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A Framework for the Classification Task of Recognizing Weather Condition in an Image using Supervised Learning Methods

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Abstract: ***The supervised learning methods are widely used in research area to predict very useful things and inference something from data. In this paper, we aim to predict weather condition in a given image/picture by using advanced supervised learning algorithms and various descriptors. The prediction of weather conditions from the image can be challenging and complicated in situations where large data sets are considered. In addition, for our purpose, we have separated train, validation and test images. And, in other words, we will classify an image into five classes as Cloudy, sunny, foggy, wet and snowy. The proposed methodology consists of four steps, pre-processing of the image was done in the first phase, extraction of the different features in the second phase. n the third phase of our methodology classification was carried out by applying the specified classification models to an input image. Finally, validation was performed for given classification results. The ultimate purpose of the knowledge obtained from the study is to developing a framework for the classification of recognizing weather condition using supervised learning methods are CNN, SVM, Random Forest, and Decision Tree.***

Keywords: Classification, Recognizing, Supervised learning methods, Weather Condition.

I. INTRODUCTION

Essentially, the problem is to recognize the weather condition in the given image by using extracted useful features from the picture by hand-crafted tools or by showing methods in the technique below but, on the contrary, most other similar works in a simplified manner. Our research focuses on extending previous works and covering different labels [1].

For some tasks of image recognition or computer vision studies, some kind of difficulties in intuition and illumination can cause errors and results beyond expectations. Some research projects may require pre-process recognition of air conditioning. It is also important for us as humans, as it can be very difficult and difficult to define the weather in a strict manner from the scene we saw at the time. As a result, trying performance of different approaches on weather condition recognition topic or related topics and combining them in general manner but by adding our own approach to extended problem are main concerns of our research at the end.

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II. RELATED WORK

In this paper, the literature relating the work carried out by different authors on classification task of recognizing weather condition in an image and classification techniques are discussed.

Cewu Lu et.al., [1] proposes a collective approach to learning to mark it as either sunny or rainy. They prepared a new dataset of 10k sunny and gloomy photos for the weather chart. They used certain classification methods, i.e. SVM, etc. Several features have been omitted in this, they are contrast, haze, heaven, shadow, etc. In order to verify our method, detailed experiments and comparisons are carried out.

Through considering the three most common weather conditions, Li-wei kang et.al. [2] provides a paradigm for deep learning-based weather image recognition. In this, for an input image, and their process classifies the image automatically into one or none of the three categories.

Mohamed Elhose et.al., [3] proposed weather classification with deep coevolutionary neural networks. We primarily analyzed weather classification from photos in this paper using CNN's and behavior from all of CNN's layers.

Mohammad Rostami et.al., [4] developed a method called SAR image classification using lessons learned from cross-domain transfer. In this, a knowledge transfer algorithm for electro-optical domains is developed.

Young I m Cho et.al., [5] suggested a method called a new weather visibility and food recognition machine learning algorithm. Two fundamentally dissimilar classification tasks are addressed in this paper, i.e. visibility estimation and CNN-based food recognition.

Weather Classification using Coevolutionary Neural Networks introduced by Jehong An, et.al. [6] In this paper, a new weather image classification technique is defined using Alex network and Resnet Coevolutionary Neural Networks (CNN) in combination with a multi-class Support Vector Machine (SVM).

Zheng Zhang et.al., [7] suggested a method of classifying single images as multi-class environment.

Most of the existing computer vision approaches assume / hypothesis that the atmosphere is evident in outdoor images or videos.

Lu Guo et.al., [8] suggested a system of haze image classification based on the network transfer model of Alex. A traffic haze image classification system based on the Alex network transfer model was implemented in this paper.

Yulia Hap sari et.al., [9] proposed a weather classification system based on hybrid cloud image using main component analysis and linear discriminating analysis. In this, using the hybrid method namely PCA and LDA, they established a climate condition classification system based on cloudy imagery.

M Syamala Devi et.al., [10] suggested a method called satellite image classification using neural network perception. In this, they present satellite image classification using neural network perception.

III. METHODOLOGY

The process for the classification task of recognizing weather condition in an image using supervised learning methods as shown in below figure.

