Weather Recognition Using Convolutional Neural Network

[1]Rounak Bisen
Department of Computer Science Engineering
Kalinga University
New Raipur, India

[2]Sakshi Paswan
Department of Computer Science Engineering
Kalinga University
New Raipur, India

[3]Asst.prof.Shikha Tiwari
Department of Computer Science Engineering
Kalinga University
New Raipur, India

Abstract---- Distinguishing proof and estimate of weather patterns are significant for transportation wellbeing, climate, and meteorology. Therefore, the automatic recognition of extreme Weather is an important factor in the application of Auxiliary traffic conditions warning for automobiles Driving, analyzing climate data, and so forth. In the modern era, where all the work is being automated and making our life easier. Therefore, using software to recognize weather and use this information to benefit different fields is not a bad idea. In traditional methods, there has been an inclination to involve numerous sensors in the customary strategy for programmed outrageous climate acknowledgment, yet with low precision and fake support. Whether recognition is software technology to recognize the conditions of the atmosphere for a given location and time by taking images.

Quantitative data about the atmosphere, land, and ocean are collected in order to make weather forecasts. They are then used to project how the atmosphere will change at a given location, but they are not 100% reliable. Using deep learning, the Weather Recognizer automates the process of taking a picture and telling the weather condition.

A novel weather recognition method based on a deep learning technique known as Convolutional Neural Network (CNN), has been proposed in this paper. Since the weather is affected by many factors, features that can accurately represent various weather characteristics are difficult to extract. We, therefore, applied convolutional neural networks (CNNs) to resolve this problem in this paper. Features of severe climate and popularity fashions are generated from massive data. Moreover, a large-scale Extreme weather dataset called 'Weather-dataset' is collected in which 1280 Extreme weather images are categorized into four classes (sunny, cloudy, rainy, haze), and all the complex scenes are covered. A recognition model for extreme weather is obtained through three steps: Image processing, Convolution filter, pooling, and convolutional neural network.

Keywords—Weather Recognition, Convolutional Neural Network (CNN),Dataset, Max Pooling .

I. INTRODUCTION

Weather plays an important role in everyone's day to day life. Whether it's a high-tech space agency or airports, or high traffic highways, or farming everything depends on the weather. So, it becomes very important to be aware of one's surroundings. In the modern era where all the work is being automated and making our life easier. Therefore, using software to recognize weather and use this information to benefit different fields is not a bad idea. Weather recognition is software technology to recognize the conditions of the atmosphere for a given location and time by taking images. The method of creating weather forecasts relies on the use of quantitative data about the current state of the atmosphere, land, and ocean, and using meteorology to predict how the atmosphere will change in a given place, although it is not 100% accurate. Weather Recognizer simply takes a picture and tells the current weather condition by using deep learning techniques. Weather recognition is one of the most important and challenging operational tasks carried out by meteorological services all over the world. Moreover, it is a complicated procedure that requires multiple specialized fields of expertise. This field has separated weather methodologies. For this project we are going to use a deep learning technique known as Convolutional Neural Network (CNN). In simple terms A CNN tries to learn from given training set images and find patterns in them and then apply the learning to classify the images. CNN's are widely used in image recognition-based software all around the world.

II. LITERATURE SURVEY

In recent years there have been great strides in building classifiers for image detection and recognition on various datasets using various machine learning algorithms.Various datasets have shown that deep learning improves accuracy. Some of the works have been described below:

Zhu, Ziqi; Zhuo, Li; Qu, Panling; Zhou, Kailong; Zhang, Jing (2016) [1]In this paper, CNN is applied to realize the extreme weather recognition, and the recognition performance can meet the demand of practical application.

[2] Li Deng presents a survey of deep learning, its applications, architectures, and algorithms. There is a detailed examination of the generative, discriminative, and hybrid architectures, as well as their algorithms. The CNN, RNN, Autoencode, DBN, and RBM (Restricted Boltzmann)

[3] Suggests ,Various problems can be solved using neural networks, such as pattern recognition, classification, clustering, dimensionality reduction, computer vision, natural language processing (NLP), regression, and predictive analysis.[4] In this paper, an active learning approach is proposed to reduce the number of training examples needed while still achieving reliable classification.[5] Proposes a deep-learning-based framework for the detection of three weather conditions in outdoor scenes, including hazy, rainy, and snowy.

III. PROBLEM IDENTIFICATION

Weather Recognition can be tricky to achieve even with modern techniques, the major challenges in recognizing weather are: Lack of proper publicly available dataset on internet,Hard to detect reliable features on certain weather conditions.Low accuracy in recognition makes it unsuitable for practical application .

