PROJECT ABSTRACT

Smart Seed Germination Chamber with Soil and Climate Monitoring

An ESP32-based seed germination chamber that monitors soil moisture, temperature and humidity, shows a live germination status on an LCD, and runs a timed LED grow-light strip — built-to-order with prototype, firmware, calibration procedure, report, PPT and viva kit.

01. Title

Smart Seed Germination Chamber with Soil and Climate Monitoring

02. Introduction / Background

Most germination failures are climate failures: the tray dries out between waterings, or sits too cold to sprout, and the student learns this a week later when nothing emerges. Checking soil by finger twice a day misses the drying cycles that matter, and there is no record of what the tray experienced. This project instruments the tray instead of guessing: soil-moisture probes report the root zone, a DHT22 reports chamber temperature and humidity, and an LCD shows a plain-language germination status with live readings. A timed LED strip supports seedlings after emergence, and the clear enclosure holds humidity in while keeping the experiment visible.

03. Problem Statement

Students are told seeds need 'warmth and moisture' but are given no instrument to verify either. Manual inspection is subjective, infrequent and unrecorded. The project provides a low-cost monitored chamber where every germination condition is sensed, displayed and logged against configurable bands — turning 'keep it moist' into measured practice.

04. Objectives

- Monitor root-zone soil moisture with in-tray probes and chamber climate with a DHT22 on an ESP32.
- Show a live germination status with temperature and humidity on a 16x2 LCD.
- Run an LED grow-light strip on a configurable schedule for emerged seedlings.
- Flag band violations in firmware when any parameter leaves its safe range.
- Retain humidity passively in a transparent observation enclosure.
- Provide a soil-probe calibration procedure and deliver the full student kit: prototype, firmware, docs, report, PPT and viva Q&A.;

05. Proposed Methodology

The system is built in three layers. (1) Sensing: soil probes and the DHT22 are sampled on a timed cycle; the student calibrates the soil probes in their own medium against dry and saturated references. (2) Decision: firmware compares each parameter against documented safe bands and sets the LCD status flag. (3) Support: the LED strip follows its schedule independently of sensing. Thresholds are firmware constants with defaults for common

vegetable seeds, retunable per seed type.

06. System Architecture / Working

Soil probes + DHT22 → ESP32 (calibration mapping, band comparison) → 16x2 LCD (status + live readings); LED strip on its own timer. The working flow is: fill the tray and bury the probes → run the calibration procedure → sow and close the chamber → read the status display daily and water only when the moisture flag says so → record the germination outcome against the logged conditions for the report.

07. Hardware / Software Requirements

- ESP32 DevKit board
- DHT22 temperature/humidity sensor
- Soil-moisture probes
- 16x2 character LCD
- LED strip with driver
- Transparent chamber + seed tray with medium
- 5 V DC supply
- Arduino IDE (C/C++ firmware)

08. Expected Outcomes

- A working chamber showing live germination status with temperature and humidity on the LCD.
- Calibrated soil-moisture readings meaningful for the student's own medium.
- A documented watering discipline driven by the moisture flag rather than by schedule.
- A complete report, PPT and viva Q&A; on sensing, calibration and threshold logic.

09. Applications

- Teaching sensor calibration with a real medium.
- Home and college nursery germination.
- Smart-agriculture sensing demonstrations.

10. Future Scope

- Capacitive soil probes for corrosion-free long-term sensing.
- Automatic watering on the moisture flag.
- Active heating for cold-climate germination.
- Logged data export for germination-rate analysis.