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Women and Child Wearable Safety Device

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Abstract

We present women and child safety device leveraging LoRa WAN technology to enhance security in urban areas. This device utilizes a LoRa transmitter attached to the individual and a LoRa receiver connected to the nearest pole for accurate location tracking. The device sends coordinates to a cloud server, enabling prompt assistance from the nearest police station and notifying family members in critical situations. With reliable communication and efficient coordination, this innovative solution ensures the safety and well-being of women and children. It offers two key advantages: seamless transmission through long-range communication capabilities, facilitating prompt emergency response, and cost-effective deployment, enabling widespread adoption and fostering a safer environment for women and children in rural areas where normal cellular connectivity is not fully available.

Keywords: *IoT, Smart city, LoRa WAN Technology, Location Tracking, Emergency Response.*

INTRODUCTION

The safety and protection of women and children are paramount concerns in today's society. As the need for enhanced security measures grows, it becomes imperative to develop innovative solutions that address these challenges effectively. In this report, we present a women and child safety device utilizing LoRa WAN (Long Range Wide Area Network)

technology, with a specific focus on rural areas. Our device incorporates a LoRa transmitter, which is securely attached to women and children, along with a LoRa receiver situated at the nearest pole within their vicinity. By leveraging the A9G module, our solution ensures accurate location tracking and reliable transmission of coordinates.

When an emergency situation arises, the LoRa transmitter promptly transmits the location coordinates to the nearby pole, acting as a LoRa gateway. From there, the information is seamlessly transferred to a cloud server, ensuring its availability for immediate action.

The cloud server plays a crucial role in this safety system, serving as a central hub for data management and distribution. The received coordinates are instantly relayed to the nearest police station, enabling swift response and assistance. Additionally, the information is shared with designated family members, providing them with real-time updates and enabling them to take necessary measures. Designed with rural areas in mind, our women and child safety device aims to bridge the security gap in these often underserved locations. By harnessing the capabilities of Lo Ra WAN technology, our solution offers a comprehensive safety network that operates efficiently over long distances and in challenging terrains.

Throughout this report, we will delve into the technical aspects, implementation strategies, and the significant benefits of our women and child safety device. We will explore its potential to enhance security measures, empower communities, and create safer environments for women and children in rural areas.

LITERATURE REVIEW

Since emergencies may happen at any moment, it's critical to have efficient mechanisms in place to protect people's safety and well-being. To improve response times and give people in need better treatment; India's emergency services have undergone substantial modifications in recent years.

First responders, medical services, emergency numbers, and other elements make up the Indian emergency system. In India, 112 is the most often used emergency number. It was created in 2016 to serve as a single point of contact for all emergency services. Similar to the 911 emergency number used in the United States is this number.

Reducing response times is one of the emergency system's main objectives in India. The ability to get aid to the area quickly often determines how well an emergency response goes. Response times are often quicker in metropolitan locations because emergency services are more easily accessible. Due to a lack of infrastructure and resources, reaction times might be much higher in rural locations.

Safety of women and children is a major concern in India. The country has been witnessing a rise in cases of violence against women and children in recent years. To address this issue, various safety devices and systems have been developed. This section aims to provide an overview of the existing literature on women and children safety devices and systems in India.

According to the National Crime Records Bureau (NCRB), in 2019, 4,05,861 cases of crimes against women were reported in India, which is an increase of 7.3% from the previous year. Additionally, there were 1,67,013 cases of crimes against children reported in the same year, which is an increase of 3.4% from the previous year. These statistics indicate the need for better safety measures for women and children in India.

Various safety devices and systems have been developed in India to address the issue of women and children safety. Some of these devices and systems are discussed below:

GPS Tracking Systems

GPS tracking systems are another popular safety device in India. These systems allow the user to track their location in real-time. GPS tracking systems are often used by parents to keep a track of their children's whereabouts. They can also be used by women who feel unsafe while traveling alone.