IV. OUR PROPOSED METHOD

Weather recognition can be hard to achieve for all weather conditions as there are many different types of weather conditions. In this paper, we have mainly focused on four different weather conditions (sunny, rainy, cloudy, haze).

According to [6], low cost cameras and webcams are capable enough to recognize different weather conditions.

We will be using CNN in this research paper for carrying out the task of recognizing the weather using images by training our model using a custom dataset.

A convolutional layer is a set of parallel features that are composed by sliding different convolution kernels. In addition, at each sliding position, an operation of a product corresponding to the product and summation is performed between the convolution kernel and the input image to project the information in the receptive field onto an element in the feature map. Convolution kernel's size is much smaller than the input image [7].

Before we proceed with training of our model, we need a dataset. A dataset is a collection of a large number of Images (in the case of CNN) of things that we want in our model to classify.

Dataset

Unfortunately, there was no such good dataset available publicly. So we searched through the web for different weather images and created a dataset of about 1280 images.Fig4.1

Fig.4.1 dataset image

Image preprocessing

Next challenge after getting a dataset is to make our model search for a pattern in order to distinguish between different classes. Every image is composed of tiny dots called pixels, this pixel are nothing but a 3-d array of color values of red, green and blue.Fig 4.2, Fig4.3

Fig.4.2 Sunny weather image

Convolution Filters

Fig 4.3 Sunny weather image represented as pixel array

An image of size 1080 pixels will have 1080 X 3 = 6220800 numbers as an input. And finding patterns from this number is not possible. That's why we need some kind of filter to filter out unnecessary information from the image. That's where convolution comes into play.

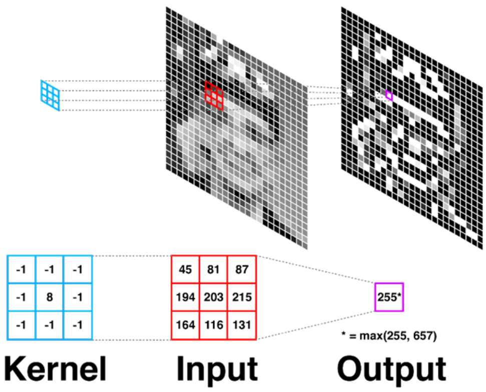

Fig4.4 An image passing through convolutional filter [8]

Convolution is a general-purpose filter effect for images. In the case that a matrix and a mathematical operation containing integers are applied to the image, the central pixel value is determined by adding the weighted average of the central pixel values of all its neighbors together into the output to modify a new filtered image.

As a consequence, convolutional layers do not record the precise position of features in the input. which means that small movements in the positions of the feature in the input image will result in a different feature map. It can happen when re-cropping the image, rotating it, shifting it, and performing other minor adjustments to the input.

Pooling

A typical way to deal with resolving this issue from signal handling is called down-inspecting. An input signal is re-created at a lower resolution with large structural elements, but without fine details that may not be needed for the task.

Generally, a pooling layer follows a convolutional layer, and can be used to reduce the dimensions of feature maps and network parameters. Like convolutional layers, pooling layers are likewise interpretation invariant, in light of the fact that their calculations consider adjoining pixels. Avg pooling and maximum pooling are the most commonly used strategies.For 8x8 feature maps, the output maps reduce to 4x4 dimensions, with a max-pooling operator which has a size of 2x2 and strides 2 [9].

Down testing can be accomplished with convolutional layers by changing the step of the convolution across the picture. A more strong and normal methodology is to utilize a pooling layer.

Down testing can be accomplished with convolutional layers by changing the step of the convolution across the picture. A more strong and normal methodology is to utilize a pooling layer.

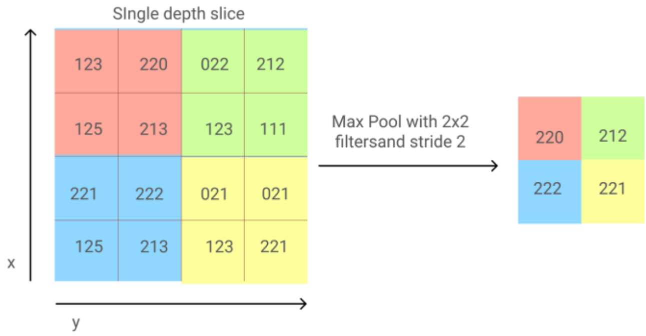

Fig 4.5 Max Pooling

The pooling operation uses two common functions:

Pooling Averages: Calculate the average value for each patch on the feature map.

The maximum pooling (or maximum pooling) of the feature map consists of calculating the maximum value for each patch.

