RescueLink: A Mobile Application for Victim Localization in Emergency Situations

Paolo Palumbo
p.palumbo3@studenti.unipi.it

Ettore Ricci
e.ricci32@studenti.unipi.it

June 2, 2024

Abstract

In emergency situations, rapid and accurate localization of potential victims is crucial for effective rescue operations. This project presents an innovative Android application using Bluetooth Low Energy (BLE) technology, trilateration, and GPS to enhance victim localization. The system ustilizes an ah-hoc BLE network to share information between devices and computes the victim's position using trilateration when GPS is not available.

1 Introduction

During emergency situations such as natural disasters, fires, and large-scale accidents, the timely and accurate localization of potential victims is foundational to effective rescue operations. Current methods usually rely on visual searches and may be ineffective in low-visibility scenarios. Due to the influence of modern technology, the majority of people carry smartphones and other BLE-enabled devices with them. This project aims to leverage these devices to localize victims in emergency situations. A version of the application can also be installed on the victim's device to further enhance the localization process.

2 Background

2.1 Bluetooth Low Energy

Bluetooth Low Energy (BLE) is a wireless communication technology designed for short-range data transmission with minimal power consumption. Experimental tests have shown that BLE can cover up to 200 meters in an open field[1]. Introduced as part of the Bluetooth 4.0 specification, BLE is optimized for applications requiring intermittent data transfers, this makes it ideal for use in mobile devices.

2.2 GPS

Global Positioning System (GPS) is a satellite-based localization system that provides accurate position information to GPS-enabled devices. GPS uses the travel time of signals to estimate the

distance between the device and the satellites, then trilateration is used to determine the device's position.

2.3 Trilateration

Trilateration is a geometric technique used to determine the position of a point by measuring the distances from that point to three or more known locations. The implementation of trilateration in this project solves an optimization problem to find the victim's position with the lowest error. To estimate the distance between the victim and the BLE devices, the Received Signal Strength (RSS) is used.

2.4 RSS

The Received Signal Strength (RSS) is a measure of the power level of a received signal. Combined with the path loss model, and knowing the transmit power, the RSS can be used to estimate the distance between the transmitter and the receiver. RSSI is the Received Signal Strength Indicator, a value that represents the power level of the received signal in dBm. The formula used to estimate the distance is:

$$D = 10^{\frac{txPower - RSSI}{10 * n}} \quad (1)$$

We used $n = 2$ as the path loss exponent because we expect a typical outdoor environment.

2.5 GATT

The Generic Attribute Profile (GATT) is a specification that defines the way that two Bluetooth Low Energy devices transfer data back and forth in an opportunistic way using concepts called Services and Characteristics. A GATT service is a collection of characteristics and two connected devices can read, write, and be notified of changes to these characteristics. The maximum size of a characteristic is 512 bytes.

3 System Design

3.1 Users

The application is designed for two types of users:

- Search and Rescue operators (SAR)
- Simple users (PV)

3.2 Application Interface

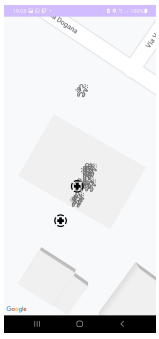

Figure 1: In the map interface, the user can see the position of SAR and PV devices.

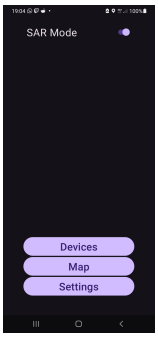

Figure 2: In the main view a SAR user can open the map or a list of detected devices. Both a SAR and a PV user can open the settings to edit their personal information.

The application is designed to let only SAR operators open the map interface and the device list. While both SAR and PV users can edit their personal

information. In the map view, the user can select a device to display its information.

3.3 Data Sharing

The application uses a gossip protocol to share data along the ad-hoc BLE network. This is done over a GATT service. The packet is in encoded in CBOR format and contains the device's information along with those of onother random device.

3.4 Localization

The application stores a number of distance-position pairs both detected from the device with BLE and received from other devices. This enables even a sigle moving device to localize a victim exploiting its own position that changes over time and is obtained from GPS.

4 Results

The application was able to detect the location of a device within a 10 meter radius in an open field. For devices with the application installed, the localization error was reduced to the error of the GPS.

5 Conclusion

A mobile application was developed to enhance the localization of victims in emergency situations. The application uses BLE technology to create an ad-hoc network and trilateration to estimate the victim's position. Further improvements could be made to the accuracy of the localization by using a more advanced data selection algorithm for the gossip protocol and a more accurate or dynamic path loss model.

References

[1] M. Lodeiro-Santiago, I. Santos-González, P. Caballero-Gil, and C. Caballero-Gil, "Secure system based on uav and ble for improving sar missions," *Journal of Ambient Intelligence and Humanized Computing*, vol. 11, no. 8, p. 3109–3120, Oct. 2017. [Online]. Available: http://dx.doi.org/10.1007/s12652-017-0603-4