

Hardware Project

September 2024



Faculty of Engineering & Information Technology

Computer Engineering Department

Hardware Graduate Project

Juice Machine

Students:

Abdullah Ghassan Sholi
Ala Derar Hamadneh

Supervisor:

Eng. Haya Samaa'neh

Acknowledgment

I would like to extend my heartfelt gratitude to everyone who supported and contributed to the development of the Juice Machine. Special thanks to my academic advisor for their invaluable guidance and feedback throughout this project. I am also deeply grateful to my family and friends for their unwavering support and encouragement. Additionally, I appreciate the open-source community and the developers behind the libraries and tools that made this project possible. Lastly, I thank all the beta testers whose insightful feedback helped refine and improve the application.

Abstract

The Juice Machine project is an innovative hardware solution designed to automate and optimize the process of juice preparation and packaging. The machine consists of four distinct stages, each meticulously designed to ensure the highest quality of the final product.

In the first stage, the juice mixer, different types of juice are combined in user-defined percentages via a sophisticated control unit, allowing for customized juice blends. The second stage involves the thorough mixing of the resulting juice to ensure a consistent flavor and texture.

The third stage provides the option for users to add pieces of ice to their juice, enhancing the refreshment factor. The final stage is dedicated to packaging the juice efficiently and hygienically, making it ready for immediate consumption or storage.

The Juice Machine project aims to deliver a seamless, user-friendly experience in juice preparation, combining automation with customization to cater to individual preferences.

Contents

1	Introduction	3
2	Constraints & Limitations	3
3	Literature Review	3
3.1	Automated Beverage Dispensing Systems	3
3.2	Juice Mixing Technologies	3
3.3	Ice Dispensing Mechanisms	4
3.4	Packaging Automation	4
4	Methodology	4
4.1	Introduction	4
4.2	System Architecture	4
4.2.1	Conveyor Belts	4
4.2.2	Fill Juices Stage	4
4.2.3	Mix Juices	5
4.2.4	Drop Ices Stage	6
4.2.5	Covering Glass Stage	6
4.3	Tools and Technologies	7
4.3.1	Arduino Mega 2560	7
4.3.2	Power Supply	7
4.3.3	IR Sensor	7
4.3.4	L298 Motor Driver	8
4.3.5	DC Gear Motors	8
4.3.6	Water Pumps& Water Flow Sensor	8
4.3.7	DC Motor	9
4.3.8	16x2 LCD	9
4.3.9	4x4 Keypad	9
4.3.10	Relay	10
4.4	Project Overview	10
5	Conclusion	11

6	Future Work	11
7	References	11

List of Figures

1	Conveyor Belts	4
2	Stage 1	5
3	Stage 2	5
4	Stage 3	6
5	Stage 4	6
6	Arduino Mega 2560	7
7	12 Volt 6A Power Supply	7
8	IR Sensor	7
9	Motor Driver	8
10	Gear Motors	8
11	5V Water Pumps and Water Flow Sensors	8
12	DC Motor	9
13	4x4 Keypad	9
14	4x4 Keypad	10
15	Relay	10
16	Project Overview	10

1 Introduction

The Juice Machine hardware project is an automated system designed to create and package customized juice beverages through a four-stage process. First, users select the glass size and specify the desired percentages of three different juices, which are then dispensed accordingly. The filled glass is transported on a conveyor belt to a mixing station where the juices are blended together. Next, the glass moves to an ice dispensing stage, where pieces of ice are added to the drink. Finally, the glass is packaged in the last stage, completing the process and readying the beverage for delivery or consumption.

2 Constraints & Limitations

- 1- Lack of time and difficulty in transportation to obtain certain parts, such as rubber strips and 3D printer components.
- 2- Difficulty in handling some electronic components because we haven't used them before, such as water flow sensors.
- 3- Finding an appropriate mechanism for all stages of the project with the simplest components.

