Experimental Analysis of Fire Turbulence and Ember Lofting

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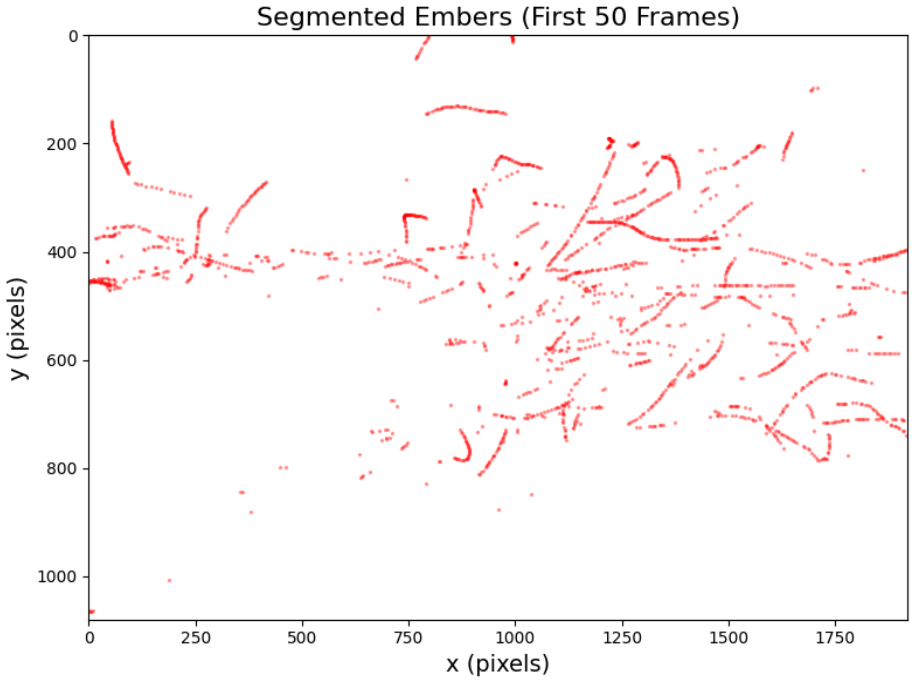
Wildfires pose an increasing risk to both humans and the environment as climate change drives hotter and drier conditions that promote extreme fire events. While extensive research has been conducted on wildfires, many wildfire models assume steady-state plumes and continuously released embers, potentially ignoring the chaotic and intermittent fire physics which influence fire spread. This summer, I spent 10 weeks processing and analyzing high-speed imaging of a pile burn experiment to track ember production and trajectories. My goal was to build image processing skills necessary for visualizing the turbulence within the fire plume. This work is the foundation for my honors thesis, which will investigate how random, burst-like processes within the plume influence ember transport and spot fires.

To analyze the footage, I used python image libraries like scikit-image and OpenCV to segment each frame, suppress the background, and mask out the flame. I then used MyPTV, a particle tracking software, to create ember trajectories and calculate their velocities and acceleration. Throughout this research, I also spent time reviewing research articles, and submitting an abstract to this year's annual American Geophysical Union Conference.

Over the coming year, I will calculate distributions of ember generation rate and ejection velocity which I will use within large-eddy simulations. I then will compare the lofting behavior and transport distance of stochastically generated embers to those initialized with single-event or continuous-release methods. These insights can be parameterized within future models, helping improve spot fire prediction. By examining a frequently overlooked aspect of wildfire dynamics, this work has the potential of enhancing future models that can help inform firefighting strategies and community resilience planning.



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Funded by the Burns Fellowship