Lost Hiker Assistance using LoRa

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Abstract

This paper proposes a checkpoint system utilizing a Low-Power-Wide-Area-Network (LPWAN) to assist in locating lost hikers. Utilizing Internet-of-Things (IoT) devices, we can effectively track hikers as they travel throughout the hiking trail. The proposed system consists of Raspberry Pi devices communicating with each other via LoRa. The hikers carry a Raspberry Pi as they hike and pass through pre-installed checkpoints on the trail. The checkpoints have Raspberry Pi devices on them to detect if hikers have reached that checkpoint's location. For an emergency situation, there exists a SOS button that will notify the headquarters the user's location for any reason at all.

1 Introduction

Every year, there are multiple reports of missing hikers. Since hikes are usually done in remote areas with limited phone connectivity, it can be difficult to communicate with the hikers if they need assistance. There is also a greater urgency to find the hikers if they require immediate assistance. This paper aims to offer a proposal for ways to track users and find them in emergency situations.

To remove the dependency on phone connectivity for communication, our solution provides hikers with a Raspberry Pi configured to communicate with headquarters. This allows for communication in locations with limited mobile network connectivity. To locate hikers faster in emergency situations, the same Raspberry Pi is configured to provide headquarters with accurate location data.

The rest of the paper is organized as follows. Section 2 reviews related works involving location tracking. Section 3 explains the design and architecture of our checkpoint system. Section 4 discusses the benefits and limitations of the system. Section 5 concludes the paper.

2 Related Works

A checkpoint system using RFID has been proposed by S M A S Masohor et al. [1] to locate missing people when they go hiking. In their system, hikers are given an RFID tag, which they use to check in whenever they pass a checkpoint. The checkpoints contain a memory card that stores data about which RFID tags have been used at that checkpoint. Rescuers can then extract the data from the memory cards of each checkpoint to trace their path and narrow the search area.

In a paper written by Wu et al. [2], they have done an experiment with a body network that is to communicate with an edge network. Workers must wear these body networks and track the health of their users and send all data to an edge network via LoRa to then process all data there. This paper offers something similar where the hikers are to wear a backpack consisting of a Raspberry Pi as well as a few other modules that enables communication via LoRa and WiFi to a phone. The purpose of the Raspberry Pi is to send and receive data that is transmitted to another Raspberry Pi (checkpoint) that is directly connected to the headquarters to transmit location data for processing.

3 Proposed Solution

Before starting their hike, each hiker will be given a backpack containing a Raspberry Pi. The Raspberry Pi is equipped with a LoRa module, a GPS module, and a WiFi module. The LoRa module and GPS module will help rescuers pinpoint the location of the hikers. The WiFi module will allow the hikers to connect their smartphones to an app to help find their own way back if they do not need outside assistance. Figure 1 presents a sample hiking trail with checkpoints along the trail. Figure 2 illustrates a simplified overview of the architecture.

3.1 Checkpoints

The proposed system incorporates checkpoint stations at a particular distance along the hiking trail. Each checkpoint is wired via a landline to the headquarters and is equipped with a metal pole with a Raspberry Pi with a LoRa module and a flag. The entire unit is powered by landlines. The user's Raspberry Pi device communicates with the checkpoints periodically to ensure a longer battery life for the power supply inside the backpack. The checkpoints are powered by landlines, which emit wireless signals to establish communication with the hikers' Raspberry Pi devices.

Once the data is received from the Raspberry Pi, the checkpoints send it to headquarters to be processed. How this is achieved is by making each checkpoint act as a node to communicate with each other in a node-to-node architecture. This architecture will have an algorithm that calculates the shortest distance to the headquarters and sends the data along that determined path. The checkpoint that receives information from the user is then passed to the neighboring checkpoint with additional data that states which checkpoint the user has connected to. This data is later passed to the headquarters, where the incoming data associated with the user is aggregated.

3.2 SOS Button

The backpack will have a SOS button hidden inside a protective box that can be activated by hikers in emergency situations (e.g., getting lost, getting injured, or excessive weather conditions). This device is directly connected to the Raspberry Pi for direct communication with the device and to prevent other factors from breaking this important functionality. When the SOS button is triggered, the GPS module is activated, and it gets information on the user's location. The data is collected by the Raspberry Pi from the GPS module and sends continuous updates on the hiker's location that are then sent to headquarters, providing them with the accurate location of the hikers. The real-time updates and SOS functionality provide a reliable means of geo-location for the rescue teams and the hiker, ensuring a quicker method of geo-location for the hiker and lessening the probabilities of further complications for the hiker if issues arise.