3 Literature Review

3.1 Automated Beverage Dispensing Systems

Automated systems for beverage dispensing have been widely studied and developed across various industries, particularly in fast food and vending machine markets. Research highlights the efficiency and precision of automated dispensing systems in ensuring accurate portion control and minimizing waste. Technologies such as flow meters, digital sensors, and microcontrollers play a crucial role in these systems, enabling the precise measurement and distribution of liquids based on user input. In particular, user interfaces for customizing beverage components have evolved, incorporating touch screens and digital controls that allow consumers to select specific proportions of ingredients.

3.2 Juice Mixing Technologies

The mixing of liquids in automated systems has been an area of ongoing innovation. Research in fluid dynamics and mixing mechanisms has led to the development of various techniques to ensure homogeneity in multi-component beverages. Automated mixers often employ rotating blades, magnetic stirrers, or

static mixers that create turbulence to blend different liquids thoroughly. Studies have shown that the effectiveness of mixing can be influenced by factors such as the viscosity of the liquids, the design of the mixing chamber, and the speed of agitation.

3.3 Ice Dispensing Mechanisms

The integration of ice dispensing in automated beverage machines has been a focus of research aimed at enhancing user experience by providing chilled beverages on demand. Ice dispensing systems typically involve mechanical dispensers that release pre-measured quantities of ice into a container. The challenges addressed in the literature include preventing ice blockages, maintaining consistent ice quality, and ensuring efficient delivery without melting. Advances in sensor technology have also improved the accuracy of ice dispensing systems, allowing for precise control over the amount of ice added to each drink.

3.4 Packaging Automation

The final stage of automated beverage systems often involves packaging the product for delivery or consumption. Packaging automation has seen significant advancements, with research focusing on improving speed, accuracy, and flexibility. Automated packaging systems use robotic arms, conveyors, and sealing machines to handle containers with minimal human intervention. Studies have explored various materials and techniques for packaging that ensure the freshness and safety of beverages while maintaining cost efficiency. The integration of packaging processes with upstream operations, such as filling and mixing, is crucial for maintaining the overall efficiency of the system.

4 Methodology

4.1 Introduction

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

4.2 System Architecture

4.2.1 Conveyor Belts



Figure 1: Conveyor Belts

A flat belt conveyor, shown in figure a, supports the glasses as a placement structure and carries them forward sequentially onto the water pumps to be filled with different juice percentages , then onto next stage to mix the juices, then to ice drop stage and then to the last stage for cover the glass. 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 Carton. Consequently, only two rollers in either side can facilitate the movement of the belt well.

4.2.2 Fill Juices Stage

The first stage is consist of 3 containers which contain different type of juices which allow user to insert the glass size & his percentage of each juice via keypad & lcd display , also there is water pumbs, water flow sensor & pipes for control the volume of liqued from each container and fill them inside the glass,

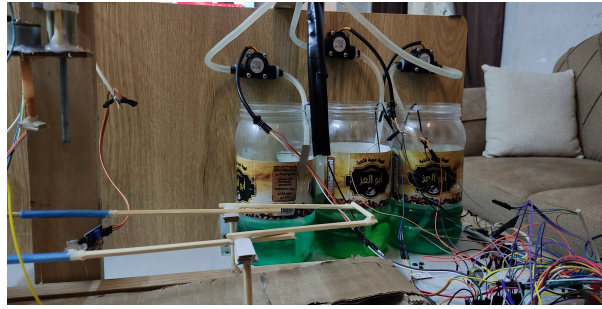


Figure 2: Stage 1

once the glass filled with liqued the conveyor belt star work and pass the glass to the next stage, for mix the juices.

4.2.3 Mix Juices

This stage is consist of 3 parts, the first part is the ir sensor which detect the glass comming from stage 1, when the ir sensor detect it , stop the conveyor belt, the second part is linear actuator idea which allow us move the mix motor up-down depend on the glass size , when the glass detect this motor start go down , once it's be on the correct glass height, the third part start work (which is simple motor works as molinix to mix the juice). after it finish the motor go up , then the conveyor belt star work , and pass the glass to the next stage , for drop piece of ice.