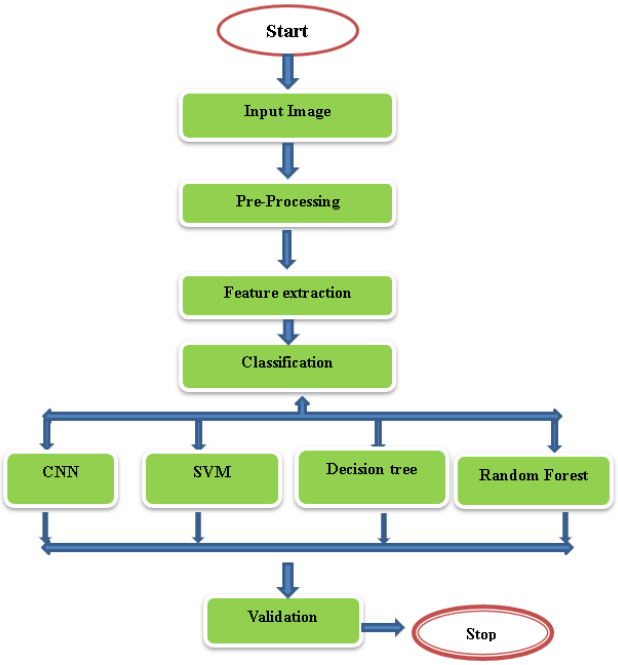

Fig. 1. Overview of Proposed Methodology

As expressed in our presentation, our aim is to build up a program that can characterize images/ pictures by their weather condition. We have been working for a long time to find out how to solve this problem more broadly but as efficiently as possible with high accuracy. Mostly we concentrated on this task of image classification on CNN, Decision Tree, Random Forest and SVM algorithms. Such algorithms are very successful in the correct area of use. Therefore, we tried to prove all these advanced optimization algorithms by modifying our approach to that particular algorithm and its hyper-parameters for our role in different kinds of experiments.

The Proposed methodology consists of following phases for solving drawbacks of existing system, they are

- Input Data set
- Pre-processing
- Feature Extraction
- Classification
- Validation

A. Input Dataset

In this methodology, we take images as our input for classifying the weather condition. we take 4 datasets from different online researches [11] [12] [13] [14], they are Image to weather data set [11], Two-class weather classification [12], Foggy road image database [13], Rain image database [14]. And we predict different weathers like Sunny, Rainy, Foggy, Snowy, Cloudy using supervised learning methods.

Fig. 2. Sample Data set with different weather conditions

B. Pre-Processing

Pre-processing refers to the transformations that are applied to our data before they are fed into the algorithm. Resizing or cropping images and organizing their file / file structure organizations with linked groups are most important and need only coevolutionary neural networks.

C. Feature Extraction

To run algorithms such as Decision Tree, random Forest and Support Vector Machine, feature extraction from an image is a necessary pre-process. Therefore, to define an image, we want to add our attribute and how we collect or obtain features, apply feature extraction libraries to images. We extract a list of the following features.

- Brightness Value
- Quality of contrast
- Factor of haze
- Value of sharpness
- Intensity of white pixels
- Colour histograms
- Cropped image

D. Classification

In this stage, for the most part we focused on this assignment of item arrangement on CNN, Decision Tree, Random Forest and SVM algorithms. Such calculations are successful in the right region of utilization. Furthermore, we attempted to demonstrate all these propelled improvement calculations by adjusting our way to deal with that specific calculation and its hyper-parameters for our venture in various types of tests.

A. Convolutional Neural Networks

CNN's are one of the most popular and commonly used machine learning classification algorithms. We used Keras library in this, the base of which uses TensorFlow back end and which is one of the most common in this area. In order to achieve better and more efficient efficiency or accuracy tests, we made a lot of experiments on them. We tried to analyse so many architectures using a lot of techniques. These various architectures are running using our new dataset.

Algorithm

Step1: Load input image "I" with dimensions (h * w * d)
Step2: Apply filter F (f_h * f_w *d) -> I
Step3: Apply model LeNet5
Step4: **IF** F>0
Observe the output dimensions (I) as (($h- f_{h+1}$) * ($w- f_{w+1}$) *1)
ELSE
Repeat steps 2 to 3
Step5: Stop

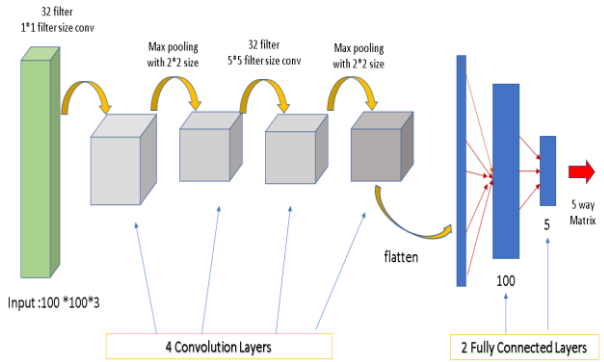

Fig. 3. CNN Architecture

B. Decision Tree

Decision Trees is a non-parametric supervised method of learning used to identify and regress. The goal is to create a model that predicts the value of a target variable by learning from the data features simple rules of decision. Scikit-learn has introduced the decision tree algorithm and we use their "DecisionTreeClassifier" module to run this python algorithm. In this, we have produced good results in a fair number of tests on decision trees, but not better than CNN.

