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CLOUD CLASSIFICATION AND RAINFALL PREDICTION

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***Abstract*—Taking up over 60% of the planet's surface, clouds are essential in controlling the planet's radiation budget because they affect both long- and short-wave warming and cooling. The past several years have seen an increase in interest in ground-based autonomous cloud photo observation techniques. Ten commonly occurring cloud formations and contrails are distinguished using Convnet (CNNs), utilizing the latest developments in deep learning. The efficiency and precision of Convnet cloud classification have not undergone comprehensive examination, despite their impressive picture classification results. For the purpose of determining a potentially dangerous weather activity, convective cloud detection technologies in particular are extremely precise and automated cloud classification techniques. Predictions regarding rainfall are also greatly having an effect by the quantity and variety of clouds in the sky. That's why research on clouds draws in academics from diverse backgrounds and is regarded as part of the most significant and fascinating.**

***Keywords*— CNN, GUI**

I. INTRODUCTION

Clouds are an integral part of Earth's atmosphere, influencing our planet's climate, weather patterns, and ecosystems. Understanding clouds and their behaviour is crucial for a diverse array of applications, from predicting rainfall to managing agricultural resources and mitigating the influence of extreme weather events. Cloud classification and rainfall prediction are fundamental components meteorological science, with noteworthy repercussions across various sectors, including agriculture, water resource management and disaster preparedness traditional methods of cloud classification and rainfall prediction have relied on manual observations and conventional meteorological techniques. While these methods have been valuable they often have limitations in the terms of accuracy, timeliness, and scalability. The advent of advanced machine learning remote sensing technologies, and the availability of vast amounts of ground-based imagery and meteorological information have opened new methods for improving cloud classification and rainfall prediction. This project seeks to utilize the potential of modern technology to tackle the challenges associated with cloud classification and rainfall prediction. By developing a robust and efficient system that merges the machine learning algorithms in remote sensing data, and real-time processing capabilities, we aim to provide more accurate and timely information about clouds and rainfall pattern. Machine learning remote sensing technologies, and the availability of vast amounts of ground-based imagery.

II. LITERATURE REVIEW

Tuominen and Tuononen [1] research was performed on ground-based cloud images, presenting a method that combines a neural network (NN) with the Lucas-Kanade method to extract information about cloud coverage and movement. This method effectively detects clouds across a range of conditions, including clear skies, dark cloud cover, and varying degrees of cloudiness.

Dev et al. [2] SWIMSEG was launched, offering a exhaustive publicly available database of sky and cloud images with partitioning capability, showcasing 1013 images taken by a high-definition sky capture device imagery. Furthermore, a fully learning-based division frame work is being considered for the splitting of the sky images including the evaluation and selection of suitable colour channels using two distinct datasets of cloud/sky images.

Gogoi and Devi [3] utilized image processing methods to analyse cloud images, extracting information such as cloud category/state and sky through subdivision of cloud evaluation procedure. By including parameters such as height, colour, altitude, classification, and appearance, evaluated rainfall status. Additionally various rainfall prediction methods, including traditional statistical and numerical approaches were explored in the discussion.

Zhang et al. [4] CloudNet, a novel Convnet based algorithm for classifying ground-based cloud images was introduced. The CCSN dataset, composed of digital cloud images taken from the ground, contains a large number of entries, compared to previous datasets, such as SWIMCAT. This dataset presents a anew cloud type known as contrails, which are line shaped clouds produced by aircraft engine emissions, with the aim of studying their impact on global warming.

Lai et al. [5] performed research on the classification of cloud images focusing on eight distinct cloud types. By utilizing both a ten-layer and a seven-layer CNN, evaluated the outcomes and noted a ten percent improvement in test accuracy upon reducing the layers. The experiments covered 1400 epochs with batch normalization integrated into the CNN after the Relu function to address over fitting concerns.

García Fernández [6] This study offers a comprehensive examination of CNN performance in autonomously classifying ground-based sky images. Two derivative datasets are generated from the original. One containing the cloud images of two categories and the other six types. This experiments involve activating and deactivating sub sampling layers and testing various optimizers (SGD and Adagrad) to attain satisfactory precision.

Muruvvet Kalkan [7] Commonly we experienced false prediction of rainfall so we need to make the weather predictions as accurate as possible by F1-Score, namely VGG-16 prediction. This method proposes to compute these estimations with pre-trained based models.

