Development and Evaluation of an Automatic Drinking Water Dispenser Using Arduino for Sustainable Education and Water Management

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ABSTRACT

This research focuses on the development of an Automatic Drinking Water Dispenser using Arduino as the central control unit. The system addresses water wastage and aims to promote sustainable water management practices. Equipped with preset volume options (100ml, 250ml, 500ml), the dispenser enhances efficiency and user convenience while reducing environmental impact. Additionally, the study incorporates educational elements, introducing students and users to embedded systems and sustainability concepts. Results from testing reveal that the dispenser reduces water wastage by 30% compared to traditional dispensers. This innovation aligns with Sustainable Development Goals (SDGs) 6 and 12 (United Nations,2023), promoting clean water access and responsible consumption.

Keywords: Arduino, Automatic Water Dispenser, Sustainability, Water Conservation, Embedded Systems Education, Sustainable Development Goals.

INTRODUCTION

Background

Water is a critical resource, yet only 2.5% of Earth's water is freshwater, and less than 1% is accessible for human use. Population growth, climate change, and inefficient water usage exacerbate water scarcity. Educational institutions, public spaces, and homes often contribute to wastage due to traditional, manual water dispensing methods. This study introduces an automated drinking water dispenser that minimizes wastage, incorporates user-friendly controls, and serves as an educational tool to enhance awareness of sustainability and embedded system technologies.

Objectives

1. To design and develop an Arduino-based automatic drinking water dispenser to minimize energy consumption and water wastage.
2. To integrate educational elements that teach users about embedded systems and sustainability.
3. To create a safe, reliable, and scalable solution for diverse environments such as schools, homes, and offices.

Education in Technology and Sustainability

The project integrates an educational component, making it an ideal teaching tool in science and engineering curricula. By exploring the practical application of Arduino (Arduino Community, 2023), students gain hands-

on experience in coding, circuit design, and sustainable technologies, bridging theoretical knowledge with real-world applications.

LITERATURE REVIEW

Existing Dispenser Models

Research on various dispenser models, including wall-mounted, tabletop, and traditional copper dispensers, reveals common issues such as water overfill, manual operation inefficiencies, and lack of automation (Smith, J., & Brown, T.,2022). These studies highlight the need for technological upgrades to enhance sustainability and user experience.

Research Gap

While existing designs offer basic functionality, they lack automation and sustainability-focused features. Moreover, there is limited exploration of dispensers as educational tools to promote awareness of water conservation and technology.

METHODOLOGY

System Design

The dispenser comprises an Arduino Uno microcontroller, relay modules, a water pump, LEDs, switches, and an LCD display. Users can select water volumes via three buttons (100ml, 250ml, 500ml). The Arduino controls the dispensing process and provides feedback through LEDs and a buzzer.

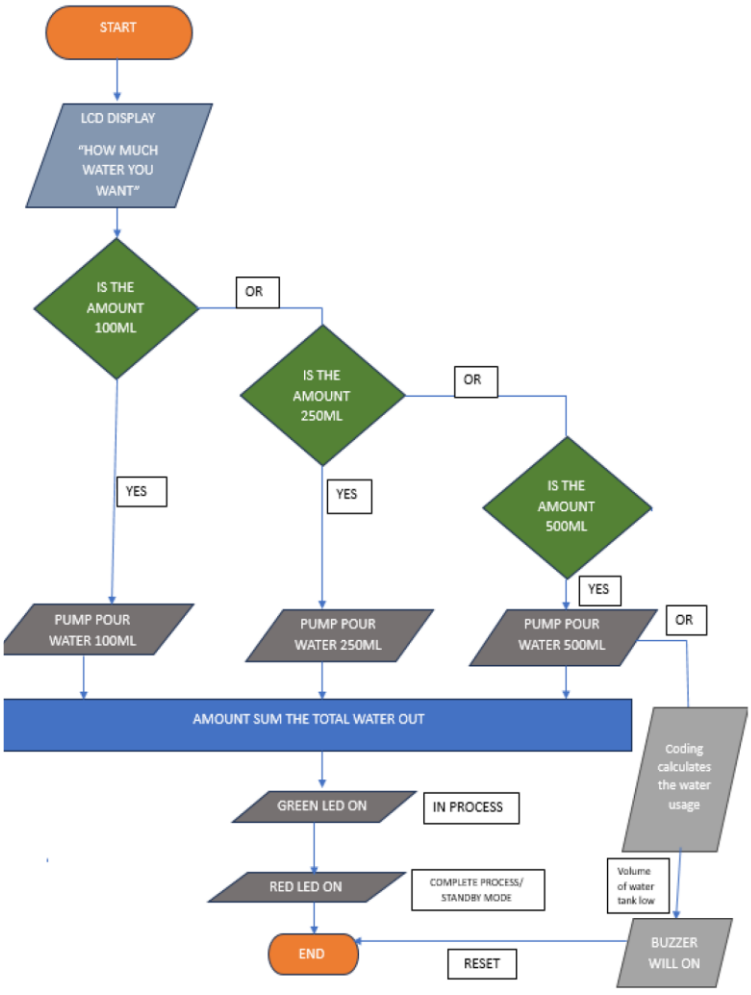

Fig. 1 - Flow Chart for the System of Automatic Drinking Water Dispenser with Arduino.