Safety Apps

There are several safety apps available in India that can be used by women and children. These apps often have features such as emergency contacts, panic buttons, and GPS tracking. Some of the popular safety apps in India include Safetipin, VithU, and Himmat.

Self-Defense Devices

Self-defense devices such as pepper spray, stun guns, and tasers have also gained popularity in India. These devices can be used by women and children to protect themselves in case of an attack. However, it is important to note that the use of such devices is often restricted by law.

CCTV Cameras

CCTV cameras are widely used in public places and residential areas in India. These cameras can help in deterring crimes against women and children. They can also be used as evidence in case of an attack.

One-Stop Centers

One Stop Centers (OSCs) have been established by the government of India to provide support and assistance to women who have experienced violence. These centers provide a range of services such as medical assistance, legal aid, and counseling.

To solve this problem, many safety tools and methods have been created. These tools and technologies include CCTV cameras, one-stop centers, safety applications, self-defense tools, and GPS tracking systems. While these tools and procedures can aid in guaranteeing the protection of women and children, it is crucial to provide a secure atmosphere that is supportive of their development.

HARDWARE COMPONENTS USED

For our proposed design we are using the below listed components:

- Esp8266
- LoRa Module SX1276(915 MHz)
- A9G Module(GPS/GSM)

Esp8266

- A cheap Wi-Fi microprocessor called the ESP8266 makes it possible for microcontrollers to connect to Wi-Fi.
- With a 32-bit processor and Wi-Fi capabilities, it is a highly integrated chip that is appropriate for Internet of Things (IoT) projects.

- Multiple Wi-Fi protocols and security protocols including WPA/WPA2, WEP, and TKIP are supported by the ESP8266.
- It can connect to the Internet through Wi-Fi since it contains a built-in TCP/IP stack.
- C++, Lua, and MicroPython are just a few of the computer languages that may be used to code the ESP8266.
- It contains a number of GPIO pins that may be used to connect to sensors and other electronics.
- The ESP8266 microcontroller may be connected to other microcontrollers like the Arduino or Raspberry Pi or used alone.
- Without utilising Wi-Fi, the ESP8266 may connect with other ESP devices using the ESP-NOW protocol.
- Low latency and power consumption communication between devices is made possible via the ESP-NOW protocol.

Fig1: Esp8266

- Robotics, industrial automation, and smart home automation are just a few IoT projects that frequently employ the ESP8266.

LoRa Module SX1276:

- A low-power wireless transceiver module called the LoRa Module SX1276 uses the Long Range (LoRa) modulation technique to communicate.

- It is appropriate for a variety of wireless communication applications since it can operate across a broad frequency range, 137 MHz to 1020 MHz.
- The module's high sensitivity and output power allow for long-range wireless communication in open spaces up to several kilometers.
- Advanced features including Automatic Frequency Correction (AFC) and Adaptive Gain Control (AGC), which lessen the impacts of interference and signal fading, are included in the LoRa Module SX1276.
- It can operate in a variety of modes, including LoRa, FSK, and GFSK, making it appropriate for a variety of applications.
- Multiple spreading factors (SF) and bandwidths are supported by the module, enabling optimization of data throughput and power consumption.
- A special coding technique used by LoRa Module SX1276 offers great receiver sensitivity and interference immunity.

Fig2: SX127 (LoRa Module)

- It contains a built-in temperature-compensated crystal oscillator (TCXO), which offers precision and stability at high frequencies.
- The module has an integrated RF switch that makes switching between the receive and transmit modes simple.
- Various microcontrollers and development boards may be interfaced with the module utilizing common communication protocols like SPI and UART.

The module transmits and receives data using the LoRa modulation technique, which is how LoRa communication is supposed to function. Chirp spread spectrum (CSS) modulation is a

LoRa technology that enables low-power, long-distance communication. The SX1276 module boosts the communication system's dependability by utilising cutting-edge signal processing techniques including forward error correction (FEC) and interleaving. Additionally, it offers a variety of data speeds and spreading factors that may be adjusted according to the application's distance and power needs.

