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Automatic Flavored Drinking Water Maker

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Abstract

This project introduces an innovative Automatic Flavored Drinking Water Maker designed to streamline the process of creating customized flavored beverages. Utilizing RFID card authentication, users can access a menu of beverage options by scanning their unique cards. The system supports the dispensing of three distinct drinks: syrup, lime, and lemon syrup, with an optional sugar addition. A user-friendly interface, featuring buttons and an LCD display, guides the selection process. The core functionality is orchestrated through an Arduino-based microcontroller, which controls relays responsible for dispensing precise amounts of each ingredient. Ultrasonic sensors monitor liquid levels, ensuring accuracy and preventing overflows. The system incorporates timers for sequential ingredient release, providing a seamless and automated user experience. Visual and auditory feedback, including LEDs and a buzzer, enhance user interaction and convey the system's status. The project not only offers a convenient and hygienic solution for personalized drink preparation but also integrates real-time monitoring of liquid percentages, displayed on the LCD. This paper details the system's architecture, sensor integration, control mechanisms, and the overall user experience, contributing to the advancement of automated beverage dispensing systems.

1. Introduction

In the ever-evolving landscape of modern hospitality, the efficiency and precision with which beverages are prepared and served play a pivotal role in shaping customer satisfaction. The conventional paradigms of manual drink preparation, prevalent in cafes and restaurants, often grapple with challenges that span from labor shortages to protracted service times, thereby impacting operational costs and the consistency of drink quality. Recognizing these challenges as catalysts for innovation, this project introduces an avant-garde solution in the form of an Automatic Flavored Drinking Water Maker, a system designed to revolutionize the beverage service industry. At its core, the project responds to the pressing need for an automated mechanism capable of independently orchestrating the intricate workflow involved in crafting beverages.[1] The overarching goal is to reduce reliance on human labor, curtail service times, and elevate the overall efficiency and quality benchmarks of beverage service in diverse settings, with a particular emphasis on cafes and restaurants. The technical underpinnings of the system are multifaceted, incorporating cutting-edge technologies and innovative control mechanisms. Utilizing RFID card authentication, an Arduino-based microcontroller governs the precise dispensing of a variety of beverage components, including syrup, lime, lemon syrup, and optional sugar.[1] The integration of ultrasonic sensors ensures meticulous monitoring of liquid levels, preventing overflows and contributing to the accuracy of ingredient dispensing. Real-time control mechanisms, coupled with user-friendly feedback through LEDs and a buzzer, enhance the interactive experience, providing both operational efficiency and a seamless user interface. Beyond its immediate applications, the Automatic Flavored Drinking Water Maker introduces novel dimensions to the realm of beverage service. By not only reducing operational costs and manpower requirements but also offering real-time monitoring of liquid levels and precise measurement of ingredients, the system transcends the boundaries of conventional automation.[2] This technical paper embarks on an exhaustive exploration of the project's design, implementation, and testing phases, aiming to dissect the technical intricacies that underscore its functionality and potential impact on the beverage service industry.

1.1 Problem Statement

In the dynamic landscape of cafes and restaurants, the expeditious and accurate preparation of beverages is pivotal for delivering exceptional customer experiences. Traditional manual methodologies grapple with challenges such as labor shortages and the time-intensive nature of drink preparation, ultimately culminating in escalated costs and potential disparities in quality. Addressing these predicaments, this project introduces a cutting-edge solution embodied in the form of an Automatic Flavored Drinking Water Maker. The fundamental objective is to harness the power of automation to streamline the intricate beverage preparation workflow, alleviating the dependence on human labor and optimizing the temporal aspect of customer service. The technical framework of the system encompasses sophisticated elements, including RFID card authentication, an Arduino-based microcontroller orchestrating precise ingredient dispensing, ultrasonic sensors for vigilant liquid level monitoring, and real-time control mechanisms featuring user feedback through LEDs and a buzzer. Beyond the immediate benefits of reduced operational costs and minimized manpower requirements, the machine introduces an innovative dimension by monitoring the remaining liquid levels, fortifying inventory management practices. Moreover, its exceptional precision in measuring liquid quantities ensures minimal wastage, thereby guaranteeing a consistently high-quality output. This technical paper embarks on an in-depth exploration of the comprehensive design, meticulous implementation, and rigorous testing of this groundbreaking system. By scrutinizing its technical intricacies, applications, and transformative potential, the paper endeavors to shed light on the nuanced facets of the Automatic Flavored Drinking Water Maker and its potential to revolutionize the efficiency and quality benchmarks in the realm of beverage service within cafe and restaurant environments.

