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An Interactive Framework for Analysis of Weather Prediction using Digital Image Processing

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Abstract:- To forecast the atmosphere's characteristics at a specific location It uses Predict Weather. Technology and science are applied in weather forecasting. Because it predicts how the weather will be in the future, weather prediction is more beneficial to people because it allows them to make plans. Farmers will stand to gain the most since they may cultivate crops in accordance with rainfall predictions. There are numerous methods for predicting the weather, such as using historical data or looking at the current cloud cover. Using picture recognition, we can forecast the weather. To make more accurate weather predictions, the author employed approaches such as Normalization, Clustering, and Cloud Mask Algorithm. By employing algorithms, we can take a test data set and forecast the weather. Digital image processing has grown more affordable in many scientific domains, as well as in commercial and military applications.

Keywords:- *Weather Forecasting, Normalization, Cloud Masking Algorithm, K means Clustering, Support Vector Regression, JUPYTER, Python, Residual Neural Network, Digital Images, Cloud Computing, Artificial Neural Networks.*

I. INTRODUCTION

Weather forecasting is predicting the weather and describing how it changes over time. Energy transfer or movement causes weather to change. The actual physical transfer of heat and moisture by convective processes is the cause of numerous meteorological patterns and phenomena, such as anticyclones, depressions, thunderstorms, hurricanes, and tornadoes. The evaporation of water vapour produces clouds. As the water cycle continues to change, the amount of water in the clouds rises, which causes precipitation. This is how both the convective process and weather changes take place. When predicting the weather, a number of variables are taken into account, including temperature, precipitation, pressure, humidity, sunshine, wind, and cloudiness. It is also feasible to recognize the various cloud types connected to various weather patterns. These weather patterns aid in the forecasting of the weather.

When predicting the weather in the past, people used the barometric pressure, the current weather, and the sky's condition. Today, however, there are many computer-based models that take atmospheric factors into account. Due to the chaotic nature of the atmosphere and how frequently it changes, these methods are not accurate. The majority of the existing forecasting models only predict weather for a few days, rarely longer than 10. Even longer-term forecasts will not be accurate. As the passage of time increases, accuracy decreases. [Fig:1] Since weather forecasting is not a purely mechanical, linear process, conventional methods cannot be applied in their entirety.The job of a forecaster relies on theoretical knowledge and laboratory work, both of which need years of study, but it also entails daily practise in a weather forecasting service with a specific technical environment. Support Vector Regression (SVR) is employed to forecast the highest temperature at a required location. Due to the fact that it lowers the upper bound on generalization error, it outperforms MLP, which is trained using back propagation algorithms. For applications of weather prediction, it can take the role of neural network-based models by choosing the appropriate parameters.

Fig. 1: Day- to- day Weather prediction

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II. TECHNOLOGIES USED

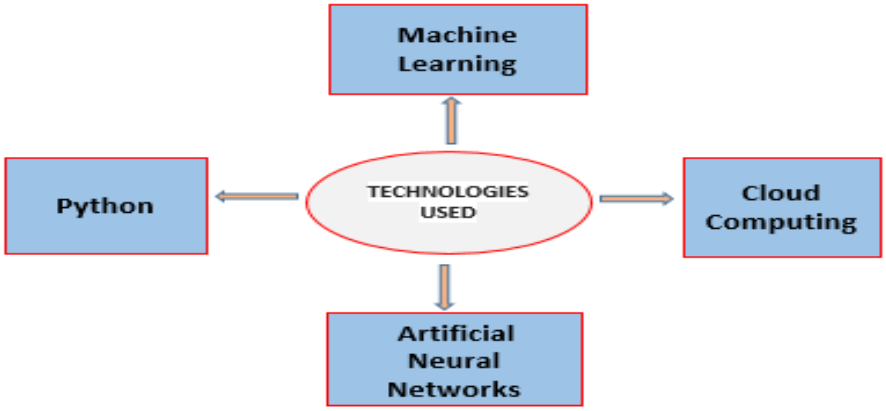

Fig. 2: Technologies used

A. Machine Learning:

The field of study known as machine learning enables computers to learn without explicit programming. One of the most intriguing technologies one could have ever encountered is machine learning (ML). As implied by the name, it grants the computer a feature that more closely resembles that of humans: automatic learning. [Fig:3] Nowadays, machine learning is being actively applied in a lot more domains than one may think.

