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UAV Hotspot Detection

The search for any remaining hot-spots begins once a vegetation fire has been extinguished. Hotspot detection has been done in the past either by hand or with the help of infrared (IR) scanning from a helicopter, both of which have limitations. Helicopters are expensive and walking the fire ground is slow and risky. It requires fire crew to remove gloves and feel for heat. They look for white ash which indicates intense burning and may even use smell and sound to locate smouldering vegetation. The terrain is often unforgiving and littered with burnt scrub such as broom or blackberry, there are holes in the ground from fire consumed stumps, acrid fumes and other hazards.

Scion began working with the University of Canterbury and Tait Communications Ltd in 2013 to develop a cheaper, safer option – an unmanned air vehicle (UAV) fitted with IR camera technology and GPS.

The UAV could fly hundreds of metres above the ground, distinguish between burned and unburned ground in order to fly around a fire's perimeter and record video, still images and identify hotspots.

Key findings:

- Accurate location of hotspots become feasible due to recent developments in GPS technology that can cope with rapid UAV rolling and pitching.
- The greatest opportunities for UAV hotspot location are at night, when other aircraft are not flying, and in early morning when the ground is coldest and hotspots more visible to IR.
- The greatest barriers to UAV operations are sharing airspace with other aircraft and the effect of high winds, which are common at fires.
- Operational deployment requires professionally trained UAV pilots who have the confidence of the fire command personnel.

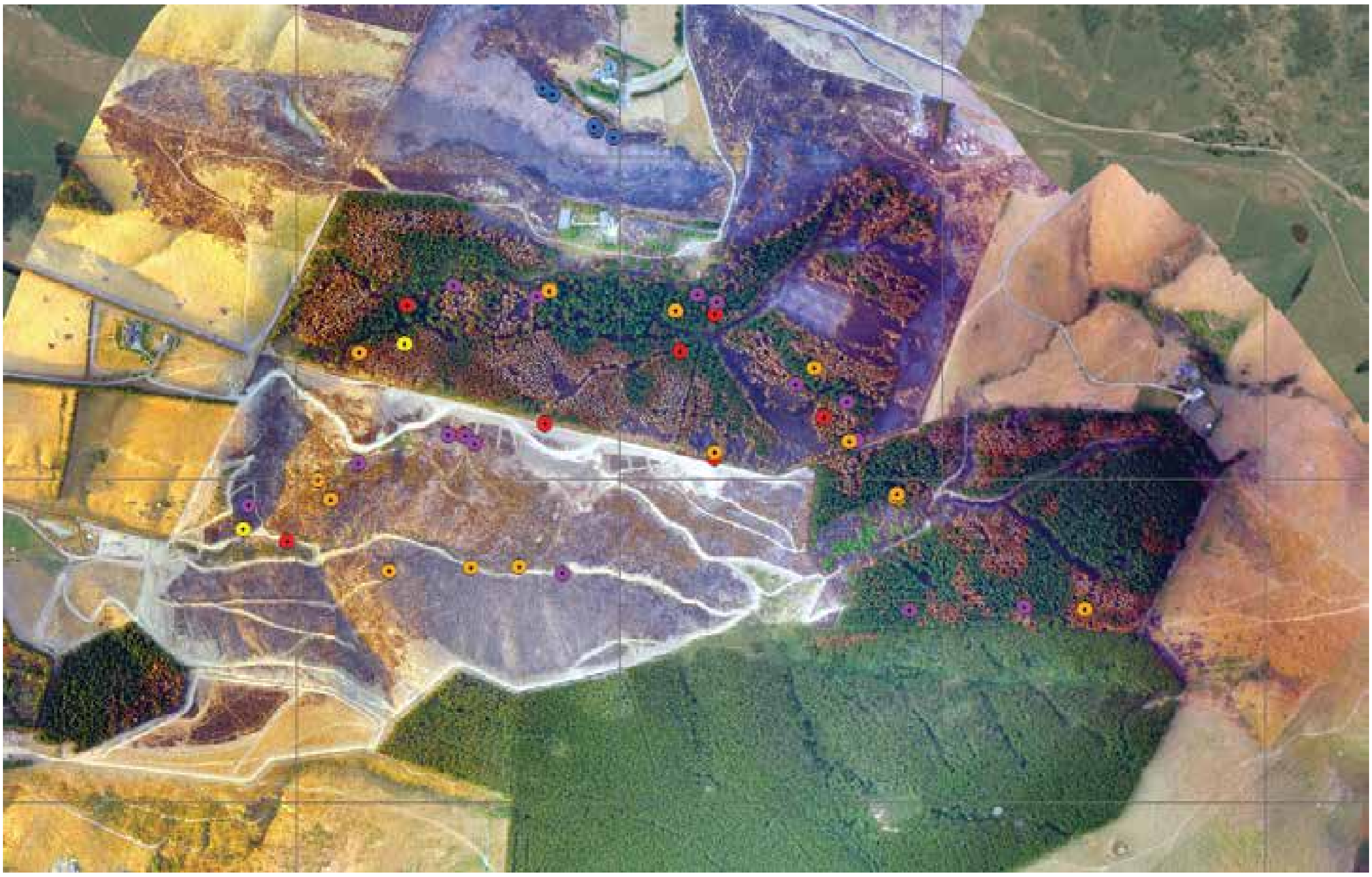

Photo: Interpine Group Ltd.