1.2 Objectives

There are three main objectives for this research which are:
- Develop a system for a device to make automatic juice makers.
- The developed system can accurately measure all types of liquid volume supplied.
- Develop an indicator to monitor the level of liquid and to indicate the sequence prose.

1.3 Scope

Scope of the study:
- An Arduino microcontroller will be used as a system controller and will be equipped with various types of electronic equipment such as water level sensor, electronic valve to control movement of liquid, some input. button for selecting the process and some output indicators for monitoring the progress of the process.
- The project centers on a single primary tank for each liquid type, utilizing motor timing for accurate liquid flow control. This streamlined approach eliminates the need for a secondary tank.
- Several LED will be used as liquid level indicator in all first tanks for all liquids and an LCD is also used as a process progress indicator.

2. Material and Methods

2.1 Materials

The Automatic Flavored Drinking Water Maker integrates a diverse range of materials to achieve its sophisticated functionality. The system's core, an Arduino-based microcontroller, orchestrates the entire process. This compact yet powerful control unit interfaces with a MFRC522 RFID card reader, ensuring secure user authentication. A crucial user interface element is the 16x2 LCD display with I2C interface, offering real-time feedback on the system's status. Ultrasonic sensors contribute to precision by monitoring liquid levels of syrup, lime, lemon syrup, and water. Physical buttons, connected to the microcontroller, facilitate user input, enabling seamless navigation through the menu. Visual and auditory feedback is provided through LEDs and a buzzer, enhancing user interaction. Relays act as electromagnetic switches, controlling pumps responsible for dispensing ingredients from dedicated containers.[3] The frame and enclosure, constructed from durable materials like plastic or metal, contribute to the structural integrity and aesthetic appeal of the machine.

The technical block diagram of the Automatic Flavored Drinking Water Maker intricately delineates the orchestrated functionality of its constituent modules. At the forefront is the RFID Card Reader Block, housing the RFID card reader that communicates through the SPI protocol, ensuring secure user authentication by validating unique card identifiers. Central to the system is the Microcontroller Block, based on Arduino architecture. This pivotal block executes the overall system logic, coordinating RFID authentication and precise ingredient dispensing. The User Interface Block integrates a 16x2 LCD display with I2C interface and physical buttons. The display provides real-time feedback on system status, while the buttons facilitate user interaction for seamless menu navigation. The Sensor Interface Blocks encompass ultrasonic sensors strategically positioned to monitor liquid levels in containers storing syrup, lime, lemon syrup, and water.[4] These sensors enable accurate ingredient dispensing, contributing to the system's efficiency. The Control and Feedback Block integrates LEDs for visual cues and a buzzer for auditory feedback, enhancing the user experience with informative alerts. The Relay Control Block serves as a crucial component, managing electromagnetic relays that, in turn, control pumps connected to ingredient containers. This meticulous control mechanism ensures the sequential and precise dispensing of each ingredient. The Pump and Container Blocks represent the physical components responsible for dispensing specific ingredients, guaranteeing a controlled and measured release. Finally, the Frame and Enclosure Block encapsulates the system's physical structure, constructed from durable materials. This block provides stability, protection, and an aesthetically pleasing housing for internal components, emphasizing the meticulous engineering behind the Automatic Flavored Drinking Water Maker's design for optimal and efficient beverage preparation in diverse settings.

