Smart Water Pouring System

IOT102-IA1805, Group 3

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Abstract

The Smart Water Pouring System represents a groundbreaking approach to optimizing water usage across various applications, including agriculture, household chores, and commercial settings. This innovative system integrates several key components, including an Arduino Uno microcontroller, a Bluetooth module for wireless communication, a YF-S201 water flow sensor for accurate flow measurement, an LCD with I2C interface for real-time data display, a relay for controlling the pump, and a water pump for dispensing water. By combining these technologies, the system empowers users to monitor and control water dispensing with precision and ease. A user-friendly interface enhances the overall experience, enabling users to access the system's features through a mobile application. This remote operation capability allows for on-demand water dispensing and monitoring, promoting convenience for users while facilitating efficient water management. The real-time data display on the LCD provides immediate feedback on flow rates and total volume dispensed, ensuring that users can make informed decisions regarding their water usage. In addition to its functional benefits, the Smart Water Pouring System emphasizes the importance of sustainable water management. As global water scarcity becomes an increasing concern, this system aims to reduce waste and promote responsible water consumption practices. Through rigorous testing and evaluation, the system has demonstrated impressive performance and reliability, achieving accurate water measurement and effective automated control. Overall, this project not only showcases the capabilities of modern technology in addressing pressing environmental issues but also sets the foundation for future innovations in the field of automated water management.

I. Introduction

The Internet of Things (IoT) is revolutionizing how we engage with our environment by interconnecting physical devices, allowing them to communicate and respond intelligently to data from the world around them. This connectivity transforms everyday objects into "smart" systems capable of real-time monitoring, data collection, and automated decision-making. By embedding sensors, microcontrollers, and wireless communication capabilities into these devices, IoT facilitates a seamless integration of the physical and digital realms. For instance, in smart homes, IoT applications enable homeowners to automate lighting, climate control, and security systems, enhancing comfort and energy efficiency. In industrial settings, IoT enhances operational efficiency by providing valuable insights into machine performance, allowing for predictive maintenance and reduced downtime. Overall, the promise of IoT lies in its ability to create responsive, intelligent environments that adapt to user needs, improve resource management, and optimize various processes across different sectors.

[1] A compelling application of IoT technology is the Smart Water Pouring System, which utilizes a range of interconnected components to automate and precisely control water dispensing. Central to this system is the Arduino Uno, a versatile microcontroller that serves as the core processing unit, orchestrating the functionality of the various components [2]. The YF-S201 water flow sensor is critical to the system's operation, measuring the flow rate of water in real time. This information is essential for ensuring that the correct amount of water is dispensed, whether for irrigation, beverage dispensing, or other applications where precision is key. The data gathered by the flow sensor is processed by the Arduino, which then commands the operation of the system based on predefined parameters.

To enhance user interaction and control, the system incorporates a Bluetooth module, enabling remote management through smartphones or other Bluetooth-enabled devices. This capability allows users to monitor and adjust the water dispensing process from a distance, adding convenience and flexibility to the system's operation [3]. Furthermore, an LCD with I2C interface is integrated into the design to provide users with real-time feedback, displaying crucial information such as the current flow rate and total volume dispensed. This feature enhances usability by allowing users to quickly assess the system's performance without needing to access the main controller directly.

The relay is utilized to control the pump, managing its operation based on the input received from the flow sensor and the commands from the Arduino [4]. This ensures that water is only pumped when necessary, significantly reducing waste and promoting efficient water usage. For added functionality, a push button is included, allowing users to manually activate or deactivate the water dispensing system when needed. This manual override is particularly useful in situations where immediate action is required or when users prefer direct control over automation.

Overall, the Smart Water Pouring System exemplifies the practical application of IoT technology in enhancing resource management and automation. By integrating diverse components like the Arduino Uno, Bluetooth module, LCD with I2C, YF-S201 water flow sensor, relay, pump, and push button, this system provides a comprehensive solution for managing water dispensing efficiently. As the world faces increasing challenges related to water scarcity and resource conservation, such

innovative solutions are essential in promoting sustainable practices and improving operational efficiency in both residential and commercial settings. The Smart Water Pouring System not only showcases the capabilities of IoT but also highlights the potential for creating smarter, more responsive environments that cater to the evolving needs of users and society as a whole.

II. Methods and Materials

A. System Model and Block Diagram

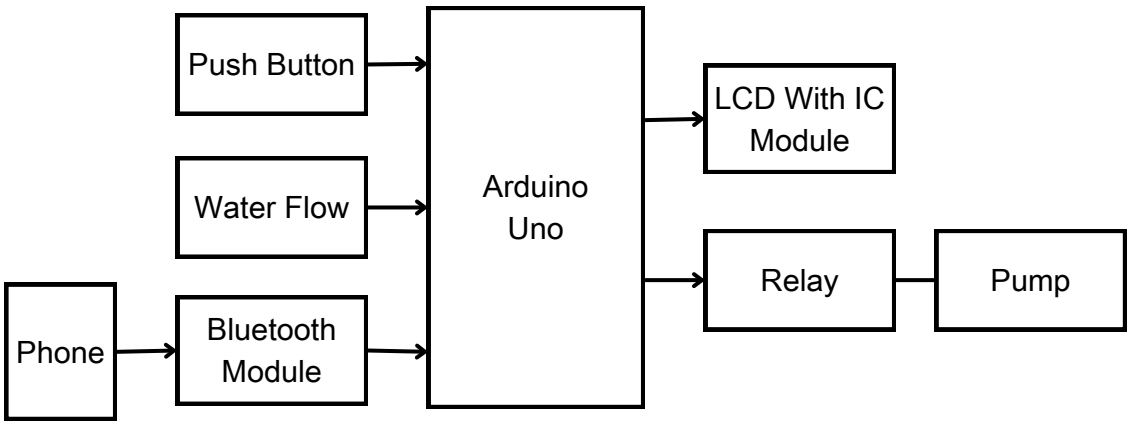

Fig. 1. Block diagram of the developed system.

