Detecting Wildfires Using Machine Learning

Tanvi Thoria – tanvi.thoria@gmail.com
Lynbrook High School, Class of 2022
USC Viterbi Department of Computer Science, SHINE 2021

Introduction

This project in Professor Raghavan's Networked Systems lab focuses on using machine learning models to perform early fire detection. Machine learning(ML) is a type of artificial intelligence in which a computer is trained to find patterns in data sets without those patterns being programmed by a person. These ML models use deep computer vision, a subset of ML that trains computers to identify and comprehend visual information. They also use convolutional neural networks (CNN), a type of neural network commonly implemented in visual deep learning problems. These early fire detection models receive a live video feed generated from sensors to detect if there is a fire. The model being implemented also shows the specific area that the fire occurs in.

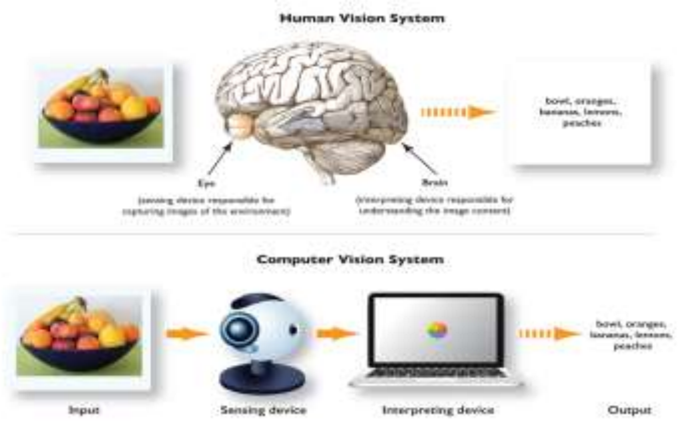
Human Vision System
bowl, oranges, bananas, lemons, peaches
Eye
(sensing device responsible for capturing images of the environment)
Brain
(interpreting device responsible for understanding the image content)
Computer Vision System
bowl, oranges, bananas, lemons, peaches
Input
Sensing device
Interpreting device
Output

Figure 1: Visual representation of objects are detected

Objective & Impact of Professor's Research

Oftentimes, wildfires occur in remote areas where they can proliferate for extended periods of times before being reported by humans. The objective of this project is to detect wildfires, especially in remote areas, so that they can be effectively contained during their early stages. Early fire detection will not only alert fire responders to the wildfires but also allow them to make effective, educated responses about the situation. Eventually, this detection work will be used to create a real time fire perimeter map which will be used to predict wildfires. Broadly, this project's goal is to effectively manage wildfires and reduce damage to infrastructure and human lives.

Methods/Process

Initially, I studied machine learning and how it works in a broader context. Since our project was concerned with object (fire) detection, I studied deep computer vision in detail, such as how convolutional and dense neural networks work together to detect certain patterns in image frames. I also studied TensorFlow and Pytorch, two popular machine learning frameworks. The model that the lab planned on using (superpixel model) was initially built to detect city fires, so I investigated its suitability to detect wildfires. I gathered past wildfire data from the 2020 California wildfires and ran the model on that video data. However, wildfire detection proved to be a very different task as wildfires produce an orange haze when burning that city fires lack. Since the superpixel model worked by selecting groups of pixels in the frame, grouping them according to a color histogram and then evaluating the difference between the colors of groups of pixels next to each other, the difference in colors of wildfires and city fires proved to change the accuracy of the model. After seeing that the model was not accurate enough (Figure 5), we decided to use a different deep computer vision model (YOLO3) and train it using wildfire specific data. We gathered wildfire videos and sliced them into image files. I annotated the image files to indicate if they had fire in them or were clear (Figure 2). I changed the code of the original model so that it effectively served our purposes. I then fed the wildfire data to the model in order to train it. The new model was significantly more accurate than the previous one and showed more detail (Figure 3).