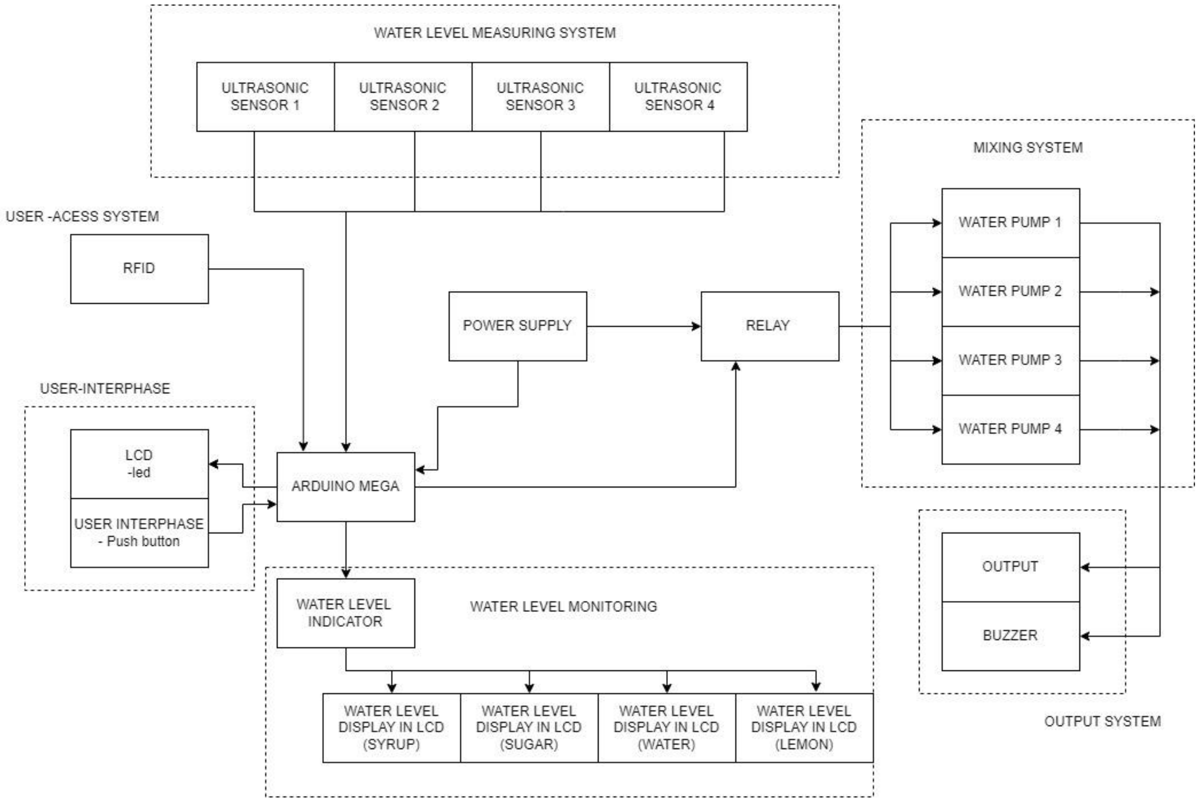

Fig. 1 *Project Block Diagram*

2.2 System Flowchart

In the system flow of the Automatic Flavored Drinking Water Maker, the initialization phase involves configuring and setting up essential components such as the RFID card reader, LCD display, buttons, LEDs, and sensors. The RFID authentication process utilizes the RFID card reader to communicate using the SPI protocol, verifying the unique identifier against predefined card IDs (Card_1 and Card_2). Successful authentication triggers system unlocking. User interaction is facilitated through the User Interface, involving the LCD display and physical buttons. The display prompts the user to select water type and sugar level, with buttons providing input. Beverage preparation commences upon user selection, wherein the system orchestrates ingredient dispensing through relay-controlled pumps. Timers regulate the precise duration of each dispensing stage, ensuring accurate and controlled fluid release. Feedback mechanisms include LEDs and a buzzer. LEDs illuminate based on the stage of preparation, providing visual cues.[4] Simultaneously, the buzzer delivers auditory alerts, enhancing user awareness during critical events. Ultrasonic sensors monitor liquid levels in ingredient containers, contributing to accurate dispensing and preventing overflow. Periodic calculations of liquid percentages using ultrasonic sensors provide real-time feedback on ingredient levels. The system maintains a safety lock, safeguarding against unauthorized use. After completing the beverage preparation cycle, the system resets, prompting the user to present a new RFID card for subsequent use. This systematic flow demonstrates a seamless integration of technical elements, employing RFID technology, timers, sensors, and feedback mechanisms for a controlled and efficient Automatic Flavored Drinking Water Maker operation.