The Smart Water Pouring System, managed by an Arduino Uno, is designed to provide efficient control over water flow through both manual and automated inputs. The system takes in data from several sources: a push button for manual operation, water flow sensors that continuously monitor the amount of water being dispensed, and a Bluetooth module that allows for remote control via a smartphone or other Bluetooth-enabled device. The Arduino processes this input information and uses it to control a relay, which in turn operates the water pump, ensuring that water flow is accurately regulated. The flow sensors provide real-time data that helps adjust the water flow to the desired rate. An integrated LCD with an I2C module displays key information such as the current flow rate, system status (active or idle), and other relevant metrics. This real-time feedback allows users to monitor the system's performance. The combination of manual, sensor-driven, and remote control options makes this system highly adaptable for a range of applications, including irrigation or automated water dispensing, offering a flexible and efficient solution to manage water flow based on user input or sensor data. This system also ensures water conservation by dispensing water only when necessary, based on the real-time feedback from the sensors. With its Bluetooth capability, users can conveniently adjust settings remotely, making it ideal for situations where manual intervention is not always feasible.

B. Components and Peripheral Devices

- **Arduino Uno:** The Arduino Uno is an incredibly versatile microcontroller board based on the ATmega328P, designed to cater to a wide array of electronics projects, making it suitable for both beginners and advanced users. This board is equipped with 14 digital input/output pins, including 6 PWM outputs, which allow for precise control over various devices such as LEDs and motors. Additionally, it features 6 analog inputs, facilitating easy integration with a variety of sensors, thereby enabling robust interfacing with numerous components.Operating on a 16 MHz ceramic resonator, the Arduino Uno strikes a perfect balance between speed and efficiency. It connects effortlessly to a computer via USB, which also serves as its power source. For more flexible powering options, the board includes a power jack that supports an AC-to-DC adapter or battery, making it ideal for mobile and portable applications. An ICSP (In-Circuit Serial Programming) header provides direct programming access, while the onboard reset button aids in troubleshooting and allows for quick reboots during development.These features collectively make the Arduino Uno a foundational tool for prototyping and experimentation. It supports a diverse range of projects, including but not limited to robotics, home automation, and environmental monitoring. The board's versatility and ease of use have made it a staple in the maker community, fostering innovation and creativity.

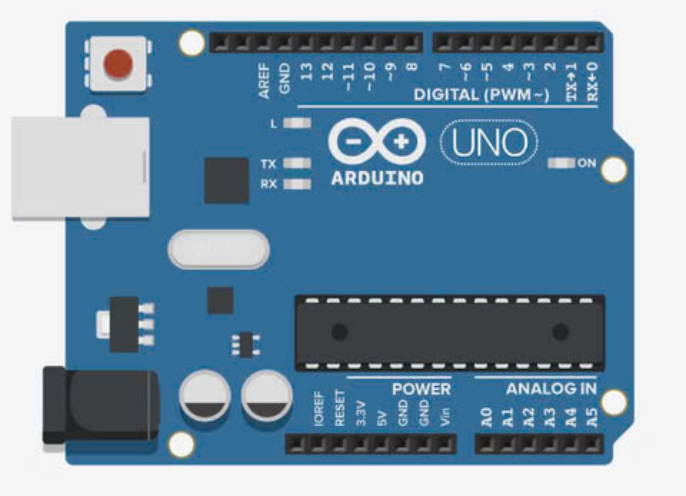

Fig. 2. Arduino Uno

- **Bluetooth Module:** The Bluetooth module serves as a critical component that enables seamless wireless communication between the Arduino and a mobile application, transforming the Smart Water Pouring System into a fully interactive and remotely manageable setup. Through the mobile app, users gain control over multiple aspects of the system, such as selecting precise amounts of water to be dispensed, which adds flexibility and precision to water usage. Additionally, the app allows users to monitor real-time data on total water consumption, providing insights into usage patterns and promoting more sustainable practices. Furthermore, the Bluetooth-enabled control of the pump allows users to start and stop water flow remotely, enhancing convenience and efficiency by reducing the need for direct physical interaction with the system. This wireless capability thus offers a comprehensive, user-friendly interface for managing water usage, making the system ideal for various applications where remote control and monitoring are beneficial.

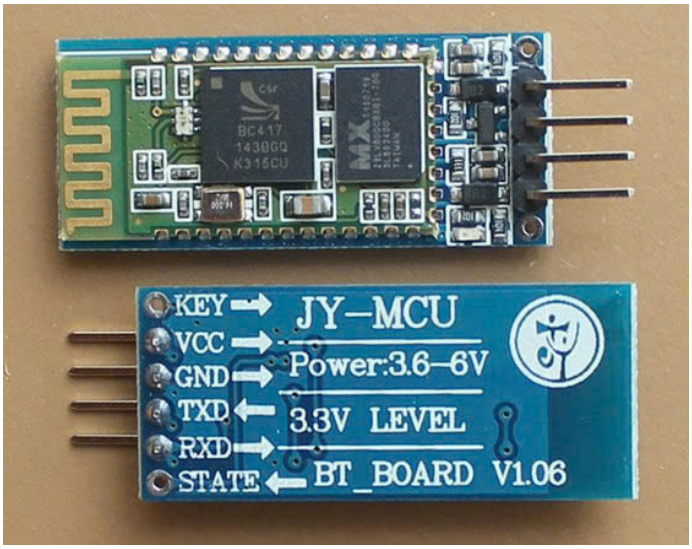

Fig. 3. Bluetooth Module

- **LCD with I2C:** The LCD with an I2C interface is a crucial component in the Smart Water Pouring System, providing a clear, real-time display of essential information such as the current amount of water being poured and the total water consumed. This allows users to monitor the system's status directly and make informed adjustments as needed. By using the I2C interface, the LCD requires significantly fewer pins than traditional setups, reducing the complexity of wiring and freeing up additional pins on the Arduino for other components. This streamlined connection simplifies the overall design and improves both functionality and ease of use, making it an efficient choice for displaying real-time data in an organized and accessible format.

Fig. 4. LCD with I2C

- **YF-S201 Water Flow Sensor:** The YF-S201 water flow sensor plays a key role in the Smart Water Pouring System by precisely measuring the rate of water flow as it passes through the sensor. It generates pulses in response to the movement of water, and by counting these pulses, the Arduino can accurately calculate the volume of water poured over time. This allows for precise control and monitoring of water usage, making the system more efficient and adaptable to specific needs. With its reliable pulse-based measurement, the YF-S201 ensures that users can track water flow in real time, which is essential for maintaining desired water quantities and conserving resources effectively.

