Wildfires Detection Using UAV Images

Ricardo Gonzalez, Fellow, IEEE,

Abstract—This my abstract And this is how it ends

Index Terms—CNN; Deep Learning; Wildfires

1 Introduction

Convolutional neural networks (CNN's) currently are one of the must explored topics due to their high efficiency in several areas of ML, in particular Computer Vision and Image Recognition. This led to the creation of popular datasets such as MNIST and ImageNet, which are used nowadays to introduce the topic or to pre-train the CNN's to be able to perform Transfer Learning for more specific tasks. This had led to the researchers to not only improve the performance of the CNN's but also found a use for them, one of these cases have been for the detection of Wildfires.

Wildfires currently are on of the must dangerous natural disasters that are threating the world. According to an investigation done by the NOAA (National Oceanic and Atmospheric Administration), the emissions produced by the wildfires often lead to harmful pollution not only in the area near the wildfire but also can extent even farther from the area, harming humans and other specials alike [1]. In addition to that, there are ecosystems which fauna and flora are being threatened due to the fires and to human intervention. Being that the case of the Amazon Rainforest, where the mentioned causes alongside droughts, could led to a possible "tipping point" where the Reinforces would be unsustainable in the case that there's no effective intervention of the matter [2].

Due to the formerly mentioned there have been attempts by the scientific community to develop models that can detect based on the image if there is fire or not. Leading to the creation of datasets such as FLAME, a dataset created and provided by the IEEE [3], or less academic but still important FIRE dataset hosted on Kaggle which is also home of several images showing environment with and without fire [4].

Nevertheless, the models are not very accurate, as an example the model trained with the FLAME dataset had only a 76% accuracy [3], showing that there are still are of improvement in the regard. And with the knowledge that the FLAME model was trained only with the FLAME dataset, it's possible that using both the FLAME and Kaggle dataset in addition to some data augmentation and a new model it will be possible to improve the score previously obtained solely by the FLAME dataset.

2 Background / Literature Review

2.1 Convolutional Neural Network

Are a type of Neural Networks commonly used for the areas of Image Recognition and Computer Vision, this type of networks have the main feature of being divided in several deeply connected convolutional and pooling layers, to finally end with a classifier which is a fully connected layer comparable to a layer of traditional Multi-Layer Perceptron (MLP).

2.1.1 CNN Architectures

As CNN's are one of the state of the art topics in research nowadays, there have been many popular architectures that either have very high performance, or have very little parameters with the objective of having a lightweight model with good performance. For developing actual applications for a problem researchers actually use this predefined architectures to solve the problem they're facing as this provides the advantages of being a proven useful architecture.

In addition that due to their popularity people train these models with popular datasets so researchers can use these pre-trained weights enabling to do transfer learning, which is when using an already trained model, retrained the top layer to be able to have a good performance in the new problem.

Actually in the case of the FLAME research done, it's mentioned in the paper that the model that achieved a 76% of accuracy was using an architecture called Xception [5].

2.2 Data augmentation

Is a method that allows to increase the amount of data that we have in a dataset, allowing to be persistent being that you generate new data based on the previous one and save it on the same dataset. Or add randomness prior to training a batch, making that every epoch and batch should not consist of the same data in the same order [6].

For images datasets, normally the transformation/augmentations done to increase the dataset is by performing modifications in the same image being by simple image transformations such as shearing, rotation and translation. But it also may be the modification of the brightness, flipping the image vertically or horizontally, or by cropping it [7].

3 Methods

3.1 Dataset

As mentioned in the introduction 1, the objective of this research is to use both the FLAME and Kaggle datasets, thus prior to training both datasets will be merged. But also to provide a little more diversity new images will be created, this will help a lot considering that after giving a quick look to the FLAME dataset must of the images are just burst of the same environment with/without fire. Due to this the model could instead of learning to detect fire, could learn to detect the environments.

3.1.1 Data Augmentation Transformations

All random transformations have a probability of 50% of happening

- A reduction of the brightness by 50%
- A random rotation of 45º
- A random horizontal flip and a random vertical flip

3.2 Model

As mentioned in the cnn architectures section 2.1.1, the architecture that the FLAME researchers used was the Xception architecture, which improves over its previous version called Inception, which improves primarily the performance while keeping the same amount of parameters. Nevertheless, the architecture could be consider old, being published in 2017 and many other architectures that have improve accuracy, or just other models which already had better performance than this case.

Due to the former, if we want to improve the performance of the classifier it's recommended that we attempt to use other architectures. For this case the models consider to test will be EfficientNet and ReXNet. With these models instead of training randomized weights we will do transfer learning on a model trained using the ImageNet dataset, training only the top layer which is a densely connected layer in both cases.

3.2.1 EfficientNet

An architecture published in September 2019, that wanted to tackle the problem of scaling up an architecture by having a smaller amount of parameters, but also by keeping/increasing the accuracy of the model, this was able by the use of compound coefficient [8].

3.2.2 ReXNet

An architecture proposed in July 2020, aiming to follow the trend of creating accurate and lightweight architectures, distinguishing themselves by the use of representational bottlenecks. The result was quite good improving the accuracy when doing transfer learning from trained models using the COCO dataset, while keeping a small amount of parameters to train [9].

3.3 Training

For the training must things will be very straightforward, the validation will be checked splitting the training dataset into 80% training and 20% validation, just like in the FLAME paper. In addition this training dataset will also have a set of transformations both to do data augmentation and to normalize the data, this with the intention to not always have the same data in a batch every epoch and give diversity and randomness to the training.

3.3.1 Optimizer and Criterion/Loss Function

The optimizer chosen for the training is the Adam optimizer. Meanwhile, the criterion used to calculate the loss of the model will be due to being a binary classification problem, the binary crossentropy loss function with logits, meaning that a Sigmoid function will be used as a final activation function and based on this the loss function will calculate the current loss.

3.3.2 Hyperparameters

- Batch-size: 28
- Learning Rate: 2e-3
- Max epochs: 10

3.3.3 Callbacks

- EarlyStopping, a callback to stop the training if the validation loss have increased or decreased by little values in the last three epochs
- LRScheduler, this callback will reduce the learning rate every epoch in a ration of 9e-1

3.3.4 Transformations

All random transformations have a probability of 50% of happening. And the random transformations are only for the training dataset

- Resize the image to a size of (254, 254)
- Random horizontal flip
- Random vertical flip
- Normalization

4 Results and Discussion

5 Conclusion

This is my conclusion

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