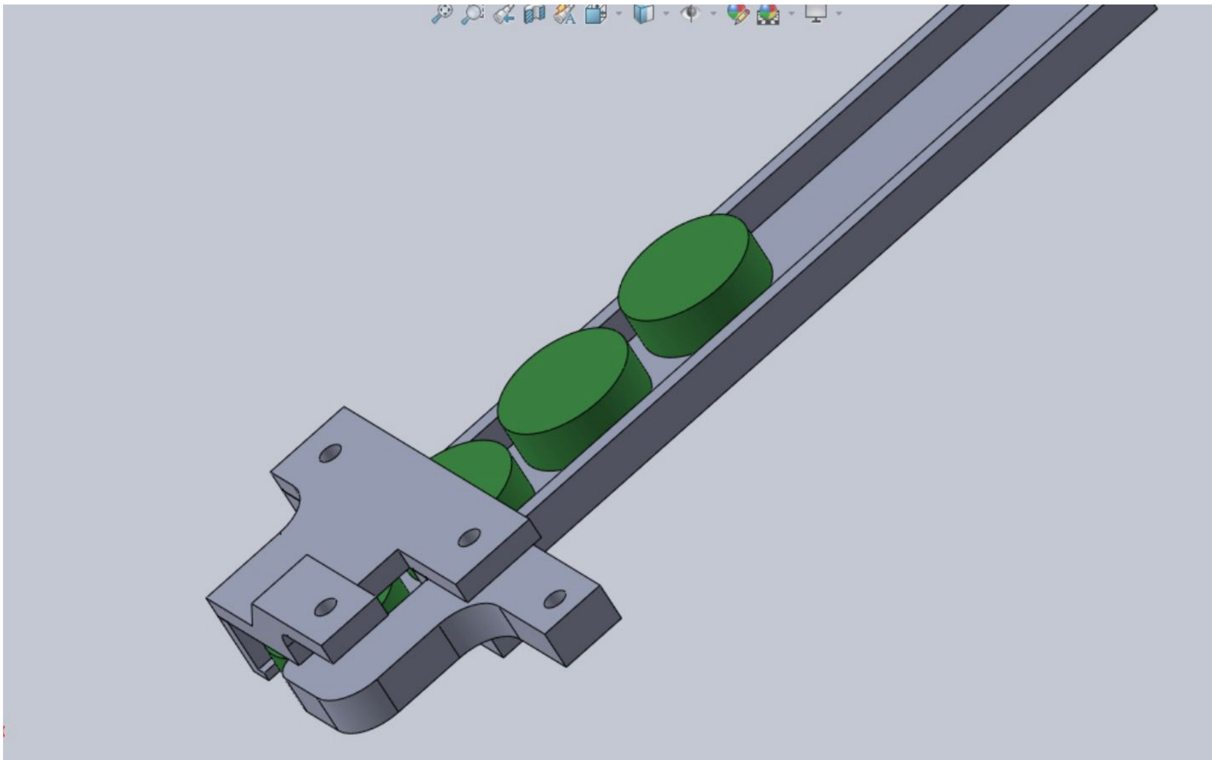


Figure 3.19: Slider

3.6 All Parts And full Project Assembled

Figure 3.20: All Parts Assembled

Chapter 4

Conclusion And Future Work

Contents

4.1 Conclusion

In conclusion , this project was made with high accuracy and a lot of work to maintain , eventually it could make the bottles filled and capped automatically without the help of human , which is a good impact on the working industry to use less hands on work and make the process automatic and giving less cost to produce bottled water .

4.2 Future Work

1- Make the project full automatic using robotic hand .

2- Adjustments for the accuracy for further faster work

3- Make the machine handle many sizes by a new mechanism which moves the slider and the motor mount up and down.

Chapter 5

Results And Discussion

Contents

5.1 Results

The water production line project fulfilled all its requirements and made the production of bottled water easier and achieved the following:

1- The bottles are filled and ready to use !

2- The project works as planned and the tools used are very efficient which have the mechanisms that were needed to provide the final product .