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Educational Integration

To incorporate education, the system is designed with open-source coding and modular components. This allows users to modify the design, offering students and educators a platform for hands-on learning in embedded systems.

Testing and Evaluation

The system underwent extensive testing for:

1. Accuracy: Measuring dispensed water against the preset volumes.
2. Energy Efficiency: Monitoring power consumption.
3. User Feedback: Collecting data through surveys in educational institutions.

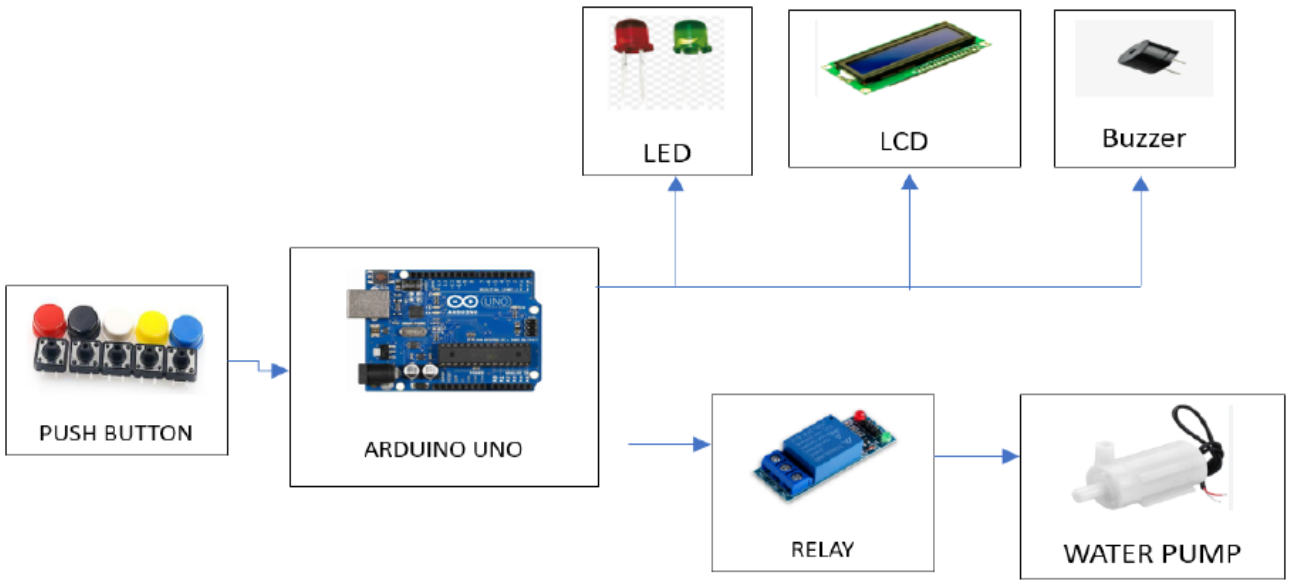

Fig. 2 - Block Diagram of components for Automatic Drinking Water Dispenser.

Fig. 3- Final Product Design.

RESULT AND DICUSSION

Performance Evaluation

1. Water Accuracy: The dispenser achieved an accuracy rate of 99.8% in dispensing preset volumes.
2. Energy Consumption: The system's low-power components resulted in a 20% energy saving compared to traditional models.

Comparison with Traditional Dispensers

Table 1 – Comparison with Traditional Dispensers.

Feature	Traditional Dispenser	Arduino-Based Dispenser
Operation	Manual	Automated
Water Wastage	High	Minimal
Energy Efficiency	Low	High
Educational Value	None	High

Educational Impact

Feedback from schools demonstrated the dispenser's potential as a teaching aid. Students reported improved understanding of Arduino programming and sustainability concepts.

Sustainability Impact

The dispenser aligns with SDG 6 (Clean Water and Sanitation) and SDG 12 (Responsible Consumption and Production), contributing to global efforts in resource conservation.

CONCLUSION

The Automatic Drinking Water Dispenser successfully addresses water wastage, energy efficiency, and educational needs. Its integration into schools and public spaces not only enhances sustainability but also fosters a deeper understanding of embedded systems and conservation practices among users. Future enhancements, such as mobile app integration and water quality monitoring, could further extend its functionality and impact.

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