Hotspots identified in Port Hills fire, February 2017.

A brief account of UAVs

UAVs have a long history and the technology is developing rapidly. The first recording of a UAV comes from Austria in 1849, when a balloon loaded with explosives was used to attack the Italian city of Venice. In the First World War, pilotless aircraft took aerial photos of German trenches and in the 1930s, the US Navy began experimenting with torpedoes from radio-controlled aircraft.

With advances in computing power, and lighter more powerful batteries the technology took off in the 1990s and now UAVs are used for everything from video production to warfare. With commercial, military and hobbyists now taking up UAV development, the technology has reached a critical mass for exploring new uses.

Firefighter locating and extinguishing hotspots.

Project background

A vegetation fire can continue to burn underground long after the surface burning is extinguished. The underground “hotspots” are usually burning tree roots or plant material that could reignite the fire. Before the fire crew can leave, the hotspots must be located and doused. Finding hotspots is often done by time-intensive manual searching by teams of firefighters and sometimes by aerial search using a helicopter and thermal camera.

Prototype Quad rotor UAV with gimbal-mounted IR camera at fire site.

Manual searching carries many risks for firefighters. Walking on the burnt terrain releases clouds of soot and dust requiring mouth and eye protection. Hotspots have to be felt out with bare hands, risking burns. Sometimes burnt stumps leave deep holes in the ground resulting in a hazardous pit of burning embers that can be difficult to see.

A collaborative project between Scion, Tait Communications and the University of Canterbury aimed to provide a quick and cost-effective way to map a burned area and provide GPS coordinates of all hotspots using a UAV. The UAV could successfully photograph the burn area and identify hotspots with its infrared (IR) camera. However, the actual location of the hotspots could not be successfully mapped because the UAV moved too much to get an accurate GPS fix.

Methods

The first part of the project focused on building and testing a prototype hotspot detecting and mapping UAV. The UAV was constructed from off-the-shelf parts – a 600 mm quadcopter fitted with a stabilised, gimbal-mounted thermal camera, a small digital video recorder and GPS enabled flight controller. The UAV and sensor combination was tested with hotspots simulated by a bowl of warm water sitting on burnt ground after a recent wildfire.

The second part of the project saw an upgrade to the software and processing system that allows images to be displayed in Google Earth.

Results

Initial tests of the prototype hotspot-locating UAV were promising. The UAV could fly around and above high trees and remain stable in 20 knot winds. The UAV was fast and effective at locating the simulated hotspots. Using the autopilot for automated take-off and landing reduced the operator’s workload.

Although hotspots were seen by the IR camera, they could not be accurately georeferenced because of movement of the camera as the UAV was buffeted by the wind. Real time hotspot location was not possible. The IR images of hot spots had to be processed after the UAV had landed.

Infrared video image of simulated hotspot (bowl of warm water) from a height of 20m.

Hot spot map showing firefighters precisely where to focus efforts during mop-up.

First operational real time hot spot detection by UAV

Port Hills Fire, February 2017

The technical problems encountered in the prototype hot spot UAV were solved by commercial developers using more sophisticated cameras, multiple GPS units on more capable UAVs and faster software. Interpine Group Limited operationally deployed a sophisticated IR-enabled UAV for the first time in New Zealand during the Port Hills Fire in February 2017 to provide information and support for firefighters. The UAV was flown at night, when only rescue helicopters were likely to fly, and when the ground was coldest, giving the greatest contrast with hotspots. Hotspots were identified by the UAV team viewing a real time video feed.

The hotspots were tagged on a map with GPS coordinates and maps were created overnight. The maps were provided to firefighters at the morning briefing as paper hard copies or via cell phones using Quick Response (QR) codes printed on the incident management plan. By photographing the QR code, firefighters could use their cell phones to view the location of hotspots on a map of the fire ground. Armed with these maps, firefighters were deployed to extinguish hotspots.

The UAV pilots were in continuous contact with Air Traffic Control and the fire command structure so the location of the UAV was known at all times, eliminating the risk of collision with other aircraft flying at night such as fixed wing or rescue helicopters.

Port Hills fire, February 2017.

Conclusions

Early research demonstrated the potential of a UAV-mounted IR camera to locate the presence of hotspots.

The first operational deployment in New Zealand of UAV mounted IR technology provided vital information and support for firefighters during the Port Hills fire. UAVs were deployed in synergy with helicopter operations during the response. It was a cost effective and successful operation. Helicopters with IR cameras scanned the entire fire perimeter and identified key areas of concern. UAV mounted IR cameras then located hotspots and mapped them in detail providing the information to firefighters.

The benefits of this technology are:

- **Increase mop-up efficiencies:** reducing the time to locate hotspots for quicker mop-up.
- **Improve situational awareness:** site familiarisation for fire fighters and improving their understanding of the terrain and structures from a birds eye view.

Further information

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Photo: Selwyn District Council.

UAV deployed to work with firefighters during the day.

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