Fig. 5. YF-S201 Water Flow

- **Relay Module:** The relay module functions as an electronic switch that is pivotal in controlling the operation of the water pump within the Smart Water Pouring System. By receiving signals from the Arduino, the relay module can efficiently turn the pump on or off according to the amount of water selected for dispensing by the user. This setup allows for precise control over the water flow, enabling the system to respond dynamically to user inputs and ensuring that the desired volume is poured accurately. The relay not only enhances the automation of the process but also adds a layer of safety by isolating the low-voltage control side of the system from the high-voltage pump operation, thereby preventing potential electrical hazards.

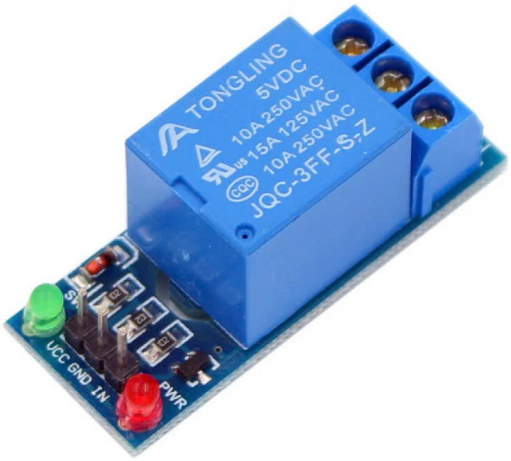

Fig. 6. Relay

- **Water Pump:** The water pump is a vital component of the Smart Water Pouring System, tasked with the essential function of transporting water from the source into the designated container. Operated by the relay module, the pump is precisely controlled to ensure that the correct volume of water is dispensed according to user inputs, whether these inputs are made via physical buttons or through a mobile application. This capability allows for seamless integration of user preferences into the water delivery process, enhancing the system's efficiency and responsiveness. By accurately regulating the flow of water, the pump contributes to optimal water management, preventing over-pouring and waste while providing users with the convenience of tailored water dispensing. Furthermore, the reliable performance of the water pump ensures consistent operation.

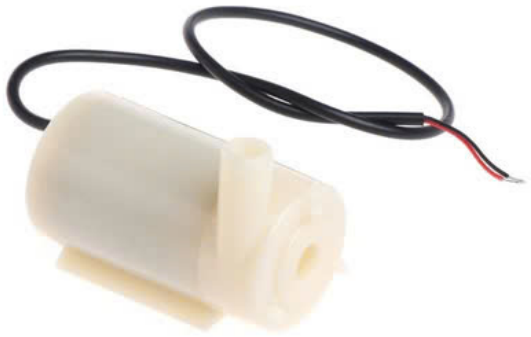

Fig. 7. Water pump

- **Push Button:** Push buttons serve as fundamental mechanical switches that enable user input within the Smart Water Pouring System. In this project, three distinct push buttons are utilized to allow users to select from three predefined amounts of water to be poured: small, medium, and high. When a user presses one of these buttons, the system interprets the input and calculates the appropriate volume of water to dispense accordingly. This simple yet effective interface enhances user interaction with the system, making it accessible and intuitive. By providing a direct means of communication with the system, the push buttons facilitate quick adjustments to water dispensing preferences, ensuring that users can easily control their water consumption based on their immediate needs.

Fig. 8. Push Button

- **Circuit diagram:** This Smart Water Pouring system circuit uses an Arduino Uno as the main controller, connected to various components to manage and monitor water flow. A water flow sensor sends pulse signals to the Arduino, allowing it to calculate and track water usage. A Bluetooth module is included to enable wireless control, allowing users to operate the system remotely through a mobile app. The LCD display, which connects via an I2C interface, shows the water flow rate and system status, giving real-time feedback to the user. A relay module acts as an electronic switch that controls the power to a water pump, which is powered by an external battery. This setup allows the Arduino to activate or deactivate the pump based on measured flow rates or Bluetooth commands. Additionally, a push button is connected to provide manual control, allowing users to start or stop the water flow directly. Together, these components make the system versatile and convenient for automated water dispensing.