Anuska Sarkar, Riya [8] As we know prediction of the rainfall is greatly influenced by the clouds. In this CNN is used to classify the clouds and predict the rainfall. Based on the precipitation the clouds are divided into three types such as no rain to low rain, low rain to medium rain, and lastly medium to high rainfall.

Teena Varma [9] introduced an algorithm called remote sensing is nothing but the science and application of obtaining the given information regarding an object without actually coming into contact withit. In more suitable terms for our understanding, remote sensing is a mechanism for samplifying reflected and emitted electro-magnetic(EM) radiation from the earths terrestrial and acquatic ecosystems and atmosphere.

Sushant Jadhav [10] In this machine learning process is used to carry out the complex tasks in the nature. K-means clustering is used to classify the clouds in to high level clouds medium level clouds and low level clouds.

Manzo and Pellino [11] A framework for cloud based image identification is developed, incorporating various CNN methods through transfer learning. During classification, a voting system is utilised, taking into account each methods prediction likelihood.

III. METHODOLOGY

Convolutional Neural Networks (CNNs) can have an impact tool for cloud classification and rain prediction when utilized in combination with meteorological data and ground-based images. Convolutional Neural Networks (CNNs) are robust tools for cloud classification and rain prediction when they work with meteorological data and ground-based images. Assemble a sizable collection of aerial photos taken from the ground that incorporates various cloud types and meteorological data such as wind, temperature, and humidity. Ensure that the data is suitably classified for cloud types and contains information on historical rainfall records. Make changes such as rotation, scaling, and flipping to enhance the diversity of the dataset. This improves the model's ability to generalize. Create training, validation, and testing sets from the dataset to evaluate the CNN's efficacy. Our system will incorporate cloud data, meteorological conditions, and historical rainfall records into predictive models. Machine learning methods will be employed and numerical weather prediction techniques for determining the amount and patterns of rainfall. Several models and data sources will be combined in our ensemble forecasting techniques to increase precision and dependability. By helping to take prediction uncertainties into account, this will improve the overall standard of the forecast.

IV. PROPOSED SYSTEM

We suggest a thorough method for classifying clouds and forecasting rainfall. To make better precision and promptness of the cloud and rainfall forecasts, our suggested system combines cutting-edge deep utilizing deep learning in conjunction with real-time data processing. Convnet (CNNs) and HSVs. will employed for create and train models in machine learning it will be able to recognize various cloud types and their attributes. The key features used to differentiate between different cloud types in the classification process include color, texture, shape, size, altitude, and appearance. These features are extracted through image processing techniques such as segmentation and color analysis.Predictive models created by our system will incorporate historical rainfall records, atmospheric conditions, and data on cloud classification. We intend utilizing numerical weather prediction techniques in combining machine learning techniques to assess the intensity and patterns of rainfall. Several models and data sources will be combined in our ensemble forecasting techniques to increase precision and dependability. By helping to take prediction uncertainty into account, this will improve the forecast's overall quality.