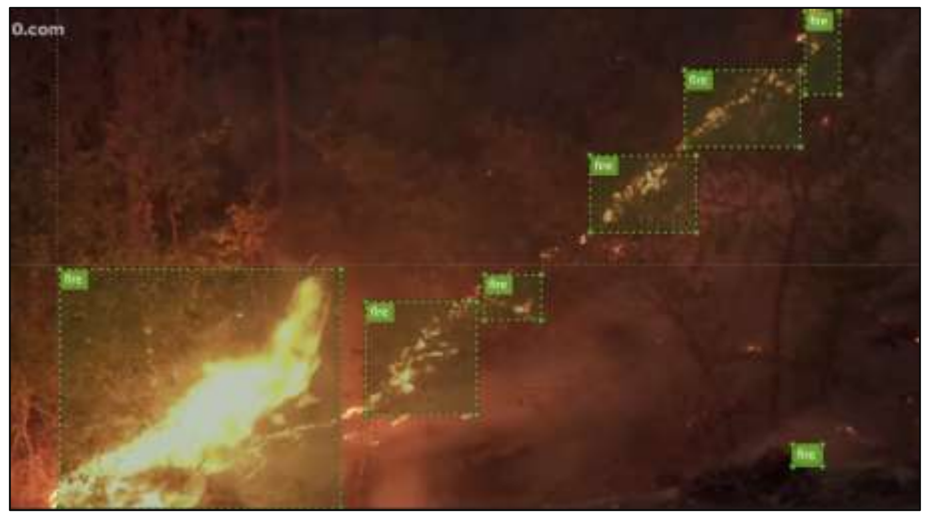

Figure 2: Annotating the data (using Vott) to train the model with

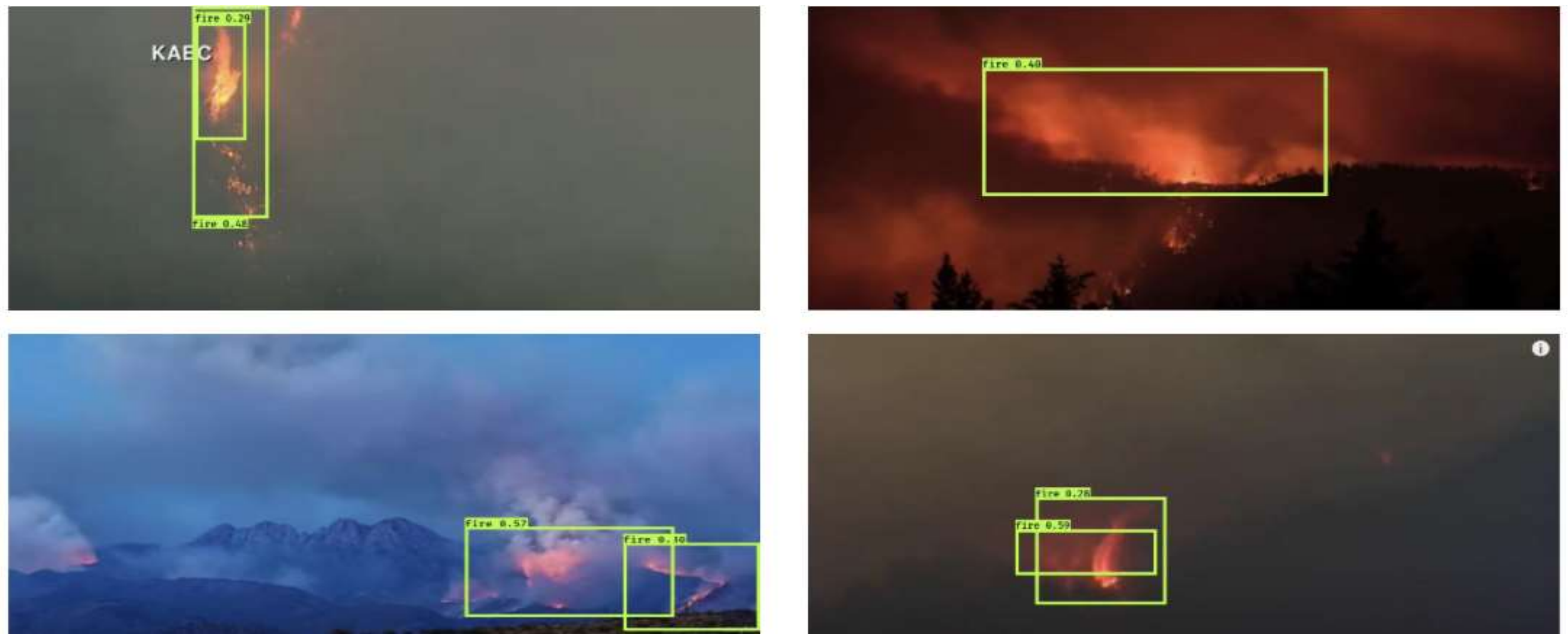

Figure 3: The results from model that I trained and evaluated

Now that we had a newer, more accurate model, my mentor and I created a GitHub repository of all of the work that we did this summer. It includes all of the wildfire data we collected and our trained model. We also worked on a web scraper that browsed through a website that had live video feeds of wildfire prone areas. We then ran our models on the data that we scraped from this website in real time.

Figure 4: QR Code on more information/ resources about our project

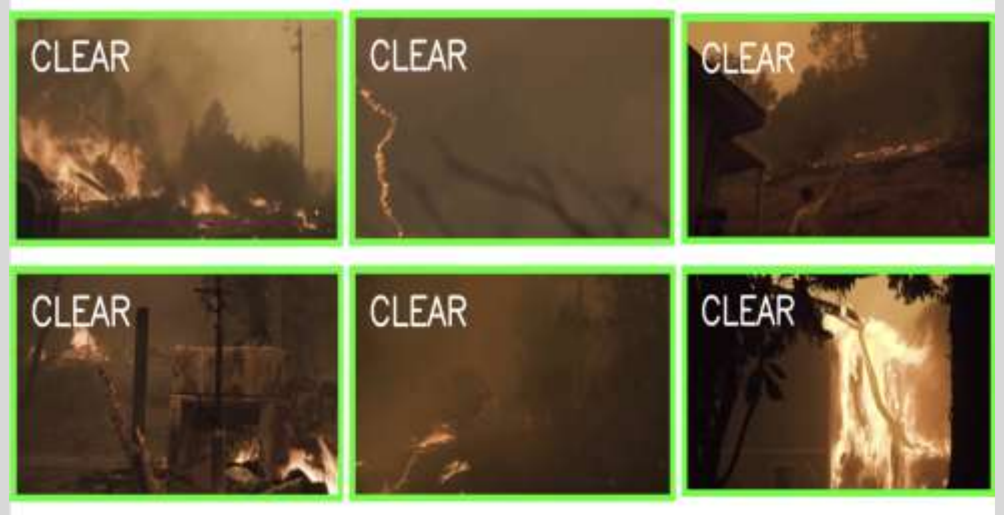

Figure 5: Original inaccurate wildfire detection results

Next Steps

The next steps is to implement these models with data collected from sensors and deploy them in wildfire prone areas. Eventually, the data from these sensors could be streamed to android and IOS applications to inform citizens of wildfires.

Works Cited

"ALERTWildfire." *YouTube*, YouTube, www.youtube.com/channel/UCan3Wnqj2kRqKwt2HgLgw1g/videos

"California Wildfires Morning Update: September 10,   2020." *YouTube*, YouTube, 10 Sept. 2020, www.youtube.com/watch?v=v9Oj38-8TTA.

Muehlemann, Anton. "AntonMu/TrainYourOwnYOLO: Train a State- of-the-Art yolov3 Object Detector from Scratch!" *GitHub*, 2019,   github.com/AntonMu/TrainYourOwnYOLO.

Thompson, W., et al. *Efficient and Compact Convolutional Neural Network Architectures for Non-Temporal Real-Time   Fire Detection*, IEEE, Dec. 2020, breckon.org/toby/publications/papers/thompson20fire. pdf.

Acknowledgements

My sincerest thanks to Professor Raghavan for giving me the opportunity to work on the summer research program. Thank you to my wonderful mentor, Xiao, for your guidance and support. And thank you to Dr. Mills for all the insightful and fascinating conversations we had. Finally, a big thank you to Monica and the SHINE team for making this a fun experience.