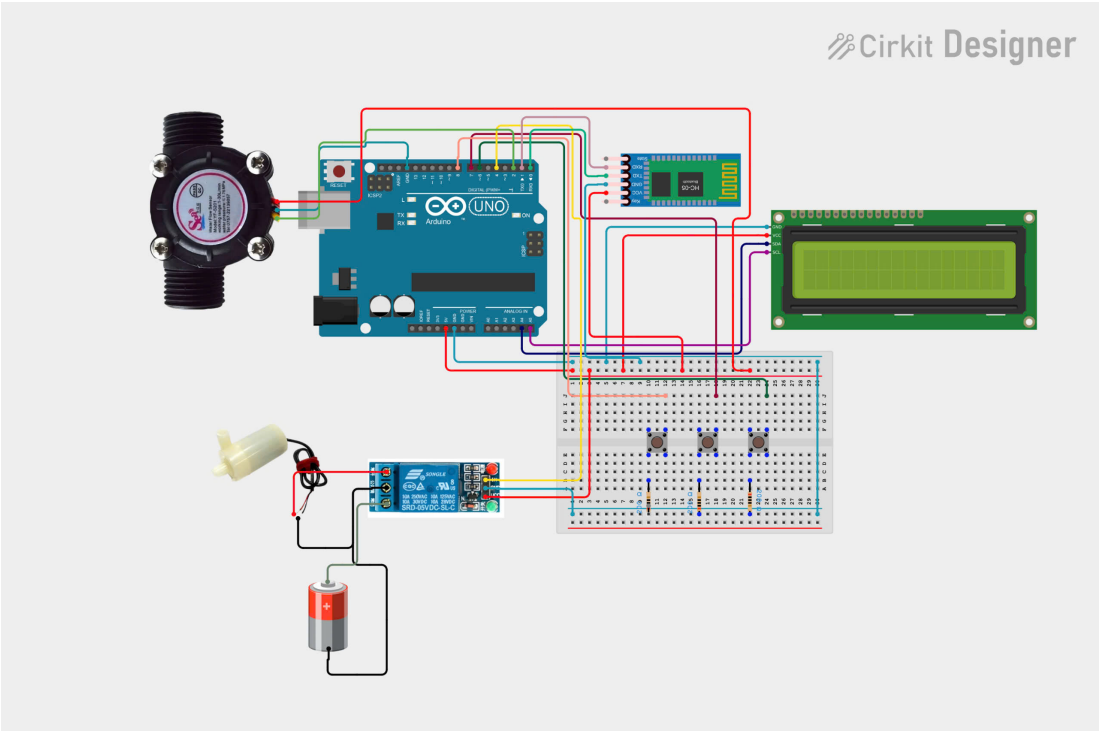

Fig. 9. Circuit diagram

TABLE I
INTERFACING BETWEEN ARDUINO UNO AND ITS COMPONENTS

Component	Arduino Pin(s)	Power Supply	Communication/Type
Bluetooth Module	TX → RX, RX → TX (Pins 0,1)	5V/3.3V & GND	Serial (UART)
LCD with I2C	SDA → A4, SCL → A5	5V & GND	I2C
YF-S201 Water Flow Sensor	Pin 2 (interrupt)	5V & GND	Digital
Relay	Digital Pin (e.g., Pin 7)	5V & GND	Digital Output
Pump	Connected to Relay	External Power	N/A
Push Button	Digital Pin (e.g., Pin 3)	5V (or pull-down resistor) & GND	Digital Input

C. Software Programming

This project uses the HC-05 Bluetooth module to connect an Arduino to a smartphone, allowing remote control of the Smart Water Pouring System. The HC-05 enables wireless communication, letting you send commands to the Arduino to control the water pump, adjust water flow, and monitor the system. By connecting the Bluetooth controller, the system can be managed remotely, offering greater flexibility and efficiency in dispensing the exact amount of water needed, without physical interaction. This integration streamlines the control and automation of the water pouring process.

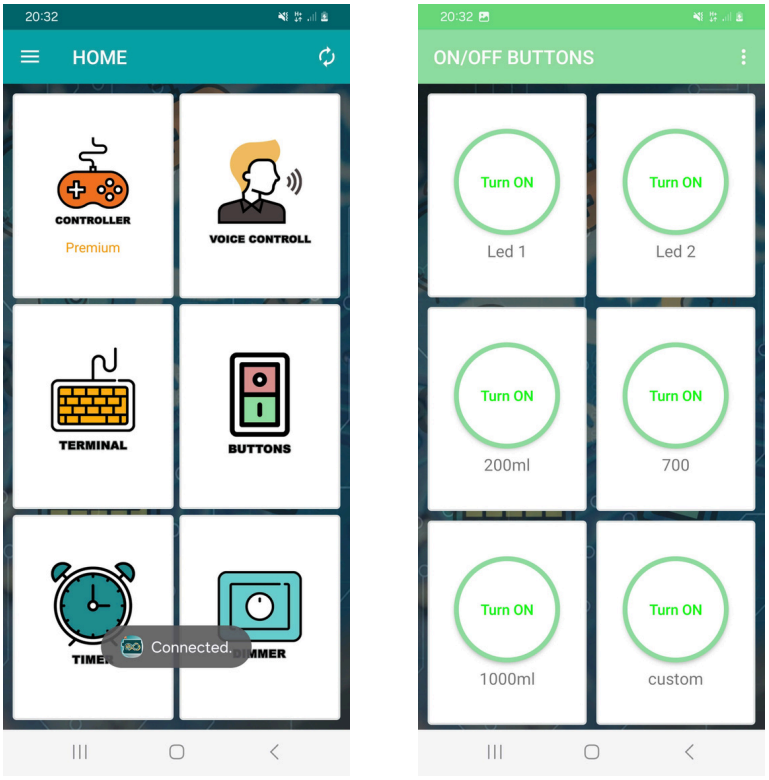

Fig. 10. Setup

Steps to set things up :

- **Step 1**: Open Arduino Bluetooth Controller, connect through Bluetooth HC-05.
- **Step 2**: As shown in the 2nd image, the app displays 4 buttons. The first 3 buttons are for pre-installed ml values, and the last button is Custom button, which allows input of a custom ml value.
- **Step 3**: Turn off all 4 buttons (as shown in the 3rd image).
- **Step 4**: Click the Custom button twice.
- **Step 5**: Return to the app's home screen, open the terminal, and input the custom ml value (Ex. 500ml as shown below).

