PROJECT ABSTRACT

IoT Bird Deterrent System for Farms

A solar-powered ESP32 field unit that detects birds with PIR sensors and fires a randomized mix of ultrasonic, strobe and motion deterrents to slow habituation — delivered as a built-to-order hardware prototype with firmware, wiring docs and viva kit.

01. Title

IoT Bird Deterrent System for Farms

02. Introduction / Background

Birds can strip a standing crop in days, and farmers' traditional defenses — scarecrows, reflective tape, firecrackers — either stop working within a week or demand constant human attention. The core problem is habituation: a deterrent that always looks and sounds the same becomes background noise. This project builds an IoT bird deterrent that attacks exactly that problem: a PIR-triggered ESP32 unit firing a randomized sequence of ultrasonic bursts, high-intensity strobe flashes and a servo-driven moving scare device, with randomized timing and intervals, while logging every detection over Wi-Fi. Solar power with battery backup keeps it running in the field without grid wiring.

03. Problem Statement

Existing bird deterrents fail on two counts: static deterrents habituate quickly, and active deterrents need a person present to operate them. Farmers need a self-running field unit that varies its deterrent pattern automatically, works through the high-activity dawn and dusk windows, and reports its activity without a site visit. The project addresses this with a solar-powered ESP32 unit combining three deterrent modalities under a randomized scheduler.

04. Objectives

- Detect bird presence with dual PIR motion sensors covering the crop zone.
- Fire a randomized mix of ultrasonic bursts, strobe flashes and servo-driven scare motion with randomized timing to slow habituation.
- Run fully on solar power with battery backup sized for approximately 2-3 days of autonomy.
- Report detection counts, battery voltage and firing logs over Wi-Fi to a status page, with a configurable quiet-hours window.

05. Proposed Methodology

The firmware runs a sense-decide-act loop on the ESP32. PIR interrupts wake the scheduler, which draws a randomized deterrent combination — ultrasonic sweep parameters, strobe pattern, servo sweep angles — from seeded ranges so no two triggers look alike. Firing duration is randomized between configurable bounds (typically 5-20 seconds). Every trigger is timestamped with battery voltage and pushed over Wi-Fi to a Blynk or local web dashboard. A hardware timer enforces quiet hours. Solar sizing follows a simple energy budget: panel wattage and battery capacity are matched to the expected daily trigger count documented in the report.

06. System Architecture / Working

PIR sensors -> ESP32 interrupt handling -> anti-habituation scheduler -> deterrent drivers (ultrasonic transducer, LED strobes, servo) -> Wi-Fi telemetry -> dashboard. The 10 W solar panel feeds a charge controller that guards the rechargeable battery against over-charge and deep discharge. The weatherproof IP65 enclosure with pole-mount bracket houses the controller, battery and drivers; the PIR domes and solar panel mount externally. The wiring diagram documents every connection for the viva walkthrough.

07. Hardware / Software Requirements

- Hardware: ESP32 development module, 2x HC-SR501 PIR sensors, ultrasonic transducer module, high-intensity LED strobes, servo motor with reflective scare panel, 10 W solar panel, charge controller, rechargeable battery pack, IP65 enclosure, pole-mount bracket.
- Software: Arduino IDE, ESP32 board support, Blynk library or the included local web dashboard code.

08. Expected Outcomes

A working field prototype that detects motion in its coverage zone and responds with varied deterrent sequences, a Wi-Fi status page showing detection counts and battery health, and a test log documenting trigger behavior across the trial period. The report honestly discusses habituation limits and the mixed evidence base for ultrasonic bird deterrence.

09. Applications

- Standing-crop protection on small and medium farms.
- Orchards and vineyards during fruiting season.
- Fish farms and aquaculture ponds troubled by birds.
- Academic demonstration of anti-habituation scheduling in embedded systems.

10. Future Scope

- Camera-based species detection to fire deterrents only for target birds.
- LoRa-linked multi-unit coordination across large farms.
- Distress-call audio playback as a fourth deterrent modality.
- Solar-yield forecasting to adapt firing intensity to battery state.