

Automatic Multi Functional Water Bottle Using ATmega Microcontroller

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Abstract- *The Automatic multi-functional water bottle using ATmega microcontroller with both hot and cold water capabilities is designed to offer a convenient and versatile hydration solution for modern consumers. This innovative bottle features dual-chamber technology allowing users to store hot and cold liquids ensuring optimal temperature control without cross contamination. The heating and cooling mechanisms are integrated into the bottle cap with a rechargeable battery powering the temperature adjustments. The ATmega microcontroller is employed to regulate an element that has the capability to both heat and cool water. The heating feature offers preset temperature settings, while the cooling mechanism utilizes thermoelectric cooling technology to maintain refreshing and chilled liquids. The bottle also contains a flash light. The ergonomic design is leak-proof, easy to carry and eco-friendly with materials like BPA-free plastic and stainless steel. The bottle is also equipped with hydration reminders offering health conscious users consistent hydration prompt.*

Keywords- Peltier Module, Heat Sink, Water Bottle, Adapter, Temperature Sensor.

I. INTRODUCTION

In today's fast-paced and technology-driven world, staying hydrated is more important than ever and advancements in innovation have paved the way for smarter, more efficient solutions to everyday challenges. One such groundbreaking development is the multi-functional water bottle, a cutting-edge device designed to provide instant heating and cooling capabilities. This project focuses on creating a state-of-the-art stainless-steel water bottle that integrates advanced components such as a temperature sensor, a Peltier module and a heat sink to regulate water temperature with precision and efficiency. By harnessing the power of thermoelectric technology, this bottle allows users to seamlessly switch between hot and cold water, catering to their specific needs and making it an incredibly versatile tool for various climates, lifestyles and situations. The Peltier module, a core component of the system, operates on the thermoelectric effect, a scientific principle that enables the

transfer of heat from one side of the module to the other when an electric current is applied. This mechanism allows the bottle to either heat or cool the water inside, depending on the user's preference. For instance, on a cold day the bottle can provide warm water for comfort, while on a hot day it can deliver refreshingly cool water. To ensure the system operates efficiently, a heat sink is incorporated to dissipate excess heat generated during the process, preventing overheating and maintaining optimal performance.

Additionally, a temperature sensor is embedded within the bottle to continuously monitor the water temperature, ensuring it remains at the desired level with high accuracy. This not only enhances user convenience but also promotes energy efficiency by minimizing unnecessary power consumption. Beyond its functionality, this smart water bottle is designed with sustainability in mind. By offering a portable, all-in-one solution for heating and cooling water, it reduces the need for external appliances such as electric kettles or refrigerators, thereby lowering energy consumption and contributing to environmental conservation.

The use of durable stainless steel not only ensures the bottle's longevity but also provides excellent insulation, helping to maintain the desired temperature for extended periods. This makes it an ideal companion for a wide range of users, including travellers, outdoor enthusiasts, athletes and individuals living in extreme weather conditions. The integration of these advanced features transforms the multi-functional water bottle into more than just a hydration tool; it becomes a smart, eco-friendly and energy-efficient device that aligns with the demands of modern life. Its ability to provide instant temperature control, combined with its portability and sustainability, makes it a practical and innovative solution for anyone seeking convenience and reliability in their daily hydration routine. This project represents a significant step forward in merging technology with everyday utility, offering a product that is not only functional but also environmentally conscious and user-centric.

II. LITERATURE REVIEW

Ambekar Gajanan *et al.*,(2022) designed the automation of bottle filling involves use of PLC for control but is expensive. Despite all these advanced technologies small industries still involved in manual filling of bottles. The study emphasizes cost reduction using Arduino microcontroller and relays. Arduino microcontroller and relays are relatively cheap and widely available. In small industries bottle filling operation is done manually. The manual filling process has many flaws such as spill while filling the bottle, equal amount of water cannot be filled, delays due to human natural activities.

Atharva Achrekar *et al.*,(2021) implemented a smart water bottle which has temperature sensors where it can sense the water temperature inside the bottle and with the help of peltier module it can cool down or warm up the water to a desired temperature. This desired temperature can be preset manually and the temperature adjustments will done automatically.

Ishani *et al.*,(2023) provided the IoT- grounded Smart Water Bottle allows the stoner to track the quantum of water he drinks on a diurnal base, as well as the time he last drank water. It also reminds the stoner to drink water and refill the bottle when it's empty. This bottle is designed to track and help the stoner in analyzing and perfecting his water drinking habits.

