Forest Fire Image Classification

CS484 Term Project Proposal Report

Melike Demirci
Dept. of Computer Science
Bilkent University
Ankara, Turkey
melike.demirci@ug.bilkent.edu.tr

Yuşa Babademez
Dept. of Computer Science
Bilkent University
Ankara,Turkey
yusa.babademez@ug.bilkent.edu

***Abstract*— Forest Fires are increasingly take place in many different countries and threating peoples and many other living creature's lives. Early detection of the fire is significant to decrease the damage. Computer vision technologies have been used widely in order to detect and classify these dangerous situations from their images. The purpose of this study is to examine the binary classification of the forest fire images with Convolutional Neural Networks (CNN). ResNet-50 architecture is chosen to experiment training and test. The effects of different hyperparameters will be examined.**

Keywords—Image Classification, Convolutional Neural Network, ResNet-50, Forest Fire

I. Introduction

Forest fire is a significant threat to forests or wooden areas. Increasing number of fire incidents leads to damaging biodiversity, disappearing habitat of animals, and losing animal or human lives. Early fire detection is very significant in terms of saving lives and habitat since it is hard to put it out when it spreads[1].

In this project, our aim is classifying images in terms of two classes such as fire and smoke by using ResNet-50 Convolutional Neural Network(CNN) architecture. By conducting many training with different parameters, the effect of different parameters on performance of the model will be observed. Images are taken from Forest Fire dataset [2]. Same dataset will be used for training, validation and testing. For image preprocessing, data augmentation techniques will be used.

The rest of the paper is organized as follows. In the following section we present the details about the dataset. In section 3, convolutional neural networks and ResNet-50 architecture are explained. Section 4 presents the research methodology that will be used.

II. Dataset

Forest Fire is a dataset which includes forest images with labels from two different classes; fire and smoke. The whole dataset is divided into 4 sub parts as two test datasets, a training dataset for smoke, and a training dataset for fire. There are 12571 images for training smoke and 1102 images for training fire. For testing, there are 2032 images in total. In this project, some of the images will be used from this dataset. For both fire and smoke, 900 images will be used for training, 200 for validation and 200 images for testing.

In the dataset, resolution of images varies. In some high resolution images smoke or fire is more clear while in some other images fire or smoke is not so obvious. In the two different test dataset one of them includes more clear images; but for the other one it is hard to determine the objects. We will perform tests on both of them to see whether our model can classify images even if smoke or fire are not so clear. Examples of images from unclear and clear smoke are given in Figure 1 and Figure 2.

Binary classification will be performed on the dataset in order to classify them as fire or smoke images.

Fig. 1. Example of a clear image from test dataset

Fig. 2. Example of an unclear image from test dataset

III. Using the Template

Convolutional Neural Networks are the networks which can capture spatial patterns in the two dimensional structures such as 2D image. They include convolutional layers together with pooling layers between them. Kernels, or filters, are main tools to feature extraction. By convolving the image with these kernels, it can be found out where particular features exist in an image [3]. With max pooling, the computational cost can be reduced and only the most important features can be extracted. Max pooling also provides translation invariance [4].

Deep CNNs are used for different applications nowadays. There are different CNN architectures which can perform image classification with very low errors, ResNet is one of these architectures. ResNet is a short name for Residual Network which uses residual learning. With residual learning training errors of the deeper CNN models could have been decreased by creating shortcut connections using identity mapping as in Figure 3.

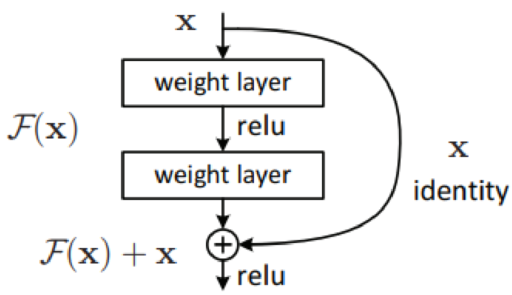

Fig. 3. Residual learning: a building block [5].

In the plain models without shortcuts, the model becomes harder to train and training errors increase while the depth of the network increases. Experiments showed that the ease of training with residual functions is better [5]. In this project we will explore how the ResNet50 model performs to classify forest images.

IV. METHODOLOGY

A. Data Preparation and Preprocessing

We will use the Forest Fire dataset which is mentioned before. In this dataset there are various images from the forest fires which are labeled as “Fire” or “Smoke”. While there are 12600 images from smoke class, there are only 1102 images from Fire class which may create the imbalance classification problem. An imbalanced classification problem occurs when the distribution of examples is uneven by a large amount in the training dataset [6]. Even though there is no exact ratio for when the classification becomes imbalanced, to be on the safe side we decided not to use all the fire images for training. 1100 images from both classes will be selected and data preprocessing will be performed.

For the image preprocessing, we will perform data augmentation similar to the augmentation proposed in the ResNet paper [5]. Data augmentation is a technique to increase the amount of training data by artificially creating new images from existing ones. We are planning to resize images randomly and perform standard color augmentation. Finally, the augmented dataset will be divided into training and validation dataset.

B. Training

We will create a model by using the Keras library for ResNet. We are not going to use pre-trained weights because these weights are obtained from the training performed on the ImageNet dataset. Instead we will only use the ResNet architecture with randomly initialized weights. We will start training with similar hyperparameters as in the ResNet paper [5]. Stochastic gradient descent with a mini-batch size of 256 will be used and epoch size will be set to 1000. From the Keras callback library early stopping will be utilized in order to avoid overfitting. Learning rate will start from 0.1 and will decrease when there is no more learning.

C. Validation and Hyperparameter Tuning

Performance of the model will be monitored and evaluated on the validation dataset. By using Keras callbacks and Tensorboard, performance metrics like accuracy and loss will be visualized. By conducting trainings with different hyperparameters, the effect of them will be observed and the best parameters for the model will be obtained.

D. Testing

After validation and hyperparameter tuning, the acquired model will be tested with two different test dataset. One of the test dataset includes more clear images while other has low resolution images. We will test our final model with a diverse range of clarity for both smoke and fire. Final model performance results will be obtained.

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