As a result, LoRa Module SX1276 is a flexible and dependable wireless transceiver module that can be used for a variety of wireless communication applications. Developers and engineers working on IoT and other wireless communication projects frequently choose it because of its long-range communication capabilities, low power consumption, and sophisticated features.

A9G Module:

Fig 3: A9G Module

- A9G Module is a GSM/GPRS+GPS/BDS development board that is small and very effective.
- Its extremely small form size enables integrating it into a range of applications.
- It is perfect for location-based applications since it supports dual-band GSM/GPRS and GNSS (GPS/BDS) positioning.
- An A9G chip that is already within the module can be configured using AT instructions. A9G's GPS/BDS module can pick up signals from various satellites to precisely pinpoint the location of the device.
- The fact that it supports a number of positioning modes, including standalone, aided, and hybrid, makes it possible for it to offer precise location data even in difficult settings.

- Additionally, the module supports location-based services such as location-based social networking, search, and advertising.
- Applications for the A9G module include tracking assets, tracking people, and tracking vehicles.
- The module has a number of interfaces, including UART, SPI, I2C, and GPIO, allowing simple device integration.
- It is appropriate for applications that need mobility and a long battery life due to its small size and low power consumption.

Using GPS location to operate:

- To pinpoint the position of the device precisely, the A9G module combines GPS and BDS signals.
- It utilizes trilateration to identify the device's position after receiving signals from many satellites.
- The module contains an inbuilt antenna that picks up GPS/BDS signals, which the chipset of the module then decides to produce the coordinates of the position.
- Even in difficult circumstances like urban canyons and enclosed spaces, the GPS/BDS module offers precise position data.
- Depending on the presence of GPS/BDS signals, the A9G module can function in solo, aided, and hybrid modes.
- The module exclusively uses GPS/BDS signals in solo mode to pinpoint its location.
- In aided mode, it leverages extra data to increase location accuracy, such as signal strength and satellite locations collected from a nearby base station.
- In hybrid mode, it correctly pinpoints the position by fusing GPS/BDS signals with data from a nearby base station.
- Latitude and longitude coordinates are used by the A9G module to deliver location data.
- Using GSM/GPRS connectivity, the module's location data may be sent to a distant server or device for tracking or other location-based applications.

In summary, the A9G Module is a flexible tool that delivers precise GPS position data. It is suited for a variety of location-based applications because of its small size, low power consumption, and compatibility for numerous interfaces.

COMMUNICATION PROTOCOL

LoRaWAN Communication Protocol:

A low-power wireless communication technique called LoRa (Long Range) is utilized for long-distance communication. To transfer data over great distances while using little power, it employs chirp spread spectrum (CSS) modulation.

LoRaWAN (Long Range Wide Area Network), a proprietary physical layer protocol used by the LoRa technology, is intended for low data rate, long-range wireless communication between devices in a network. Since the LoRaWAN protocol uses an unlicensed frequency band, anybody can utilize this technology without needing to purchase a licence.

LoRa technology is usable everywhere since it uses unlicensed industrial, scientific, and medical (ISM) frequency bands including 868 MHz, 915 MHz, and 433 MHz. LoRa devices operate at a range of up to 5 km in cities and up to 15 km in rural areas thanks to a specialized modulation scheme that is optimized for long-range communication.

Chirp spread spectrum (CSS), a specialized modulation method used by LoRa, enables excellent sensitivity and interference immunity. LoRa is able to carry data over great distances while using very little power because of the CSS modulation algorithm. In rural regions, the LoRa signal can go up to 15 km, whereas in cities, it can go up to 5 km.

Popular LoRa communication protocol is LoRaWAN (LoRa Wide Area Network). It is an IoT device-supporting low-power, wide-area networking (LPWAN) protocol. LoRaWAN is accessible everywhere because it uses unlicensed frequency channels, where it functions. It offers secure connection using AES-128 encryption as well as bidirectional communication between end devices and gateways.