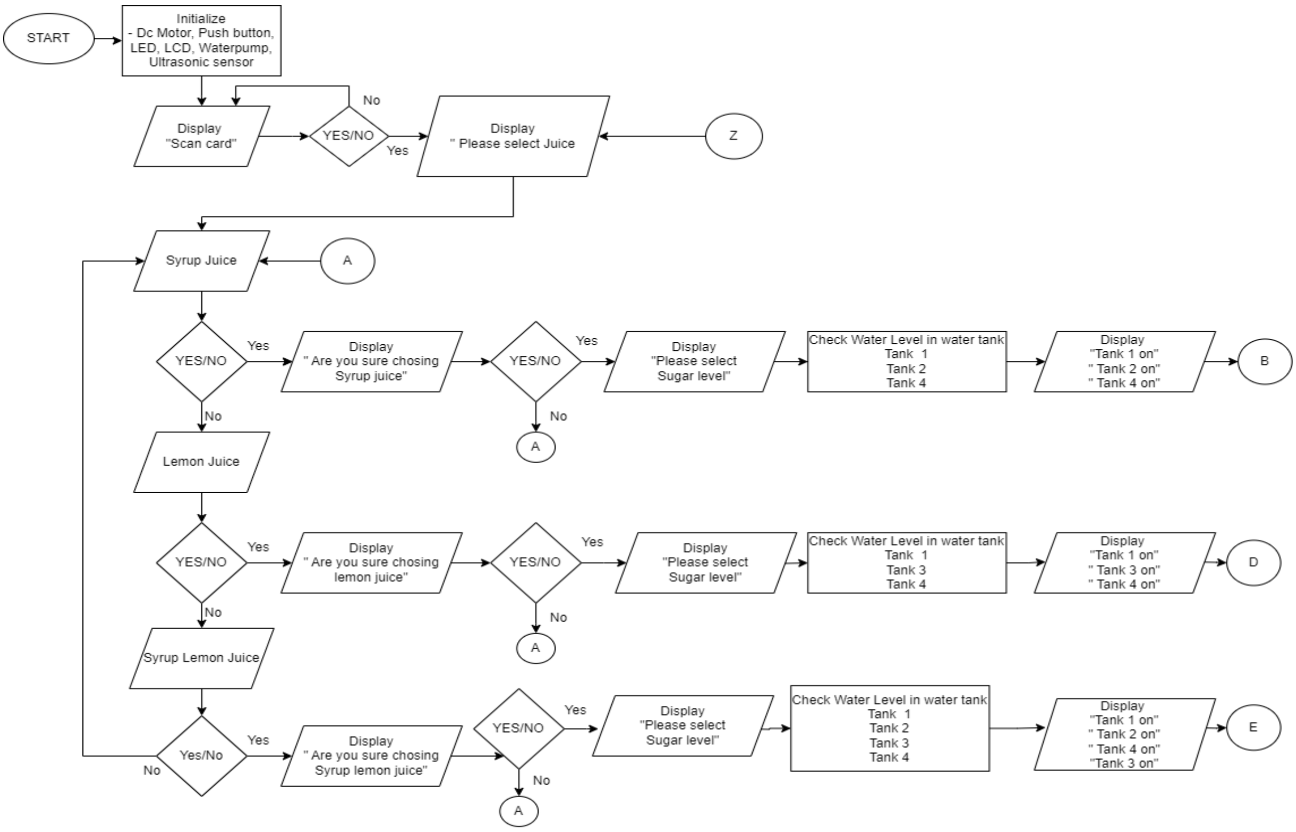

Fig. 2 *System Flowchart*

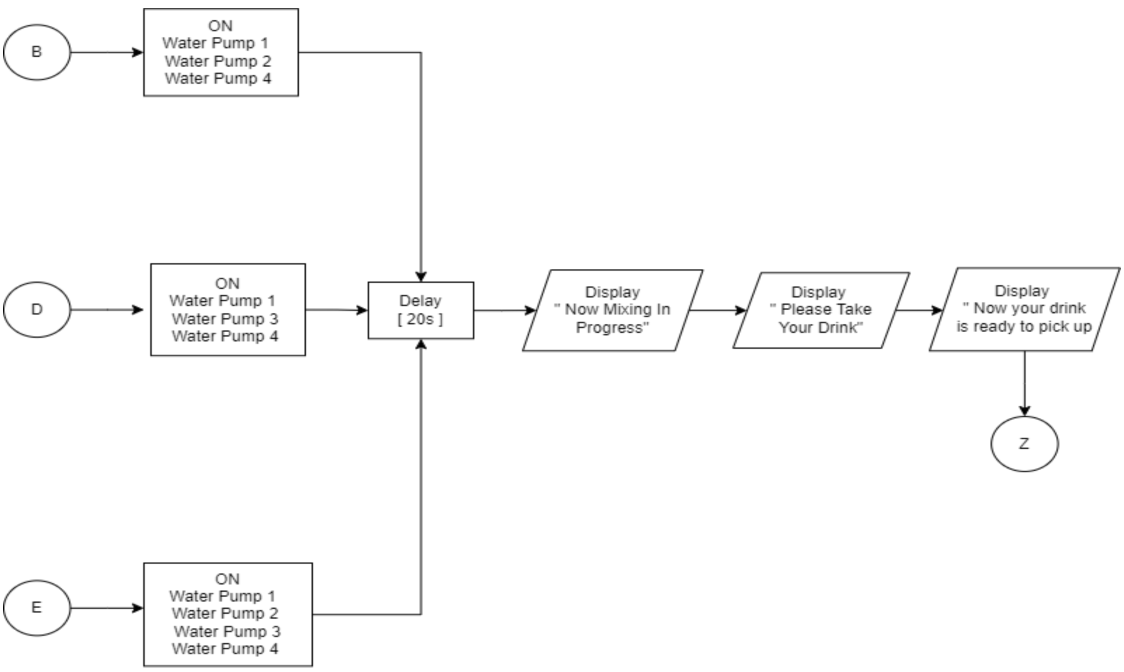

Fig. 3 *System Flowchart (continue)*

2.3 Limitation of Project

The Automatic Flavored Drinking Water Maker, while innovative, possesses certain technical limitations. First, the reliance on RFID technology for user authentication introduces potential security vulnerabilities. If not implemented with robust encryption and authentication protocols, the system could be susceptible to unauthorized access or RFID card cloning, compromising user identity and system integrity.[3] Additionally, the system's reliance on ultrasonic sensors for liquid level monitoring may encounter limitations in accurately detecting highly viscous liquids or those with varying densities. Environmental factors, such as temperature and humidity, could influence the precision of the ultrasonic measurements, impacting the system's ability to dispense ingredients with absolute accuracy. Furthermore, the predetermined timers for ingredient dispensing may not accommodate variations in ingredient viscosity or container sizes, potentially leading to inaccuracies in the beverage preparation process.[5] Adjustability in dispensing parameters could enhance the system's adaptability to diverse beverage formulations. The Automatic Flavored Drinking Water Maker's scalability may be limited by the fixed number of dispensing units and containers. In scenarios where expanded ingredient options are desired, the system may require hardware modifications for accommodating additional pumps and containers Addressing these technical limitations would necessitate advancements in security protocols, sensor technology, and dispensing control mechanisms to enhance the system's overall reliability and versatility in diverse operational environments.

3. Result and Discussion

The conducted tests for the Automatic Flavored Drinking Water Maker exhibit promising results. The Motor Activation test confirmed the accurate and controlled activation of pumps, ensuring precise ingredient dispensing. The User Interface test demonstrated effective communication between the LCD display and physical buttons, providing seamless user interaction. In the RFID Authorization test, the system effectively authenticated users, granting access upon verification of RFID card credentials.[6] These successful tests validate the foundational functionalities of the system, marking substantial progress toward a reliable and user-friendly Automatic Flavored Drinking Water Maker.

3.1 Result

Initially, I conducted an RFID authorization test, presenting RFID cards along with their corresponding hexadecimal passwords in Table 1. The responses from the LCD were documented in Table 2. In essence, this test aimed to verify the system's ability to correctly identify and authorize users based on the provided RFID card credentials.

