An-NAJAH NATIONAL UNIVERSITY

FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY

DEPARTMENT OF COMPUTER ENGINEERING

Hardware Graduation Project

Soap Stream

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Disclaimer

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Abstract

This project highlights the challenges faced by small businesses and local producers in liquid hand soap production by developing a cost-effective and automated system that is designed for small-scale operations, particularly in rural areas. The system automates the whole process beginning with ingredients dispensing to mixing them and finally bottling and capping the final product, using low-cost and off the shelf components.

The system used ultrasonic sensors to measure ingredient volumes to be dispensed using pumps and valves controlled by relays for precise dispensing of the ingredients,and used stepper motors controlled by L298N motor driver to dispense specific amounts of coloring and fragrance depending on the user's choice, a drill motor was use in the mixing process. A conveyor belt system, controlled by LDR-laser pairs to control the stop stations for each stage in the bottling and capping, servo motors were used to handle the mechanism where the cap is dropped to the bottle, and stepper motor holds a dc motor and lefts up or brings it down to seal the cap and tighten it.

Though the testing process, our system showed its ability to maintain the product quality and reduce human intervention as possible. despite all the challenges we faced during the process of developing this system such as some components malfunctions and restricted access to resources, our project achieved its objectives.

Some Future enhancements include improving the system to handle different sizes of bottles, raw material handling in a more automated way, and scaling up the capacity of the current system.This project is a good representation of a significant step toward automating the liquid hand soap for small-scale producers, as it offer more practical and cost effective solution.

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Chapter 1

Introduction

1.1 Problem Statement

Despite the fact that large factories that produce liquid hand soap do exist, small businesses and local producers are left behind,struggling with manual methods and lack of access to automation. our project fills this gap by designing a relaible and user friendly automated system for liquid hand soap production.

1.2 General Background

Liquid hand soap is one of the most used products in daily life, a product that helps to improve cleansing the skin surface and sanitizing it by destroying microbes, preventing the spread of diseases.

For the essential roles it plays, the demand for liquid soap continues to grow, and large burden is placed on manufacturers due to the requirement of producing high-quality products efficiently and sustainably.

While large-scale factories have taken over the industry, smaller producers face many hardships, often relying on manual processes that are less consistent, slower, and more susceptible to contamination. Automated manufacturing made big changes in Industrial production in general, considering enhancements in various aspects of the industry, such as precision, labor cost reduction, and optimizing consistent product quality. And, as many other products, the production of liquid soaps is to be improved by integrating automation into the process, allowing to streamline the process, from ingredient dispensing and mixing to bottling and capping, while maintaining high hygiene standards. This project is considered an attempt to bridge the gap between industrial setups and manual methods, by establishing an automated system adapting to smaller-scale production.

1.3 Objectives of the work

The primary objective of this work is to implement an automated system for producing liquid hand soap efficiently. **The system aims to:**

- Streamline Production:
- Ensure consistency:
- Promote Hygiene : by minimizing the human intervention in the production process
- Increase accessibility:

1.4 Significance of the work

In the past years , the spread of infectious diseases around the world has been faster than ever , hence the awareness of personal hygiene and the need to eliminate germs has increased , leading to an expansion in sanitary products market , and specifically liquid soaps.Looking into market reports, the liquid soap industry is projected to grow significantly in the coming years, as a result of rising health concerns and changing consumer needs.

This project holds forth to the need for an automated system suited for small-scale production, that is to be efficient and hygienic at the same time.
This will give the ability to move away from relying on large industrial set ups, reducing the cost, and having more efficient production lines with high-quality standards actively maintained, presenting more accessible solutions in the market. The innovation aims to optimize precision , cost-effectiveness and the support of scalable production, which promotes modern manufacturing in the personal care field.

1.5 Organization of the report

This report was well structured to explain how our system works, starting with an introduction and stating the problem that made us consider working on this project, and then we gave a grief background about our system. Then in the literature review chapter, we discussed the previous work and the researches done related to our project. From there, we go to the methodology chapter in which we described and gave a detailed about the our system structure, the hardwar components and what every component was used for, then we described how exactly our system works and we explained briefly how our software is implemented. After that in the Results and Analysis chapter we stated out the results that came out from testing the project. This chapter was followed by discussion and finally in the conclusion section we stated our conclusion and mentioned some future work that can be done.