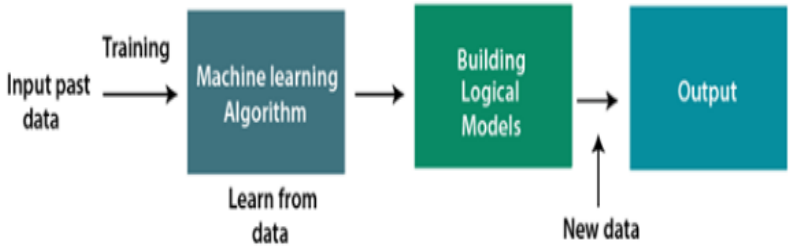

Fig. 3: Process of Machine Learning

When a machine learning system learns from data, it creates prediction models and predicts the results for new data as it comes in. The amount of data helps to construct a better model, which predicts the output more precisely, hence the accuracy of the anticipated output depends on the amount of data.

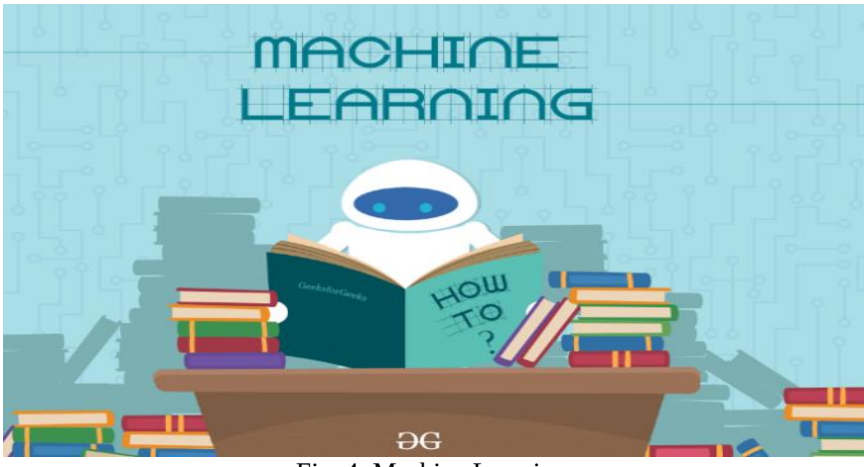

Fig. 4: Machine Learning

B. Python:

Python is an interpreted high-level, general-purpose programming language that was developed by Guido van Rossum and initially released in 1991. With its noticeable usage of substantial white space, Python places a strong emphasis on code readability. This language's object-oriented design principles are intended to assist programmers in creating clean, comprehensible code for both little- and big-projects. Python uses garbage collection and has dynamic typing. [Fig:5] It supports various paradigms of programming, including as procedural, object-oriented, and functional programming.

Fig: 5. Python

C. Artificial Neural Network:

Artificial neurons, which loosely replicate the neurons in a biological brain, are a collection of connected nodes or bumps that form the foundation of an ANN. Like the synapses in a human brain, every link has the ability to send a signal to neighbouring neurons. [Fig:6] An artificial neuron receives all impulses, analyses them, and can communicate with the neurons that are attached to it. Each neuron's output is calculated using some non-linear functions of the sum of its inputs, and the "signal" at a connection is a real value. Edges refer to the connections. As learning begins, neurons and edges typically have the weight that adjusts. The weight alters the signal capacity at a connection by increasing or decreasing it.A signal may only be sent by a neuron if the aggregate signal passes a certain threshold.

Fig. 6: Artificial Neural Network

D. Cloud Computing:

Pay-as-you-go IT resource distribution via the Internet is known as cloud computing. You can use technological services like computing power, storage, and databases from a cloud provider like Amazon Web Services (AWS) on an as-needed basis rather of purchasing, owning, and maintaining physical data centers.

