Early Wildfire Detection With Machine Learning

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Introduction

Machine learning is the idea of inputting data into models in order to train them to analyze and recognize patterns in a dataset. This summer we used machine learning to train models to detect whether wildfires were present in an image or not. We used pre trained models from a GitHub repository which were accurately able to detect whether a fire was present or not for city fires. This repository provided us with two models: Firenet Full Frame Model and the Superpixel Model. We ended up using the Superpixel Model since it gives a more through and detailed analysis of each frame. Our research focused more on wildfires so we had to retrain the model to be able to detect wildfires. Although city fires and wildfires don't seem that different, they are since wild fires usually have an orangey haze which city fires lack, making them easier to detect. We collected wildfire video footage and sliced them into single frames, and then labeled them either fire or clear for the model.

Objectives & Impact of Professor Rhagavan's Research

Professor Raghavan's research and our SHINE Mentor Xiao Fu's focuses on implementing early fire detection models to prevent or reduce the harmful effects that a fire usually has. When a fire approaches, the normal process is for the resident to call the fire department to access help. By the time the firefighters have arrived, it could have been too late for the resident and neighboring communities. With the use of early fire detection models, the trained models would automatically call the fire departed when it detects a fire. This process is much more efficient and minimizes the total amount of time for help to arrive. This research can have a huge impact as it is tremendously helpful, and can help save countless amount of lives from fires.

Overview of the Models and Results

The Firenet Model has two outputs: either FIRE or CLEAR, fire meaning there is a fire in the frame it is analyzing and clear meaning there is not. This model is known to have a 95% accuracy when tested with urban fires. The superpixel model tells you whether there is a fire or not at each pixel in the frame. In this model if a pixel is surrounded by a green border, it means there is a fire, and red meaning there is not. The superpixel model is known to have a 97% accuracy with city fires. Our goal was to test these models with wildfire data and see if they can perform with the same accuracy.

Caption 1: This is an example of a correct result for the firenet model with a city fire. This model uses temporal approaches to classify fire pixels.

Caption 2: This is an example of a False Negative result for the firenet model. We used an image of a wildfire for this model and it produced an incorrect result.

Caption 3: This is an example of a correct result for the superpixel model with a city fire. This model uses pixel localization techniques by over-segmenting frame to proved a more detailed analysis.

Caption 4: This is an example of a false positive result for the superpixel model with wildfire data.

Figure 1

Figure 2

Figure 3

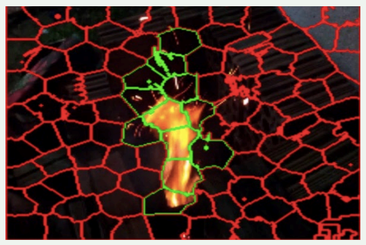
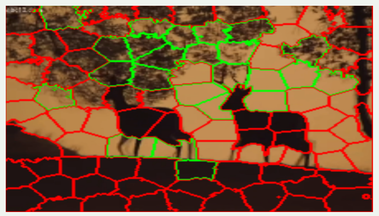
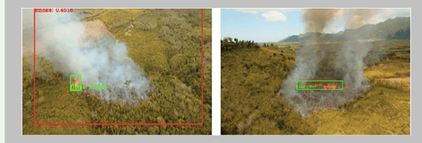


Figure 4



Relation to STEM Coursework

I will be taking AP Computer Science A in my sophomore year, and HL Computer Science in my junior and senior year as part of the International Baccalaureate Program. SHINE has helped my improve my confidence in many aspects of Computer Science, which will greatly benefit me in my future years.



This is an example of what we would want our smoke detection model to look like.

Next Steps in Fire Detection

I would like to further my research done at SHINE by implementing a smoke detection model with a combination of our early fire detection model. This would be extremely useful since smoke is the first visual sign of a fire. By identifying this beforehand, it could save many more lives than ever known and help prevent fires more efficiently. My mentor has arranged a presentation of our research to Ph.D students in the future as well as collaborating with other SHINE students. We are also planning on burning a banana farm in Hawaii to evaluate the hardware such as the sensors and the model. This event can also be used to collect more wildfire data.

Acknowledgement

I would like to formally thank my SHINE mentor, Xiao Fu, for always being available to help when I needed her, my fellow partner Tanvi Thoria, Professor Raghavan, Dr. Mills for putting her whole heart into organizing SHINE for us, Cassandra Jeon for being a wonderful Center Mentor, and Monica for always being a resource available to us.