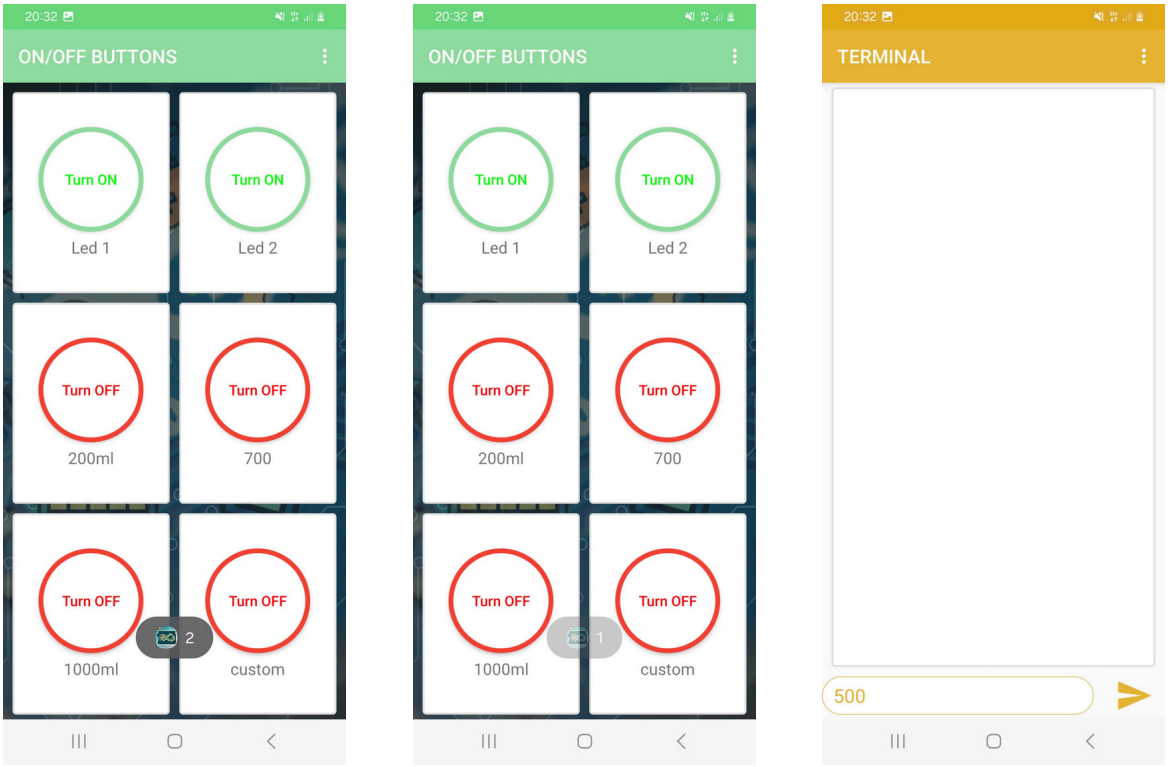

Fig. 11. Setup

D. Programming Flowchart

1) **Initialize Component:**
   The system begins by initializing all components, setting up the sensors, Bluetooth module, and relay.
2) **Input Check:**
   The system checks for a Bluetooth input.
   - If there is no input from Bluetooth, it then checks for a Button input.
   - If neither Bluetooth nor Button input is detected, it loops back to continue checking for input.
3) **Reset Total:**
   When a button input is detected, the system resets the total water volume measurement, preparing to start a new measurement cycle.
4) **Relay ON:**
   The relay is turned on, allowing the water to start flowing.
5) **Measuring Water Volume:**
   The system begins measuring the water volume as it flows.
6) **Target Check:**
   The system continuously compares the total water volume to a preset target value.
   - If the total volume reaches or exceeds the target, the system proceeds to turn off the relay.
7) **Relay OFF:**
   The relay is turned off, stopping the water flow. The system then returns to check for a new input.

The smart water pouring system starts by initializing its components and checking for Bluetooth or button input. If detected, it resets the total water volume. The relay then turns on to start pouring water. The system measures the water volume and checks if it has reached the target. If it has, the relay turns off; if not, it continues measuring.

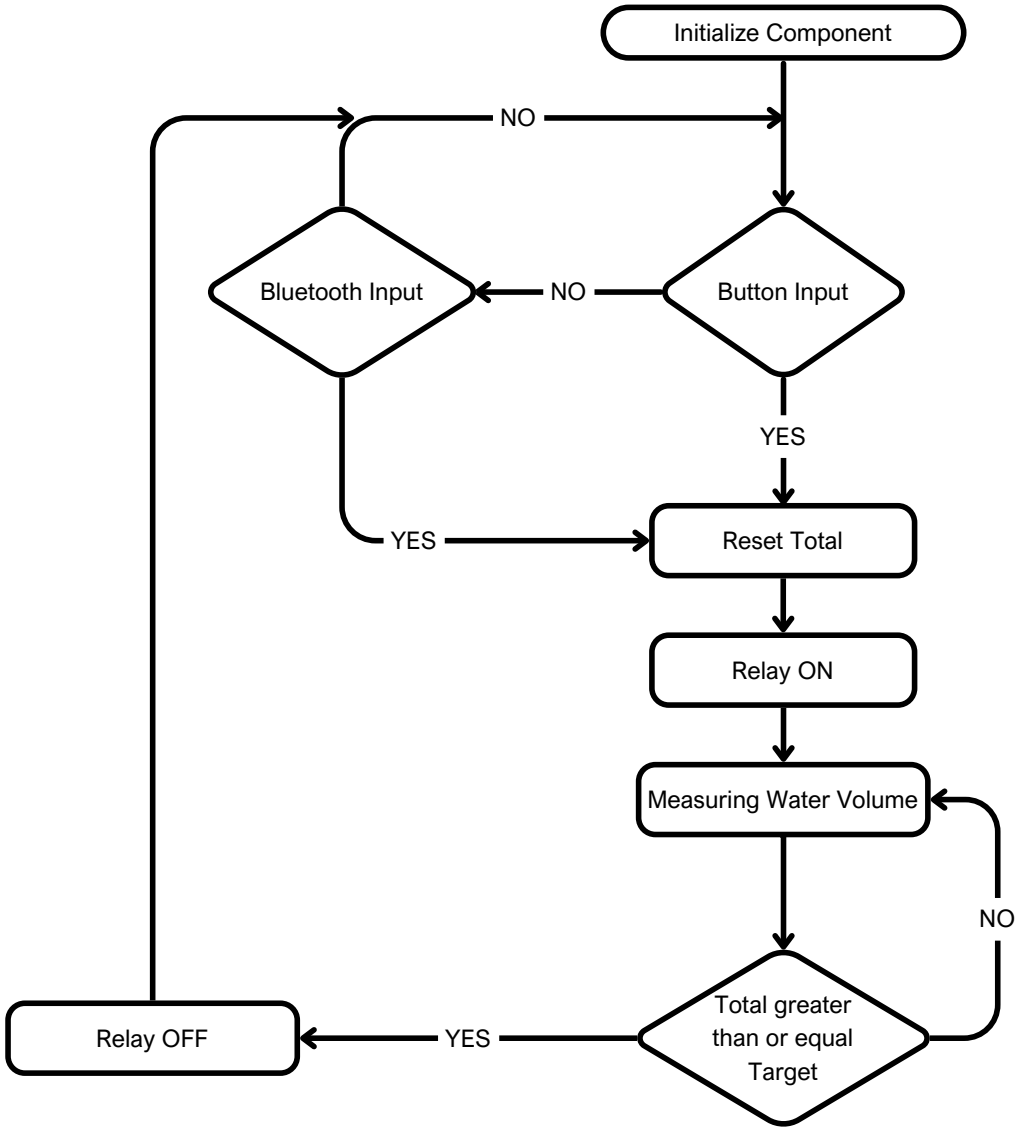

Fig. 12. Programming Flowchart of the system

III. Results and Discussion

A. Prototype Implementation

The prototype implementation of the Smart Water Pouring System begins with the integration of key hardware components, including the Arduino Uno as the central microcontroller, which coordinates all system operations. The Bluetooth HC-05 module is connected to the Arduino, enabling wireless communication between the system and the user's mobile device, allowing for remote control via three push buttons, each linked to a specific machine learning model. The YF-S201 water flow sensor is incorporated to provide real-time monitoring of the water dispensed, ensuring that the system can precisely track and regulate the flow rate. The relay module controls the activation of the pump, ensuring that water is delivered only when necessary and stopping once the desired amount of water has been dispensed. An LCD with I2C is connected to the Arduino to display real-time system feedback, including the water flow rate, machine learning predictions, and operational status, giving the user a clear and user-friendly interface to monitor and control the system. The machine learning models, pre-configured to adapt to different watering needs based on environmental data, predict the appropriate amount of water to dispense, enhancing