Fig. 7: Cloud Computing

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[Fig:7] Delivering hosted services through the internet is referred to as "cloud computing" in general. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are the three basic categories of cloud computing into which these services are divided.

III. SOFTWARE REQUIREMENTS SPECIFICATION

SRS is a comprehensive description of the system's projected performance. At the conclusion of the requirements engineering phase, it is typically approved[fig:8]. It outlines how a software system will communicate with all internal components, hardware, other programmes, and human users in a variety of realistic situations.

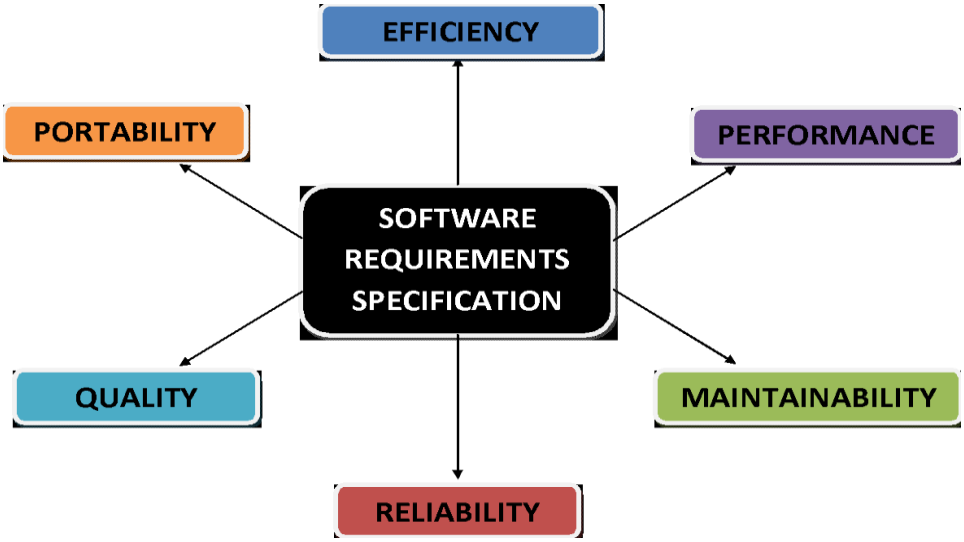

Fig. 8: SRS

- Reliability: The concept of "reliability" offers information about whether the user can rely on the forecast in the sense of using it to make decisions, in the simplest words possible.
- Quality: This project has higher quality, and the prediction can accurately predict an occurrence based on some objective standards.
- Maintainability: Weather forecasting has a plethora of potential applications. Because they are used to safeguard property and human life, weather warnings are among the most crucial forecasts.
- Effectiveness: Using techniques like persistence, climatology, sky-gazing, barometer use, now-casting, using prediction models, analogue forecasting, and ensemble forecasting.
- Portability: It would be free to use in any browser and portable on any machine.
- Performance: A forecast that is truthful and conveys some level of assurance about the accuracy of the result utilizing the data set is more performance.

IV. EXISTING SYSTEM

The current method of predicting the weather primarily relies on satellite pictures. Most websites that provide weather forecasts use GPS and satellite picture data to forecast the weather. We hardly ever come across software or websites that use digital image processing to forecast the weather. These programme or websites make weather predictions using satellite photos, which provide information on the amount of cloud cover in a certain area. They monitor the clouds' movement over a specific time period and utilize that information to forecast the weather. This is the current method of forecasting the weather.

Every day, the weather predictions beat our models with a little amount of variability on later days and a considerable amount on earlier days. This was anticipated since, while the physical models of the atmosphere might be solved precisely for a brief period of time, their instability over the long term led to the inaccuracies amassing quickly. On the other hand, our models beat expert weather predicting services over the long term and machine learning techniques are more effective for early-stage disturbances. If the default technique is used, the cost will be higher.

A. MODULES

- Data gathering and preparation
- Developing weather module
- Weather prediction in Celsius using a user interface.