End devices, gateways, and a network server make up the three levels of the LoRaWAN network architecture. The devices that gather data, such as temperature, humidity, and other sensor measurements, are known as end devices. The end devices send their data to the gateways, which then transmit it to the network server. The data is processed by the network server before being sent to the application server for additional processing.

There are two categories of devices in a LoRa network: end devices and gateways. Sensors or other devices known as end devices gather data, whereas gateways are the devices that take that data and deliver it to a cloud server or an application server.

LoRa technology allows low-power, long-range communication, which makes it perfect for Internet of Things applications. The following are some real-world uses for LoRa communication:

- **Smart Agriculture:** Soil moisture, temperature, and humidity in agricultural areas may all be monitored via LoRa connectivity. The information may be sent to a central server for analysis in order to maximize agricultural production and cut down on water usage.
- **Smart Cities:** Traffic, air quality, and noise pollution levels in cities may all be monitored via LoRa connectivity. To enhance traffic flow and lower pollution levels, the data may be sent to a central server for analysis.
- **Asset tracking:** Assets like trucks, containers, and machinery may be tracked via LoRa communication. The information may be sent to a central server for analysis in order to maximize asset use and minimize downtime.
- **Industrial Automation:** Industrial equipment may be monitored and managed via LoRa connectivity. The data can be sent to a central server for analysis in order to maximize equipment efficiency and minimize downtime.

In conclusion, LoRa technology offers low-power, long-range communication, making it perfect for Internet of Things applications. Spread-spectrum technology, which is employed in LoRa communication, enables dependable long-distance communication with less power usage. Smart cities, asset tracking, industrial automation, and smart agriculture are some examples of practical uses for LoRa communication.

SENSOR ARCHITECTURE

The system's major goal is to make it possible for the victim to inform the nearest police station their live position in the event of an emergency. Two LoRa devices make up the system; one is attached to the victim's GPS module, and the other is to the smart pole. Over a considerable distance, the LoRa devices wirelessly interact with one another.

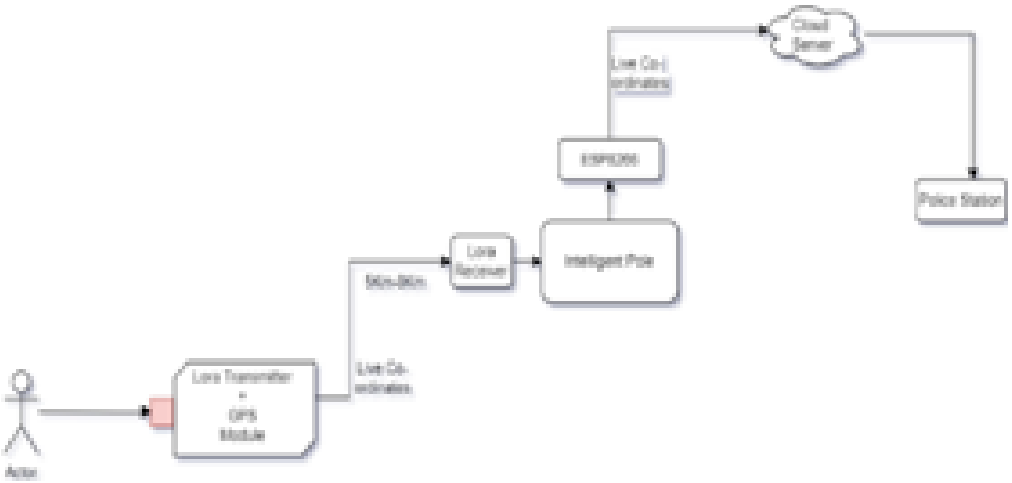

Fig 4: Sensor Architecture for Women and Children Safety Device

The system's major goal is to make it possible for the victim to inform the nearest police station their live position in the event of an emergency. Two LoRa devices make up the system; one is attached to the victim's GPS module, and the other is to the smart pole. Over a considerable distance, the LoRa devices wirelessly interact with one another.

