



LINKING GROUND AND SPACE SYSTEMS TO AUTONOMOUSLY ASSESS WILDFIRES

The Moore Foundation, Moraga-Orinda Fire District, UC Berkeley and Planet Collaborate to Deliver Timely, Accurate Satellite Imagery

A NEED FOR THE RAPID DETECTION AND ASSESSMENT OF WILDFIRES

Driven by global climate change, more frequent and severe wildfires in California have damaged and destroyed thousands of homes, exposed millions to toxic smoke, and killed hundreds of people. Detecting and suppressing wildfires in their earliest phases immediately after ignition can vastly reduce their scale and impact, saving lives and preserving structures, and more efficiently utilizing fire management resources. Large areas of land, often remote and challenging to reach, are at risk of fire during any given season, making it difficult to detect and assess fires.

Remote fire detection and assessment has the potential to supply timely and comprehensive information about wildfires, which may in turn help fire managers deploy resources with greater efficiency and efficacy¹. But, incorporating and aligning different data sources poses unique logistical and technical challenges. Fire observation towers, aircraft- and satellite-based fire detection, and civilian 911 calls can all play a role in delivering timely fire intelligence, but these approaches have not yet been unified into comprehensive or effective systems².

The Gordon and Betty Moore Foundation

The Gordon and Betty Moore Foundation is an American foundation established by Intel co-founder Gordon E. Moore and his wife Betty I. Moore in September 2000 to support scientific discovery, environmental conservation, patient care improvements and preservation of the character of the Bay Area.

The Moore Foundation provided a grant to leverage advances in remote sensing, artificial intelligence, real-time modeling, and cloud computing technologies to support dynamic and analytic wildfire risk mapping and response.

Moraga-Orinda Fire District

Located in the San Francisco Bay Area, the Moraga-Orinda Fire District (MOFD) provides fire protection, rescue, and emergency medical services in the communities of Moraga and Orinda and the surrounding unincorporated areas. The District responds to over 3,000 incidents annually from five fire stations.



UC Berkeley Department of Electrical Engineering and Computer Sciences

The Department of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley pursues an array of cross-disciplinary, team-driven projects. Their integration of EE and CS forms the core, with strong interactions that extend into biological sciences, mechanical and civil engineering, physical sciences, chemistry, mathematics, and operations research.

1 <https://www.intechopen.com/books/sustainable-development-authoritative-and-leading-edge-content-for-environmental-management/use-of-remote-sensing-in-wildfire-management>
2 <http://frg.berkeley.edu/wp-content/uploads/2019/09/MOORE-FOUNDATION.pdf>

A NEW APPROACH: ALIGNING GROUND AND REMOTE SENSING

A pilot program funded by the Gordon and Betty Moore Foundation aimed to push the boundaries of existing tools for the remote detection and assessment of wildfires. They funded a collaborative project between Moraga Orinda Fire District (MOFD), Planet, and the UC Berkeley Department of Electrical Engineering and Computer Sciences, seeking to autonomously gather and integrate wildfire data into a single cohesive system.

The goal of the pilot was to connect networks of ground fire sensors to an automated system that would then rapidly gather timely, high-resolution, and location-accurate satellite imagery from Planet capturing fires in their earliest stages.

Motes

In the Moraga Orinda Fire District, a new network of ground sensors that detect heat and moisture conditions can offer near-real-time detection of new wildfires. These sensors produced by Analog Devices are called motes. Motes are deployed in locations where the landscape is at risk of wildfire. Every 10 seconds, the motes send temperature and humidity data over a multi-hop mesh network to a nearby gateway, which subsequently routes to a web interface called BurnMonitor.com.



Integrating Ground Data with the Planet Tasking API

BurnMonitor detects signals of potential fires from drops in humidity and spikes in temperature, and notifies subscribers in real time about the location and presence of fires.

In what was dubbed the “Long Selfie Project,” a team of researchers in UC Berkeley’s Department of Electrical Engineering and Computer Science under the direction of Kristopher Pister developed a Python script to connect those fire notifications to the collection of satellite imagery.

The script processes “publications” of detections of fire from BurnMonitor and links them to Planet’s Tasking API, which triggers a request for satellite imagery at the latitude and longitude where the motes signal a potential fire. Because one fire can generate multiple fire-alert messages, the script filters out repeated and false alarms.

Planet SkySat Satellite Imagery

Key to the pilot program’s aim was to collect high-resolution satellite imagery automatically, without the need for human involvement. Chief Dave Winnacker of the MOFD notes that, “As the density of satellites increases and advances in ground based sensors allow us to rapidly identify fire starts, the rapid integration between systems will allow the generation of hyper accurate fire perimeters during the critical early hours.”

Synced to the motes’ sensors and filtered through the BurnMonitor integration and the Long Selfie Project script, Planet’s Tasking API is able to ingest requests for imagery and autonomously task a SkySat satellite to collect data from the specific latitude and longitude where a fire is detected.

