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Project/Problem Justification

Currently, there is no easy way to quickly and effectively identify meteors within spectrographs. This is problematic because people are required to do the tedious work of manually identifying meteors within spectrographs. While this may take less than a minute per spectrograph, there is a constant stream of spectrographs from BRAMS (Belgian RAdio Meteor Stations). To further complicate matters, there are “... [at least] 30 receiving stations are spread on the Belgian territory...” (Gamby, n.d.). This means that BRAMS alone can produce 30+ spectrographs per minute across all of their stations, and thus highlights the major drawback for people based meteor identification approach. It is both impractical and expensive to employ people to manually identify meteors.

The current solution to this problem is RMZ (Radio Meteor Zoo), hosted by Zooniverse (Zooniverse, n.d.). RMZ offers BRAMS the ability to crowdsource people to identify meteors within spectrographs for free. However, this only removes one of the two issues, financial cost. The time cost still remains as a person is still required to identify meteors within spectrographs. Removing this time cost would allow BRAMS to analyze more data in a shorter amount of time since there is less time being spent detecting meteors within spectrographs. Furthermore, the interactions between the Earth, meteors, and space can be better inspected if additional time is obtained through more efficient methods of processing data.

To solve the presented problem, a machine learning feature recognition model or a feature recognition algorithm can be implemented to detect meteors within spectrographs. Either implementation would be designed to be as efficient and lightweight as possible, allowing for existing or low end hardware, such as a raspberry pi, to be used for data processing. By introducing a solution that can be run on existing hardware, such as a machine that already exists within a radio receiving station, the total time involved for data processing can be further reduced while cost of implementation kept to a minimum. These benefits would allow BRAMS and Zooniverse to allocate more time and resources into new analysis of data as well as future research into new areas as they would not have to conduct data collection, manipulation, and transmittance carried out by and between countless people.

Alongside these cost and time benefits, the Kubeflow organization and I would also benefit from the creation of a machine learning model that detects meteors within spectrographs. The Kubeflow organization would benefit in two ways, the first is by direct publicity. By using Kubeflow Pipelines to train a machine learning model that will dramatically increase efficiency of data processing for BRAMS and Zooniverse, their software solution will be seen in good light. The second benefit is due to the fact that Kubeflow is an open source solution, this means that as I use the software, I can propose changes and make them myself if necessary. This would result in less work being required by the engineers behind Kubeflow Pipelines and would result in a better product overall. Finally, I would benefit from this in two ways as well, the first is that I will be using this to obtain a grade for my senior design class, the second is that I can use this as a way to write blog posts and share my own personal work as a way to sell myself to companies for my future career.

This will not be a new concept or software, however, the method in which the machine learning model is created and the application are new. The usage of Kubeflow Pipelines for model training for feature detection within images/spectrographs has yet to be done within this context, at least to my knowledge. Alongside this difference, color salience will be used to associate hotspots within a spectrograph with additional importance to provide additional data points to the machine learning model, which according to Weijer (2006), machine learning models and feature detection algorithms generally "focus on shape saliency, rather than color saliency." (p. 100). This is important because meteors within a spectrograph are not only detectable by shape but also color. Furthermore, noise within spectrographs can produce similar shape patterns to those produced by meteors, taking color salience into consideration when creating a machine learning model can further strengthen its detection ability.

Work Cited

Gamby, E. (n.d.). BRAMS. Retrieved from https://brams.aeronomie.be/.

Weijer, J. V. D., Gevers, T., & Bagdanov, A. (2006). Boosting color saliency in image feature detection. IEEE Transactions on Pattern Analysis and Machine Intelligence, 28(1), 150–156. doi: 10.1109/tpami.2006.3

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