V. BLOCK DIAGRAM

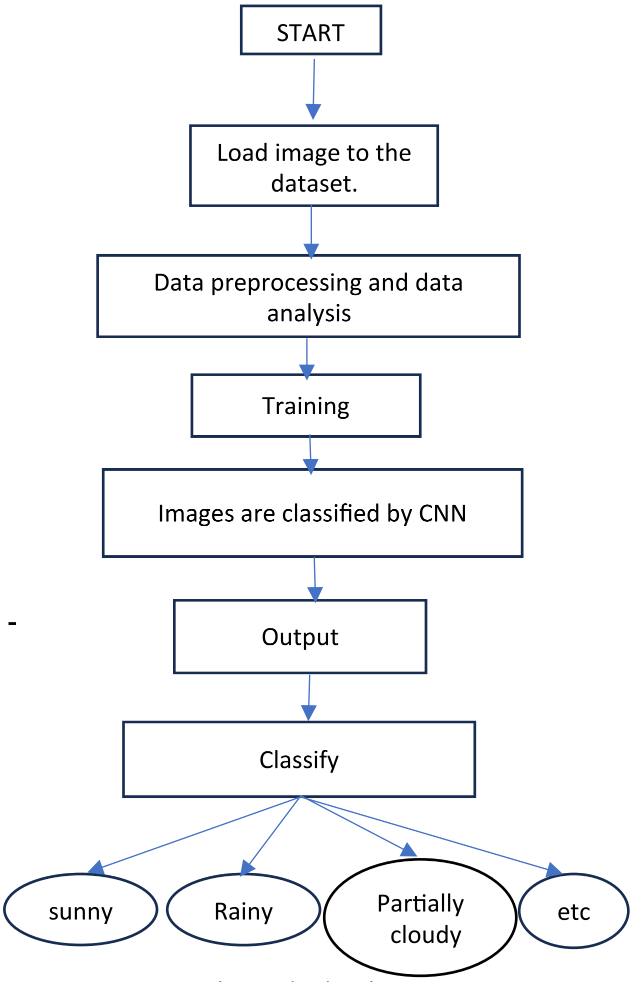

Fig1. Block Diagram

Here firstly we need to undertake the images of the cloud from the ground. Then we need to load images to the data-set. Now we have to analyse and preprocess the data. Again we have to instruct the data and then proceed for the categorization of images by using convnet algorithm. Now we will get the output. From the output we can classify the clouds as Sunny, Rainy, Partly Cloudy.

VI. OUTPUT

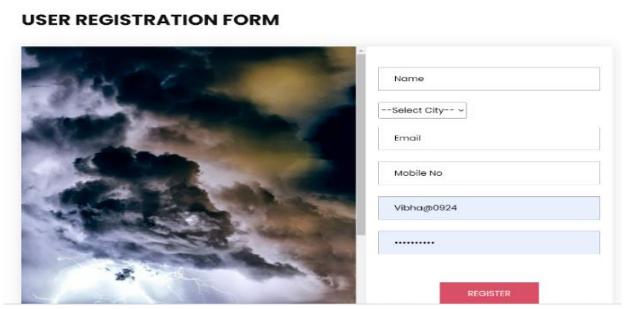

Fig2. Admin Register Page

The URL 27.0.0.1:5000/admin login results in the login page where the admin can view the rainfall. The admin can also view the names and localities of new users. Go to the login page and enter the login user's details, including name and email address. Provide the password under the requirements needed to ensure its high level of security.

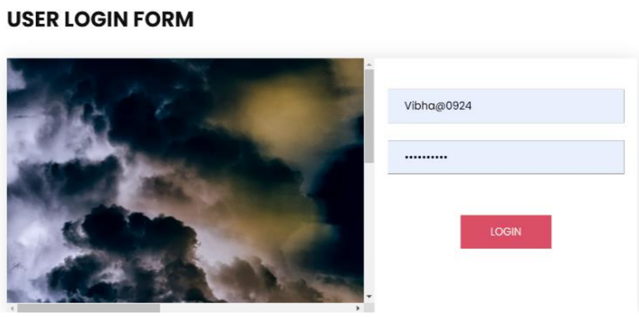

Fig3. Admin Login Page

After entering the password and username provided, click "Login."

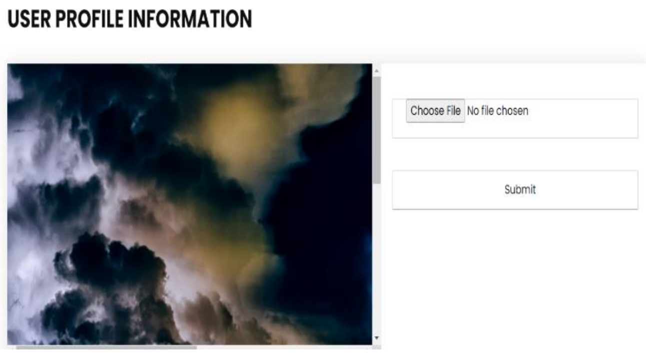

Fig4. Select Image

Select an image from the dataset. The images were captured using a fish-eye lens and hemispheric dome camera from the ground.

