

Advanced and Accurate Weather Forecasting using Digital Image Processing

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Abstract: In this review paper we are discussing about the weather forecasting and climate using DIP or Digital Image Processing technology. Images through satellite getting easier to access for arriving new satellite imaging techniques where images can be used to predict the recent condition in weather. Mostly, they are divided into two parts where the first part describes about the coverage of the cloud through the satellite image for extracting and a process known as Image Segmentation process to segment an image from the cloud the segmentation and the other part describe about the segmentation process of an image which can be calculated over the percentage value to coverage the cloud. Cloud cover percentage includes some kinds of inputs like humidity, temperature, speed of wind for artificial neural networks. Cloud extraction is the major process for implementing convolution energy in major cases. So, this review paper describes about the technologies which is easy to implement and execute their runtime faster.

Keywords: Digital Image Processing, Climate, Weather, Image segmentation, rainfall, thunderstorm, GPS, Rader, Satellite.

I. INTRODUCTION

Image Processing is known as a very famous and successful technology in many applications. We can use this technology in various field now let's focus about how to use this useful technology in climate and weather prediction. Mainly 3 types of satellite image processing are there- Visible, Infrared and Water Vapor. The first type visible image is only got in the day time and they are used to get the thickness of the clouds. The second type Infrared images are getting by using the specific infrared sensors and the major advantage of using this kind of images is that it can be able to work even in night. It's used to determine the temperature of cloud top. The third type means water vapor is used to point the moisture content or humidity. Now climate and weather are always the most important factor for many fields such as tourism, growing crops etc. Now, it's a time to take care and be aware of weather and climate for safety and a successful economic growth. Weather is a state of the air at a specific time and for a specific area and climate is a long-term weather condition in a location or a region which is observed at least for 30-35 years. So basically, keep observing on weather and climate are important because they are connected to life and property. To predict accurate contrasting, it can help to save lives and compress the property damage. It also can be very important for agriculture such as a farmer can track when it's the perfect time to plant crops.

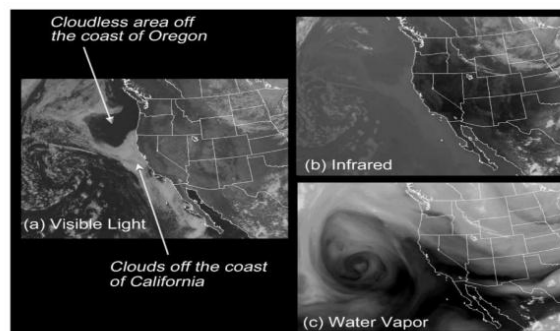


Figure 8-3: GOES-West visible light (a), infrared (b), and water vapor (c) images of the northern Pacific Ocean on September 26, 2003, 2000Z. (Images courtesy NOAA)

Figure1:Picture of a. Visible Light, b. Infrared and c. Water Vapor.

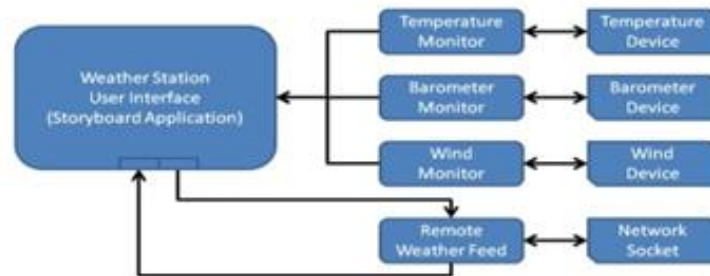


Figure 2:Weather Station

II. HISTORY

Initiation of Weather Forecasting: The early initiative of weather forecasting was taken by Egyptians and Babylonians. They were basically observed the natural incidents and also astronomical ways to predict weather. They even observed the behavior change of animals to forecast the weather changes. **Primary Meteorological Instruments:** In 15 and 16 centuries various meteorological instruments were invented such as thermometer, hydrometer and barometer which helps to get the important data for studying.

Starting phase of modern metrology: At the mid of 19th century the Telegraph enabled the rapid communication of weather observation during the long distance and it was revolutionized at advancements in science and technology revolutionized weather forecasting. And the main function is to establish a network between two meteorologists.

God of Modern Weather Forecasting: Vilhelm Bjerknes a Norwegian scientist is known as the “Father of modern weather forecasting.” He was invented a concept of “weather fronts” at 20th century. And also approach the concept of weather prediction based on fluid dynamic equations.

Satellite Technology in weather forecasting: The weather satellites were launched in the year 1960 it helps to increase the forecasting capabilities. It basically notices the Earth’s clouds, weather and atmosphere from the space. As the day passes the accuracy of data and timeliness continuously improved.

History of Radar and Doppler Radar Technology: Radar technology becomes a very important technology for predicting and tracking weather’s phenomena. There is a huge use of Radar technology such as precipitation after detecting cloud, measure the wind speed and its direction as well and also various weather features like tornadoes and thunderstorms. And the next technology Doppler radar was invented in the year 1980s.

III. LITERATURE SURVEY

In paper1, Weather Forecasting using Satellite Image Processing and Artificial Neural Networks. In November 2016, this paper was published by Nilay S. Kapadia, Urmil Parikh, Dipti P. Ran. They said in their paper that new satellite technologies are more accessible than previous satellite technology where this paper is based on the prediction of weather. They want to approach and rely on the image of the satellite and take some data inputs through that. There are also two parts which describe the weather satellite. The one part talks about the image segmentation process technique to extract the coverage of the cloud, percentage and calculation which depends on the value of percentage and the other one talks about the cloud cover percentage which involves humidity, wind speed and temperature through the neural network artificially. This neural network is done for weather prediction accordingly through the cloud coverage. For the slow potentiality, the algorithms of the current cloud extraction implement and execute complicatedly. So, this paper represents a novel approach for implementation, execution and for qualified results which can be described by that paper.

