

YushanNet: A Delay-Tolerant Wireless Sensor Network for Hiker Tracking in Yushan National Park*

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Abstract

The objective of YushanNet is to provide a reliable and robust system for hiker tracking in Yushan National Park, Taiwan. The aggregated information can help national parks to provide various services to tourists, and the collected hiking traces can provide more precise information to professional rescue teams if there are hikers lost in the mountains. YushanNet is a delay and disruption tolerant system. In the system, each hiker is required to carry a matchbox-size device, which consists of a ZigBee-based mote and a GPS receiver, and the device records its hiking trace, along with encounter information with other devices. Then, the recorded data is disseminated in the network in a store-carry-and-forward fashion, until it reaches one of the base stations along the trail. In this demo, we will present the design, implementation, and deployment of the YushanNet system, and we will demonstrate the system using a small-scale network scenario.

1. Introduction

The objective of this work is to develop a reliable and robust system for hiker tracking in a national park. Knowing tourists' hiking traces is important for the administration and operation of a national park. For instance, the aggregated information can help administrators to provide various services to tourists, such as map information, and the locations of sightseeing spots, toilets and pavilions. Moreover, the collected hiking traces can provide more precise information to rescue teams if hikers are lost in the mountains. However, since the full wireless coverage is impossible in wilderness environments, network communication in the proposed system is inevitable intermittent and thus very

challenging.

The basic ideas of our work are based on [1, 2], which apply a delay/disruption tolerant network technique and make use of opportunistic, ad hoc, and short-range wireless communications to disseminate data in a network. As funded by Yushan National Park Headquarters¹, we are now deploying a WSN-based system, called YushanNet, for hiker tracking in Yushan National Park. The Yushan Peak Trail, where the YushanNet system is deployed, is 10.9km long from the entrance to the summit, with a 1,302 m altitudinal shift. YushanNet base-stations are situated at the entrance, the West-Summit Pavilion, and Paiyun Lodge. In the last year, several large-scale field experiments have been conducted, and a great deal of positive feedback has been received from the participants.

In the YushanNet system, each hiker is required to carry a 70 gram matchbox-size device that can be attached to a backpack, as shown in Figure 1. The devices, which are handed out at the entrance to the park, are called *Taroko motes*, and have a GPS receiver, a Zigbee radio and 10 KB of memory. When hikers pass each other on hiking trails, the motes automatically exchange their IDs and locations and store the received information in the memory. Then, when a hiker reaches one of the three base-stations installed at frequently visited spots in the park, all the information stored in his/her device is uploaded to an Internet server at the base station via GPRS or Wi-Fi.

As well as supplying vital information about hikers' whereabouts to park administrators and rescue services, the system allows family members to logon to a website and check that hikers have reached their planned destinations, as shown in Figure 2. To protect hikers' privacy, access to the information is restricted to family members. Most importantly, if hikers become lost in the mountains, the YushanNet system can quickly calculate their last known position (as shown in Figure 3). By comparison, conventional approaches for locating hikers are labor intensive and very

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¹Yushan National Park Headquarters; <http://www.ysnp.gov.tw/>



Figure 1. The device carried by the hiker

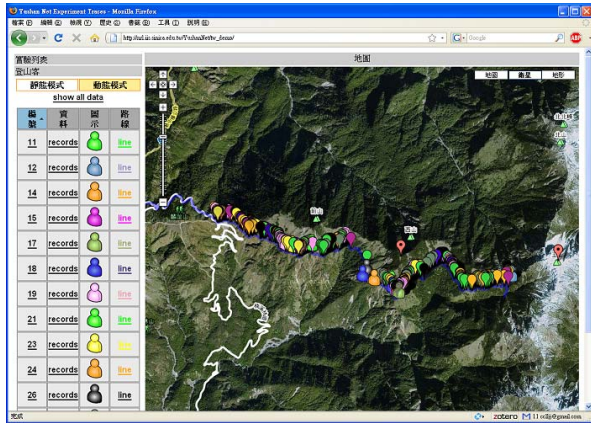


Figure 2. The YushanNet system allows the hikers' family members to logon to a website and check that hikers have reached their planned destinations.

costly.

The state-of-the-art wireless sensors with GPS receivers provide several pieces of vital information, such as the average speed of hikers on each hiking trail. The condition of each trail can be assessed by comparing the current hiking speed with the historical records of hiking speeds on the same trail. For example, if the trail is damaged, the current hiking speed may be well below the recorded average hiking speed. Moreover, by observing changes in the average hiking speed every year, the system can even be a good indicator of the physical stamina of hikers. Most importantly, if hikers become lost in the mountains, the YushanNet system can quickly calculate their last known position. By comparison, conventional approaches for locating hikers are labor intensive and very costly. Finally, the results of the YushanNet project may be extended to a variety of other applications, such as wildlife tracking, scientific monitoring, landslide and debris flow monitoring, and disaster networks.

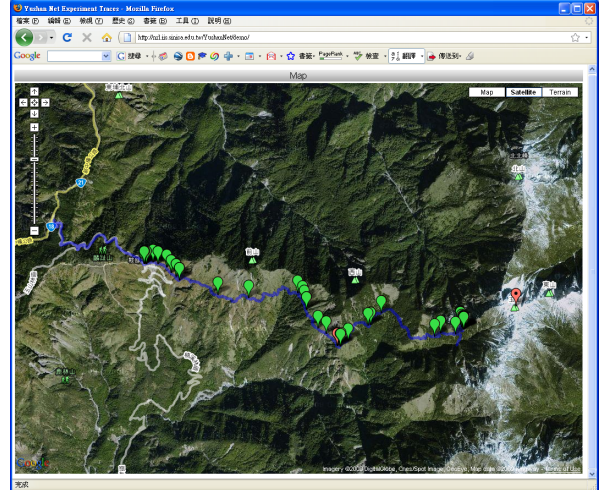


Figure 3. If one hiker becomes lost in the mountains, the YushanNet system can provide his hiking trace to the professional rescue team, thus facilitating mountain search and rescue.

2. Future Work

We plan to incorporate biosensors with our system for monitoring the health condition of the hiker. The carried mote will alarm signals while detecting abnormal conditions, and it will automatically dial out for help if there is GSM coverage and the mote could be connected to the mobile phone (via USB or Bluetooth). Moreover, we plan to keep the tight collaboration with Yushan National Park, and extent the coverage of the deployment, so that the national park can provide more helpful and safe services for the tourists in the near future. Finally, the results of the YushanNet project may be extended to a variety of other applications, such as wildlife tracking, scientific monitoring, landslide and debris flow monitoring, and disaster networks. For more detailed information about this work, please visit <http://nrl.iis.sinica.edu.tw/YushanNet/>.

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