

PROJECT ABSTRACT

Solar-Powered Water Tank Level Monitor with Ultrasonic and Float Sensors

A solar-powered ESP32 water-tank level monitor with HC-SR04 ultrasonic sensing, float-switch backup, deep-sleep cycling, median ripple filtering and a low-level alert. Delivered built-to-order with prototype, firmware, calibration and solar-sizing notes, report, PPT and viva kit.

01. Title

Solar-Powered Water Tank Level Monitor with Ultrasonic and Float Sensors

02. Introduction / Background

Water tanks in remote spots are checked by walking to them, and a dry tank is discovered only when it matters. Where mains power is unavailable, the monitoring node must live on sunlight: a solar panel, a battery, and aggressive power management. Ultrasonic time-of-flight sensing gives a continuous level percentage from above the water without touching it, while a float switch provides a hard digital backup that works even when the acoustic path is confused. This project combines all three disciplines — sensing, redundancy and low-power design — in one field-ready ESP32 node.

03. Problem Statement

Remote tanks fail silently: float valves stick, supply lines break, and nobody knows until the next visit. A single ultrasonic sensor can be fooled by ripples or obstructions, and a continuously-powered node drains its battery in days. The project addresses this with redundant sensing (ultrasonic percentage plus float-switch hard backup), median filtering against ripple noise, deep-sleep cycling between readings, and a solar-battery power budget documented as a sizing method rather than a fixed claim.

04. Objectives

- Measure tank level continuously with an HC-SR04 ultrasonic sensor on a PVC bracket.
- Provide an independent float-switch low-level backup.
- Power the node from a solar panel and battery pack with documented sizing.
- Sleep the ESP32 between measurement cycles to stretch battery life.
- Filter ripple noise with median sampling before any decision.
- Raise a buzzer alert and Wi-Fi status flag on low level.

05. Proposed Methodology

The node operates on a wake-measure-sleep cycle. (1) On its timer the ESP32 wakes, powers the sensor rail, takes a burst of rapid ultrasonic samples and keeps the median to reject ripple and splash spikes. (2) The median distance is mapped to a level percentage

using the buyer's empty/full calibration; the float switch is read as an independent digital check, and either sensor can assert low level. (3) Readings, battery voltage and alert events are logged to flash and served on the Wi-Fi status page; the node then returns to deep sleep until the next cycle.

06. System Architecture / Working

The HC-SR04 mounted above the tank fires its burst, and the echo time converts to water-surface distance; the firmware's median filter cleans the burst before mapping to percentage. The float switch sits at the low point as the redundant channel. A threshold breach — by percentage or by float — sounds the buzzer in a repeating pattern and flags LOW WATER on the status page until the level recovers. Between cycles the ESP32 sleeps, the solar panel tops up the battery through its charge module, and the status page always shows the last reading with its timestamp so staleness is visible.

07. Hardware / Software Requirements

- ESP32 development board
- HC-SR04 ultrasonic distance sensor
- Float switch (digital backup)
- Solar panel with charge module
- Battery pack
- Status display
- Piezo buzzer
- Arduino IDE (C/C++ firmware)
- PVC sensor bracket

08. Expected Outcomes

- A working solar-powered node reporting tank level with redundant sensing.
- Low-level alerts via buzzer and Wi-Fi status flag.
- A documented empty/full calibration and solar-sizing procedure.
- A complete report, PPT and viva Q&A; on time-of-flight sensing, filtering and deep sleep.

09. Applications

- Level visibility for remote and farm water tanks.
- Teaching ultrasonic sensing and median-filter signal conditioning.
- Demonstrating deep-sleep low-power design and solar power budgeting.

10. Future Scope

- LoRa backhaul for beyond-Wi-Fi-range installations.
- Pump auto-start tied to the level thresholds.
- Water-quality sensing (turbidity/pH) as an added module.

- Multi-tank aggregation on one dashboard.