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LoRa-Based Emergency Communication Device Without Network or External Power

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Abstract: *This tool intended to provide communication in instances of disaster when the conven- tional wireless systems fail to function due to the absence of power supply as well as internet connectivity. Long Range (LoRa) modules are employed for transmitting mes- sages from one device near another without necessarily depending on other electricity or connectivity to the internet. It comes equipped with a GPS module as well for monitoring location.*

The gadget has an SOS button, which when pressed sends the user's location to all the surrounding devices through LoRa communication. The feature helps the distressed users raise alarms fast in case there are any mishaps in their location, such as in natural disas- ters when all means of communication go down.

The machine is driven by a solar panel as well as a dynamo motor, and this means it will be operational during disaster situations without the need for an external power source..

Keywords: LoRa, Emergency Communication, Disaster Rescue, Wireless Communica- tion, GPS, Solar Powered Devices

I. INTRODUCTION

Disaster situations like earthquakes, heavy rains, and tsunamis tend to cause large-scale power disruptions, seriously damaging communication infrastructure such as cell towers and telephone lines. In such a situation, people—particularly those who have no access to mobile phones—are usually not able to reach rescue teams or their relatives. Such a communication discrepancy can slow down rescue operations and aggravate the consequences. There have been countless cases when individuals lost their lives stuck merely a few feet under rubble, purely because rescue workers were not able to find them in time. With ever-developing technology, it becomes crucial to formulate solutions that can be dependable, economical, and work independently of conventional power and network infrastructures to solve such life-risking problems.

Such disasters as landslides result in numerous casualties throughout different regions of India. For example, the Wayanad, Kerala landslide was said to have resulted in the death or disappearance of 359 people [1]. Such tragedies underscore the necessity for a functional and efficient system of communication in order to aid in the rescue and location of victims buried beneath the rubble, particularly in isolated areas.

Thus, in this paper, I propose a Long Range (LoRa) module-based communication device that is able to send information to nearby devices without the use of external power sources or network infrastructure. It is meant to function autonomously in disaster scenarios and has an SOS feature to broadcast the user's location in order to make rescue operations more rapid.

Project Objectives

- Enable off-grid communication: Offer long-range LoRa-based messaging inde- pendent of internet or external power during disasters.
- Facilitate rapid distress signaling: Employ SOS button and GPS to send user location to surrounding devices.
- Ensure autonomous power supply: Incorporate solar panel and dynamo for uninterrupted operation in extreme conditions.

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- Support user-friendly operation: Provide pre-programmed multilingual mes- sages for simple use in high-stress situations.

Device Functionality:

This device is designed to function without relying on the internet and other power sources. The key function is to facilitate communication in disaster situations with the assistance of LoRa technology to exchange messages in the event of emergencies, such as GPS location, to devices/nodes within the vicinity. The SOS button is a trigger, enabling users in distress to signal rescuers with a one-click operation. This comes in handy when there is no mode of communication.

The device is made to be small, energy-saving, and powered by renewable power sources such as a solar panel and a dynamo motor. In order to improve the functionality of the device during crises, there is also an inbuilt feature that allows the selection of predefined emergency messages which include “Food”, “Clothes”, “Water”, and “Medical Help”. These messages can be selected by scrolling with two navigation buttons and pressing one select button to confirm the decision. The SOS option is also included in this menu. Such design allows users to specify particular needs without the need to type, which is beneficial in high-pressure situations where ease of communication is important.

Working Principle:

Once SOS is activated, it alerts the NodeMCU controller, and the NodeMCU controller then activates the GPS module to acquire the current position of the user (longitude, latitude). When the data has been received, the NodeMCU packages this data into a message and transfers it to the LoRa module.

The LoRa module will then broadcast the message to other LoRa-based devices in prox- imity. They either get the location of the affected user or further forward the signal for peer-to-peer personal communication. The process makes it possible for the message to cross the nodes and hence cover an extensive area without relying on the internet. Be- ing a device to be used off-grid, the device makes sure that important messages are still reached even in instances of power or infrastructure destruction.

It is integrated with a solar panel and dynamo motor, which guarantees functionality of the device in needful hours.

System Components

- LoRa Module (SX1278): LoRa operates using Chirp Spread Spectrum (CSS) technology for wireless communication. It encodes the given information into a chirp signal, where the frequency changes over time. These signals are spread across the frequency band, making them more resistant to noise. Since LoRa is just a physical layer, it requires additional modules for communication. LoRaWAN is a media access control (MAC) layer protocol that runs on top of the LoRa module. It ensures the mechanism of LoRa for the transmission of information.
- NodeMCU (ESP8266/ESP32): NodeMCU ESP8266/ESP32 is a module that combines a microcontroller with Wi-Fi module, making it a cost-effective device for communication. It includes a full TCP/IP stack additionally with microcontroller capabilities, enabling easy communication over a Wi-Fi network or the internet.
- GPS Module (NEO-6M): NEO-6M is a GPS module and is used for navigation. It returns the data of present longitude and latitude. It has the capability to scan 22 satellites to serve the location. It also offers PSM (Power Saving Mode), allowing a reduction in system power consumption by switching the receiver to on or off state as per the need.
- Waterproof Push Button (IP67 Rated): Used to make or break a temporary electrical connection, ideal for SOS messages. Alternatively, it can also be used to get input from the user.
- Solar Panel: Sunlight is used to power electrical energy, which in turn powers the device. It generates independent daily charge, which leaves the system always self-supportive in off-grid locations.

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- Dynamo Motor: Hand-crank power generator as manual back-up power supply for emergency backup power under poor light conditions or in an emergency situa- tion, creating continuous function during low levels of solar power.
- Rechargeable Battery: Holds energy produced by the solar panel or dynamo motor and supplies power to the system elements. Allows the device to run contin- uously even in periods of no active energy input.

Output Result

This section demonstrates the working of the LoRa-based emergency communication device through two interface screenshots:

Figure 1: Digital interface showing a list of pre-stored SOS messages with an indicator pointing to the currently selected option.

Figure 1 shows the digital interface of the device with a list of pre-stored SOS messages such as ”SOS,” ”Need Water,” ”Need Food,” and ”Need Clothes.” An indicator highlights the currently selected item. This simple and intuitive design enables users to communicate their needs quickly and clearly, even under stressful situations.

Figure 2: Transmitted SOS message with user location (longitude and latitude).

Figure 2 displays the SOS message that has been triggered, along with the user’s location details, including longitude and latitude. These coordinates are sent over LoRa communication to nearby receivers, ensuring rescue teams can reach the individual even in the absence of regular communication infrastructure.

II. CONCLUSION

The project fulfills the critical need for guaranteed communication in case of disaster when the conventional infrastructure normally breaks down. Based on LoRa technology, GPS module, and dual power system consisting of solar panels and dynamo motor, the suggested device ensures that the users will have the ability to send emergency messages and give location information without having any dependence on internet connectivity or external power supply. With added pre-programmed multilingual messages and simplicity of interface, the system remains useful and usable even under high-stress conditions. Given its low cost, portability, and autonomy, the device is a workable solution to mass deployment in remote and disaster areas, having the potential to speed up and expand search and rescue efforts.

REFERENCES

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