➢ *Data collection and Pre-processing*

The process of gathering data involves employing radar and satellite to gather every aspect of weather forecasting. After assembling a high-quality data set, each data set is created separately. Both the accuracy rate and the ideal model will rise as a result. The preparation of data sets according to specifics is known as pre-processing. For the model, two data sets are prepared. picking features for pre-processing that will influence our model but have no impact on the output. The data set is utilized to train our model after the features are chosen.

➢ *Creating weather modules*

The data set is utilized for training once the data have undergone pre-processing. The data set is divided into features and labels, which are used for model training. The programme for calling the algorithm is called SK Learn. Numerous algorithms are used, including random forest, SVM, naive Bayes, and others. The final model is created using the algorithm that has the highest accuracy.

➢ *Weather Celsius prediction using Interface with UI*

Both the train set for training and the prediction test are used. Find the accuracy of each method after the prediction to create the ideal model. To view the prediction results, a web application is required. However, the fields of machine learning and web development are distinct. pipeline for a machine learning model and interacting machine learning in the prediction step. The user can then provide input and receive output after that.

B. WEB DEVELOPMENT MODULES

➢ *Login and Registration:*

An authenticated user may log in and make weather predictions in this module. Otherwise, the invalid user must register with the required information and create an account; after doing so, they will receive a username and password. The user can log into the system with this username and password, get authenticated, and forecast the weather.

➢ *Modules*

This module's goal is to have valid users contribute data such as temperature, visible temperature, humidity, wind speed, wind bearing, visibility, and pressure (millibars). As a result, they are able to estimate the weather's approximate value for any given location.

V. PROPOSED SYSTEM

A. Normalization:

Every pixel's values are taken into account. Red, Blue, and Green values make up a pixel's value. With the assistance of pre-defined Python libraries, these values are extracted from the image. To distinguish clearly between the sky and the clouds, we must now use these pixels to shift the intensity range of the pixels to [0,1] and raise the intensity. As a result, the digital image is normalized. Any digital image with the.jpg or.jpeg extension is acceptable as the input image.

Fig. 9: Original cloud image and image after Normalization

B. Cloud Masking Algorithm:

We separate the cloud from the sky in the input image using the threshold value produced by the normalization module in order to determine the region of the cloud on which to do subsequent operations, such as feature extraction.

The data set is taken into account, and each and every image in it is normalized. The mean point is then computed from each cloud once the clouds have been removed from the image. These mean points are used to analyse clouds. When comparing the threshold value of the input image with the cloud's mean value, the cloud would be placed in the category for which its values are similar.

Fig. 10: Image obtained after performing cloud masking algorithm

C. K means Clustering:

We take clustering into account because there are likely to be many classes involved in classification. [Fig:11] However, since there were nine types to consider, clustering rather than classification was taken into account. Here, as we divided the image based on the cloud mean point, we took into account the cloud clusters. Nine clusters comprise this division of the clouds. These are the clusters: 1. Cirrostratus Cirrus 2. Cirrocumulus 3. 4. Altostratus, 5. Stratus, 6. Altocumulus, and 7. Stratocumulus Nimbostratus, ninth, and Cumulonimbus.

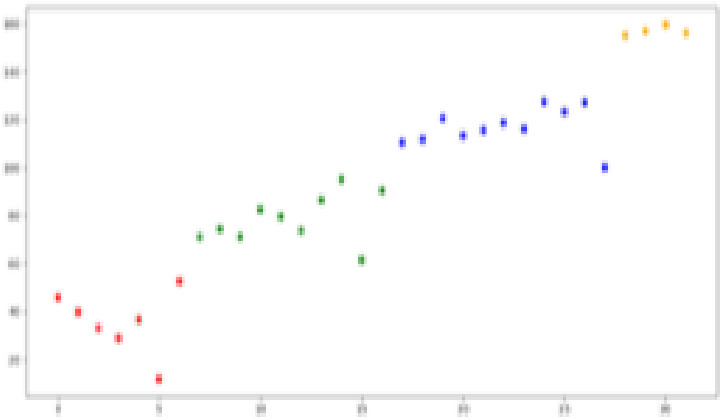

Fig. 11: K means clustering

VI. SYSTEM ARCHITECTURE

With this system, the user begins the procedure with weather information. The weather data collected from the user during the data collecting and pre-processing steps is used to initialize the weather module. The initialized data is then put to the test using tested and trained data modules, producing a forecast of the weather that is given to the user.