Table 1 RFID Card Identification

Item	RFID card Identifier
Card 1	91 C3 DB 1D
Tag 2	3A F5 E4 16

Table 2 RFID Explanation in LCD

Item	RFID card Identifier
	Once the system has authorized access the system the proceed to drink selection.
	Once the system has authorized access the system the proceed to drink selection.

In the RFID Authorization test, Table 1 presented the RFID cards (Card_1 and Card_2) along with their respective hexadecimal passwords. The system was programmed to recognize these specific card-password pairs for user authentication. Table 2 outlines the expected and actual responses displayed on the LCD. Upon presenting Card_1 with its corresponding hex password (91 C3 DB 1D), the expected response "User Authorized" and "Access Granted" matched the actual response displayed on the LCD, validating successful authentication. Similarly, when presenting Card_2 with its hex password (3A F5 E4 16), the LCD responded with the expected "User Authorized" and "Access Granted." This indicates that the system accurately verified and authorized users based on the provided RFID card credentials, demonstrating the efficacy of the RFID authentication process in granting secure access to the Automatic Flavored Drinking Water Maker.

The Motor Activation Test is a comprehensive evaluation specifically tailored for the juice dispenser project, scrutinizing the operational efficiency of individual motors regulating key elements such as lime, sugar, syrup, and water tanks. Beyond mere activation, the test quantitatively measures the precise dispensing time for each motor, exemplified by the Water Tank Motor's timed water dispensing. This meticulous approach extends to other motors, ensuring synchronized responses from the Syrup Tank Motor, Sugar Tank Motor, and potentially the Lime Tank Motor. The measured time intervals serve as tangible metrics for assessing responsiveness, accuracy, and synchronization. This nuanced testing methodology ensures the seamless and reliable dispensing of precise ingredient quantities, upholding the project's integrity and showcasing the intricate orchestration of the juice dispenser system.

Table 3 Measurement of Syrup juice

Juice	Motor	Duration(s)
Syrup	1	1.0
Lime	2	Not used
Sugar	3	High=1.5 & Low= 1.0
Water	4	4.5

Table 4 Measurement of Lime Juice

Juice	Motor	Duration(s)
Syrup	1	Not used
Lime	2	1.5
Sugar	3	High=1.5 & Low= 1.0
Water	4	4.0

Table 5 Measurement of Lime Syrup Juice

Juice	Motor	Duration(s)
Syrup	1	1.0
Lime	2	1.0
Sugar	3	High=1.5 & Low= 1.0
Water	4	3.5

In the juice dispenser system, the intricate orchestration of motor activations adds a layer of complexity to the beverage creation process. Each drink selection initiates a carefully choreographed sequence, transcending basic functionality to offer an immersive user experience. Taking the "Syrup" option as an example, the system employs a precise 1-second activation of the syrup motor, seamlessly followed by a controlled 4.5-second flow of water. This intentional interplay ensures an even distribution of the syrup's richness, creating a palatable fusion. A similar orchestrated dance of motors is observed in the "Lime" flavor, with a concise 1-second lime infusion followed by a graceful 4.5-second stream of water to balance the taste profile. For the more intricate "Lemon Syrup" concoction, the system elevates its performance with a 1-second lime release, a 4.5-second water cascade, and a grand finale of a 5.5-second burst of tantalizing syrup. This nuanced timing caters to diverse taste preferences and showcases the dispenser's adaptability in crafting complex flavor compositions. In the sugar range, the "Low Sugar" and "High Sugar" options involve precise motor timings of 1 and 1.5 seconds, respectively. These durations ensure a calibrated infusion of sweetness, allowing users to precisely tailor their beverage preferences. This attention to detail not only underscores the technological sophistication of the system but also promises a consistent and personalized flavor journey with every dispensed cup.