C. Support Vector Machine

Support Vector Machines are collection of supervised learning methods that are used for classification, regression and identification of outliers. SVMs encouraged us to run them out of the project as well. To run SVM algorithms in python, we use implementation in the Scikit-Learns "SVC" module. Even if with tree algorithms we used the same methodologies. We tested lots of SVM architecture in both linear and non-linear models and as a result, disgraced SVM algorithm with different hyper parameters is our classification task for our weather recognition task.

D. Random Forest Classifier

Random forest, like its name implies, consists of a large number of individual decision trees that operate as an ensemble. Each individual tree in the random forest spits out a class prediction and the class with the most votes becomes our model's prediction. Decision Tree algorithm models and scikit-learn's "RandomForestClassifier" module used.

E. Validation

In this phase, we utilize K-Fold cross approval which is a model assessment technique while testing or models, designs and various calculations. In our technique we will utilize 10 percent cross approval only which isolates 10% of train information for approval. In this technique, the dataset is partitioned into K parts and train and assessment is isolated K times. Each time one of these K parts is utilized as approval information and the rest is utilized for preparing. Toward the end, the normal blunder for all K preliminaries will be processed. The benefit of this is it doesn't squander train information for approval procedure and split pleasantly by rearranging.

IV. EXPERIMENTAL RESULTS

In this, when we use CNN, SVM, Decision Tree and Random Forest algorithms to do all these experiments. We get CNN among them all was the best algorithm or architecture. We display all algorithms with accuracies needed results and performance analysis. We used 2 convolution layers, 2 pooling layers and 2 fully connected layers respectively in our best architecture.