Data augmentation Techniques

Increasing the size of the data used for training a model is called data augmentation. In order to make reliable predictions, deep learning models usually require a large amount of training data, which is not always available. This is done in order to make a more generalized model from the existing data.[10]

Convolutional Neural Network

A convolutional brain network is a progression of Convolution filters , pooling and Artificial neural networks stacked together to create a network.

When building a CNN more than one layer of convolution filter followed by pooling layers are added at starting. Which generates a number of output feature maps. This feature map becomes the input for an Artificial neural network.

Artificial trains over the dataset that we have created and measures error and adjusts the weights and biases of different connections and retrains the model. This process continues till the epochs specified by the programmer end.

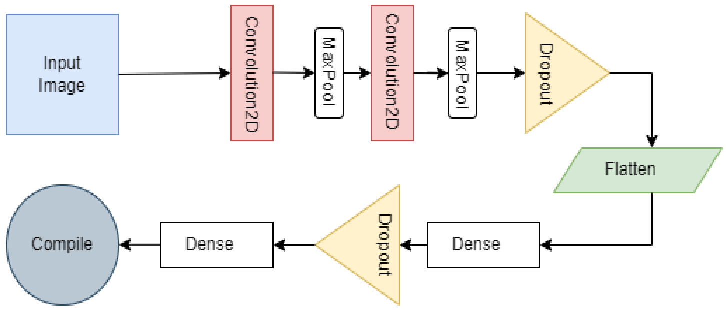

FIg 4.6 Flow Chart of different layers in our CNN and there arrangement

In our model we have passed the input image through several convolution layer followed by max pool layer to remove unnecessary information and keep only useful features.

To reduce overfitting, dropout layers are introduced.and finally it is connected to Artificial Neural Network (ANN) to create full connection. We have used the “relu” Activation function in the input layers and “softmax” activation function on the output layer. Then all the layers are compiled together with ‘adam’ optimizer ,“caltegorical_crossentropy” loss function and metrics set to accuracy.Before initiating the training, dataset images are being augmented by zooming, rescaling, shearing and horizontal flipping to simulate real world inputs.

Model was trained using a custom dataset of 1279 images, dynamically divided into validation and training dataset respectively in 1:4 ratio.for 60 epochs.

V. CONCLUSION

We were able to recognize 4 different weather conditions with accuracy of 94% which is sufficient enough to meet the demand of practical application.

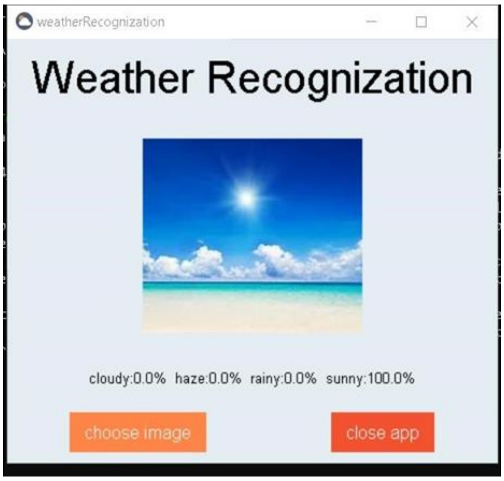

Fig. 5.1 program classifying entered image as 100% sunny

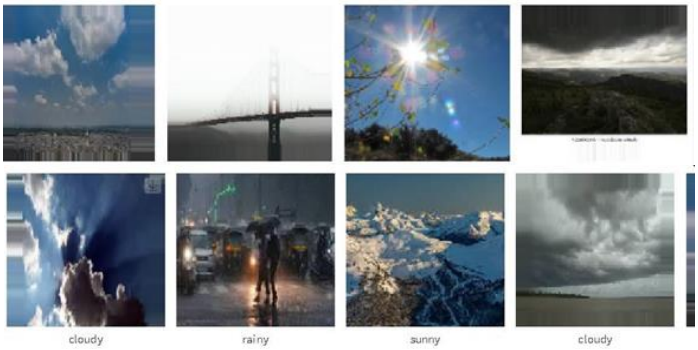

Fig. 5.2 Classified Images By our trained model

Attempts	Training Accuracy	Validation Loss	Validation Accuracy
1	80.9	0.76	78.5
20	89	0.29	94

Tabe 5.1 Accuracy Matrix after 20 attempts.

table 5.1 shows the progress of our CNN Model over its various attempts. After a few modifications and fine-tuning in the training model, we were able to get 94% accuracy in just 20 attempts with a small dataset and very simple training model design.

