

Smart Water Bottle for Daily Intake Optimization and Purity Monitoring

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Abstract: The proposed smart water bottle is designed to monitor both the quality and quantity of drinking water and remind users to stay hydrated. This system integrates multiple sensors and communication modules to provide real-time information about the water inside the bottle. The bottle uses a TDS (Total Dissolved Solids) probe to measure the purity level of the water, ensuring that the user drinks safe water. An ultrasonic sensor is used to detect the water level inside the bottle and to estimate the amount of water consumed by the user per day. A temperature sensor is included to monitor the temperature of the water, which is useful for understanding the suitability of water for drinking. All the measured parameters such as TDS level, water temperature, and water level are displayed on an LED display attached to the bottle. The system also includes a buzzer alert mechanism that reminds the user to drink water at regular time intervals, promoting healthy hydration habits. Additionally, the collected data is transmitted to the user's mobile phone via SMS, allowing the user to monitor hydration and water quality remotely. This project demonstrates the application of sensor technology, embedded systems, and wireless communication to develop an intelligent water bottle that improves user awareness about drinking water quality and daily water intake. The system aims to promote healthy hydration habits and safe drinking water monitoring in a simple and efficient way.

Keywords: Smart water bottle, Water Quality Monitoring, Water level Monitoring, ESP32, TDS sensor, Temperature sensor, Lithium-ion battery.

1. Introduction

The increasing awareness of health and the importance of proper hydration have created a need for smart solutions that help people monitor their drinking habits and water quality. In daily life, many individuals do not pay attention to the purity of the water they drink or the amount of water they consume throughout the day. Traditional water bottles do not provide any information regarding water quality, temperature, or daily intake, which may lead to poor hydration habits and potential health issues. The proposed Smart Water Bottle System uses sensor technology to measure important characteristics of drinking water and track the user's water consumption. A TDS (Total Dissolved Solids) probe is used to measure the purity level of water, ensuring that the water is safe for drinking. An ultrasonic sensor is used to detect the water level inside the bottle and calculate the quantity of water consumed by the user throughout the day. Additionally, a temperature sensor is used

to measure the temperature of the water. The collected data is displayed on an LED display, allowing the user to easily view parameters such as water temperature, TDS level, and the current water level in the bottle. A buzzer alert system is also integrated into the bottle to remind the user to drink water at regular time intervals, promoting healthy hydration habits. Furthermore, the system sends information about the water level and consumption data to the user's mobile phone through SMS, enabling remote monitoring of daily water intake. This project demonstrates how combining sensor technology, embedded systems, and wireless communication can create an intelligent hydration monitoring system. The Smart Water Bottle not only helps users maintain proper hydration but also ensures that the water being consumed is of good quality, thereby promoting a healthier lifestyle through simple and efficient technology.

2. Literature Review

Several research studies have focused on developing smart hydration systems using IoT and embedded technologies. These systems aim to monitor water consumption and improve healthy drinking habits. Many researchers have proposed smart bottles that track the amount of water consumed by users and provide reminders to drink water at regular intervals. Some research works have used water level sensors and microcontrollers to measure the quantity of water inside a bottle and calculate daily water intake. These systems help users maintain proper hydration by providing notifications through mobile applications or alert systems. However, most of these systems mainly focus on water consumption and do not consider other important parameters such as water quality and temperature. Other studies have introduced water quality monitoring systems using sensors such as TDS sensors to measure the purity of drinking water. These systems help users ensure that the water they consume is safe and free from excessive dissolved solids. In addition, some systems integrate temperature sensors to monitor the temperature of drinking water for better user awareness. Recent developments in IoT-based monitoring systems combine multiple sensors, displays, and wireless communication modules to provide realtime information about water parameters. These systems improve user convenience by displaying data on screens and sending

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information to mobile devices. The proposed Smart Water Bottle system builds on these concepts by integrating water quality monitoring, water level detection, temperature sensing, hydration reminders, and SMS communication into a single intelligent device.