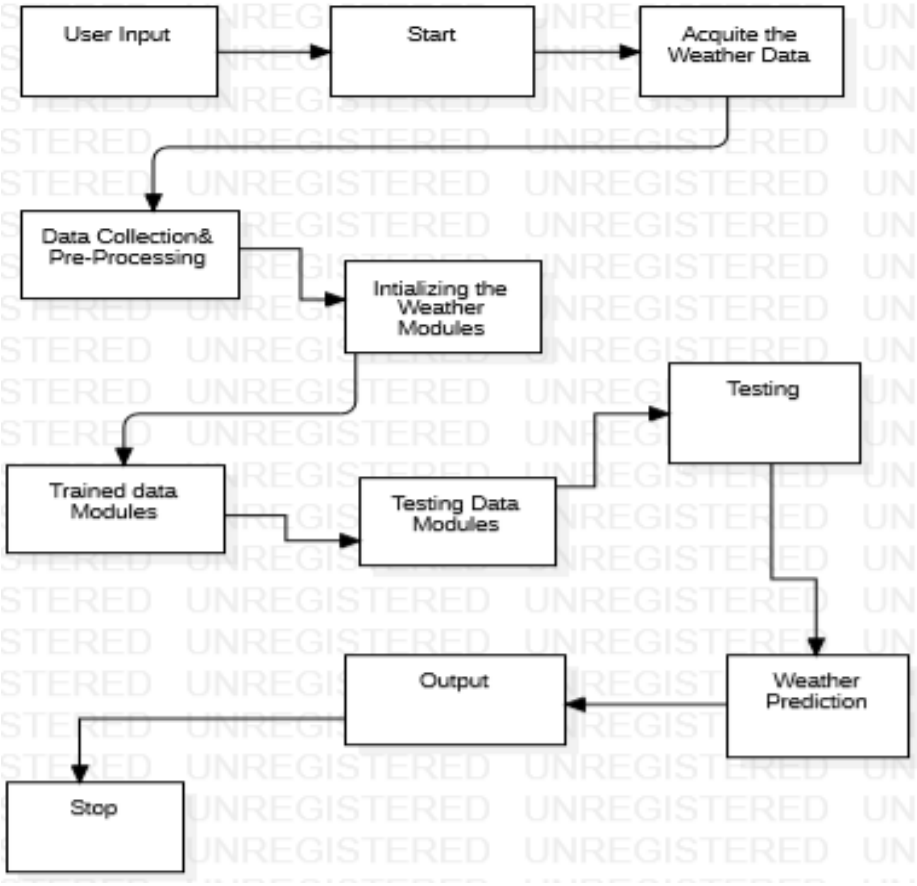

Fig. 12: System architecture

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VII. UML DIAGRAMS

A. *Use case diagram*

The user's data are used as inputs. The data is processed after that. Data are tested and incorporated in the trained module. The weather is forecaster and executed after the data has been tested.