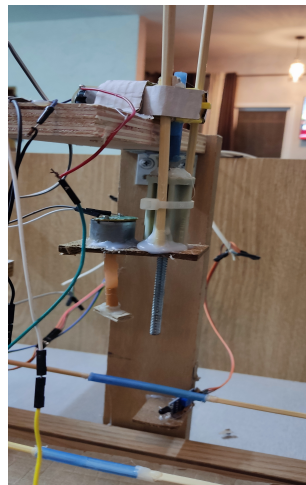


Figure 3: Stage 2

4.2.4 Drop Ices Stage

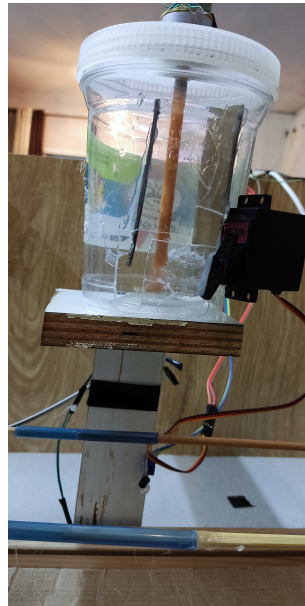


Figure 4: Stage 3

The stages consist of 3 components also, the first is ir sensor which detect the glass coming from stage 2 via conveyor belt, once it detect the glass the conveyor belt stop , the second part is servo motor is work as door controller, open when glass stopped under the container, then the third part start work , which push the piece of ices , after that the servo motor close the door, and conveyor belt start work and pass the component to the last stage for cover the glass.

4.2.5 Covering Glass Stage

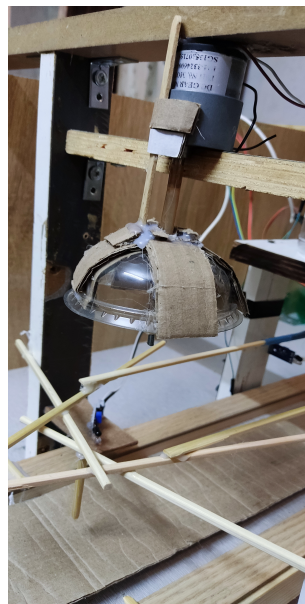


Figure 5: Stage 4

This stage we build it depend on Linear Actuator idea , which consist of two components the cover & DC Gear Motor, We use the dc gear motor because it's purpose is provide high torque enough to close the glass, & go down-up depend on the glass size .

4.3 Tools and Technologies

Our juice machine 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 juice machine 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.

4.3.1 Arduino Mega 2560

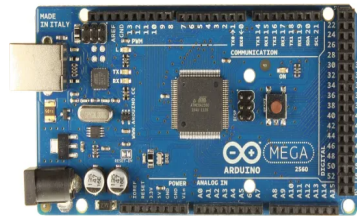


Figure 6: Arduino Mega 2560

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 Integrated 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.

4.3.2 Power Supply



Figure 7: 12 Volt 6A Power Supply

This power supply which we use it for provide the enough power to all our project components.

4.3.3 IR Sensor

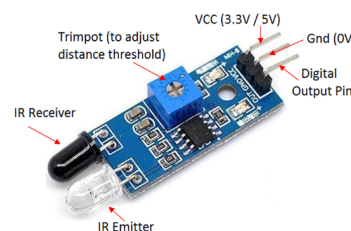


Figure 8: IR Sensor

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.

4.3.4 L298 Motor Driver

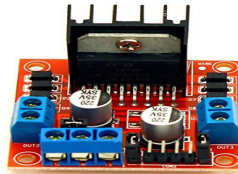


Figure 9: Motor Driver

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.

4.3.5 DC Gear Motors



Figure 10: Gear Motors

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.

4.3.6 Water Pumps & Water Flow Sensor

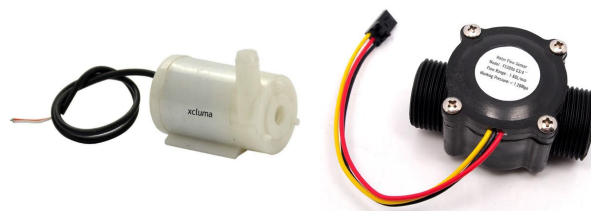


Figure 11: 5V Water Pumps and Water Flow Sensors

A 5V water pump is a compact, low-power device commonly used in small-scale projects requiring liquid transfer, such as water dispensing systems. It operates on a 5-volt DC power supply, making it

ideal for use with microcontrollers like Arduino. The pump can efficiently draw water from a reservoir and push it through pipes to the desired location. Its ease of integration, low power consumption, and cost-effectiveness make it suitable for automated systems in DIY projects.