the system's ability to optimize water usage. The Bluetooth-controlled interface allows the user to select different modes for varying levels of water requirements, enabling personalized control over the watering process. Once the system is activated via the mobile app, the Arduino processes the signals and communicates with the flow sensor, pump, and relay to adjust water delivery accordingly. As the system operates, it continually updates the user on the amount of water dispensed, and when the target amount is reached, the pump is automatically turned off, ensuring no water is wasted. This real-time feedback loop ensures that the system provides optimal performance and accuracy. Although the prototype is built on the basic Arduino platform, the next steps involve refining the machine learning models, expanding the sensor capabilities for more detailed environmental monitoring, and possibly integrating cloud computing or more powerful microcontrollers to handle complex data processing and enable more advanced machine learning models for future scalability and efficiency improvements.

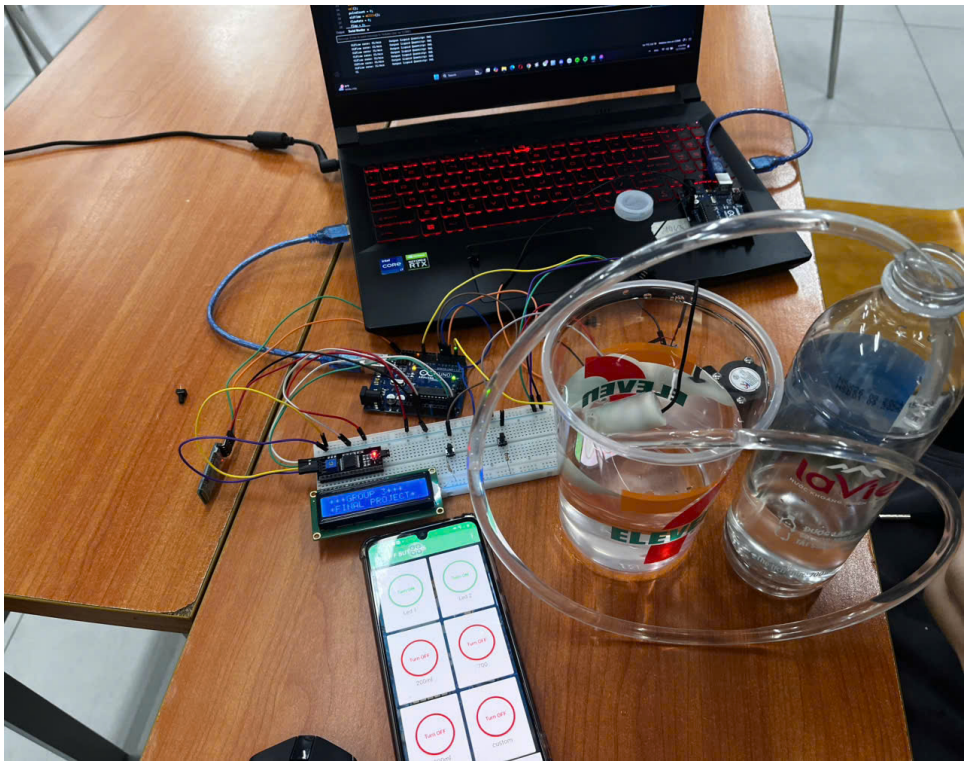

Fig. 13. Simulate System

B. Experimental Results

The Smart Water Pouring System begins when the user enters the required amount of water in milliliters (ml) into the control app. Once the value is entered, the system receives the command via Bluetooth and prepares the necessary components such as the water pump, valve, and flow sensors to get ready for watering. The flow sensor (YF-S201) will automatically adjust to measure the exact amount of water passing through and send signals to the controller to know when the desired amount of water has been reached. Once the system starts watering, the water pump is activated, and water begins to flow into the area to be watered. The flow sensor continuously measures the water passing through and sends real-time data to the Arduino. Any sudden changes in the flow rate will be detected by the sensor and automatically adjusted to ensure the accuracy of the required water amount.

When the flow sensor confirms that the desired amount of water has been dispensed, the system will automatically turn off the water pump, effectively halting the watering process. This automatic shutoff ensures that no excess water is wasted, promoting efficiency and conservation. Upon completion, a notification will be displayed on the app, providing the user with real-time feedback on the amount of water that has been dispensed, ensuring transparency and control over the process. The app will show the exact quantity of water delivered, confirming that the system has met the specified requirements. Once the watering cycle is finished, the system will enter a standby mode, where it remains idle, waiting for the next command. In this mode, the system is ready to be reactivated at any time, ensuring that it can quickly respond to new tasks or requests.

