



International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Smart Ecorefill Auto Tap.

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ABSTRACT :

Abstract: With rising global concern over water conservation and plastic pollution, there is a growing need for sustainable, intelligent, and user-friendly solutions. The Smart Eco Refill Auto Tap is designed as an automated water dispensing system that supports eco-conscious habits by allowing refills only in steel bottles—eliminating the use of plastic containers. At its core is the ESP32 microcontroller, which processes input from three ultrasonic sensors for bottle detection and level monitoring, a metal detect sensor to verify the bottle's material, and a soil moisture sensor to assess environmental water needs. The output is a servo motor-controlled valve that precisely controls the water flow based on sensor input. The system not only encourages eco-friendly behavior but also incorporates IoT-driven automation to minimize human contact, reduce water wastage, and maintain hygiene. This paper presents the design, working, and advantages of this innovative project that bridges the gap between technology and sustainability.

Introduction

In today's fast-paced world, issues like plastic pollution, water wastage, and lack of hygiene in public utilities are becoming more alarming. Our project, Smart Eco Refill Auto Tap addresses these issues by offering a contactless water dispensing solution, focused exclusively on refilling steel bottles. Unlike traditional taps or dispensers, this system intelligently determines whether the approaching bottle is reusable and steel-based using a metal detect sensor, and accurately fills it using ultrasonic sensors without human intervention. The ESP32 microcontroller serves as the brain of the system, coordinating sensor inputs and triggering the servo motor to control a water valve accordingly. The system is ideal for deployment in public spaces such as railway stations, schools, airports, and offices, where hygiene, automation, and sustainability are key.

Significance Of the System

1. Environmental Impact

- Reduces plastic waste by encouraging refilling rather than using single-use containers.
- Supports sustainable practices in homes, businesses, and public spaces.

2. Smart Technology Integration

- Uses sensors or automation to dispense the exact amount of liquid (e.g., soap, sanitizer, water).
- May include IoT connectivity to monitor usage, alert for refills, or track consumption patterns.

3. Convenience & Hygiene

- Touchless operation improves hygiene, especially important in healthcare and food industries.
- Automatic refilling or low-level alerts ensure consistent availability.

4. Cost Efficiency

- Minimizes product waste by dispensing precise amounts.
- Lowers long-term costs by reducing the need to frequently buy new containers.

5. Commercial and Industrial Use

- Ideal for malls, airports, hospitals, or schools where bulk dispensing is needed.
- Can integrate with larger supply chain systems to optimize refill schedules.

Methodology

1. Sensor Activation

The system uses infrared (IR) or motion sensors to detect the presence of a hand or container beneath the tap.

2. Automatic Dispensing

Upon detection, a microcontroller (like Arduino or ESP32) sends a signal to activate a solenoid valve or motor, dispensing a preset amount of liquid.

3. Eco-Refillable Container

The system is connected to a refillable reservoir that holds the liquid (e.g., soap, sanitizer, detergent).

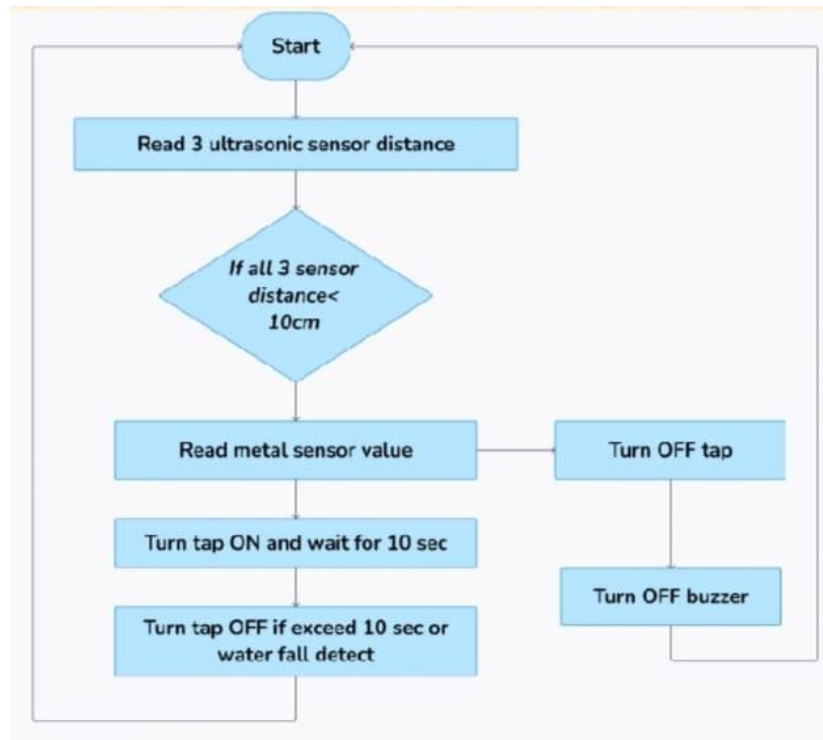
These reservoirs are designed to be eco-friendly, promoting bulk refilling and reducing single-use plastics.