Chapter 2

Theoretical Background and Previous Work

2.1 Theoretical Background

Automation has notably changed manufacturing by joining advanced technologies to replace manual labor. As a result of this integration, precision is enhanced, costs are reduced, and consistency in production is achieved [1].

Liquid hand soap production consists of several stages :

- Ingredient Measurement :accurate quantities of ingredients
- Mixing: ensuring a blending that maintains the quality of the product.
- Bottling and Capping: Filling bottles and sealing them tightly.

It's important to maintain quality control and hygiene standards during the three stages to come out with the best result that meets the consumer expectations.

A production line can't be one without the Conveyor belt, it provides smooth transport of materials between the stages in the whole process, which enhances efficiency and minimizes the human intervention and as a result it reduces the contamination risks.

2.2 Previous work

Automation has been adopted by large-scale soap factories so that the efficiency is improved and hygienic standards are met. Automated process handles all the steps ranging from dispensing ingredients to packaging, resulting in reduced labor costs and high-end product quality. However, the complexity and high prices of such systems make them unreachable to small producers.[2]

Projects that focus on making the liquid soap production automated have revealed that it is really possible to integrate components like mixers, conveyors, and filling machines.

The development of low-cost automation for soap making has been discovered, aiming to design systems that include mixing materials, and mechanisms for filling and capping the soap.[3] Materials and automation that are locally sourced help to reduce the costs of production, and boosts efficiency for the small-scale soap system as Dickson et. al stated [4].

Similarly, the concept of small-scale factories or systems demonstrates that flexible and decentralized production systems really reduce the waist and help people in rural areas and they also can adapt to market changes.[5].

Building on insights from these previous studies, our project integrates hardware components to automate the process of soap-making. This study aims to enhance the ease of access and efficiency of soap making at a small scale.

Chapter 3

Methodology

3.1 System Structure

Our System for liquid hand soap making consists of multiple interconnected components that work together to dispense, mix, bottle and seal the final product. This system follows a structured process to ensure everything works well.

3.1.1 External structure of the machine

3.1.2 Ingredient Dispensing Stage

In this stage all the components will work together to dispense our product ingredients from the 3 main compounds of our soap.

Figure 3.1: ingredients Containers

3.1.2.1 Pumping system

This system starts by activating the pumps and valves that are connected to three separate ingredients containers, each pump is responsible for dispensing a specific value of liquid to the mixer, depending on the values read by the ultrasonic and the specified amount for our very special soap recipe. Each pump and valve is connected to a relay to control its operation.

Figure 3.2: pumps and valves

Figure 3.3: pump and valve

3.1.2.2 Secondary ingredients

This part is the one who is responsible for the additives dispensing such as color and fragrance, depending on the user choice through the application it decides one color with its smell and the two motors dispense a specific amount like 1 10ml of smell and 0.5ml of coloring.

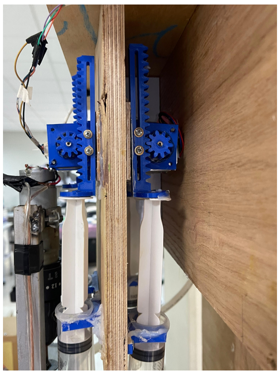

Figure 3.4: Color and smell dispensing

Figure 3.5

3.1.3 Mixing Process

once all the ingredients have been dispensed into the mixing chamber, the Drill motor well be activated using a relay it keeps blending like for 2 minutes. This stirrer ensures to achieve a uniform liquid soap consistency.

Figure 3.6: Mixer

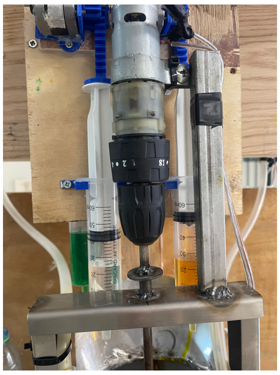

Figure 3.7: Mixer Motor

3.1.4 Bottling Stage

This stage is dedicated to handle the bottling and capping stage, in this part of our system, a conveyor belt system will move the empty bottles to continue the process.

3.1.4.1 Pushing the Bottle

In the part we printed some 3D parts to handle pushing the empty bottles to the conveyor belt, a stepper motor is responsible for that.

Figure 3.8: Pushing empty bottle system

3.1.5 Dispensing the final product

After the Mixing is done and the product is ready to be bottled, the mixer is connected to a pump and valve so that when the bottle from the conveyor belt process arrives at its specified spot, this liquid is dispensed through them to the bottle.

