Wildfire Research Update

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Operational use of the wearable thermal camera at a wildfire. Naked eye and thermal camera views of hot spots

Wearable thermal camera for hot spot detection

After the flaming front of a vegetation fire has been extinguished, roots, bark and organic material in the soil can continue to burn in Hot Spots. These can flame up with increasing winds or a drop in humidity, causing the fire to reignite. Firefighters' 'mop-up' by patrolling the perimeter of the fire, extinguishing any burning or smouldering material.

Navigator 520 thermal camera

- Hot spots are visible against the cooler soil or vegetation background and effectiveness of suppression (water or digging) is seen immediately.
- The device is hands free, enabling firefighters to use a hand tool or hose. This eliminates the need for a second firefighter.
- Hands can be used for support on steep or difficult terrain.
- The device is comfortable to wear; however, practice is needed to become accustomed to looking down at the screen to view the scene through the thermal camera display.
- Current trials have only used the camera features of the device. It is a wearable computer and can access files, participate in Teams meetings and send video and still images from locations with Wifi. We plan to explore these additional features in future work.

Mop-up using a conventional handheld thermal camera to detect hot spots and requiring two firefighters

Background

To successfully mop-up, firefighters use all their senses - except taste - to locate material burning on the fireground:

Hearing – If it is quiet and windless, the hot spot can occasionally be heard crackling.

Smell – Acrid fumes are released by smouldering that sometimes can be smelt. In this case, the firefighter positions themselves downwind of the suspected hot spot and moves back and forth staying in the plume of combustion gases until they find the hotspot.

Sight – More often, the firefighter will use visual clues to look for evidence of intense burning (white ash) and concentrate the search in that area. Occasionally smoke can be seen rising from smouldering material. However, the smoke column may be very narrow and difficult to see against the surrounding vegetation and cannot be seen at all in windy conditions.

Touch – Ultimately, the sense of touch is used to locate hot spots. For this, firefighters must remove a glove and feel with their fingers for heat. This works well if the hot spot is small or not too hot. But fingers can get burnt if the hot spot is big and active. Also, it is awkward to remove and replace gloves repeatedly and gloves get lost resulting in an additional safety hazard.

To further assist in hot spot detection, handheld thermal cameras can be used on the fireground during mopping up. They are very successful at locating hot spots and are commonly used at vegetation fires. However, they are awkward to use because one hand is occupied with the camera. Firefighters normally carry a hand tool (e.g. Pulaski, rake or shovel) and must put the camera down on the ground or release it on its retractable tether while they use the hand tool. The camera bangs around their body and gets in the way of the hand tool when the firefighter is bent over digging.

Another practical problem with the handheld camera is that the firefighter loses thermal vision as soon as they are not looking through the camera. They can no longer see heat and can dig in the wrong place. A solution is to have two firefighters working together. One viewing the hot spot through the camera and verbally guiding their colleague who has the hand tool. This can work well with an experienced crew, but it does tie up two firefighters.

Considerable effort has gone into the development of remote sensing thermal camera platforms for wildfire hot spot detection. Helicopter and UAV mounted cameras can rapidly identify hot spots from the air and have become a huge asset in mopping up. But they struggle to distinguish small hot spots or those under logs and debris. Firefighters with thermal cameras can search for these more difficult to locate hot spots.

Feeling for hot spots with the back of the hand and not wearing a glove

A new way to locate hot spots

Hot spots represent an ongoing challenge for firefighting crews. Locating smouldering organic material on the fireground is difficult and potentially dangerous because the material is burning and hot. If hot spots are not found, they can reignite, and embers can start a new fire. Wildland firefighters have handheld thermal cameras to detect hot spots on the fireground. A wearable thermal camera gives the firefighter a view of hot material while freeing up hands for a hose or hand tool.

A hands-free device

Wildfire researchers have been searching for wearable thermal cameras suitable for wildland firefighters and the RealWear device appeared the most promising. The RealWear Navigator 500 series device is a hands-free Android wearable computer.

It features:

- A FLIR Lepton® 3.5 thermal camera with a frame rate of 8 Hz and a conventional visible light camera that can capture video (1080p, 60fps) and still images (12 Mb).
- The device is a voice controlled, hands free camera and viewer designed for industrial environments where the wearer can communicate with remote colleagues. It was designed for automotive, oil & gas, warehousing and healthcare industries; Scion Wildfire researchers have adapted it to the fireground. The device presents the thermal (or visible light) camera image on a display mounted on an adjustable boom and can be controlled by spoken commands. The display is best viewed just below the line of sight of the dominant eye.
- A pair of clips were specially fabricated by RealWear to fit the NZ wildfire helmet (Pacific Helmets model BR9).
- Lightweight, only 275g.

