Camera-Based Distributed Automatic Wildfire Detection and Monitoring Systems

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ABSTRACT

Wildfires are immensely destructive events that, due to climate change and more frequent droughts, means they are occurring in exponentially more areas [2]. This requires more monitoring systems to keep track of them, but our current methods are difficult to expand due to the use of human operators. One of the main ways fires are discovered is through camera monitoring systems, like AlertWildfire [1], that run dozens of camera feeds 24/7 and display them on a website. Fire officials encourage users to Tweet about fires they observe on the website or call their local departments to send alerts, making crowdsourcing one of their most used methods [3]. Furthermore, many fire monitoring officials say that these cameras are mainly used to monitor fires that are currently in progress, rather than preemptively finding ones before they become a large issue. While they are extremely useful at helping firefighters during emergency situations, the pre-existing infrastructure of these systems should be embraced for mitigating and detecting wildfires just as intensely [4].

The need for smart monitoring systems in addition the current systems that require human operators to watch all the camera feeds opens the door to innovating with automation. Specifically, using machine learning to automatically process images and detect fires without the need for constant human oversight. Machine learning algorithms can be trained using neural networks that analyze thousands of annotated images to find patterns in areas of interest. These patterns include pixel colors, gradients between pixels, and luminosity to develop a full understanding of what we are trying to detect. Machine learning based systems can be quickly adapted to new locations by training with new images dataset, which allows for a flexibility that cannot be matched with traditional image processing based systems. The ability to run a large amount of camera feeds through a single system also exceeds what a human operator would be able to monitor all at once, allowing for more cameras to be deployed in areas of interest.

Our research poster will study the performance of selected machine learning algorithms on embedded devices for use in wildfire detection. The machine learning algorithm has been trained with a dataset we built upon a large amount of fire and non-fire images to develop a well-rounded

detector that can find fires, while avoiding false positives. Once trained, we validate the detector on Raspberry Pi 4 devices that we have demonstrated similar detection and collected preliminary performance data. The validation consists of multiple fire and non-fire pictures that will be run using the machine learning algorithm, with performance and accuracy data being collected for comparison purposes.

This poster will focus on the areas of "Ecological Sustainability and Conservation: technology for nature conservation and management" and "Societal Implications / Quality of Life: risk management". The environmental and societal impacts of wildfires cannot be overstated. Pollution from wildfires expedites climate change, which creates more common wildfires through droughts and rising temperatures. These wildfires have also become more destructive, which has obliterated hundreds of communities, forests, and lives in recent years. Mitigating wildfires with more efficient monitoring systems will improve ecological sustainability and help reduce our impact on ecosystems worldwide.

References

[1] "About: Nevada Seismological Lab." About | Nevada Seismological Lab, www.alertwildfire.org/about.html.

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[3] "Frequently Asked Questions (FAQ)." *FAQ | Nevada Seismological Lab*, www.alertwildfire.org/faq.html.

[4] Skully, Caitlin. Eyes on Wildfires, 5 Nov. 2020, ucsdnews.ucsd.edu/feature/eyes-on-wildfires.