Figure 3.9: the Pump that pumps the final product

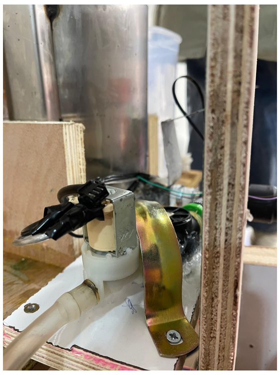

Figure 3.10: 220v Solenoid Valve

3.1.5.1 Filling the Bottle

After the bottle is pushed, the belt moves the empty bottle into position under the dispensing hose, an ldr and laser are responsible for stopping it when its detected. The soap well be dispensed through a pump and a solenoid 220volt valve and the flow sensor verfies that the bottle has received the correct amount of soap.

Figure 3.11: Filling the bottle

3.1.5.2 Capping the Bottle

Once the bottles are filled they proceed moving on the belt to the capping station, the second ldr and laser detect the bottle and stops the belt at this stage.

3.1.5.3 Dropping the cap

First part of this process is that the cap being dropped at the bottle two servo motors well control this process ....

Figure 3.12: Capping Process Stage 1: Dropping the Cap

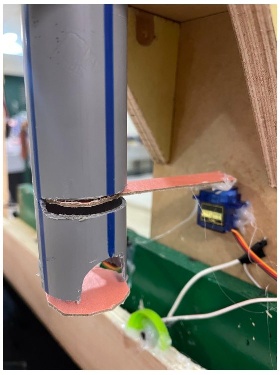

Figure 3.13: Capping Process Stage 1: Dropping the Cap

3.1.5.4 Sealing the cap

After the cap is dropped and positioned on its place, the bottle proceeds to move to arrive to the final stage were the cap is sealed here using a stepper motor that holds the a dc motor that is connected to a rod and this rod is connected to a 3D-printed caps holder, the stepper moves this holder down, when it reaches the bottle, the cap is seald using the dc motor that turns it around and after it finishes it comes up and the bottle move forward and then sops, and voila the final liquid hand soap is ready to use!

Figure 3.14: Capping process Stage 2: Sealing the Cap

Figure 3.15: Capping Process Stage 2

3.2 Hardware components

3.2.1 Arduino mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.[6].It is widely used in larger projects requiring more resources, such as robotics, automation, or multi-sensor systems, and is compatible with the Arduino IDE, making it accessible for developers of all levels.

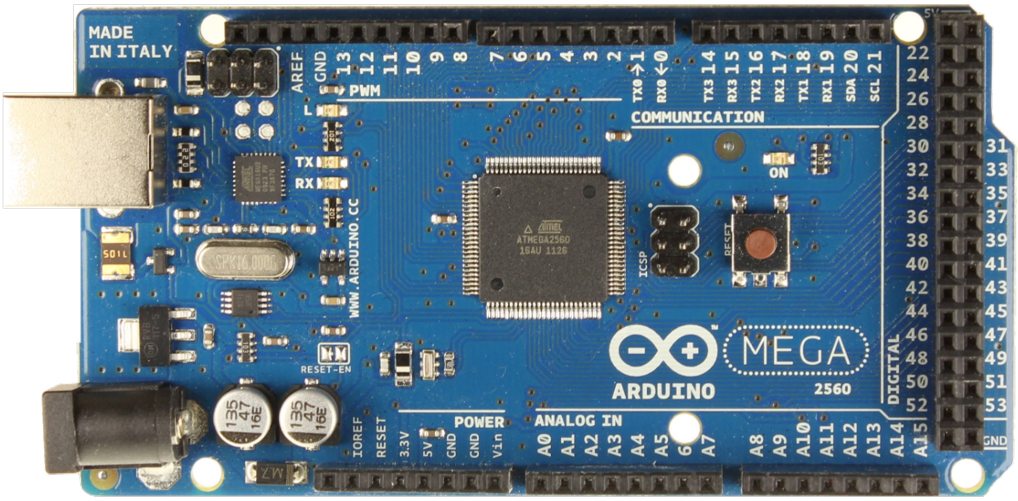

Figure 3.16: Pinout diagram of the Arduino Mega 2560

3.2.2 Power Supply

A pc power supply is used to provide power to all hardware components in our system. It converts the high-voltage AC power from the mains into low-voltage DC power suitable for the connected devices. With multiple output voltage levels, such as 12V, 5V, and 3.3V, it can simultaneously power components like motors, sensors, and control circuits, ensuring stable operation.