We have used the Weights and Biases tool for tracking the progress of our training model and generating graphs Fig 5.3 and Fig.5.4.

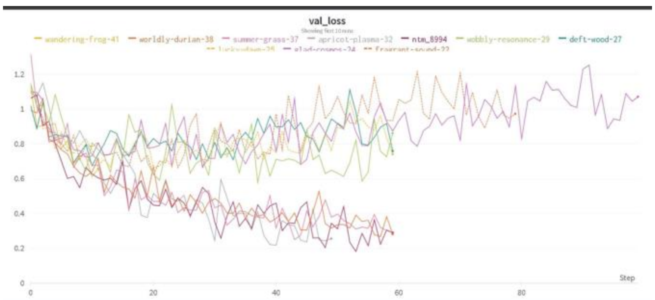

FIG 5.3 GRAPH FOR VALIDATION LOSS PER EPOCH FOR 20 ATTEMPTS

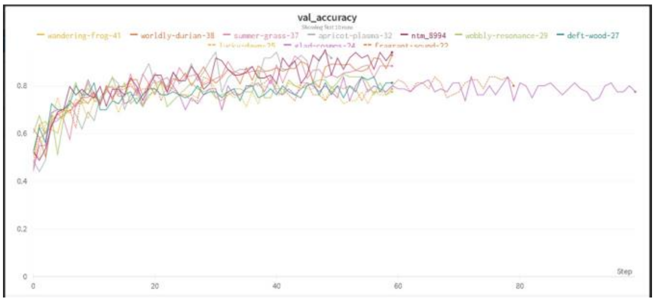

FIG 5.4 GRAPH FOR VALIDATION ACCURACY PER EPOCH FOR 20 ATTEMPTS

V. REFERENCE

[1] Zhu, Ziqi; Zhuo, Li; Qu, Paneling; Zhou, Kailong; Zhang, Jing (2016).[IEEE 2016 IEEE international symposium on multimedia (ISM)- sam jose, CA,USA(2016.12.11-2016.13)] 2016 IEEE international symposium on multimedia(ISM)- Extreme weather recognition using convoluation neural,network., (), 621-625. doi:10.1109/ISM.2016.0133

[2] Li Deng, "A tutorial survey of architectures, algorithms, and applications of Deep Learning", APSIPA Transaction

[3] Shrestha, Ajay; Mahmood, Ausif (2019). *Review of Deep Learning Algorithms and Architectures. IEEE Access, 7(), 53040–53065.* doi:10.1109/ACCESS.2019.2912200

[4] Joshi, A.J.; Porikli, F.; Papanikolopoulos, N. (2009). *[IEEE 2009 IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops (CVPR Workshops) - Miami, FL (2009.06.20-2009.06.25)] 2009 IEEE Conference on Computer Vision and Pattern Recognition - Multi-class active learning for image classification. , (), 2372–2379.* doi:10.1109/cvpr.2009.5206627

[5] Kang, Li-Wei; Chou, Ke-Lin; Fu, Ru-Hong (2018). *[IEEE 2018 International Symposium on Computer, Consumer and Control (IS3C) - Taichung, Taiwan (2018.12.6-2018.12.8)] 2018 International Symposium on Computer, Consumer and Control (IS3C) - Deep Learning-Based Weather Image Recognition. , (), 384–387.* doi:10.1109/IS3C.2018.00103

[6] Chen. Z, Yang. F, Lindner. A, Barrenetxea. G, and Vetterli. M, "HOW IS THE WEATHER: AUTOMATIC INFERENCE FROM IMAGES,"in Image Processing, 2012 19th IEEE International Conference on. IEEE, 2012, pp. 1853-1856.

[7] Application of deep convolutional neural network Published in: 2017 14th international computer conference on wavelet active media technology and information processing(ICCWA TIP) DATE of conference: 15-17 dech 2017 INSPEC Accession number:17615158 Publisher: IEEE DOI: 10.1109/ICCWAMTIP.2017.8301485

[8] Image Source : https://medium.com/analytics-vidhya/introduction-to-computer-vision-5e104ed62ef1.

[9] Jia, .Xin (2017). [IEEE 2017 29th Chinese control And Decision Conference (CCDC)- Chongqing,China DecisionConference (CCDC)- Image recognition method bases on deep learning., 4730-4735. doi: 10.1109/CCDC.2017.7979332.

[10] Agniseszka mikolajczyk, michal Grochowski(2018),[Data augmentation for improving deep learning in image classification problem].,DOI: 10.1109/IIPHDW.2018.8388338 10, NSPEC Accession Number: 17859931.(2018 International Interdisciplinary Ph.D. Workshop (IIPhDW)).