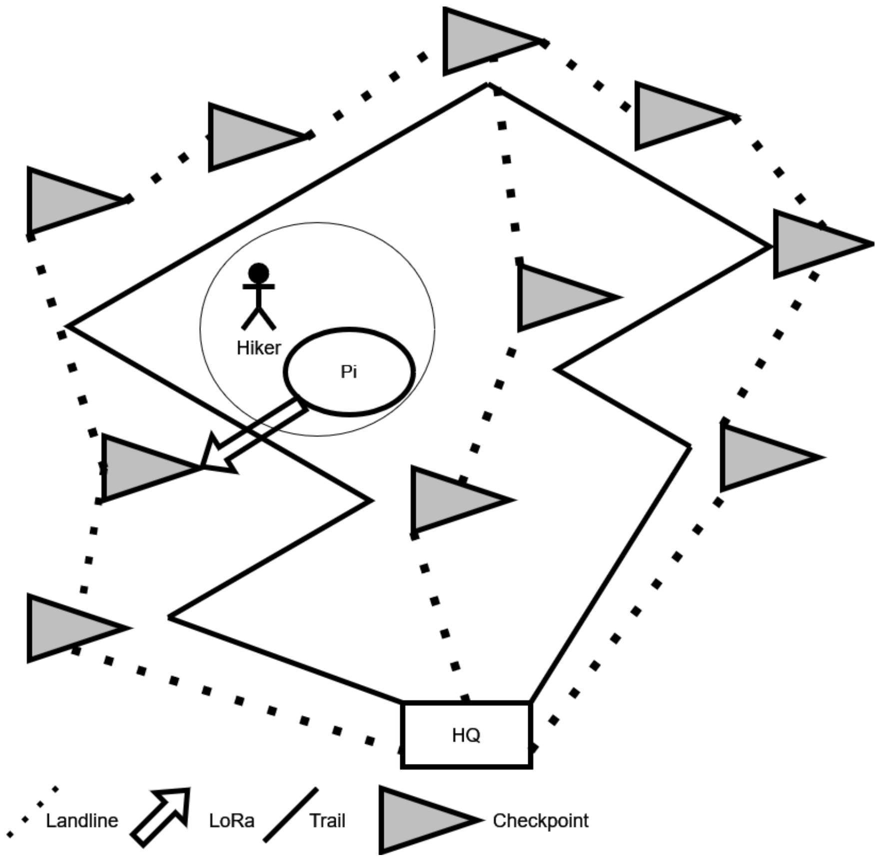

Figure 1: Checkpoints are installed along the trail and connected to each other and headquarters through landlines. The hiker's Raspberry Pi communicates with each checkpoint via LoRa.

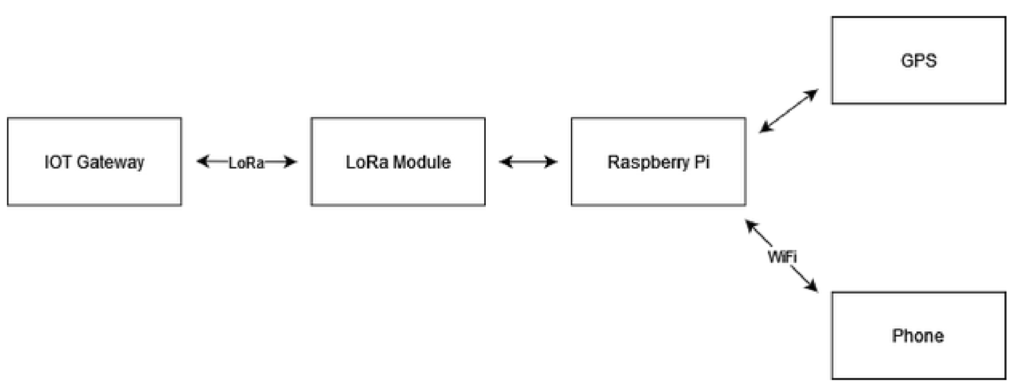

Figure 2: Simplified system architecture of checkpoint tracking system.

3.3 Phone App

There will be an optional feature where the hiker can use a phone app to assist with the Raspberry Pi. This app could utilize the GPS function already embedded within the phone to further assist in identifying the location of the hiker if there is a need for a fail-safe. The phone will have a map of the location that the hiker can use as a reference to aid their trek. The map will feature safe and non-safe locations that are advised to the hiker. If the hiker approaches a non-safe zone, the app will notify them if they are going off course. If GPS is not enabled on the hikers' smartphones, then the checkpoints will be used to determine the location of the hikers. The purpose of this app is to provide additional functionality to the user if they so desire more information presented to them.