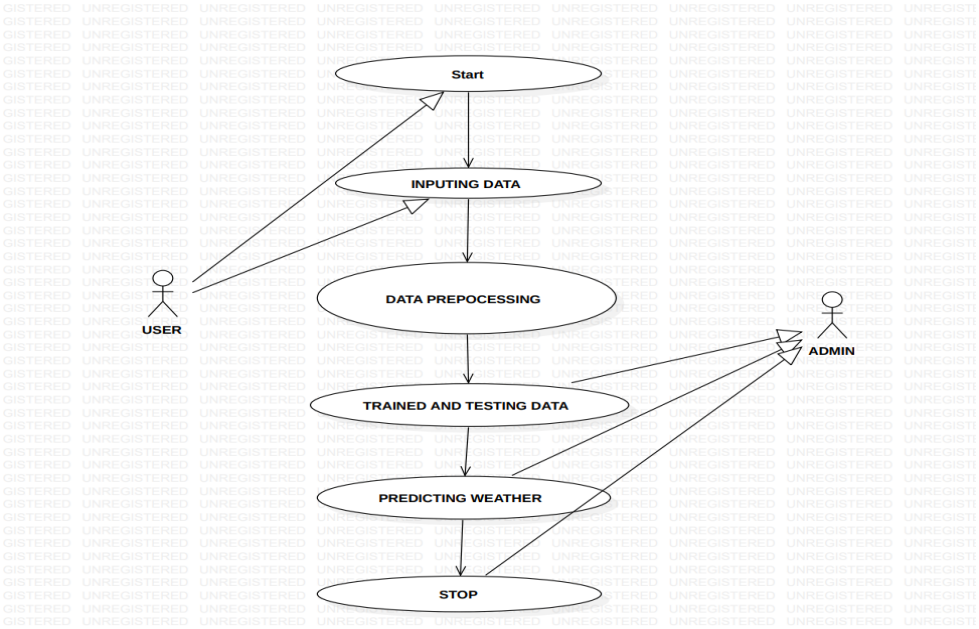

Fig. 13: Use case diagram

B. *Flow chart*

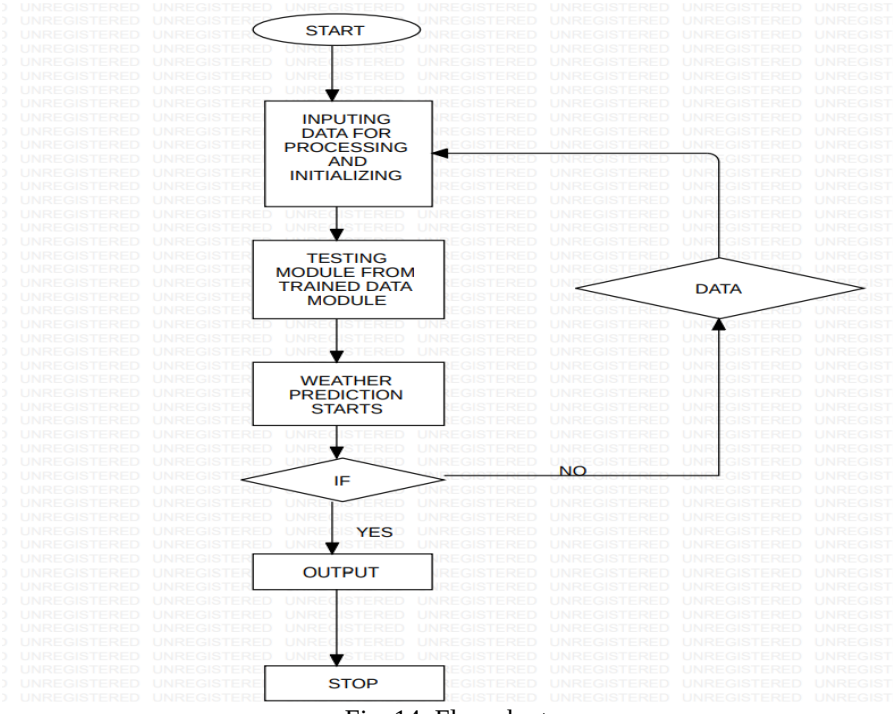

Fig. 14: Flow chart

A flowchart is a diagram-based depiction of the process. It can alternatively be described as a diagrammatic depiction of algorithms or a method for solving problems step by step.

VIII. FUTURE SCOPE

We may extend our current project by modifying our system and applying alternative methods to obtain the weather forecast for the upcoming few days.

IX. CONCLUSION

The weather report for that specific area would typically be provided by all other weather forecasting tools and sources. area would be recorded using GPS, and weather conditions at that area would be provided using satellite data. The types of clouds that the author took into consideration can purposefully provide realistic meteorological conditions. The model can now predict the weather at that moment.

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BIOGRAPHIES

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