Figure 3.17: Pc Power Supply

3.2.3 Plastic containers

We have used three plastic containers to hold the main ingredients of our product before being dispensed,they contain water, glycerin and Texapon or SDES. these ingredients are later dispensed at the start of the production process, it will be discussed later.

Figure 3.18: Plastic container

3.2.4 Pumps

Water pumps were connected to each storage container to ensure a steady and controlled flow of the liquids. They were responsible for transferring ingredients from containers to the mixer (through the valves), automation of the pumps ensured accuracy in this process. We chose this pump for its ability to handle the ingredients effectively.

Figure 3.19: Pump

3.2.5 Hose

A plastic hose was used to connect valves and pumps together, ensuring that the ingredients are then transferred to the mixer.

Figure 3.20: Hose

3.2.6 Valves

Our system used solenoid valves, they are designed to face high pressure, and its design allows for precise control of liquid flow. They are opened and and closed as needed during the process to prevent leaks, they are being controlled by relays to do so. we used three valves that operates on 24 volt for the three ingredients of our product as shown in 3.21.

A 220 volt solenoid valve with a 0=pressure design was used to dispense the final product into bottles 3.22. Its was selected for its ability to operate well under low-pressure conditions.

Figure 3.21: 24v Valve

Figure 3.22: 220v Valve

3.2.7 Relays

A relay is an electrically controlled device that opens and closes electrical contacts, or activates and deactivates operation of other devices, in our project Relays are used to act like switches to control the operation of pumps and valves.

By receiving orders from the Arduino, they allow precise control over when the ingredients are dispensed or not. we used in total six relays, 2 relays each-channel and one relay 4-channels for pumps and valves. we also used three relays each 1-channel for mixer, the soap valve and the soap pump.

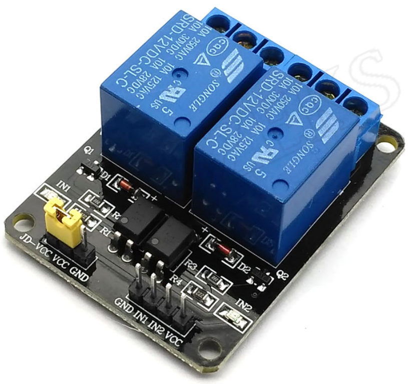

Figure 3.23: Realy

3.2.8 HC-SR04 UltraSonic

This sensor can send eight 40 kHz and detect whether there is any pulse signal back.If it back, a high level signal will be outputed by IO, and the duration of the signal is the time from sending ultrasonic to returning. The modules includes ultrasonic transmitters, receiver and control circuit. There are 4 pins out of the module : VCC , Trig, Echo, GND. So it's a very easy interface for controller to use it ranging.[7] In our system this sensor measured the distance to the liquid level to determine the exact volume of ingredients dispensed. It provided a real-time feedback to the system, ensuring the dipensing process is stopped when the exact value was reached.

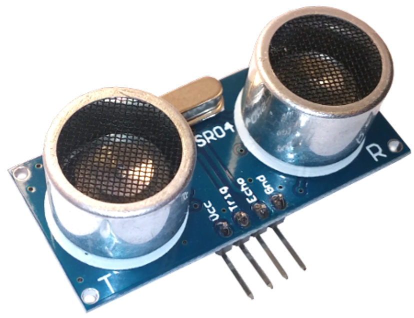

Figure 3.24: Ultrasonic Sensor

3.2.9 Stepper Motor

This motor needs 200 steps to complete a revolution and these steps have an accurate angle of 1.8 degrees per step. Its coils can take a maximum current rating of 3.5 A each and one can also apply voltage inputs that range from 3 to 12 volts. In our system it was used in different stages, four stepper motors were used in the coloring and smell dispensing, they are connected with syringes to dispense a specific amount of each one of them, we defined the quantities by controlling the motor steps.

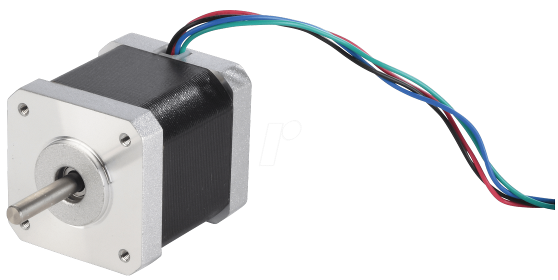

Figure 3.25: Stepper Motor Nema17

3.2.10 Syringe

Four syringes was used in this system, tow for holding colorants, and the other 2 for fragrances. they are connected to a stepper motor using a 3D-printed toothed (gear-like) that moves along a toothed (rack-like) track.