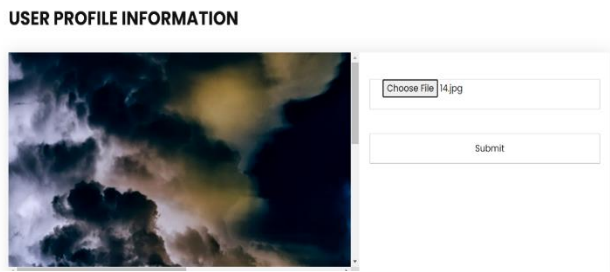

Fig5. Submit Image

The screen is showing the selected image. To discover the sky condition and rainfall, click the submit button now. To discover the weather, upload the most recent photos of the sky.

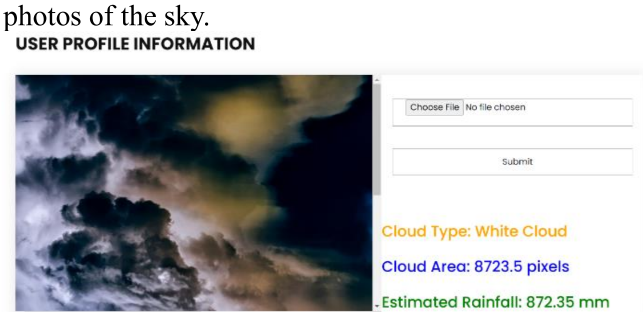

Fig6. Output

The output is displayed in the graphical user interface (GUI) with cloud characteristics such as cloud type and estimated rainfall. There are four categories for the cloud status: Sunny, White, Blue and Grey.

USER PROFILE INFORMATION

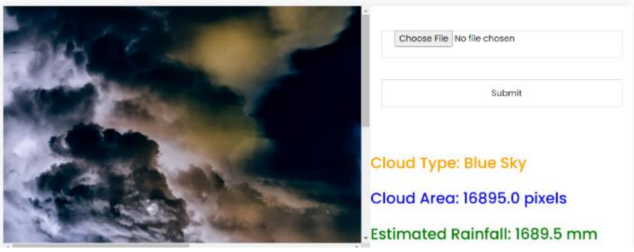

Fig7. Output

Select the various cloud types to learn about the various kinds of rainfall from the provided image. The HSV colour space utilization fixed for the colour range, so for example, blue sky low = [90,50,50].

The pixels are employed to calculate the cloud area.

Rainfall in mm = cloud area * 0.1 is the formula used to estimate rain.

TABLE

CLOUD TYPE	CLOUD AREA (in pixels)	AMOUNT OF RAINFALL
BLUE SKY	4689.5	468.95
WHITE SKY	7723.5	772.35
GREY SKY	9432.9	953.29
SUNNY DAY	2388.5	238.85

GRAPH

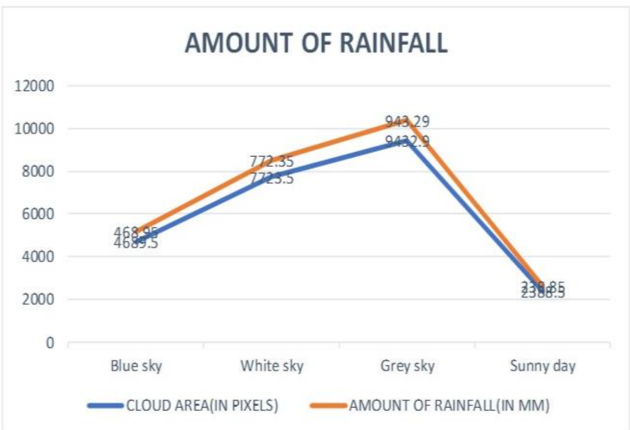

Fig8. Graph Output

VII. CONCLUSION

Based on images taken from the ground, CNNs can be utilized to automatically and precisely categorized different kinds of clouds. This allows for a deeper understanding of cloud behaviour and how it affects weather patterns. Predicting rainfall more accurately and promptly is made possible by the integration of data with meteorological data and numerical weather prediction models. This is very helpful for disaster preparedness, agriculture, +and water resource management. The system's ability to process data in almost real-time guarantees that rainfall forecasts and cloud classification are current, giving decision-makers across various sectors vital information. Since the methodology combines scalability with effective data integration, it is adaptable enough to handle large-scale data processing and a range of data sources, including radar data, satellite imaging, and ground-based observations. Cloud classification and rainfall prediction are now available to a wider range of users, including meterological farmers and disaster management organizations, thanks to generate an intuitive dashboard.

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