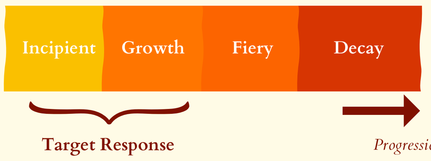
Firebird : Crowdsourced Wildfire Identification & Localization

Owen Li , Zacchaeus Chok , Gabriel Yang , Varun Swaminathan

A Race Against Flames

In the expansive rural landscapes of California, the menace of wildfires looms large. A rapid detection system can significantly mitigate the havoc these fires wreak, yet, alarmingly, the path to identifying a wildfire in its early stages can be protracted and cumbersome.



Every Second Counts...

Given that wildfires can spread at speeds of up to 33 km per hour, each hour's delay in detecting a fire can result in extensive damage and increased difficulty in containment. Existing solutions, such as satellite imagery and sensor data, are hindered by lengthy data processing times and limited exposure, often taking hours to days for the critical data to be ready for use. These delays prove catastrophic in the face of rapidly spreading wildfires. Firefighting authorities grapple with these inherent limitations in real-time monitoring capabilities and the daunting resource constraints that come with them.

"Current wildfire detection mechanisms can astonishingly take anywhere from hours to even days to collect, process, and finally identify emergency fire situations - a daunting lag in the face of an imminent catastrophe."

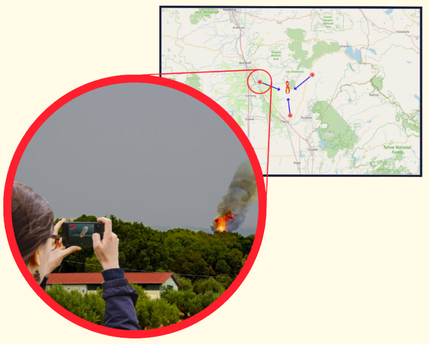
Humans as sensors?

The Challenge

The core challenge is simple, but not easy. How could we augment slow aerial data with rapid ground-level information to quickly identify and locate wildfires? Traditional physical sensors were considered, yet their cost and maintenance challenges in entropic environments, like forests, were prohibitive.

The Insight

We turned to the smartest ground-level sensor we knew - humans! We realized that humans could easily identify wildfires if the flames or the smoke clouds were in their visual line of sight. Despite human ability to identify wildfires, our skill in estimating directions and distances is less reliable. Yet, in the era of smartphones, we can overcome this shortcoming. These devices provide precise GPS coordinates, and the phone's magnetometer can determine its orientation.



A Novel Approach

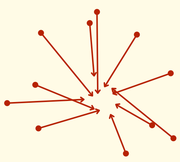
Our approach hinges on triangulation from at least three separate observers capturing photos of the fire. Plotting the directional vectors from their distinct locations yields an intersection, thus approximating the wildfire's location with reasonable accuracy. This forms the backbone of Firebird - a rapid, lightweight method to crowdsource crucial wildfire data.

The Firebird Solution

Detect	Upload	Inform	Crowdsource	Calculate	Respond
Person notices a wildfire in its early stages	Person takes a photo of the wildfire using the Firebird App	GPS metadata and magnetometer direction values are sent to Firebird server	Upon verification, the vicinity will be alerted of the wildfire via SMS and prompted to submit photos	Using triangulation and clustering algorithms, we locate the fire source from crowdsourced wildfire reporting	First responders can direct their resources towards the wildfire more promptly, as more accurate satellite data streams in for refining the wildfire localization

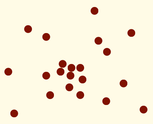
From Metadata to Wildfire Localization

1



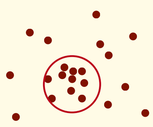
Retrieve latitude and longitude data from image metadata from multiple mobile devices

2



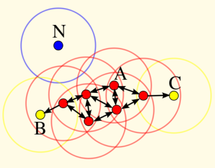
Identify intersection points between every possible pair of lines

3



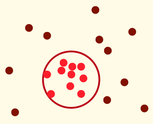
High-quality data points should cluster together, reflecting photos accurately aimed at the wildfire

4



DBSCAN identifies subsets of intersection points that form the most cohesive clusters

5

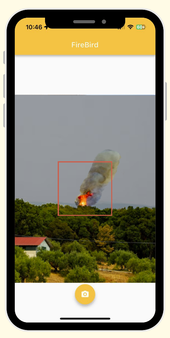


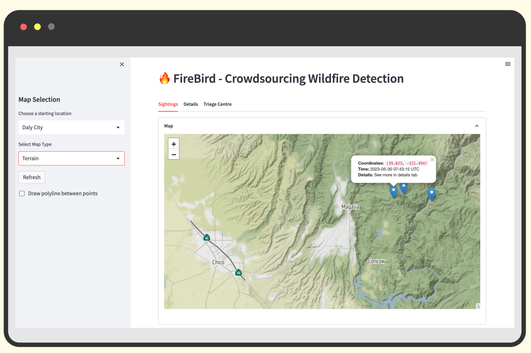
Obtain set of intersection points from DBSCAN forming strongest cluster

6

The approximate location of the wildfire is determined by the average of all the final intersection points.

Ignite Rapid Response. Simply.





Firebird Mobile App

Firebird's mobile application reimagines wildfire detection, leveraging the prevalence of smartphones for immediate data collection. Traditional methods like remote sensors and satellite imagery can face resource and time constraints. Firebird's app empowers instant reporting, allowing authorities to swiftly respond to wildfires, potentially preventing minor fires from escalating.

Triaging Dashboard for Localisation

Firebird's innovative triaging dashboard is the next key component of its solution. With wildfires spreading at alarming speeds, every second counts. The dashboard employs a triangulation approach using data from the mobile app, enabling rapid localisation of fire outbreaks. This quick response capability can significantly reduce fire spread, protect communities, preserve habitats, and cut firefighting costs and risks.

References

Barmpoutis, P., Papaioannou, P., Dimitropoulos, K., & Grammalidis, N. (2020, November 11). A review on early forest fire detection systems using optical remote sensing. Sensors (Basel, Switzerland). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7697165/

Shafer, M.L. (1987). Triangulation. In: Brinker, R.C., Minnick, R. (eds) The Surveying Handbook. Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-1188-2_10

Goodchild, M. F. (2010, January 18). Crowdsourced Geospatial Data Quality: Challenges and Future Directions. Crowdsourcing geographic information for disaster response: a research frontier. https://www.tandfonline.com/doi/full/10.1080/13658816.2019.1593422

Paziewski, J., Fortunato, M., & Mazzoni , A. (2021, February 12). An analysis of multi-gnss observations tracked by recent Android smartphones and smartphone-only relative positioning results. Measurement. https://www.sciencedirect.com/science/article/pii/S0263224121001858