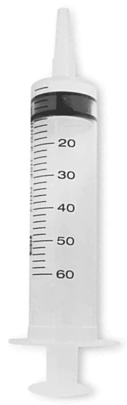

Figure 3.26: Syringe

3.2.11 Cordless Drill Motor

We used a drill motor as the mixing mechanism for the soap production process, it was operated at 3.3 volt to reduce the speed, to ensure a slow and controlled mixing of the ingredients. this step was necessary to avoid creating excess foam while mixing.

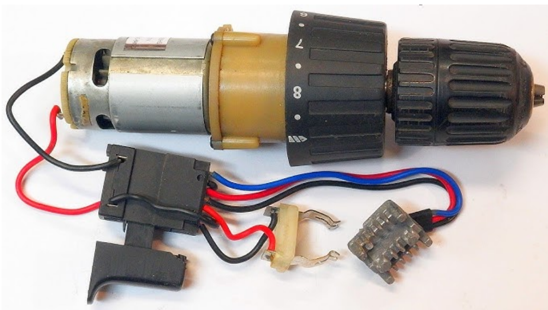

Figure 3.27: Cordless Drill Motor

3.2.12 Flow Sensor

The Water Flow sensor measures the rate of a liquid flowing through it. The YF-S201 water flow sensor consists of a plastic valve body, flow rotor and Hall Effect sensor. It is usually used at the inlet end to detect the amount of flow. When liquid flows through the sensor, a magnetic rotor will rotate and the rate of rotation will vary with the rate of flow. The Hall Effect sensor will then output a pulse width signal. In this project we will interface this sensor for measuring the flow rate of our final product so that only 500ml is dispensed which is the size of our final product bottles.

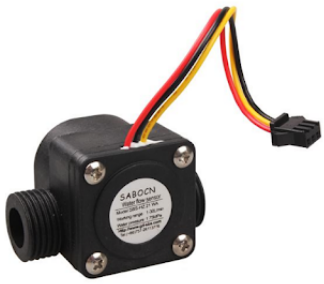

Figure 3.28: Flow Sensor

3.2.13 L298N Motor Driver

The L298N module has two H-Bridges. Each H-bridge drives one of the electromagnetic coils of a stepper motor.
By energizing these electromagnetic coils in a specific sequence, the shaft of the stepper can be moved forward or backward precisely in small steps. we used 6 h-bridges in our project 4 for the syringes one for the stepper motor for pushing the bottles and another one for the Dc motor. it's operated on 12 volt from the power supply and the four INs will be connected to the Arduino.

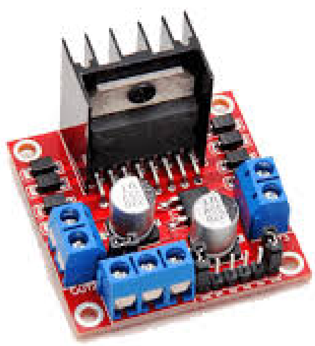

Figure 3.29: L298N Motor Driver

3.2.14 BTS7960 - 43A H-bridge Driver

The BTS7960 is a fully integrated high current H bridge module for motor drive applications. Interfacing to a microcontroller is made easy by the integrated driver IC which features logic level inputs, diagnosis with current sense, slew rate adjustment, dead time generation and protection against overtemperature, overvoltage, undervoltage, overcurrent and short circuit.

[8] This driver was used to control the movement of the wiper motor that is connected to the conveyor belt and control its movement and speed, the conveyor belt is responsible for the movement of the bottle so that ii can be filled and capped.

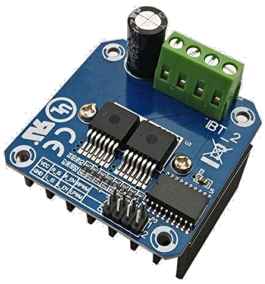

Figure 3.30: H-Bridge Driver

3.2.15 YS-DIV268N-5A Driver

The YS-DIV268N-5A is a hybrid stepper motor driver designed to control two-phase hybrid stepper motors with a current range of 0.2–5A. in our project we have connected the stepper motor that holds the rod that holds the 3d thing that twists the cap on the bottle, this stepper motor moves down to place the cap on the bottle waits fir it to be sealed and then it goes up so that the bottle can continue its movement.