The system operates as follows:

- **A9G GPS Module:** The victim's GPS module is an A9G module, and it is linked to the first LoRa device. This module has the ability to deliver precise real-time location data. Additionally, the gadget features a button that the sufferer may touch to alert for help.
- **LoRa Transmitter:** After pressing the emergency button, the LoRa device begins communicating the victim's position in real time via the LoRa protocol. The gadget sends the latitude and longitude information together with the coordinates in a packet format.
- **LoRa Receiver:** The second LoRa device has a LoRa receiver and is attached to the smart pole. The packet sent by the first device is received by the recipient.
- **Cloud Server:** The packet is then routed to the cloud server after being received. The address and phone number of the closest police station that can locate the victim are stored on the server.
- **Police Station:** After receiving the victim's real-time position from the cloud server, the police station dispatches a team to rescue the victim.

In order to sum up, the LoRa-based emergency system offers a reliable and efficient solution to transmit real-time location data in the event of an emergency. The system is intended to offer the victim prompt aid, and its long-range communication capabilities makes sure that

the victim's position is immediately communicated to the closest police station. The technology is simple to use and may be applied in many emergency scenarios.

CODE AND RESULT

Transmitter (GPS and button) code:

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>

#define BUTTON_PIN 2
#define GPS_RX_PIN 4
#define GPS_TX_PIN 5
#define LORA_RX_PIN 6
#define LORA_TX_PIN 7
SoftwareSerial gpsSerial(GPS_RX_PIN, GPS_TX_PIN);
SoftwareSerial loraSerial(LORA_RX_PIN, LORA_TX_PIN);
TinyGPSPlus gps;

void setup() {
Serial.begin(115200);
gpsSerial.begin(9600);
 loraSerial.begin(115200);
 pinMode(BUTTON_PIN,  INPUT_PULLUP);
 // Configure the LoRa module
 loraSerial.println("AT+ADDRESS=1");
  loraSerial.println("AT+NETWORKID=1");
  loraSerial.println("AT+BAND=915000000");
  loraSerial.println("AT+MODE=0");
}

void loop() {
  while (gpsSerial.available()) {
    gps.encode(gpsSerial.read());
  }
```

```
  if (digitalRead(BUTTON_PIN) == LOW) {
    if (gps.location.isValid()) {
      String message = String(gps.location.lat(), 6) + "," + String(gps.location.lng(), 6);
      loraSerial.print("AT+SEND=1,");
      loraSerial.print(message.length());
      loraSerial.print(",");
      loraSerial.println(message);
      Serial.println("Sent location: " + message);
    } else {
      Serial.println("GPS location not valid");
    }
  }
}
```

Receiver (ESP8266 connected to the cloud server) code:

```
#include <SoftwareSerial.h>
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>

#define LORA_RX_PIN 4
#define LORA_TX_PIN 5
#define SERVER_URL "http://your-server-url.com/api/save_location"

SoftwareSerial loraSerial(LORA_RX_PIN, LORA_TX_PIN);
String receivedData = "";

void setup() {
  Serial.begin(115200);
  loraSerial.begin(115200);

  // Configure the LoRa module
  loraSerial.println("AT+ADDRESS=1");
  loraSerial.println("AT+NETWORKID=1");
```

```
  loraSerial.println("AT+BAND=915000000");
  loraSerial.println("AT+MODE=0");

  // Connect to WiFi
  WiFi.begin("your_ssid", "your_password");
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi...");
  }
  Serial.println("Connected to WiFi");
}

void loop() {
  if (loraSerial.available()) {
    receivedData = loraSerial.readStringUntil('\n');
    Serial.println("Received location: " + receivedData);

    // Send the received data to the cloud server
    if (WiFi.status() == WL_CONNECTED) {
      HTTPClient http;
      http.begin(SERVER_URL);
      http.addHeader("Content-Type", "application/x-www-form-urlencoded");
      String postData = "location=" + receivedData;
      int httpResponseCode = http.POST(postData);
      if (httpResponseCode > 0) {
        String response = http.getString();
        Serial.println("Server response: " + response);
      } else {
        Serial.println("Error sending data to server");
      }
      http.end();
    } else {
      Serial.println("Not connected to WiFi");
```