4. Smart Monitoring

Built-in sensors (e.g., ultrasonic or weight sensors) monitor the liquid level in the reservoir.

The system sends alerts (via app or display) when the liquid is low or if maintenance is needed

Block Diagram



Ultrasonic Sensor – Overview

An ultrasonic sensor is a device that measures the distance to an object using ultrasonic sound waves. It's widely used in smart systems like automatic taps, robotics, and object detection.

Key Components:

Trigger Pin: Sends an ultrasonic pulse.

Echo Pin: Receives the reflected pulse.

Transmitter (TX): Emits ultrasonic waves (usually at 40 kHz).

Receiver (RX): Detects the reflected wave.

ESP32 Module – Overview

The ESP32 is a powerful, low-cost microcontroller with built-in Wi-Fi and Bluetooth, making it ideal for IoT projects like the Smart Ecorefill Auto Tap.

Key Features:

Dual-core processor: Tensilica Xtensa LX6, up to 240 MHz

Wi-Fi & Bluetooth (BLE): Built-in for wireless communication

GPIO Pins: 34+ General Purpose Input/Output pins

ADC/DAC: 12-bit ADCs and 8-bit DACs for analog signal handling

PWM Support: Useful for controlling motors and pumps

Low Power Consumption: Suitable for battery-powered devices

Soil Moisture Sensor – Overview

A soil moisture sensor is used to measure the water content in the soil. It's commonly used in agriculture, gardening, and smart irrigation systems, and it can even be creatively repurposed for liquid-level detection in tanks.

Common Types:

1. Resistive Soil Moisture Sensor

Measures moisture by checking the resistance between two probes.

More affordable but less durable (can corrode over time).

Future perspective

ensor-based: Dispenses product automatically when hands or containers are detected. Eco-friendly: Uses refillable pouches or cartridges to reduce plastic waste. Smart-enabled: Connects to an app to monitor usage, reorder refills, and track sustainability impact.

2. Key Future Trends & Benefits

A. Sustainability & Waste Reduction

Eliminates single-use plastic bottles.

Encourages refill culture and bulk buying.

Promotes circular economy models.

B. Smart Home Integration

Syncs with smart home systems (Alexa, Google Home).

AI learns user habits and optimizes dispensing amount.

Notifies users when refills are low or auto-orders them.

C. Commercial & Public Use

Useful in public restrooms, hotels, restaurants.

Tracks usage analytics for efficient supply chain management.

Reduces theft and overuse of liquid products.

Advantages

1. Eco-Friendly & Sustainable

- Reduces plastic waste by using refillable cartridges.
- Minimizes carbon footprint through bulk refilling and less packaging.
- Encourages zero-waste or low-waste lifestyles.

2. Cost-Effective

- Bulk refills are cheaper in the long run compared to buying single-use bottles.
- Smart dispensing reduces overuse and waste, saving product.

3. Hygiene & Convenience

- Touchless dispensing improves hygiene—especially useful post-COVID.
- Sensor-activated for easy use, especially for children or elderly.
- Reduces mess and clutter in kitchens, bathrooms, and public spaces.

4. Smart Monitoring & Reordering

- Tracks usage patterns and sends alerts when a refill is needed.
- Auto-reordering ensures you never run out of essentials.
- Helps users manage household supplies efficiently.

5. Brand & Consumer Engagement

- Offers personalization (e.g., amount dispensed, scent preferences).
- Brands can use refill stations as loyalty touchpoints.
- Allows consumers to track environmental impact (plastic saved, carbon reduced).

6. Versatility & Multi-Use

- Can dispense a variety of liquids: soap, sanitizer, shampoo, detergent, etc.
- Suitable for homes, offices, hotels, hospitals, and public restrooms.

Conclusion

The Smart Eco Refill Auto Tap is an innovative and eco-friendly solution designed to promote sustainable living by encouraging the use of reusable metal bottles and reducing plastic waste. By integrating modern technologies such as the ESP32 microcontroller, ultrasonic and proximity sensors, and a solar-powered energy system, the project offers an automated, touch-free, and intelligent water dispensing system.

It not only conserves water and energy but also enhances hygiene, user convenience, and environmental awareness. The system's ability to operate efficiently using solar energy makes it ideal for both urban and remote locations. With future enhancements like IoT connectivity, smart payments, and water quality monitoring, the project has vast potential for real-world implementation and scaling.

Overall, the Smart Eco Refill Auto Tap reflects a perfect blend of technology, sustainability, and social responsibility, making it a valuable contribution to smart and green infrastructure.

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