Ravindran *et al.*,(2022) explored the Hydration Check, an IoT based smart water bottle will come to the rescue. This smart water bottle will allow the user to track their daily amount of fluid intake, average amount of fluid consumption in a day, last time of fluid intake and also notify the user reminding them to fulfill their daily fluid consumption goal, the user will be reminded to drink water every two hours by a notification message, which will be sent over email utilizing the SMTP protocol, which enables free email delivery.

Wijanarkoet *al.*,(2019) provided system has input data from water level and temperature levels. Various water levels and room temperatures are used to calculate the level of water consumption. By using the fuzzy logic method, the prediction of the consumption of drinking water needed for daily activity is quite accurate and it can also be observed that the prediction model by fuzzy produces the appropriate output. This model is tested with a 3-hour notification period for one day and is able to predict water consumption.

III. EXISTING SYSTEM

Existing smart bottle systems primarily aim to improve user convenience by incorporating features such as

hydration tracking, temperature monitoring and insulation, but most lack the ability to actively control temperature. For example, products like the HidrateSpark smart bottle monitor water consumption and sync data with a smartphone app to remind users to stay hydrated, while the Thermos Smart Lid Bottle provides real-time temperature readings of the liquid inside. These bottles use vacuum insulation technology, often with stainless steel construction, to passively keep beverages hot for long durations. However, they do not include mechanisms to actively heat or cool the contents. Other products, such as the Ember Temperature Control Mug, offer active heating but are restricted to maintaining a specific temperature for drinks like coffee or tea and do not support cooling. Similarly, self-heating cans, like those from HeatGenie, utilize chemical reactions to instantly heat beverages but are designed for single use and cannot cool liquids. While these systems perform well in areas like hydration tracking or thermal retention, they do not provide a complete solution that integrates both heating and cooling in a portable and energy-efficient manner. This limitation underscores the demand for a multi-functional smart bottle that employs thermoelectric technology to actively regulate temperature, addressing modern hydration needs more comprehensively.



Figure 1. Existing System

IV. PROPOSED SYSTEM

The proposed system aims to develop a multi-functional water bottle capable of instantly heating water through thermoelectric technology. By integrating a Peltier module, heat sink and temperature sensor, the system efficiently regulates temperature, offering users the flexibility. Designed to be compact, lightweight and portable, the bottle is an ideal solution for travellers, outdoor enthusiasts and anyone in need of on-the-go temperature control. At the heart of the system is the Peltier module, which operates on the thermoelectric effect. When an electric current is applied, the module transfers heat from one side to the other, enabling heating functionalities. To optimize performance, a heat sink is incorporated to enhance heat dissipation, ensuring efficient

temperature regulation without excessive power consumption. A temperature sensor continuously monitors the water temperature and adjusts the Peltier module's operation to maintain the desired temperature.

The bottle will be constructed from stainless steel, offering durability, safety and insulation to help maintain the desired temperature for extended periods. Additionally, a user-friendly control system will be implemented, allowing users to easily adjust temperature settings via buttons or a digital interface. The power supply will be designed to be efficient and rechargeable, promoting sustainability and energy conservation. The design emphasizes energy efficiency, minimizing unnecessary power consumption while ensuring rapid heating. This project seeks to provide a convenient, eco-friendly and technologically advanced solution to modern hydration needs, eliminating the reliance on external heating or cooling devices.



Figure 2. Proposed System

V. DEVELOPED MODEL

Working model

The multi-functional water bottle is engineered to deliver instant heating and cooling through thermoelectric technology in a compact and portable design. At its core is a Peltier module, which facilitates efficient temperature regulation, enabling users to heat or cool water as required. To maintain optimal performance, a heat sink is incorporated to dissipate excess heat, preventing overheating and ensuring system efficiency. A temperature sensor continuously tracks the water temperature, allowing for automatic adjustments to

achieve precise control. An intuitive LCD display provides real-time temperature readings, enhancing user convenience. Powered by a 12V adapter, the system operates with low energy consumption while delivering effective temperature control. The bottle's design emphasizes portability and durability, making it ideal for daily use, travel and outdoor activities. Constructed from stainless steel, it offers excellent insulation and long-lasting performance, while its compact form ensures ease of handling.