Figure 3.31: Driver for stepper motor

3.2.16 Servo Motor

A servo motor is a motor that provides a control over angular or linear position,speed Two servo motor were utilized in the capping process in this project.

Figure 3.32: Servo Motor

3.2.17 LDR Sensor Module

The LDR Sensor Module is used to detect the presence of light / measuring the intensity of light. The output of the module goes high in the presence of light and it becomes low in the absence of light. We used 3 LDRs at the conveyor belt stage, the first ldr used was to detect the presence of a bottle at the final soap dispensing spot with a laser that points to it, the second one is at the first stage of capping process were the bottle stops so that the cap is dropped on it, the final one is for the second stage of capping and the final stage of the project where the bottle with the cap stops, so that the cap is sealed tightly and it's now ready to be consumed by users.

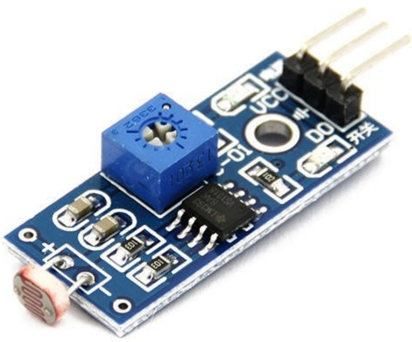

Figure 3.33: LDR Module

3.2.18 laser Module

A device that emits a single static laser beam of a single or multiple wavelengths.

Figure 3.34: Laser Module

3.2.19 Dc motor with gearbox

A DC motor was used, mounted on a gearbox, to securely tighten the bottle cap. It allows controlling torque and speed reduction so as to make sure that the cap is sealed properly but not over-tightened. The motor is attached to a rod, which transfers rotary motion through it to a 3D-printed holder of the cap to seal every bottle precisely and consistently in the production process.

Figure 3.35: Dc Motor with Gearbox

3.3 Mobile app

We created our application using App Inventor, to allow users tot chose the color they want and how many soaps they need.

3.3.1 Start Page

This is the first page in the application, it contains the startbutton to start the production of soap

Figure 3.36: Start Page

3.3.2 User Page

When the user clicks on start on the first page it will open this page so that he can choose the color he prefers, and specify the amount of soaps he would like to create. this page also Shows the level of ingredients in the containers to the user so that he knows that there is a good quantity that can make the needed number of bottles.

Figure 3.37: User Page

3.4 How the system works

The automatic liquid hand soap manufacturing system works in a progressive manner, to ensure precise dispensing,mixing and bottling.Arduino and esp32 are connected to power, the application is opened on a phone which is connected to the network provided by esp, the system is ready to be used by the user, Through the mobile application the user clicks on start and then he chooses the color of soap that he wants to produce and the number of bottles he wants.The flowchart shown in 3.38 describes how the system works in general.