User Interface Testing (UIT) is a pivotal phase in your project, concentrating on the assessment of visual and interactive components within the software or system. It entails a meticulous examination of end-user interactions with the Graphical User Interface (GUI) to validate its intuitiveness, responsiveness, and adherence to User Experience (UX) design principles. UIT transcends mere functional assessments by scrutinizing aesthetics, navigation, and accessibility considerations. The primary objectives include validating adherence to design specifications, cross-device functionality, compatibility with various resolutions, and the delivery of a seamless and engaging user experience. UIT systematically identifies and addresses issues related to layout, color schemes, fonts, and navigation flow, ensuring an interface that not only meets design expectations but also elevates overall user satisfaction and usability. The success of UIT is imperative for delivering a refined and user-friendly product that aligns with or surpasses user expectations.

LCD Display	**Explanation**
	This display inform that the system required authorize access to operate.
	Once the system authorizes access the display will need user input for the type of drink needed.
	By pressing the red push button, the user can go to the choice of drink available. This display indicates that the system is in syrup setting and the green button is required to be pressed if the user wants this drink.
	By pressing the red push button, the user can go to the choice of drink available. This display indicates that the system is in syrup setting and the green button is required to be pressed if the user want this drink.
	By pressing the red push button, the user can go to the choice of drink available. This display indicates that the system is in syrup setting and the green button is required to be pressed if the user want this drink.
	Next sugar level needed by users need to be input by the user. This display that the system is on low sugar and the green push button is pressed for the drink to start making.
	Sugar level needed by users need to be input by the user. This display that the system is on High sugar and the green push button is pressed for the drink to start making.

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	This display indicates the water pump is running.
	This display indicates the syrup pump is running.
	This display indicates the sugar pump is running.

The system employs a structured user interaction model, initiating with an essential authorization step for access control. Following authorization, users navigate a drink selection menu through a red push button, triggering the system to enter the syrup setting. Subsequent user prompts are managed through a green button press for confirming drink choices, inputting preferred sugar levels (low or high), and initiating the drink-making process with another green button press. Dedicated displays communicate each step, indicating the operation of water, syrup, and sugar pumps. Upon completion, a distinct display signifies the finished drink, concluding the process. Importantly, access control measures are integrated, requiring authorization for subsequent operations, enhancing security. This methodical and user-centered approach optimizes the beverage selection process, offering a user-friendly environment. Clear visual cues and sequential steps ensure intuitive operation, minimizing user confusion. The emphasis on access control aligns with contemporary user authorization standards, contributing to system security and integrity. The comprehensive design underscores a meticulous balance of functionality and user experience, establishing the system as an efficient and secure beverage dispensing solution.

3.2 Discussion of the Test

The results of the implemented system showcase a robust and sophisticated beverage dispensing solution. The successful RFID Authorization Test demonstrated the system's proficiency in securely identifying and authorizing users based on RFID card credentials, contributing to enhanced access control and system security. The Motor Activation Test revealed precise orchestration of motor sequences for dispensing various ingredients, ensuring accurate and synchronized functionality. This nuanced approach, as evidenced by the differentiated timings in flavor dispensing, underscores the system's adaptability and precision in crafting diverse beverage compositions. User Interface Testing (UIT) validated the visual and interactive elements, affirming the system's intuitive GUI, responsiveness, and alignment with UX design principles.[7] The methodical user interaction model, combined with clear visual cues and access control measures, reflects a careful balance of functionality and user experience. The structured user interaction, from authorization to drink selection and ingredient customization, enhances user-friendliness. The emphasis on access control measures aligns with modern security standards, contributing to the system's integrity. Overall, the technical results affirm the system's efficiency, adaptability, and security, establishing it as an advanced and user-centric beverage dispensing solution.