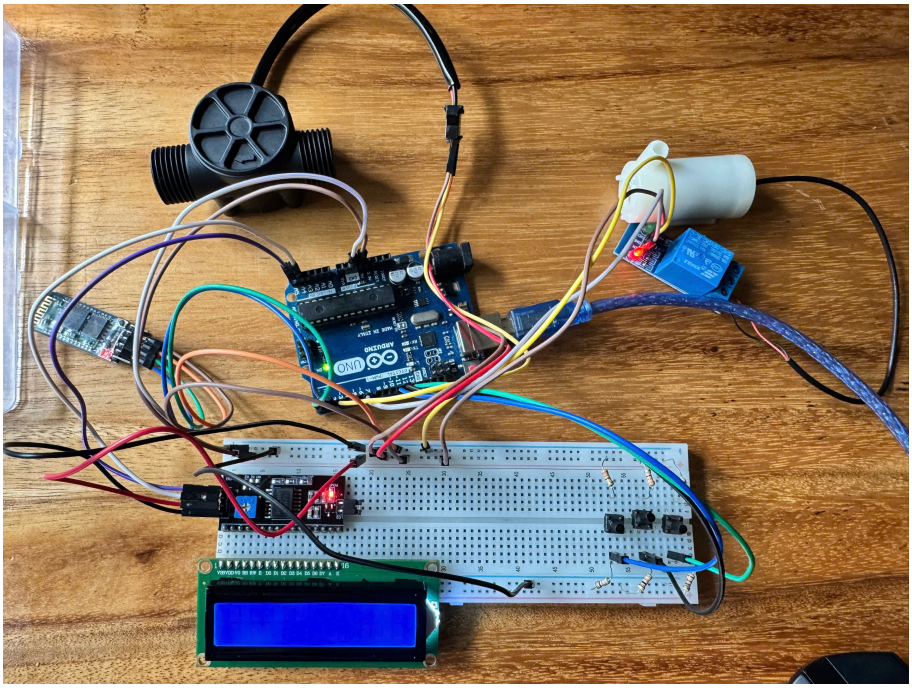

Fig. 14. The system

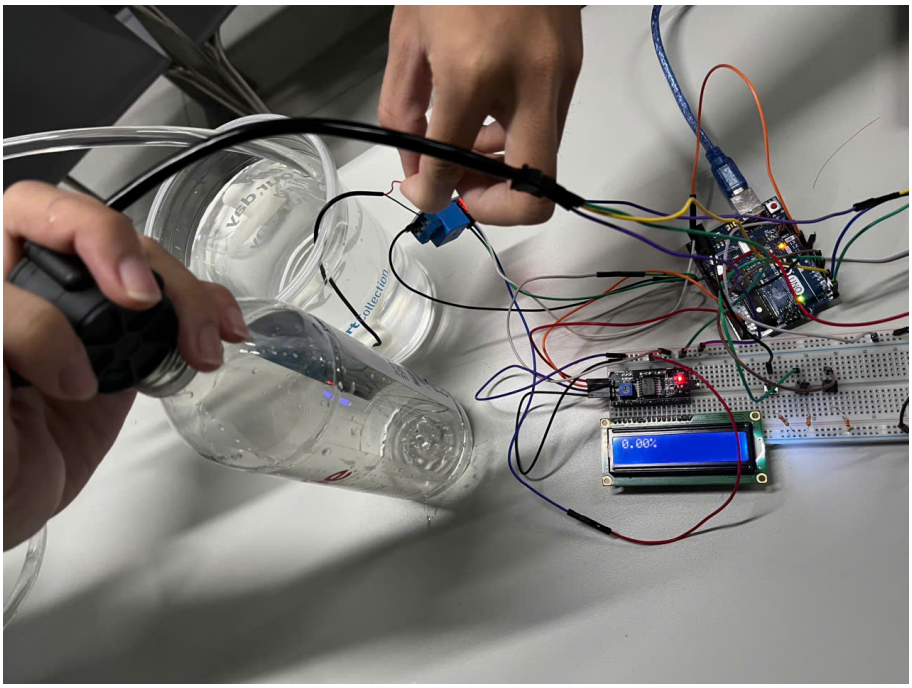

Fig. 15. Begin to pour water for the required ml

This efficient process not only ensures the precise dispensing of water but also contributes to overall water conservation by preventing over-watering. It guarantees that the system delivers exactly the amount of water specified by the user, minimizing waste while maximizing the effectiveness of the watering cycle. This approach helps create an eco-friendly and reliable smart watering system that can be trusted for consistent and optimal performance in various conditions. This system not only enhances user convenience by providing seamless control and real-time updates, but also supports sustainable practices by ensuring that water usage is both accurate and eco-conscious, making it a valuable tool for anyone looking to optimize their water management.