Comfort and usability

The camera was comfortable to wear but the user must be patient to build familiarity with the position of the thermal camera screen mounted below their eye.

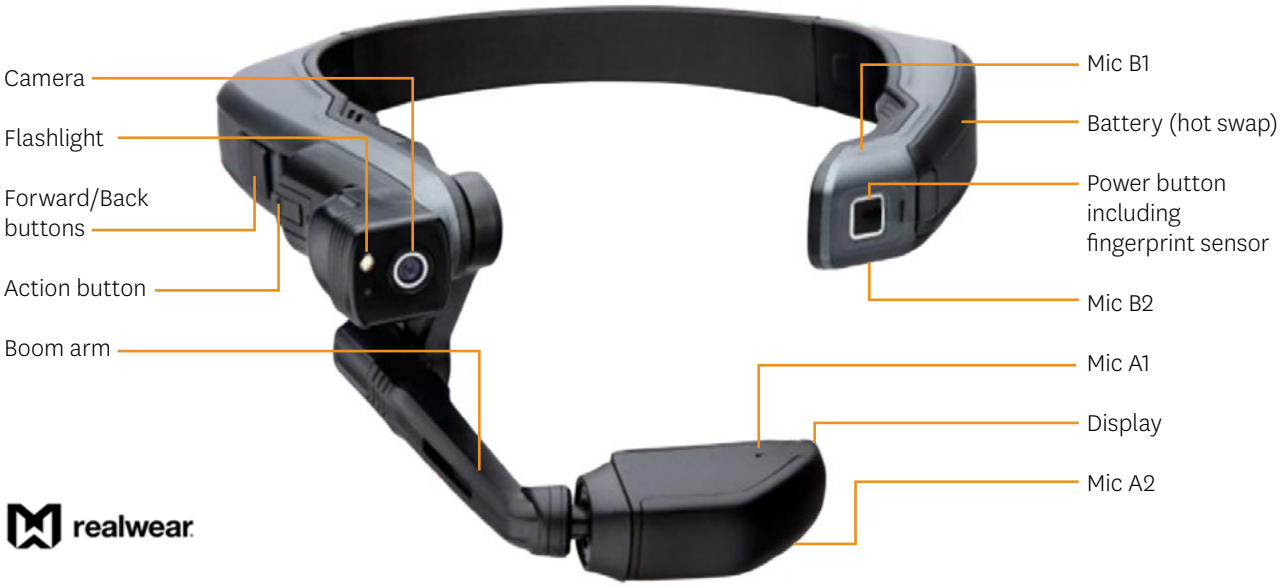
Trial participants reported:

- A tendency to close one eye to view the scene through the camera – the camera is best used with both eyes open.
- The need for slow and deliberate scanning. The camera refresh speed of 8 frames / second cannot keep pace with rapid head movements.
- After 5 to 10 minutes of use with the device, walking and scanning seemed natural.
- No eye strain was experienced
- No noticeable additional weight on the wearers head.

Thermal capability

The thermal capability of the device was tested by burying air activated chemical warming pads that heat up to 36°C on exposure to air. The pads were not visible to the naked eye and the thermal camera wearer did not know where the pads were placed. Trial participants scanned the test area with the thermal camera looking for heat signatures and the pads were found immediately. Air temperature was 9°C and soil temperature was 3°C, which were ideal conditions to find hot spots.

Camera attached to a New Zealand fire helmet



The camera provides excellent situational awareness showing hot material

The wearable thermal camera successfully located hotspots at wildfires in Canterbury during December 2024. Wearers of the camera could easily see hot spots on the fireground even through vegetation.

Discussion

Firefighters have always wanted to see hot spots without carrying an additional piece of equipment in their hands. The Navigator 520 wearable thermal camera provides that capability. After getting used to keeping both eyes open and looking down to the cheek mounted display users could walk and locate hot spots with ease. However, the slow refresh rate of the thermal camera required slow head movements so the camera could keep up. Initial testing was under ideal conditions with very cold soil and the device located hot spots with ease. The device was further trialled at real wildfires and easily imaged the hot spots.

Naked eye and thermal camera view of buried heating pads

Next steps

Explore the communication and image recording features of the Navigator 520 for training and intelligence gathering on the fireground.

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Further information

Hsieh, R. & Refai, R. (2020). National handheld infrared scanner usage survey. Technical Report No. 32. FPInnovations

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