3. Methodology

The Smart Water Bottle system is designed using Nano ESP32-S3 and different sensors to monitor water parameters. First, all the components such as TDS sensor, temperature sensor (DS18B20), ultrasonic sensor, LED display, and GSM module are connected to the Nano ESP32-S3. When the system is powered ON, the sensors start collecting data. The TDS sensor measures water purity, the temperature sensor measures water temperature, and the ultrasonic sensor detects the water level inside the bottle. The Nano ESP32-S3 receives all sensor data and processes it. The calculated values are then displayed on the LED display for the user to see in real time. The system also calculates the daily water consumption based on the water level changes. This helps in tracking hydration levels. Finally, the processed data is sent to the user's mobile phone through SMS using the GSM module. This completes the working of the Smart Water Bottle system.

4. Proposed System

A. Block Diagram

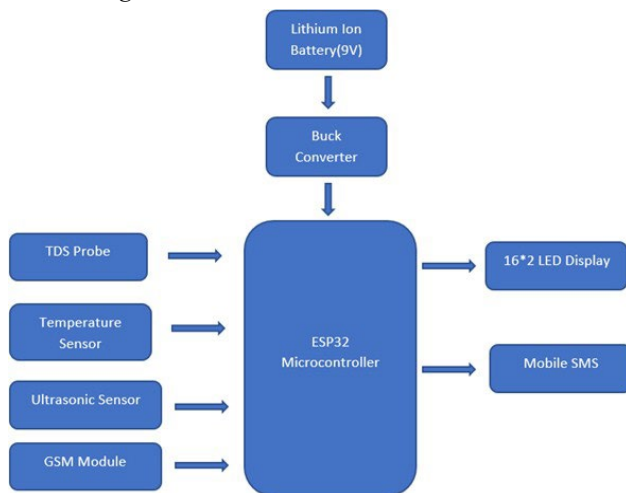


Fig. 1. Block diagram of smart water bottle for daily intake optimization and purity monitoring

The smart water bottle system is powered by a 9V lithium-ion battery, and a buck converter is used to reduce the voltage to a suitable level for the circuit. The Nano ESP32-S3 microcontroller acts as the main controller of the system. A TDS probe is used to measure the purity level of the water. The temperature sensor detects the temperature of the water inside the bottle. An ultrasonic sensor is used to measure the water level in the bottle and estimate daily water consumption. All the sensor data is processed by the Nano ESP32-S3. The measured values are displayed on the LED display for easy monitoring. A SMS message is used to remind the user to drink water at regular intervals. The system helps users monitor water quality,

Water temperature and water level in the bottle and hydration levels.

1) Nano ESP32-S2 Module

The Nano ESP32-S3 is a compact development board that combines the power of the ESP32-S3 microcontroller in a small form factor similar to the Arduino Nano. It is designed for embedded and IoT applications where space is limited, making it suitable for projects like the Smart Water Bottle system. This board comes with built-in Wi-Fi and Bluetooth, which allows it to communicate with other devices wirelessly. It can be easily programmed using the Arduino IDE or Micro Python, making it user-friendly for beginners as well as advanced users. Despite its small size, it offers high processing speed and good performance. In this project, the Nano ESP32-S3 acts as the main controller, collecting data from sensors such as the TDS probe, temperature sensor, and ultrasonic sensor. Overall, the Nano ESP32-S3 provides a compact, efficient, and powerful solution for developing smart and portable embedded systems.

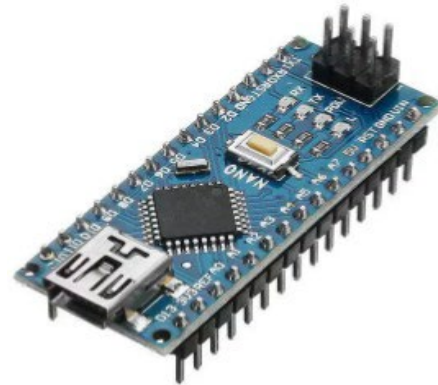


Fig. 2. Nano ESP32-S3 module

2) Temperature Sensor (DS18B20)



Fig. 3. Temperature sensor (DS18B20)