3.4 Hardware

Given that this project is to be at a hiking trail, there may be hills and other terrain that may become an obstruction for each checkpoint. Considering that we are dealing with a large range of land, we would have to focus on longer range focused protocols. Low power Wide Area Networks (LPWAN) is a strong suiter for our needs. For LPWAN we can use LoRa that is attached to the Raspberry Pi. The RFM95 module can account for this to communicate with each checkpoint using LoRa. Both the checkpoints and the Raspberry Pi can use this module as a way to communicate with each other. In an article published by the MDPI has done research on this by using a base station that is to communicate with the RFM95. In this research, they concluded that if the base station is to be approximately the height of the second floor of a common building then the RFM95 module can communicate up to a range of 520 meters. In most cases, this should be more than enough. We can make tall checkpoints that will enable connectivity with other devices for a wide area of network coverage.

4 Discussion

4.1 Benefits

By utilizing the GPS module and checkpoints system communicating via LoRa, there is a way to effectively track users without the need for user intervention. This system allows for better accuracy to track and locate users with strategically placed checkpoints. Since the LoRa module can only communicate with one checkpoint at a time, the LoRa module will send out many communication requests to the closest neighboring checkpoints to inform them of their presence. This creates an identifiable location the user has come to. In essence, the more the user is to travel the more information is being sent to the headquarters where they can trace the movement of the hiker for a more accurate idea of where the user is or is going to. For added security, there is another source of location services that is provided by a mobile phone that can be used as either a fail safe or as a more accurate GPS module already made into the phone to help locate the user.

Utilizing a Raspberry Pi and a few other components allows for a convenient way to carry a communication device for the trek. Utilizing a small system-on-a-chip with a low power demand allows for better and longer battery life of the power supply allowing for multiple uses on one charge.

4.2 Limitations

Given that the user has to carry a Raspberry Pi along with extra models and a power supply, the backpack that they must carry may be a little heavy and may put a little strain onto the hiker and their trek. With the added weight there is a more likelihood of the hiker tripping and or causing some injury onto themselves or the included Raspberry Pi. This could introduce issues if the Raspberry Pi is to become non-functional at any point into the hiker's trek. The hiker would not have any other way of communicating to anyone if it were to be inoperable.

If there are more people to attend this hiking trail, there may not be enough units around to supply to everyone who needs it. This will effectively limit the amount of people who would like to attend the hike. Furthermore, there is a possibility that enough people show up before enough time has passed to properly charge the power banks for the Raspberry Pi devices.

There may be other issues that can be introduced with Raspberry Pi checkpoints using LoRa. With every piece of additional hardware introduces extra points of failure. For example certain Raspberry Pi located in more sunny areas are exposed to higher amounts of ultraviolet radiation. Natural light can overheat some components and ultimately shorten its lifespan creating "dead zones" throughout the trail.

5 Conclusion

To locate lost hikers, we propose a system of checkpoints installed along the hiking trail to track the path and current location of the hikers as they hike. The hikers will be carrying a Raspberry Pi equipped with a LoRa module to communicate with the Raspberry Pi devices attached to the checkpoints. As they pass each checkpoint, headquarters will be able to see which checkpoints the hikers have passed, and the most recent checkpoint passed should provide an approximation of their current location. If an emergency response is needed, there is also an SOS button connected to the hikers' Raspberry Pi, which will turn on the GPS module to provide more accurate location data and notify headquarters that they are in an emergency. Additionally, there is a phone app that hikers can optionally install to their smartphones to view map data about their hike. All of these components combined together are designed to help rescuers locate lost hikers with minimal user intervention from the hikers.

References

[1] S M A S Masohor et al. "Tracking System using RFID for Hiking Activity with IoT Technology". In: *Journal of Physics: Conference Series* 1529.5 (May 2020), p. 052030. DOI: 10.1088/1742-6596/1529/5/052030. URL: https://dx.doi.org/10.1088/1742-6596/1529/5/052030.

[2] Fan Wu, Taiyang Wu, and Mehmet Rasit Yuce. "An Internet-of-Things (IoT) Network System for Connected Safety and Health Monitoring Applications". In: *Sensors* 19.1 (2019). ISSN: 1424-8220. DOI: 10.3390/s19010021. URL: https://www.mdpi.com/1424-8220/19/1/21.