A water flow sensor is a crucial component that measures the rate of liquid flow through a pipe. Typically, it consists of a rotor and a magnetic hall-effect sensor, which detects the rotation of the rotor as water passes through. The sensor generates electrical pulses, proportional to the flow rate, which can be read by a microcontroller to monitor and control the dispensing process accurately. In projects involving liquid distribution, the combination of a water pump and a flow sensor ensures precise flow control and automation, enhancing both the efficiency and reliability of the system

4.3.7 DC Motor



Figure 12: DC Motor

A 5V DC motor is a small, efficient, and versatile motor commonly used in low-power electronic projects. It operates on a 5-volt direct current supply, making it ideal for integration with microcontrollers such as Arduino or Raspberry Pi. Due to its simplicity, the motor has two terminals, allowing easy control of its speed and direction by varying the voltage or polarity. The motor converts electrical energy into mechanical motion through electromagnetic principles, providing rotational movement that can be used to drive wheels, gears, fans, or small mechanisms in various applications. Its low voltage requirement, affordability, and ease of use make it popular in DIY projects like robotics, automated systems, and other hobbyist electronics.

4.3.8 16x2 LCD

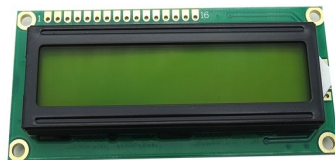


Figure 13: 4x4 Keypad

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.

4.3.9 4x4 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



Figure 14: 4x4 Keypad

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.

4.3.10 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.



Figure 15: Relay

4.4 Project Overview

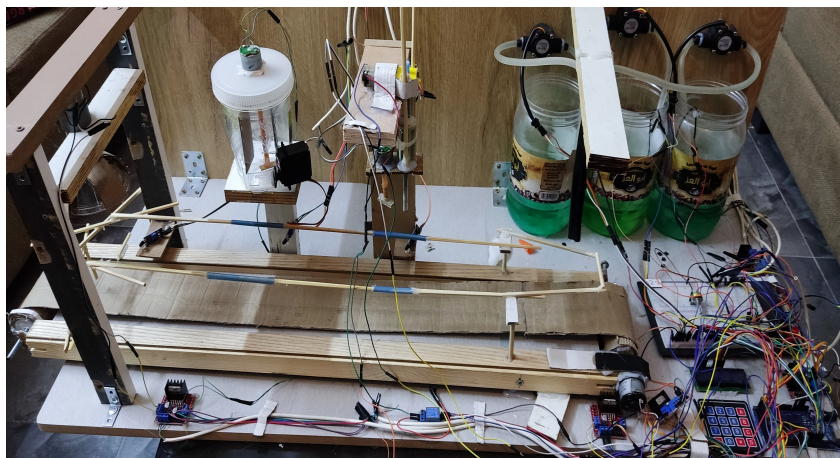


Figure 16: Project Overview

5 Conclusion

The Juice Machine project demonstrates the potential of integrating various mechanical and electronic components to create a sophisticated automated beverage system. The project's success in accurately dispensing, mixing, and packaging juice highlights the effectiveness of using Arduino Mega 2560 for control and automation. Future improvements could include enhancing the user interface, optimizing the mixing process, and exploring additional features for customization and convenience. This project provides a solid foundation for further exploration and development in automated beverage systems.

6 Future Work

- 1- Add another stage to automate the insertion of the glass cover.
- 2- Replace the fine-threaded shaft with a coarse-threaded shaft.
- 3- Replace the cardboard belt with Reinforced Rubber belt.

7 References

1. Arduino Mega 2560 Official Website. *Arduino Mega 2560 Official Website*
2. Youtube. *Youtube*
3. ChatGpt
4. Instructable. *Instructable*