**PROJECT ABSTRACT**

# LoRa Hiker SOS Beacon with GPS

*A hiker SOS beacon: a pocket ESP32 unit with GPS and LoRa where one press of the panic button transmits live GPS coordinates kilometers to a base-station receiver — no cellular coverage needed. Delivered built-to-order with both units, firmware and viva kit.*

## 01. Title

LoRa Hiker SOS Beacon with GPS

## 02. Introduction / Background

Hikers, trekkers and field workers routinely go where phones show no signal — and that is exactly where an emergency is hardest to report. Commercial satellite messengers solve this but cost far more than a student budget allows. LoRa offers a middle path: license-free long-range radio that can carry a short GPS position packet several kilometers to a base station at the trailhead or camp. This project builds that system as two units — a pocket SOS beacon (ESP32, GPS, LoRa, panic button, battery) and a base-station receiver (ESP32, LoRa, display, buzzer). One press sends the coordinates; the base station alerts and displays them with a map link. It is a genuine long-range embedded-wireless build — and an honest one: range depends on terrain, and it is a prototype, not a certified rescue device.

## 03. Problem Statement

Off-grid emergencies suffer a communications gap: shouting and whistles carry meters, phones need towers that do not exist on ridgelines, and satellite messengers need subscriptions. Student wireless projects, meanwhile, rarely demonstrate true long-range radio — Wi-Fi and Bluetooth stop at tens of meters. The project addresses both by building a complete LoRa emergency link: a low-power beacon that acquires GPS and transmits a position packet kilometers to a base station, which validates it, raises an audible/visual alarm and displays the coordinates — with an acknowledgement downlink so the hiker knows the SOS was received.

## 04. Objectives

- Build the beacon: ESP32, NEO-6M GPS, SX1276-based 433 MHz LoRa module, panic button, 18650 cell and charger, in a handheld enclosure.
- Build the base station: ESP32, LoRa module, OLED display and buzzer in a desktop case, USB powered.

- Implement the packet protocol: device ID, latitude, longitude, battery level, SOS/check-in flag and checksum, with NMEA parsing on the beacon.
- Implement deep-sleep power management with wake on button press or check-in timer.
- Implement the base-to-beacon acknowledgement downlink with LED confirmation.
- Deliver the complete student kit: both units, firmware, report, PPT and viva Q&A.

## 05. Proposed Methodology

The build follows four stages. (1) Beacon hardware: ESP32, GPS and LoRa modules are wired with the panic button (debounced) and power path, then fitted in the handheld case. (2) Base hardware: ESP32, LoRa, OLED and buzzer are assembled for continuous listening. (3) Firmware: the beacon parses NMEA sentences, builds and transmits packets, and manages deep sleep; the base validates checksums, drives the display/buzzer and returns ACKs. (4) Field testing: the documented procedure tests the link at increasing distances with line-of-sight notes, GPS fix times and battery observations recorded in the report — range is reported as measured, never pre-claimed.

## 06. System Architecture / Working

The hiker presses the panic button; the ESP32 wakes from deep sleep and powers the GPS receiver. The NEO-6M acquires a satellite fix (open sky required) and the firmware parses latitude and longitude from the NMEA sentences. The beacon builds a short packet — device ID, coordinates, battery level, SOS flag — and transmits it over LoRa at 433 MHz. The base-station ESP32, listening continuously, receives and validates the packet's ID and checksum, sounds its buzzer, and displays the coordinates, signal strength and a ready-to-open map link on the OLED. The base station then transmits an acknowledgement packet; on receipt, the beacon lights its confirmation LED so the hiker knows help was alerted. Scheduled check-in pings at a configurable interval let the base track progress even without an SOS.

## 07. Hardware / Software Requirements

- ESP32 development modules (beacon and base station)
- SX1276-based LoRa modules, 433 MHz ISM band, with antennas
- NEO-6M GPS receiver with antenna
- 18650 Li-ion cell with charger module (beacon); USB power (base)
- OLED display and buzzer (base station); tactile panic button (beacon)
- Arduino IDE with LoRa and GPS (NMEA) libraries
- Handheld and desktop enclosures
- Open sky for GPS testing; open ground for range testing

## 08. Expected Outcomes

- Working beacon transmitting GPS position packets on panic press and on schedule.
- Base station receiving, alarming and displaying coordinates with map link.
- Demonstrated acknowledgement downlink with beacon LED confirmation.
- Field-test log with measured ranges, fix times and battery observations.
- Complete documentation: firmware, wiring diagrams, report, PPT and viva Q&A.

## 09. Applications

- Hiking/trekking group safety prototype (with the stated prototype limits).
- Teaching platform for LoRa: spreading factor, link budget, ISM regulations.
- Reference design for other long-range sensor links (farm, campus, events).
- Base for asset-tracking or wildlife-monitoring variants.

## 10. Future Scope

- Multi-beacon tracking on one base station (device IDs already in the protocol).
- Mesh relay with intermediate nodes for beyond-line-of-sight valleys.
- Phone gateway at the base station forwarding SOS via SMS when back in coverage.
- Solar charging for extended base-station deployment.

## 11. References


- Semtech SX1276 datasheet — LoRa modulation and link parameters.
- NEO-6M GPS module datasheet — NMEA sentences and fix times.
- Espressif ESP32 datasheet — deep-sleep modes and power figures.
- Regional ISM-band regulations for 433 MHz — permitted power and duty cycle.