The DS18B20 temperature sensor is used in the Smart Water Bottle system to measure the temperature of the water inside the bottle. It is a digital sensor, which provides accurate temperature readings without the need for complex analog circuits. The DS18B20 works using the 1-Wire communication protocol, which means it requires only one data pin to communicate with the ESP32 microcontroller. It continuously senses the temperature and sends the digital data to the ESP32 for processing. The measured temperature is then displayed on the OLED display, allowing the user to easily check whether

the water is cold, normal, or warm. The sensor offers high accuracy, fast response, and low power consumption, making it suitable for portable devices. In this project, the DS18B20 helps in real-time monitoring of water temperature, ensuring better awareness of drinking conditions and improving the overall functionality of the Smart Water Bottle system.

3) Analog TDS Probe Sensor

The TDS (Total Dissolved Solids) probe is used in the Smart Water Bottle system to measure the purity level of the water. It detects the amount of dissolved substances such as salts, minerals, and impurities present in the water and gives the value in ppm (parts per million). The TDS probe works by measuring the electrical conductivity of water. When more dissolved solids are present, the conductivity increases, which indicates lower water purity. The sensor sends this data to the ESP32 microcontroller, which processes it and displays the TDS value on the LED display. This helps the user understand whether the water is safe for drinking or not. The TDS probe provides real-time monitoring, good accuracy, and quick response, making it suitable for water quality measurement. In this project, the TDS sensor plays an important role in ensuring safe drinking water and improving the overall functionality of the Smart Water Bottle system.



Fig. 4. Analog TDS probe sensor

5. Implementation and Working

A. Circuit Diagram

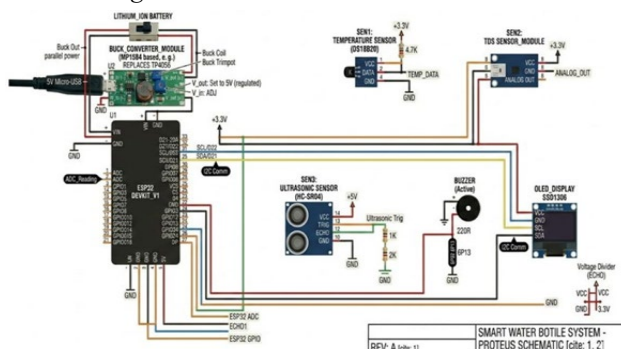


Fig. 5. Circuit diagram of smart water bottle for daily intake optimization and purity monitoring

The circuit is powered by a lithium-ion battery, and a buck converter is used to regulate the voltage to a stable level (5V/3.3V) required for the components. The ESP32 microcontroller acts as the main controller and is connected to

all sensors and output devices. The DS18B20 temperature sensor is connected to the ESP32 using a single data pin with a 4.7k Ω pull-up resistor. The TDS sensor module is powered by 3.3V and its analog output is connected to the ESP32 ADC pin to measure water purity. The ultrasonic sensor (HC-SR04) is used to measure water level. The LED display (I2C) is connected using SDA and SCL pins, allowing the ESP32 to display temperature, TDS, and water level. The buzzer is connected to a GPIO pin through a resistor and is used to give alerts. Overall, the ESP32 collects data from all sensors, processes it, displays it on the OLED, and activates the buzzer when required.

6. Working

The smart water bottle system works by continuously monitoring the water parameters using sensors connected to the ESP32. The system collects data such as water purity, temperature, and water level, processes it, and displays the information on the LED screen. It also sends the data to the user's mobile phone through SMS for remote monitoring.

1. *Sensor-Based Monitoring:* The system uses a TDS sensor, DS18B20 temperature sensor, and ultrasonic sensor to measure water purity, temperature, and water level inside the bottle.
2. *Data Processing using ESP32:* The ESP32 microcontroller collects data from all sensors, processes it, and calculates important values like water quality and daily water consumption.
3. *Real-Time Display:* The processed data is displayed on the LED display, showing TDS value, temperature, and water level for easy user understanding.
4. *Water Consumption Tracking:* The system uses ultrasonic sensor data to track the amount of water consumed per day, helping users maintain hydration.
5. *Wireless Communication:* The system sends the collected data to the user's mobile phone via SMS using the GSM module, enabling remote monitoring.
6. *Continuous Monitoring:* The system works continuously and updates the sensor readings at regular intervals and real-time information.