Figure 3. Snapshot of the Working Model

Hardware Components

A. Peltier Module

The Peltier module is the key component responsible for heating and cooling the water inside the bottle. It operates based on the thermoelectric effect, which allows it to transfer heat from one side to another when an electric current is applied. The module consists of two ceramic plates with semiconductor materials in between, arranged in an n-type and p-type configuration. When a DC voltage is applied, one side of the module becomes hot while the other side becomes cold.



Figure 4. Peltier Module

B. Heat Sink

The heat sink plays a crucial role in the thermal management of the system. Since the Peltier module generates

heat during operation, this heat needs to be dissipated to prevent overheating, which could affect performance and reduce efficiency. The heat sink is typically made of aluminium or copper, materials known for their high thermal conductivity. It consists of metal fins that increase the surface area for better heat dissipation. When the Peltier module is used for cooling, the heat sink absorbs and releases excess heat into the surroundings. In heating mode, the heat sink prevents excessive temperature buildup on the module, protecting it from damage.

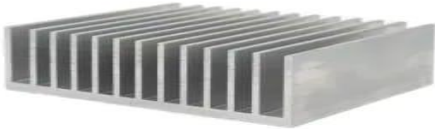


Figure 5. Heat Sink

C. Power Supply

The 12V adapter is the power source for the entire system. It provides the necessary voltage and current to operate the Peltier module, temperature sensor and LCD display efficiently. The adapter ensures a steady and stable power supply, enabling consistent performance.

It can be rechargeable, making the water bottle convenient for travel and outdoor use. Since the Peltier module requires direct current (DC) power, the adapter provides the correct voltage required for optimal operation.



Figure 6. Power Supply

D. LCD Touchscreen Display

The LCD display serves as the user interface, providing essential information about the bottle's temperature and system status. The display shows the current water

temperature in real-time, received from the temperature sensor.



Figure 7. LCD Touchscreen Display

E. Temperature Sensor

The temperature sensor is a critical component that provides real-time monitoring of the water temperature inside the bottle. It ensures that the system accurately regulates the heating and cooling process. The sensor continuously measures the current water temperature and sends the data to the control system.



Figure 8. Temperature Sensor

F. Connecting wires

The connecting wires are used to carry electrical current between different components in a circuit. They link the power supply to devices like the Peltier module, temperature sensor and display. Connecting wires ensure each part receives the required voltage to function properly. They are essential for building a complete and working electrical system.



Figure 9. Connecting Wires

V. RESULT AND DISCUSSION



Figure 10. Developed Model of the Proposed System

The multi-functional water bottle effectively incorporates thermoelectric technology to deliver instant heating with portable design. By utilizing a Peltier module, it ensures efficient temperature regulation, while the integrated heat sink optimizes thermal management, preventing overheating and boosting system performance. A built-in temperature sensor precisely monitors the water temperature and adjusts the heating or cooling process as needed, ensuring accurate control. The inclusion of an LCD display offers real-time temperature updates, adding to the user friendly experience.

Powered by a 12V adapter, the system operates with low energy consumption while delivering reliable performance. Testing revealed that the provides rapid heating, making it suitable for a variety of uses, including travel, workplaces, outdoor adventures, healthcare and emergencies. The design makes it an ideal choice for those seeking portable temperature control.

Furthermore, its eco-conscious design minimizes the need for disposable plastic bottles and external power sources, supporting sustainability initiatives. The system performs consistently, offering a dependable, efficient and user centric hydration solution. Potential future enhancements, such as smart app connectivity, solar charging capabilities and rechargeable battery options, could further elevate its functionality, transforming it into an even more innovative and adaptable product.

VI. CONCLUSION

The multi-functional water bottle utilizes thermoelectric technology to instantly heat or cool water in a portable and compact design. Equipped with a Peltier module, heat sink and temperature sensor, it efficiently regulates water temperature, preventing overheating and ensuring optimal

performance. The LCD display provides real-time temperature updates, while the 12V adapter ensures low power consumption, making it an energy-efficient and sustainable solution. This system offers instant temperature control, portability and eco friendliness, eliminating the need for separate heating or cooling appliances. It is ideal for travellers, fitness enthusiasts, professionals and emergency scenarios, reducing reliance on plastic bottles and external power sources. This innovative hydration solution combines technology, convenience and sustainability, providing users with on-the-go access to water at their preferred temperature without external heating or cooling devices.

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