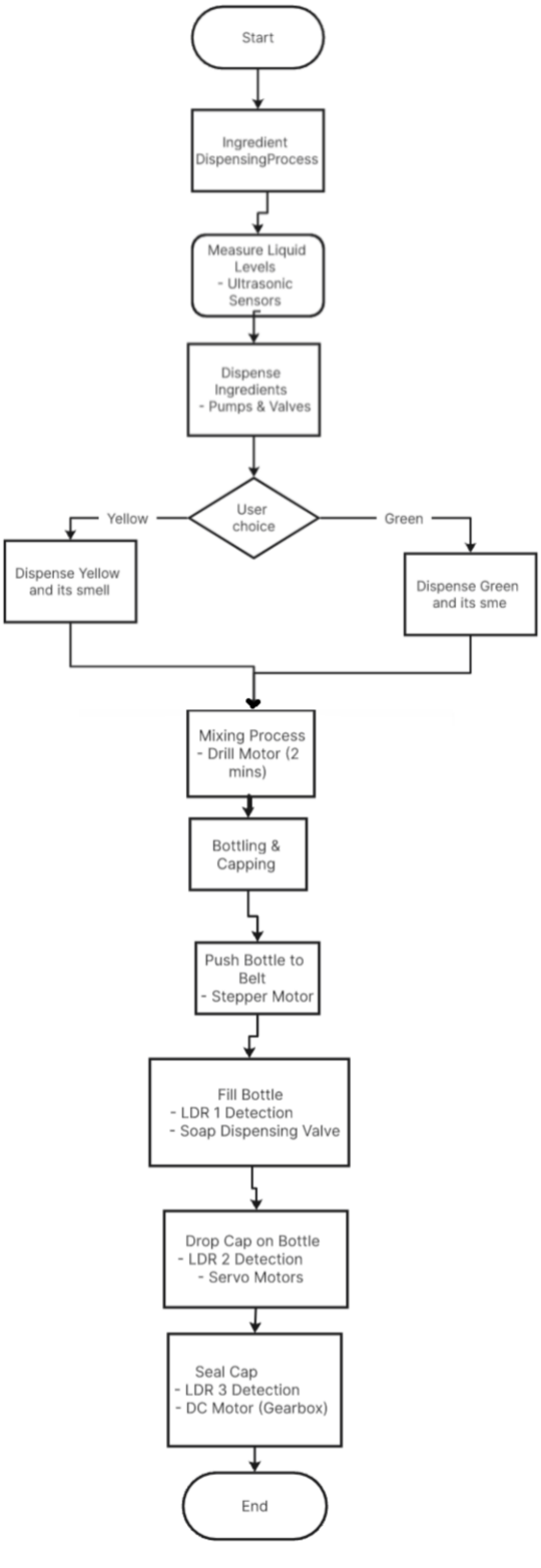

Figure 3.38: System Flow Chart

3.4.1 Ingredient Dispensing Stage

This stage ensures accurate dispensing of the three primary soap ingredients (water, glycerin, and Texapon) and secondary additives (color and fragrance). **Ultrasonic Level Monitoring:** Three HC-SR04 ultrasonic sensors measure the liquid level in each container. The Arduino calculates the volume based on the distance readings and cross-checks against the recipe's required quantitiesso that the exact quantity of each is dipensed.

Pump and Valve Control:

The Arduino activates relays to power 24V solenoid valves and pumps, allowing precise control over ingredient flow.

Each ingredient is dispensed sequentially (water → glycerin → Texapon) to avoid cross-contamination.

Additive Dispensing:

Two NEMA17 stepper motors (controlled by L298N drivers) push syringes containing color and fragrance.

The user's selection (green/yellow) determines the steps taken by the motors, ensuring exact additive volumes (e.g., 10 mL fragrance, 0.5 mL color)

3.4.2 Mixing process

after all the ingredients is transferred to a holding tank connected to a 220V solenoid valve, the Arduino triggers a relay to power the cordless drill motor operating on 3.3 volt to reduce its speed to avoid reducing excess foaming, and it keeps mixing for 2 minutes to make sure that everything is mixed together at the end of this process the liquid hand soap is done and ready and it's waiting to be filled in bottles.

3.4.3 Bottling and Capping

The conveyor belt system automates bottle handling using :

- **Bottle positioning** :

- a stepper motor that is connected to an L298N driver is also connected to a 3D printed mechanism to hold the bottles and to Push them into the belt. - Three LDR-laser pairs halt the conveyor at critical stages: Filling Station: Stops under the dispensing valve. Capping Station: Positions the bottle for cap placement Two servo motors drop caps onto bottles. Servo 1 rotates to release the cap, while Servo 2 adjusts alignment for the next cap to be dropped and ready to be used. Sealing Station: Aligns the cap for final tiThe Arduino Mega 2560 coordinates all components via relays, motor drivers, and sensor inputs.ghtening where A geared DC motor (12V, 30 RPM) tightens the cap. The motor is mounted on a lead screw-driven platform (controlled by a stepper motor) to lower/raise the capping mechanism. The Arduino Mega 2560 coordinates all components via relays, motor drivers, and sensor inputs.

3.5 Constraints and limitations

3.5.1 High Cost:

our project contained a huge number of components and their cost was relatively high, and additional expenses were because some of the components were damaged or burned out after testing, and they were replaced.

3.5.2 Hardware Malfunctions

we faced Valve Reliability Issues were the valves malfunctioned and we had to replace them, and they were not opening/closing properly. To overcome this problem we switched to higher-quality solenoid valves.

3.5.3 Wiring and Hardware Integration

When we first started, we were less experienced in wiring and connecting the components as needed.

