Smart Rainwater Harvesting Controller using ESP32

An ESP32 controller automating first-flush diversion, turbidity-gated tank routing, ultrasonic level management and filter-clog indication.

1. Introduction / Background

Rainwater harvesting fails in practice for mundane reasons: nobody diverts the first flush, filters clog silently, and tanks overflow or run dry unwatched.

This controller automates the correct procedure: rain detection, first-flush diversion, turbidity-gated routing to storage, level-managed inflow, and a filter-clog indicator.

2. Problem Statement

Manual harvesting discipline rarely survives a monsoon season. Automating the routing decisions — when to divert, when the water is clean enough to store, when the tank is full — requires multi-sensor fusion and a valve state machine, which is exactly the embedded content of this project.

3. Objectives

- Divert the dirty first flush to drain automatically on rain onset.
- Gate tank routing on turbidity; hold drain routing while water stays dirty.
- Manage tank level (full-stop, reserve top-up) and indicate filter clogging.

4. Proposed Methodology

A rain sensor wakes the controller; a motorized ball valve routes the first flush to drain for a configurable volume/time. An optical turbidity sensor then gates the tank route — persistently dirty flow holds the drain route and logs the event. A waterproof ultrasonic sensor tracks tank level with full-stop and reserve top-up, while a flow-time vs level-rise mismatch raises the clean-filter indicator.

5. System Architecture / Working

- Sensing: rain plate, analog turbidity sensor, waterproof ultrasonic level sensor.
- Actuation: two 5 V motorized ball valves (drain/tank routes) via relay/H-bridge with timed positioning and stall guard.
- Supervision: 16x2 LCD live status; SD-card event log of every routing decision.

6. Hardware / Software Requirements

- ESP32 dev board, rain sensor, turbidity sensor, waterproof ultrasonic sensor, 2x motorized ball valves + drivers, microSD module, 16x2 LCD, manual override buttons.
- Arduino IDE (C/C++); 5 V DC logic + valve supply; scaled tank demo rig.

7. Expected Outcomes

- A working controller demonstrating the full harvesting loop on a scaled rig.
- Buyer-configured turbidity thresholds from a clear-vs-dirty water check.
- A complete report, PPT and viva Q&A; on turbidity sensing, valve control and level measurement.

8. Applications

- Household rainwater harvesting automation.
- Farm pond/irrigation tank management.
- Teaching multi-sensor state-machine control.

9. Future Scope

- pH-gated routing as a second quality gate.
- Cloud rainfall/yield dashboard.
- Solar-powered field deployment.

10. Conclusion

The controller turns harvesting from a plumbing chore into an instrumentation project, with every threshold buyer-calibrated and every limitation stated.