5.2 Discussion

Water production line most likely supplied the following:

1- Speed of work, achievement and accuracy of producing the bottled water .

2- Reliability in getting the job done.

Appendices

Appendix A: Arduino Code

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

const int ROW_NUM    = 4; // number of rows in the keypad
const int COLUMN_NUM = 4; // number of columns in the keypad

char keys[ROW_NUM][COLUMN_NUM] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};

byte pin_rows[ROW_NUM] = {9, 8, 7, 6};    // connect to the row pinouts of the keypad
byte pin_column[COLUMN_NUM] = {5, 4, 3, 2}; // connect to the column pinouts of the keypad

Keypad keypad = Keypad(makeKeymap(keys), pin_rows, pin_column, ROW_NUM, COLUMN_NUM);

LiquidCrystal_I2C lcd(0x27,  16, 2);
const int stepsPerRevolution = 200;
const int HalfSteps=100;
const int QuarterSteps = 50;
const int FullSteps = 102;
Stepper myStepper(stepsPerRevolution, 13, 10, 11, 12);
int dcmotorground=51;
int dcmotorvolt=53;
int bottlesensor=33;
int waterpump=31;
int cappingmotor=40;
int capppingsensor=24;
int flag = 0 ;
void setup() {
lcd.init();
lcd.backlight();
myStepper.setSpeed(10);

pinMode(dcmotorground, OUTPUT);
pinMode(waterpump, OUTPUT);
pinMode(dcmotorvolt, OUTPUT);
pinMode(bottlesensor, INPUT);
pinMode(cappingmotor, OUTPUT);
digitalWrite(waterpump, HIGH);
 Serial.begin(9600);
```

Figure 5.1: Arduino Code 1

```
 Serial.begin(9600);
}

void loop() {
 char x = keypad.getKey();
 if (x=='#' || flag ==1 ){
flag =1 ;
   Serial.println(x);
   digitalWrite(dcmotorground, HIGH);
digitalWrite(dcmotorvolt, LOW);

digitalWrite(cappingmotor, LOW);
capppingsensor = digitalRead(24);
  bottlesensor = digitalRead(33);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Water Production");
  lcd.setCursor(0,1);
  lcd.print("Line");

   if(bottlesensor == 0){
      delay(1900);
   stoptofill();
    }
      if (capppingsensor == 0){
          delay(4000);
          runthestepper();
          }
}
 }
void stoptofill(){
  lcd.setCursor(0,0);
  lcd.clear();
  lcd.print("Filling The");
  lcd.setCursor(0,1);
  lcd.print("Bottle");
digitalWrite(dcmotorground, LOW);
digitalWrite(dcmotorvolt, LOW);
delay(750);
digitalWrite(waterpump, LOW);
delay(13000);
digitalWrite(waterpump, HIGH);
delay(500);
digitalWrite(waterpump, LOW);
```

Figure 5.2: Arduino Code 2

```
digitalWrite(waterpump, LOW);
delay(13000);
digitalWrite(waterpump, HIGH);
delay(500);
digitalWrite(dcmotorground, HIGH);
digitalWrite(dcmotorvolt, LOW);
}
void runthestepper()
{
lcd.setCursor(0,0);
  lcd.clear();
  lcd.print("Capping The");
  lcd.setCursor(0,1);
  lcd.print("Bottle");
digitalWrite(dcmotorground, LOW);
digitalWrite(dcmotorvolt, LOW);
myStepper.step(HalfSteps);
digitalWrite(cappingmotor, HIGH);
delay(6000);
myStepper.step(FullSteps);
delay(200);
digitalWrite(cappingmotor,LOW);
delay(2000);
digitalWrite(dcmotorground, HIGH);
digitalWrite(dcmotorvolt, LOW);
}
```

Figure 5.3: Arduino Code 3

Appendix B: Materials Specification

Component	Quantity
NEMA 17 Stepper Motors	1
DC Motors	3
IR Sensor	2
Arduino Board	1
Keypad	1
LCD Display with I2C	1
L298N Motor Driver	2
Relay	2
Water Pump	1

Table 5.1: Component Quantity