7. Result Analysis and Discussions

The hardware output shows the real-time values of water parameters. The LCD display shows the water temperature, TDS level, and water level inside the bottle. The ESP32 processes the sensor data and sends the output to the display. Users can easily understand the water condition and quality. Additionally, the system sends SMS updates to the mobile phone for tracking water usage and the water temperature, TDS level, and Water Level inside the water bottle.



Fig. 6. Output showing water quality monitoring



Fig. 7. Output showing temperature, water level and TDS of water

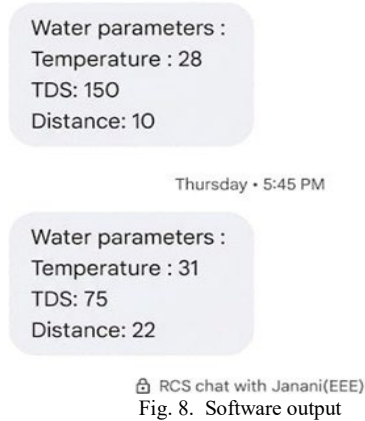


Fig. 8. Software output

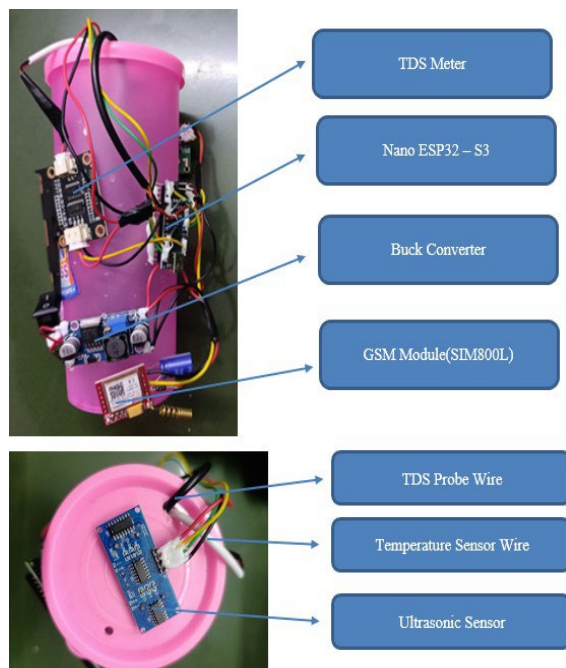


Fig. 9. Hardware circuit of smart water bottle for daily intake optimization and purity monitoring

The smart water bottle hardware consists of the Nano ESP32-S3, which acts as the main controller and connects all components. It receives input from sensors and controls the overall system operation. The TDS meter and TDS probe are

used to measure the water purity, and their output is given to the ESP32 for processing. The temperature sensor wire (DS18B20) is used to measure the water temperature inside the bottle. The ultrasonic sensor is placed at the top of the bottle to detect the water level by measuring the distance to the water surface. This helps in calculating the amount of water present and consumed. The system is powered using a lithium-ion battery, and a buck converter is used to regulate the voltage to a safe level for the components. The GSM module (SIM800L) is connected to the ESP32 to send SMS updates to the user's mobile phone. All components are connected properly to the ESP32, which processes the data and ensures smooth working of the Smart Water Bottle system.

8. Conclusion

The smart water bottle system is a simple and effective solution for monitoring water quality and daily water consumption. It uses sensors and the Nano ESP32-S3 microcontroller to measure important parameters like TDS level, temperature, and water level. The system displays real-time data on the LCD screen and also sends updates to the mobile phone through SMS. This helps users easily track their hydration and ensure they are drinking safe water. Overall, the project improves health awareness and hydration habits using smart technology. It is a low-cost, portable, and user-friendly system that can be further developed for advanced applications.

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