

PROJECT ABSTRACT

IoT Forklift Proximity Alert using Ultrasonic Sensor

An IoT proximity alert for forklift zones: an ESP32 reads an HC-SR04 ultrasonic sensor and escalates from a blinking LED to a sounding buzzer as objects enter configurable warning and danger distances, with readings published over Wi-Fi to a web dashboard. Delivered built-to-order with the prototype, firmware, dashboard, report, PPT and viva kit.

01. Title

IoT Forklift Proximity Alert using Ultrasonic Sensor

02. Introduction / Background

Forklifts and pedestrians sharing the same floor are one of the oldest hazards in warehouses: blind corners, racking aisles and loading docks create exactly the situations where a few meters of early warning prevent an accident. Industrial proximity systems exist but are expensive and closed. The sensing-and-alert loop itself, however, can be built from commodity parts: an ultrasonic sensor measures distance by echo timing, a microcontroller compares it against thresholds, and an alarm escalates as the target gets closer. This project builds that loop around an ESP32 and an HC-SR04 ultrasonic sensor, demonstrated at bench scale with a model forklift as the target. Local buzzer and LED alerts fire with no network at all, while readings and alert events are published over Wi-Fi to a lightweight web dashboard with a live distance readout and an event log.

03. Problem Statement

Students studying industrial safety or IoT rarely get to build a working proximity-alert system: real vehicle systems are certified, expensive and off-limits. The project addresses this by building the complete detect-decide-alert chain at prototype scale, where every part is visible and measurable. Threshold calibration is a documented procedure, so the report's warning and danger distances come from the student's own measurements rather than assumed values, and the dashboard gives the build a genuine IoT dimension.

04. Objectives

- Interface an HC-SR04 ultrasonic sensor to an ESP32 and convert echo timing to distance.

- Implement configurable warning and danger distance zones with escalating LED/buzzer response.
- Publish live distance, zone state and alert events over Wi-Fi to a web dashboard.
- Log threshold crossings to the serial monitor for the report's test table.
- Deliver the complete student kit: prototype, firmware, dashboard, report, PPT and viva Q&A.

05. Proposed Methodology

The build has three stages. (1) Sensing: the HC-SR04 is wired to the ESP32; firmware pings the sensor and converts echo time to distance ($\text{distance} = \text{echo time} \times 0.034 / 2$). (2) Alert logic: readings are compared against warning/danger constants — LED blink at warning, buzzer plus solid LED at danger — with thresholds set via the documented calibration procedure using real measured distances. (3) IoT layer: the ESP32 publishes readings and zone state over Wi-Fi to a simple web dashboard showing live distance and an alert event log, while the serial monitor captures threshold crossings for the report.

06. System Architecture / Working

The HC-SR04 emits an ultrasonic ping and the ESP32 measures the echo return time, converting it to distance. Each reading is compared against the configured warning and danger thresholds: inside the warning zone the red LED blinks, inside the danger zone the buzzer sounds and the LED goes solid. Readings and zone state are published over Wi-Fi to the web dashboard for the live distance display and event log. The serial monitor prints every threshold crossing with its distance, producing the test table for the report.

07. Hardware / Software Requirements

- ESP32 DevKit (Wi-Fi microcontroller)
- HC-SR04 ultrasonic distance sensor
- Piezo buzzer module and red LED indicator
- Breadboard, jumper wires, 5 V USB power supply
- Arduino IDE (firmware development)
- Wi-Fi network for the dashboard feed (local alerts work without it)
- Web browser to view the dashboard; no cloud account required

08. Expected Outcomes

- Working prototype with zone-based LED/buzzer escalation.
- Web dashboard showing live distance, zone state and alert event log.
- Threshold calibration performed by the student with documented distances.
- Serial-logged threshold crossings forming the report's test table.

- Complete documentation: report, PPT, wiring guide, calibration procedure and viva Q&A.

09. Applications

- Teaching platform for ultrasonic sensing, threshold logic and ESP32 Wi-Fi.
- Concept model for warehouse vehicle-proximity alerting (prototype scope).
- Reference build for other zone-based alert projects (parking assist, restricted areas).
- Viva demonstration with live distance readings and dashboard.

10. Future Scope

- Multiple sensors for wider zone coverage with cross-talk management.
- GSM/LoRa alerting for areas without Wi-Fi.
- Data logging of near-miss events to an SD card for safety audits.
- Industrial-grade sensor variant study for real-vehicle deployment.

11. References

- HC-SR04 datasheet — ultrasonic ranging module, 2–400 cm range.
- Espressif ESP32 Series Datasheet — microcontroller specifications.
- Arduino ESP32 core documentation — Wi-Fi and web server libraries.
- OSHA forklift safety guidance — background on powered industrial truck hazards.