```
    }
  }
}
```

Explanation:

Transmitter code:

1. Include the required libraries for the SoftwareSerial and A9G GPS modules in the transmitter code.
2. Establish pin numbers for the GPS, LoRa, and button.
3. Create instances of TinyGPSPlus and Software Serial for GPS and LoRa communication, respectively.
4. In the 'setup()' method, initialize serial communication, set the button pin as an input, and configure the LoRa module.
5. Utilize TinyGPSPlus to parse data that has been read from the GPS module in the 'loop()' method. Verify the GPS location's accuracy if the button is pushed. Messages with the latitude and longitude should be created and sent using the LoRa module if it is.

Receiver code:

1. Include necessary libraries for the ESP8266, Software Serial communication, and HTTP communication.
2. Define pin numbers for the LoRa module and the server URL.
3. Create an instance of Software Serial for LoRa communication.
4. In the `setup()` function, initialize serial communication, configure the LoRa module, and connect to the WiFi network.
5. In the `loop()` function, read data from the LoRa module. If data is received, send it to the cloud server using an HTTP POST request.

Result

We have calibrated the code as given an simulated a testing environment in which we were able to transfer the data from one point to another using LoRaWAN Protocol. Continuous stream was able to be uploaded from victim position to our cloud server which further we can transfer to concerned authorities.

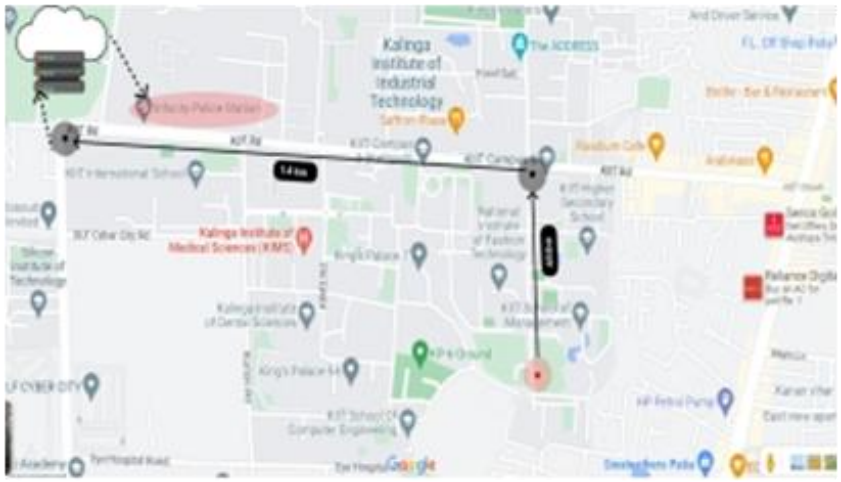

Fig 5: Working of women and children safety device

CONCLUSION

In conclusion, the development of a women and child safety device using LoRaWAN technology presents a significant step forward in enhancing security measures in rural areas. By leveraging the A9G module, our solution ensures accurate location tracking and seamless transmission of coordinates to the nearest pole equipped with a LoRa receiver.

The integration of a cloud server enables swift dissemination of critical information to both the nearest police station and designated family members, ensuring timely response and assistance in emergency situations. This comprehensive safety network offers a robust and reliable solution to address the security concerns of women and children in rural communities.

The advantages of our device are two-fold: Firstly, its long-range and cost-effective communication capabilities enable widespread deployment, making it accessible to underserved areas. Secondly, its ability to provide real-time updates and immediate assistance promotes a sense of security and peace of mind among users.

By harnessing the power of LoRaWAN technology, our women and child safety device has the potential to make a significant impact in ensuring the well-being of vulnerable individuals. It provides an effective solution for mitigating risks and improving overall safety in rural areas, thereby contributing to the empowerment and protection of women and children in our society.

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