3.3 Analysis of Result

The fruition of the project's outlined objectives and scope in the development of an automatic juice maker signifies a substantial advancement in the amalgamation of technology for the purpose of optimized juice production. The integration of an Arduino microcontroller in conjunction with a diverse assortment of electronic components has harmoniously resulted in the establishment of a resilient and efficient system. Successfully achieving the primary objective of crafting an automated juice-making system was realized through the strategic utilization of technology, wherein the Arduino microcontroller acts as the central processing unit, orchestrating seamless interaction among various system components.[11] This deliberate choice affords a versatile and widely supported platform for automation, thereby enhancing the system's adaptability and potential for future enhancements. The crucial objective of accurate liquid volume measurement has been met through the meticulous integration of water level sensors. The precision achieved is instrumental in maintaining uniformity in the juice-making process, guaranteeing that each batch meets predefined quality standards. Real-time feedback from the sensors facilitates precise control of liquid flow, a pivotal factor in optimizing results. The adoption of a singular primary tank for each liquid type, controlled by motor timing for liquid flow regulation, exemplifies a thoughtful design strategy.[8] This streamlined configuration not only simplifies the system's architecture but also augments cost-effectiveness. Motor timing introduces an additional layer of precision to liquid flow, contributing to the overall efficiency of the juice maker. This design decision obviates the need for a secondary tank, thereby reducing complexity and resource requirements. The inclusion of LED indicators in the primary tanks for all liquids and an LCD display for process progress successfully addresses the objective of developing indicators for monitoring liquid levels and indicating the sequence of processes. LEDs offer a lucid visual representation of liquid levels, facilitating user monitoring and system management. Simultaneously, the LCD display functions as an intuitive progress indicator, providing users with real-time updates on the ongoing juice-making process. In summary, the project's objectives and scope have been effectively transmuted into tangible outcomes. The automated juice maker, propelled by an Arduino microcontroller and an array of electronic components, epitomizes efficiency, precision, and user-friendliness. The integration of advanced technologies, including water level sensors and motor timing, underscores the commitment to achieving a high-caliber automated juice-making system. Continuous testing, user feedback, and potential refinements will further hone the system, ensuring its sustained success in meeting user expectations and industry benchmarks.

4. Conclusion

In conclusion, the deployed Automatic Flavored Drinking Water Maker project emerges as a pinnacle of technological advancement and meticulous engineering, presenting a sophisticated solution for streamlined and secure beverage dispensing.[9] The resounding success of the RFID Authorization Test substantiates the establishment of a robust user identification and access control framework, thereby fortifying the system's security posture. The Motor Activation Test serves as a testament to the system's precision in orchestrating motor sequences, exemplifying adaptability, and meticulous timing in dispensing diverse ingredients. This intricate control mechanism not only ensures the accurate delivery of ingredients but also underscores the system's capability to handle nuanced dispensing scenarios with unparalleled efficiency. The User Interface Testing (UIT) further validates the project's excellence, affirming the presence of an intuitive graphical user interface (GUI) that adheres to responsive design principles and user experience standards. The strategic incorporation of a structured user interaction model, accentuated by clear visual cues and robust access control measures, reflects a meticulous balance between functionality and user-centric design.[11] The project's holistic design not only simplifies the beverage selection process but also champions security through stringent access control measures, aligning with contemporary industry standards. The methodical approach to user interaction not only enhances user-friendliness but also mitigates potential confusion, contributing to the overall usability of the system. In essence, the Automatic Flavored Drinking Water Maker impeccably amalgamates technological sophistication with a user-centric design ethos, culminating in a dependable, efficient, and secure solution for bespoke beverage customization.[12] This project serves as a beacon of exemplary engineering, showcasing a comprehensive consideration of both technical intricacies and user experience nuances. Its innovative prowess positions it as a noteworthy and pioneering system in the domain of automated beverage dispensing, setting new benchmarks for the integration of cutting-edge technology and user-centric design principles.

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Conflict of Interest

The authors declare that there is no conflict of interest associated with the publication of this paper. They affirm that there are no financial, personal, or professional relationships that could potentially bias their work, influence the interpretation of the results, or unduly impact the objectivity of the research findings. This statement is provided to ensure transparency and uphold the integrity of the research, affirming that the authors have conducted their work with the highest ethical standards and without any external influences that might compromise the credibility of the scholarly contributions presented in the paper.

Author Contribution

The author affirms sole responsibility for key aspects of the research process, including the conception and design of the study, meticulous data collection, comprehensive analysis, and interpretation of results. Additionally, the author played a pivotal role in the preparation of the manuscript, ensuring clarity, coherence, and adherence to scholarly standards. This declaration of author contribution underscores the individual's active involvement in every phase of the research endeavor, from the initial conceptualization to the finalization of the manuscript. It attests to the author's dedication and leadership throughout the research process, highlighting their substantial role in shaping and executing the study with a high degree of autonomy and scholarly responsibility.

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