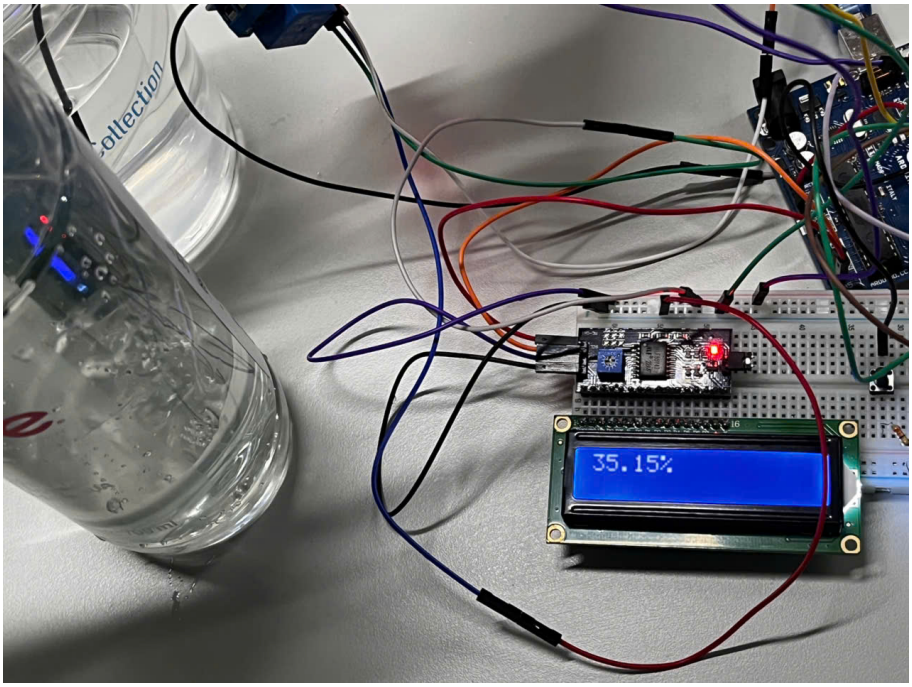

Fig. 16. Pouring Water

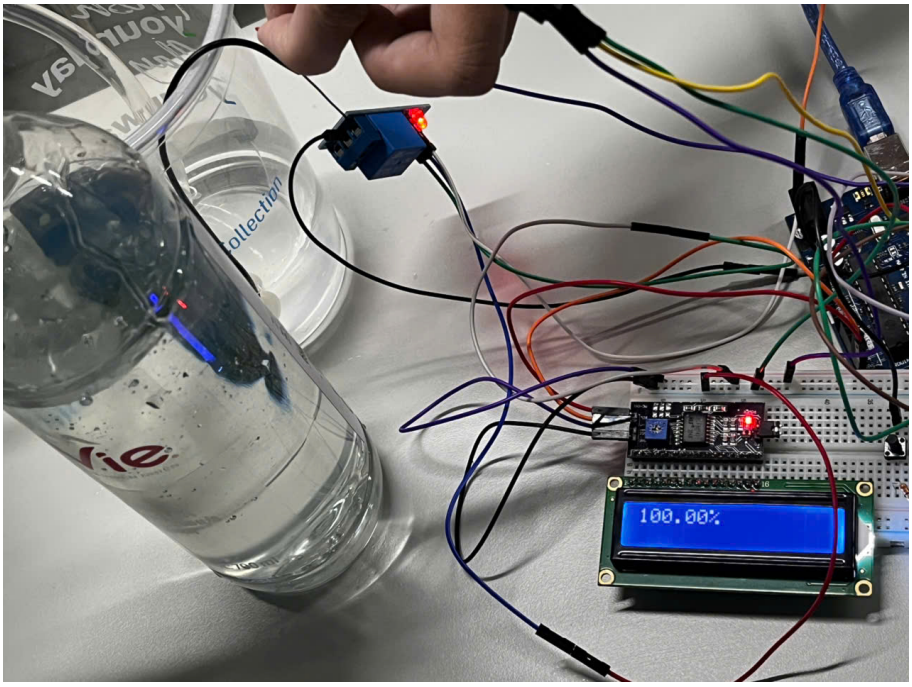

Fig. 17. Filled up the required ml

Once the required amount of water is input via Bluetooth, the Smart Water Pouring System initiates the dispensing process based on the selected machine learning model. The user inputs their desired water volume using one of the three pre-configured buttons, each corresponding to a different model that predicts the optimal dispensing parameters. The system then uses this input to calculate the required water volume, while the YF-S201 water flow sensor continuously monitors the flow in real time. The relay module controls the pump, adjusting the water flow to ensure the correct amount is dispensed. As the system

dispenses water, it compares the sensor readings to the target volume, making real-time adjustments as necessary. Once the required volume has been reached, the system automatically stops the pump, preventing any over-dispensing. Throughout the process, the LCD display provides vital information such as the current flow rate, the target volume, and the amount of water dispensed, allowing users to track the system's progress. This ensures a precise, efficient, and user-friendly experience, making it easier to control water usage and ensuring that the correct amount is dispensed every time.

C. Discussion

The Smart Water Pouring System, which incorporates the Arduino Uno, Bluetooth HC-05 module, LCD with I2C, YF-S201 water flow sensor, relay, pump, and push buttons, offers a forward-thinking approach to automated water management through the integration of machine learning and IoT technology. By leveraging Bluetooth control, the system enables users to remotely operate the pump with three push buttons, each linked to a unique pre-configured machine learning model that calculates the required water dispensing based on real-time conditions. This allows the system to optimize water usage across different scenarios, adjusting based on factors such as weather conditions, soil moisture, and user needs. The YF-S201 water flow sensor ensures that the water dispensed is accurately measured, providing real-time feedback to adjust the flow rate for maximum efficiency. Meanwhile, the relay controls the pump, activating it precisely when needed and stopping it once the target amount of water has been dispensed. The LCD provides users with valuable data, showing real-time updates on the water flow rate, system performance, and machine learning predictions, offering full transparency and control over the watering process. Despite these capabilities, there are limitations that need attention for future improvements. The performance of the machine learning models is directly tied to the quality and accuracy of the training data, which may require periodic retraining to ensure that the system adapts to changing environmental conditions or new data trends. Additionally, the Bluetooth-based control system could face issues with signal interference or range limitations, particularly in areas with obstructions or high wireless traffic. The use of the Arduino Uno as the microcontroller also restricts the system's ability to handle more complex machine learning models or process large datasets in real time due to its limited computational power. To enhance the system's capabilities, future upgrades could involve more powerful hardware, such as advanced microcontrollers or the integration of cloud computing for processing-intensive tasks. Despite these challenges, the Smart Water Pouring System represents a significant step forward in smart water management, demonstrating the potential of combining IoT and machine learning technologies to create a flexible, scalable, and efficient solution for optimizing water usage and contributing to sustainable practices. With further development, the system can continue to improve in both performance and adaptability, offering an increasingly intelligent approach to resource management.

IV. Conclusion

In conclusion, the Smart Water Pouring System designed with Arduino Uno, Bluetooth module HC-05, LCD with I2C, YF-S201 water flow sensor, relay, pump, and push buttons provides an advanced, efficient, and automated solution for water management. By integrating Bluetooth connectivity, the system allows users to control the water pouring process remotely through three push buttons, each triggering one of three pre-installed machine learning models that adjust the water dispensing based on specific predictions or conditions. The YF-S201 water flow sensor ensures accurate real-time tracking of water dispensed, offering precise data that informs the system's actions. The relay effectively controls the pump's activation, enabling the efficient flow of water when needed. The LCD with I2C adds a layer of convenience by displaying real-time system status, water flow rates, and relevant data from the machine learning model, allowing users to monitor performance with ease. This combination of IoT technologies and machine learning creates a seamless, user-friendly experience, demonstrating the potential for automation and smart resource management in everyday applications. The system not only improves water efficiency but also offers future scalability by allowing further machine learning integration or enhancements, positioning it as a valuable tool in both domestic and commercial water management solutions.

TABLE II
AUTHOR'S CONTRIBUTION

#	Student ID	Student Name	Tasks	Contribution
1	SE184982	Bui Quang Tuan	Draw charts, find material and support	25%
2	SE183218	Nguyen Hoang Bao	Prepare presentation, design slides and support	25%
3	SE182040	Nguyen Nghiem Thai Tuan	Program Arduino, main circuit assembly and support	25%
4	SE182457	Duong Hai Nam	Write report, find material and support	25%
Total				100%

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