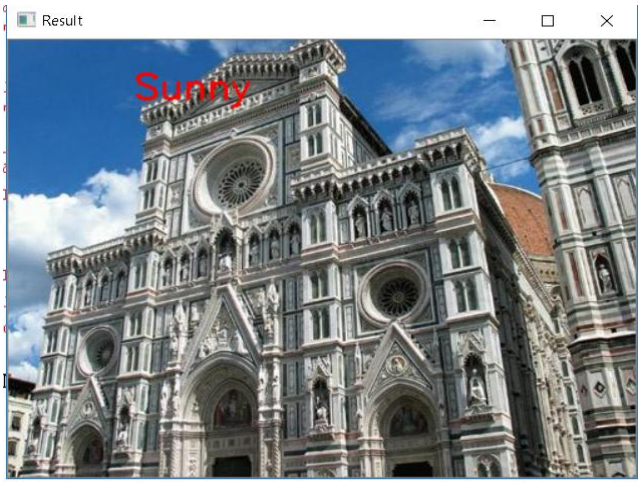

Fig. 4. Prediction is Sunny

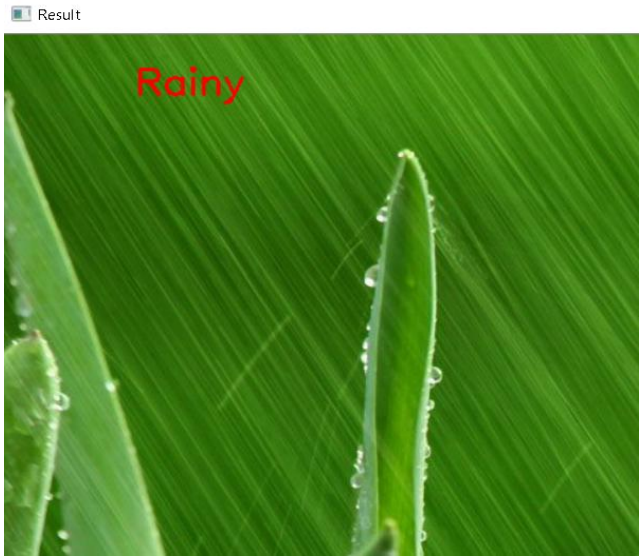

Fig. 5. Prediction is Rainy

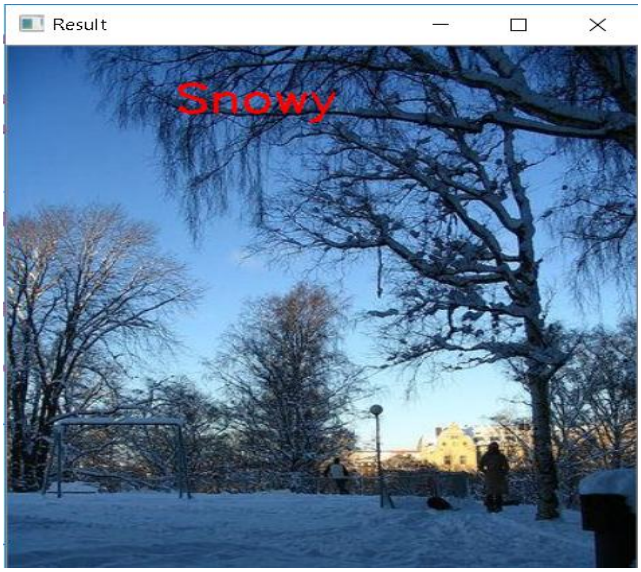

Fig. 6. Prediction is Snowy

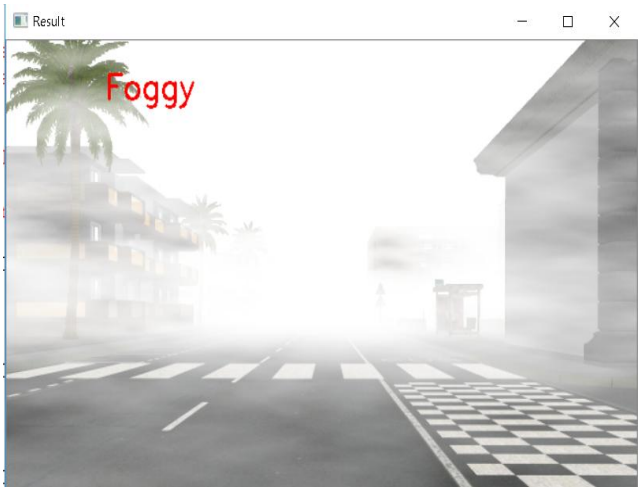

Fig.7. Prediction is Foggy

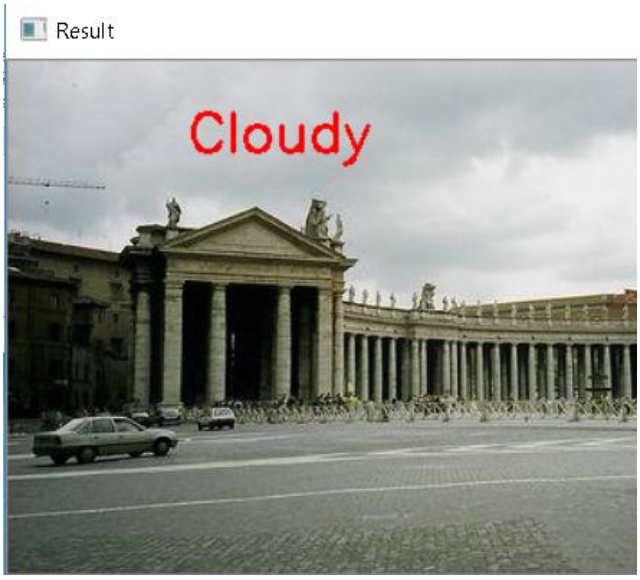

Fig. 8. Prediction is Cloudy

The performance analysis or accuracy is as shown in below table.

Table 1. Performance analysis of Algorithms

	Sunny	Rainy	Snowy	Foggy	Cloudy
CNN	87 %	86%	88%	87%	82%
SVM	75%	68%	59%	70%	55%
Decision Tree	77%	71%	70%	69%	61.22%
Random Forest	73%	76%	78%	74%	58%

V. CONCLUSION

In this work, we use supervised learning methods that are convolutional neural network, support vector machine, decision tree and random forest for classification of images. CNN gives the best result of 86% and Random Forest gives a good accuracy close to the CNN i.e. 74%. Certain techniques (Decision tree and Random Forest), however, are not good enough for our mission, the hardest part is to try CNN architectures because there are many variants and it takes too long to try every architecture. Likewise, we're going to try all the algorithms like this and determine from an image the best model for weather classification. Right features and methodologies lead to really good results for image description and other descriptors can be researched and used in future. Because all other weather conditions also include clouds, cloudy class is tricky and hard to distinguish from other classes. For most of the cases, we could succeed. In future, from this methodology there is a chance to develop a framework to identify a location from which the image has been captured.

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