RFID on Lookout for Wildfires in China

Qingyuan Forestry is piloting a fire-detection solution that includes ZigBee-based wireless sensors.

By Claire Swedberg

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Feb 13, 2012—In the Qingyuan Forest, located in southern China's Guangdong Province, a wireless ZigBee-based sensor system—with nodes installed on poles and mounted on treetops—can detect environmental changes in the air and alert park officials in the event of a wildfire. The solution is a pilot of the Early Stage Wildfire Detection and Prediction Wireless Sensor Network system, provided by Insight Robotics Ltd., a Hong Kong startup company founded by researchers at the University of Hong Kong. Insight Robotics developed the system in cooperation with the Qingyuan Forestry and Guangdong Academy of Forestry. The system also includes a thermal imaging camera to seek visual evidence of flames.

Insight Robotics, formerly known as Insight Innovation and Technology Ltd., was founded in 2009 by a group of mechanical, electrical and software engineers from the University of Hong Kong. The company's early work focused on the use of robotic technology not only to detect flames, but also to aid in the rescuing of people from fires using unmanned robotic units.

An Insight Robotics wireless sensor and solar panel mounted on a pole

"We had a focus on using robotics for humanitarian purposes," says Albert Ko, an honorary assistant professor of engineering at the University of Hong Kong and one of Insight Robotics' co-founders. The group is developing search-and-rescue robotics to locate and assist individuals who may be trapped by a fire. In the meantime, however, the company began considering wireless sensor networks that would transmit data letting forestry management know what is occurring in the forest, in real time, before any robotic response was required. In 2009, the group began working with Qingyuan Forestry, which averages at least one wildfire annually, with several such fires burning many square miles of forestland. During a typical year, in fact, fires burn an area of Chinese forests 25 times the size of Hong Kong.

Last December, the forestry staff, working with Insight Robotics, installed a network of 20 to 30 battery-powered wireless sensors across a 24-square-kilometer (9.3-square-mile) area of forest. The furthest separation between nodes was 5 kilometers (3.1 miles), while others were less than 1 kilometer (0.6 mile) apart. (The sensor tags have a maximum read range of 5 kilometers,

depending on how clear their line of sight with each other remains.) The team also installed a thermal-imaging camera that searches for anomalies in the forest, such as infrared radiation emitted by flames. The tags, which comply with the ZigBee and ISO 802.15.4 standards, create a mesh network, transmitting back to a server located onsite in the forest, near the thermal imaging camera. The nodes were developed and built in-house by Insight Robotics, Ko says, and were manufactured using antennas supplied by Group Sense.

Each wireless tag transmits sensor data every five minutes, along with its own unique identifier, to the nearest adjacent node, and ultimately back to the server, on which Insight Robotics software resides. If one of the nodes is destroyed by fire, the other tags will transmit around that lost node. Each tag is powered by a battery charged by a solar panel mounted at each node. Built-in temperature, humidity, gas and infrared sensors take measurements regularly. The humidity data, stored by Insight Robotics' software, can be used to judge the level of fire risk present at any given time. For example, a very high humidity level would indicate a low risk for fire. If the temperature were to suddenly rise, however, that reading would indicate the presence of flame, and the software would display an alert that command center employees could view, enabling them to determine where to respond. The gas sensor measures changes in the air's specific gas levels, and the infrared sensor can detect variation in the infrared level that could potentially result from a fire. The system can identify a fire's location within about 5 meters (16.4 feet), Ko says, based on the specific tag indicating a rise in temperature, as well as data from the thermal-imaging camera.

Albert Ko

To test the system, the forestry staff set a fire in a large bucket, located close to one of the nodes within the forest's mesh-network coverage area. The tag issued a wildfire alert to the Qingyuan Fire Control Center within three minutes, thereby enabling the operator to pinpoint the fire's location and release an unmanned aerial vehicle to that site. The aerial vehicle could then take infrared images and send them to the back-end server in real time, in order to aid the operator in deciding on the next action.

In March, park officials plan to return to the site to witness another test of the system with ignited fires, and to determine whether to make the system a permanent deployment for the entire park. To date, Ko says, the solution has functioned well, though there were several challenges when building the network.

"ZigBee requires some line of sight," Ko explains, and some sections of the forest were very thick, making it necessary to install several nodes on the tops of trees. The solar panels were installed to recharge the lithium-ion batteries, but Insight Robotics had to custom-design the battery to withstand the forest's conditions. When the sun is shining, he notes, temperatures can reach 40 degrees Celsius (104 degrees Fahrenheit) or higher, and the heat sometimes made traditional batteries inoperable. On the other hand, he adds, rain and wind have not proven to be damaging to the sensor tags.

In addition, Ko reports, Insight Robotics is currently in discussions with representatives of other parks throughout China and Hong Kong, as well as a park in Malaysia. In the future, he says, the system will send data to a remote location using a cellular connection, thereby eliminating the need to have a PC or a laptop computer in the vicinity.