Weather Image Recognition using Deep Learning

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ABSTRACT

In this project, we have built a convolutional neural network (CNN) model on a database containing 6862 images of 11 different weather conditions to classify the image into its correct weather phenomena.

INTRODUCTION

Image interpretation and classification was created to bridge the gap between computer vision and human vision by giving training to the system on the data. It might be a pretty simple work for humans, but it is a tremendously expensive task for computers. In general, each image is made up of a collection of pixels, each of which is represented by a separate value. It must execute a greater amount of calculations to classify photos. This mandates higher-configuration systems with more computing power. Hence we are using the deep learning models to perform predictions on the image data.

The process of analyzing the weather phenomena is very important for forecasting the weather and monitoring the quality of the environment. Making an exact prediction can be of great help in agriculture and it also helps in spatial surveillance using satellites so that we can take preventive measures to avoid severe hazardous situations. This project builds a convolutional neural network model and trains the data on the model and evaluates the model to find the accuracy. Then it predicts the data on unseen images to evaluate the results.

The existing machine learning methods uses simple linear classifiers to classify the weather, however they are not that accurate and efficient. Due to its deep structure and other techniques, CNN can be a very efficient feature for representations of images.

PROBLEM STATEMENT

In recent days, weather forecasting has become a bigger concern all over the planet. Due to abrupt changes happening, it has been requiring a significant deal of attention since a long time. But there are many limits to better forecasts, making it difficult to accurately anticipate the weather these days. Due to the success of various data related neural network methods such as computer vision and facial recognition techniques, it has been demonstrated that the deep learning methods can efficiently analyze the spatial features from the spatial data.

RELATED WORK

CNN is a feed-forward artificial neural network that does not need us to make educated guesses about which filter to apply. The training of a CNN is, in fact, the training of these filters, which are the network's weights. As a result, a CNN can completely discover details that people would never notice, such as the age of someone in a photograph.

Several methods have been used to overcome the weather forecasting issues by using statistical learning and other machine learning and neural network techniques have been used. The networks like Back Propagation neural network (BPN), Conditional Restricted Boltzmann Machine (CRBM), Decision tree and Random forest algorithms, RNNs and ANNs have been used to overcome this issue.

Various studies experimented with the CNN classification performance on weather conditions like the 2 and 3 classes weather phenomenas. Furthermore, deep learning is used to generate 5 weather events like dew, snow and rain and correctly classify them.

Three channel CNNs(3C-CNN) are used to correctly classify six weather phenomenas. Furthermore,the approach of the recognition of meteorological phenomena as a multi label classification has been approached. These studies only cover few weather phenomenas, while the sorts of weather occurrences that we see in our daily lives are significantly more diverse.

SOLUTION

As a solution to the above problems,we have created an image recognition model using convolutional neural networks(CNN) and used the model to predict on unseen images by predicting the weather conditions for the given image. The training of a CNN is, in fact, the training of these filters, which are the network's weights.The built model can be used by other models using transfer learning. As a result, a CNN can completely discover details that people would never notice In real-time weather forecast applications, the model must satisfy certain criteria, such as the accuracy response time and the efficiency of the resources. All these features are required for a real time system whereas the previous research methods focused on various machine learning methods to correctly classify the weather phenomenas

DATASET

Kaggle consists of a large catalog of datasets in which we have used the weather image recognition dataset that 6862 images belonging to 11 weather conditions out of which 75 Percent of the data is considered for training and 25 Percent of the data is considered for validation.

The dataset is imported from the below website:

https://www.kaggle.com/datasets/fceb22ab5e1d5288200c0f3016ccd626276983ca1fe8705ae2c32f7064d719de?msclkid=933bcf6acf2111ec8c7fc588f5d612bd

We have obtained the images from various weather conditions:

Rain,glaze,rime,snow,fogsmog,frost,lightning,rainbow,hail,sandstorm,dew.

Sample images from dataset:

IMPLEMENTATION

Pre-Processing

We have taken the dataset from Kaggle which is already preprocessed data.From each class we have taken 75 percent data for training data and the remaining data for validation data.

Model

To produce predictions, we have utilized a structure with three convolutional layers, followed by max pooling and flattening out the network to fully connected layers.

The baseline network structure is show below:

Convolutional input layer, 32 feature maps with a size of 3×3, a relu activation function.

Max Pool layer with size 2×2.Convolutional layer, 32 feature maps with a size of 3×3, a relu activation function.

Max Pool layer with size 2×2.

Convolutional layer, 32 feature maps with a size of 3×3, a relu activation function.

Max Pool layer with size 2×2.

Flatten layer.

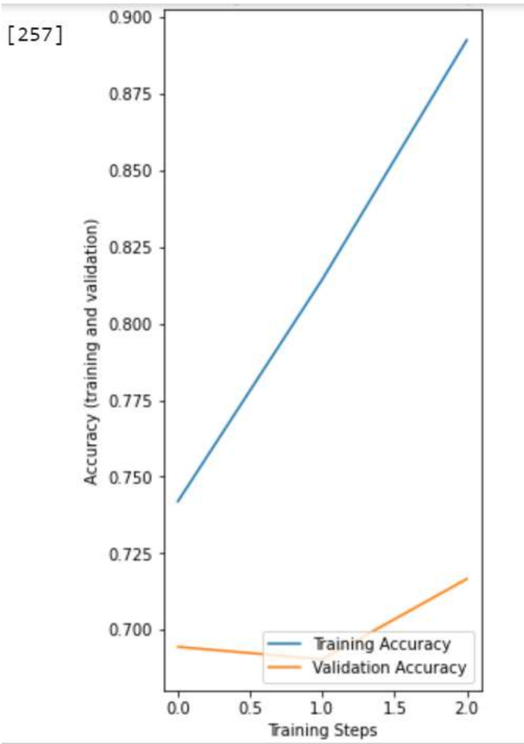
Fully connected output layer with 128 units and a relu activation function

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 rescaling_3 (Rescaling)     (None, 300, 300, 3)       0

 conv2d_9 (Conv2D)           (None, 298, 298, 32)      896

 max_pooling2d_9 (MaxPooling  (None, 149, 149, 32)     0
 2D)

 conv2d_10 (Conv2D)          (None, 147, 147, 32)      9248

 max_pooling2d_10 (MaxPoolin  (None, 73, 73, 32)       0
 g2D)

 conv2d_11 (Conv2D)          (None, 71, 71, 32)        9248

 max_pooling2d_11 (MaxPoolin  (None, 35, 35, 32)       0
 g2D)

 flatten_3 (Flatten)         (None, 39200)             0

 dense_6 (Dense)             (None, 128)               5017728

 dense_7 (Dense)             (None, 11)                1419
```

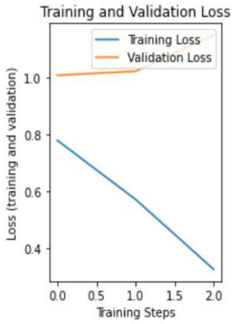
Model Summary

Model Performance:

Accuracy:



Loss:



Application

We have built a GUI using Gradio which takes any image that we upload as an input and prints the prediction (correct class) of that image.

For this, we have saved the model and loaded the saved model and defined a function for classifying the image by giving predictions and confidences.Then , we have called the gradio interface by passing the function and inputs and outputs as arguments and hosted the interface.

Below is the snapshot of the Gradio interface:

FUTURE WORK

Now that we are able to predict the images and depict the weather conditions accurately,we can build an application to detect hazardous situations and alert the necessary persons so that the safety precautions are taken.

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