Planet’s 18 SkySats can collect very-high resolution images of one point on Earth multiple times per day. This revisit cadence ensures that requests for imagery can be delivered shortly after they are requested.

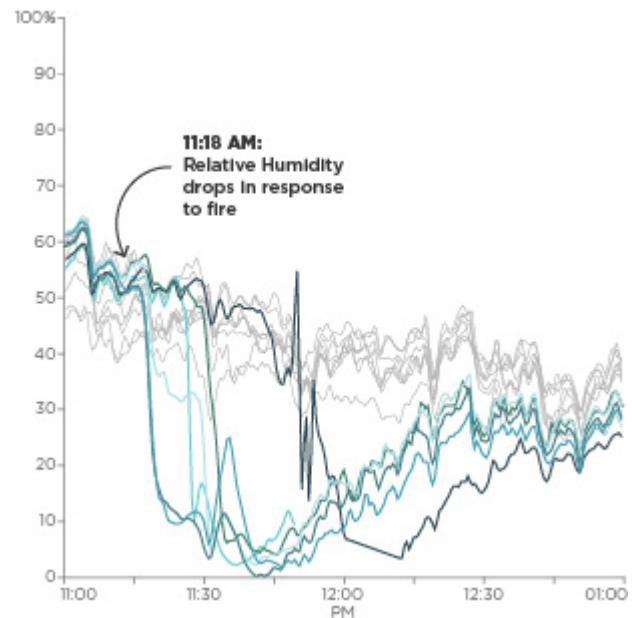
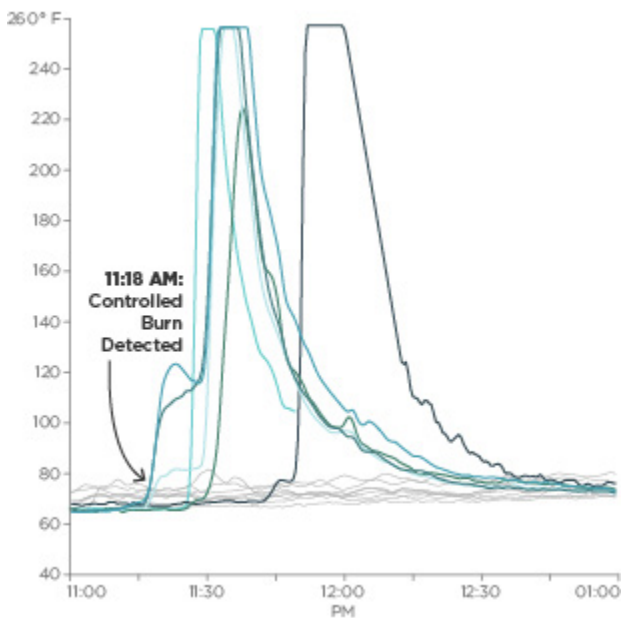
Planet's Tasking API allows requests for high-resolution satellite imagery to be automatically delivered, eliminating the need for a manual order. By integrating ground sensor data with the Tasking API, the seamless and autonomous process saves time and friction in image collection, reducing the period between the detection of a potential fire and the delivery of data.



A Planet Skysat captured the test burn while it was underway at 11:41 AM, April 30, 2020.

THE RESULTS

To assess the functionality of the motes and their connection to the Tasking API, the Moraga Orinda Fire District (MOFD) conducted several experiments in April and May, 2020. Controlled fires called prescribed burns were prepared and lit where motes had been installed on the ground. Brush piles were carefully placed at sites where there is limited tree canopy and good visibility from space, then ignited between 10 and 11 am, with the aim of producing enough smoke for remote detection.



The motes nearest to the fire detected an increase in temperature and decrease in relative humidity at approximately 11:18 AM, April 30, 2020. Motes further away (depicted in grey) show no change.

As the fires approached, the motes detected changes in temperature and humidity, and sent these data to BurnMonitor, triggering multiple fire alert messages. Subsequently, these messages generated a task via the Tasking API to collect images at the geolocation of the sensors.





A Planet Skysat image captured at 11: 37 AM, May 1, 2020 in response to the tasking request triggered by the motes. The image is overlaid with the positions of the motes in the testing area, with the motes that detected the fire highlighted.

Just a few hours later, a SkySat collected images that covered the areas tasked, showing ash piles and smoke. This data was returned to the MOFD, proving that sensors placed on the ground could successfully trigger the collection of geolocated satellite images automatically.

Chief Winnacker expressed excitement that the tests showed major strides towards the goal of rapid integration of data sources. “The success we achieved with this pilot shows it can be done and sets the stage for continued development of systems with real world applications in support of our ongoing efforts to reduce the damage caused by major wildfires.”

He noted that the earliest stages of fires pose unique challenges because information is in such limited supply and resources haven’t yet been mobilized to quickly respond with evacuation and suppression efforts.

“Having accurate, reliable, and timely information allows for the population of decision support tools to aid overwhelmed first responders as they make difficult decisions,” Winnacker said. “This proof of concept is a major milestone towards the development and fielding of these tools and is indicative of the great potential for improvements that lie ahead.”

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