3.5.4 Software Development Challenges

Writing and debugging the Arduino code for the entire system was a significant challenge. Coordinating multiple components like pumps, valves, motors, sensors, required precise timing and error handling. but we have organized everything in functions.

3.5.5 Restricted Movement

It has been challenging to access the project workspace in college, as much as planned due to restrictions that are put upon us by the occupation and the multiple checkpoints that the Palestinian citizens had to get through.

3.5.6 Environmental and Safety Concerns

we faced some issues like liquid spilling due to pumps and valves malfunctioning, in addition our system involved a high-voltage components such as the 220 volt valve, so we insulated the valve relay.

3.6 Standards / Codes

- We developed our code using Arduino IDE, enabling us to control the hardware components.

- We designed our mobile application using the App Inventor platform, providing users with the ability to control the system remotely.

- For communication, message queueing telemetry transport was our protocol, ensuring reliability and efficiency in data transmission.

Chapter 4

Results and Discussion

In this chapter, we will present the results of our project. The system was tested to evaluate its performance in dispensing, mixing, bottling and capping. We summarized and analyzed the data collected during testing. To evaluate the accuracy and efficiency of the system.

The primary goal of our project was to make the production of liquid hand soap automated,ensuring high quality and reducing labor and human intervention, and our results stated that the system achieved the goal successfully.

The ingredient dispensing stage was assessed based on the accuracy of the measurements of volumes. our system was designed to dispense 600 mL of water, 50 mL of glycerin and 200 mL of Texapon to produce 850 mL of liquid soap if the user orders 1 bottle.
The ultrasonic sensors measured the liquid levels in the containers with an average error of ±2%.

Ingredient	**Target Volume (mL)**	**Measured Volume (mL)**	**Error (%)**
Water	600	588–612	±2
Glycerin	50	49–51	±2
Texapon	200	196–204	±2

Table 4.1: Ultrasonic Sensor Measurements

Pumps and valves operated in a reliable manner, with a dispensing accuracy of ±1.5%. There was some minor delays in the response time of the valves but it did not impact the process.

The mixing process was evaluated based on the uniformity of the final product. The drill motor operated at 3.3V to avoid the excess foam when its faster. The mixing process took 2 minutes as specified in the recipe. For the final product dispensing, the evaluation was based on flow sensor accuracy and the consistency of the product dispensed. The 220V valve and pump operated perfectly, no leaks or malfunctions occurred.

In bottling and Capping stage it was evaluated based on the accuracy of positioning the bottle, placing the cap and the sealing part, the LDR-laser pairs detected bottles with 100% accuarcy. The servo motors dropped the caps with 100% accuracy because of the Cylinde we installed to ensure the proper positioning of the cap. And the dc motor tightend the caps so well ensuring a secure seal without over-tightening.

Our project plays a role in automation and small-scale projects, as it demonstrates that it can be automated using affordable components which make this technology accessible to small businesses. And the use of sensors in it Highlighted the importance of real-time feedback.

Despite the huge success of this system it has several limitations that should be addressed in future, such as the malfunctioning of some components such as solenoids and pumps leading to delays and errors, error accumulation could cause serious issues for larger-scale systems.
Our system has proved its ability to dispense, mix, bottle, and seal soap bottles with high accuracy and efficiently.

Chapter 5

Conclusion and Future Work

5.1 Conclusion

In conclusion The automated liquid hand soap production system was developed to provide a small-scale, affordable, and accessible solution for small businesses and local producers. This project made a great success in demonstrating the feasibility of making the soap production automated using low-cost components, which make it suitable for individuals and small businesses with limited resources.

The system achieved some outcomes such as : accurate dispensing of ingredients using ultrasonic sensor and flow sensor, the drill motor provided consistent mixing and the conveyor belt system with the LDR-laser pairs ensured precise and reliable bottling and capping.

5.2 Future Work

While our current system successfully automates the liquid hand soap production, there are several chances to enhance it. Here are some key areas for future development:

- Enhancing the system to handle different sizes of bottles like larger than 500 mL capacity.
- Bottle detecting system to check if there is any bottle to e filled with the product before starting the process, it can be achieved by integrating additional sensor to detect the presence of bottles in the production line.
- Adding Quality control where bottles being inspected for defects after they are filled and sealed to ensure a consistent quality.
- Filling raw materials in the containers in an automated way without any human intervention in the process for long times.
- Scaling up the system capacity to make larger number of bottles.

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Appendix

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Text ....