Wildland Firefighter Tracking System

Abstract
Currently, there is no efficient method for tracking the location and basic health status of wildland firefighters when in the field. Walkie-talkies are used for communication between the team’s base station and each team member, but this method requires active participation of both ends. Additionally, the firefighter may not know exactly where he is, nor may he be aware of subtle changes to his health that could indicate he is near serious exhaustion. There is a need for such information to be visually incorporated with other geographical maps to improve fire fighting efforts and the safety of firefighters.

The goal of this tracking system is to periodically and automatically track the geographical location, via GPS, and general health condition, via temperature, of multiple firefighters in the field. The end-user system is non-intrusive, so as not to interfere with existing communication systems and its use requires no attention from the firefighter. Each user’s data is transmitted to the base station, where it is visually displayed on a map.

With this system, neither the firefighters in the field nor those at the base station have to spend a significant amount of time to increase the efficiency of fire fighting. The base station user can easily and quickly see the location and status of each firefighter as well as the fire.

System Overview
The tracking system consists of two levels: an End-User (EU) and Base Station (BS). The system is scaled for twenty EUs, the typical size of one crew. Future scalability would include optimizing the system to handle multiple crews. The BS system is centered on a computer connected to an RF transceiver via a microcontroller; the computer displays, via a GUI system, user information on a map. The BS microcontroller polls each EU device one at a time via RF transmission. The polled user’s RF transceiver passes on this request to the unit’s microcontroller. The microcontroller obtains location and temperature information and transmits it back to the base station.

End-User System
- Linx Receiver (RXM-433-LR-S) and Transmitter (TXM-433-LR-S), transmitting at 433.92 MHz
- Minicircuits RF Switch (ZY5W-2-50DR)
- Saelig Whip Antenna, ¾ Wave at 433 MHz
- PIC Microcontroller (PIC16F690)
- Garmin GPS Receiver (Garmin 15-L) and antenna (GA 27C)
- Inverter to translate RS-232 signal from GPS to TTL signal for PIC
- Two relays to control PIC-GPS link
- Temperature Sensor (National Semiconductor LM34)
- Two 9V batteries with regulators providing +5V, -5V, and +3V

The Linx receiver and transmitter are made into a transceiver through the use of the switch. A digital signal from the PIC to the switch defines the mode (transmit or receive) of the switch and attached antenna. The PIC uses digital signals on separate lines to send and receive the data pulse streams to the transmitter and receiver, respectively.

Once the PIC receives the correct request for its data, it uses analog-to-digital conversion to receive the current temperature from the temperature sensor and converts that data into a binary string. The PIC then enables GPS communication to the PIC through the relays. Once the relays are closed, the GPS location data stream is sent to the PIC through RS-232 communication. The PIC processes the desired data into a binary string. The two binary strings are combined and formatted to be sent to the transmitter.

GUI Description
The computer at the base station will have access to a Java based application. This application has a graphical user interface (GUI) to simplify the user’s communication with it. As soon as the application starts, it begins acquiring data that is being sent to it from the BS microcontroller. By interacting with the GUI, the BS user manually adds the EUs to the system. Once added, the data being actively received from the BS microcontroller updates the particular EU it is associated with. The user then loads a map of the fire region into the GUI with location coordinates of the picture edges. This map is simply a regular picture file (.jpg, .bmp, or .gif). Once the map is loaded, the application visually displays the individual EUs on the map according to their current locations, as received from the BS microcontroller at regular intervals.

Other features:
- Roll the mouse over an EU image to get specific information about that individual.
- Select an individual EU from the list of users and push the “receive statistics” button to see various statistics about that user’s activity since added to the system.
- Manually designate active and inactive fire regions by pressing on the appropriate button and then on the map at the appropriate location.