In paper2, Prediction of rainfall using image processing. In December 2010, this paper was published by G Ayappan Govindhasamy. He said in his paper that water is elixir of life. So, rainfall becomes the inevitable part of every nation which decides the prosperity and economic scenario of a country. In this fast-moving world, estimation of rainfall

has become a necessity especially when the global heat levels are soaring. The proposed approach here is to use the digital cloud images to predict rainfall. Considering the cost factors and security issues, it is better to predict rainfall from digital cloud images rather than satellite images. The status of sky is found using wavelet. The status of cloud is found using the Cloud Mask Algorithm. The type of cloud can be evolved using the K-Means Clustering technique. As per previous research works done by the researchers, it is stated the Nimbostratus and Cumulonimbus are the rainfall clouds and other clouds like cumulus will produce rain at some rare chances. The type of rainfall cloud is predicted by analyzing the color and density of the cloud images. The cloud images are stored as JPEG file in the file system. Analysis was done over several images. The result predicts the type of cloud with its information like classification, appearance and altitude and will provide the status of the rainfall. The proposed approach can be utilized by common people to just take the photograph of cloud and can come to conclusion about the status of rainfall and to get the desired detail.

In paper3, Survey on the Application of Deep Learning in Extreme Weather Prediction. In 21 May 2021, this paper was published by Wei Fang, QiongyingXue, Liang Shen, Victor S. Sheng. They said in their paper that uncertainty of weather and the complexity of atmospheric movement, extreme weather has always been an important and difficult meteorological problem. Extreme weather events can be called high-impact weather, the 'extreme' here means that the probability of occurrence is very small. Deep learning can automatically learn and train from a large number of sample data to obtain excellent feature expression, which effectively improves the performance of various machine learning tasks and is widely used in computer vision, natural language processing, and other fields. Based on the introduction of deep learning, this article makes a preliminary Summary of the existing extreme weather prediction methods. These include the ability to use recurrent neural networks to predict weather phenomena and convolution neural networks to predict the weather. They can automatically extract image features of extreme weather phenomena and predict the possibility of extreme weather somewhere by using a deep learning framework.

In paper4, Use of model predictive control and weather forecasts for energy efficient building climate control. In 24 September 2011 this paper was published by Frauke Oldewurtel, Alessandra Parisio, Colin N. Jones, Dimitrios Gyalistras, Markus Gwerder, Vanessa Stauch, Beat Lehmann, Manfred Morari. They discuss in their paper that an investigation of how Model Predictive Control (MPC) and weather predictions can increase the energy efficiency in Integrated Room Automation (IRA) while respecting occupant comfort. IRA deals with the simultaneous control of heating, ventilation and air conditioning (HVAC) as well as blind positioning and electric lighting of a building zone such that the room temperature as well as CO₂ and luminance levels stay within given comfort ranges. MPC is an advanced control technique which, when applied to buildings, employs a model of the building dynamics and solves an optimization problem to determine the optimal control inputs. In this paper it is reported on the development and analysis of a Stochastic Model Predictive Control (SMPC) strategy for building climate control that takes into account the uncertainty due to the use of weather predictions. As first step the potential of MPC was assessed by means of a large-scale factorial simulation study that considered different types of buildings and HVAC systems at four representative European sites. Then for selected representative cases the control performance of SMPC, the impact of the accuracy of weather predictions, as well as the tenability of SMPC were investigated. The findings suggest that SMPC outperforms current control practice.

IV. FUTURE SCOPE

There will be a huge scope to enhance the weather and climate analysis by using image processing. As much as scientists focus on various noticeable data sources like satellites, aircraft, buoys, weather stations and ground-based sensors they get the accuracy of weather forecasts. In current years AI and machine learning technology have been applied to weather and climate forecasting. Basically, these techniques can be able to analyze a huge amount of data and also enhance the prediction accuracy. So in future by improving this AI and machine learning process the weather and climate forecasting will be more accurate and it will provide a high-resolution and short-term forecast. In future weather and climate forecasting will continue to develop with the help of advancements in technology, observational capabilities and modeling techniques. The present and future aim is to get more accurate data of weather and climate forecasting which can help to tourism business, agriculture field and also help governments to make decision about whether such as heavy rain fall, thunderstorms.

V. CONCLUSION

From all the above discursion let's conclude that this digital image processing technology become a very useful for forecasting weather and climate. Basically, any kind of weather and climate forecasting applications or data sources give the weather detail of a specific location by using GPS. Image segmentation is a major step for self-operating weather satellite image interpretation system. AABT is a well-known technique which is used to designed to provide a perfect and fast method of image segmentation which is also very simple in terms of implementation as well. Weather and climate forecasting is not only useful for tourism and agriculture field it also helps us to aware from thunderstorms, rainfall and having a knowledge about weather and climate forecasting is also very helpful and it's also have a vast scope for develop and further research about this topic.

REFERENCES

- [1] In the year 2010 in Technology and Engineering, Craig M. Wittenbrink, Glen Langdon, Jr., "Feature Extraction of Clouds from GOES Satellite Data for Integrated Model Measurement Visualization
- [2] In the year 2009 at IEEE, a paper named "Studies on Cloud Detection of Atmospheric Remote Sensing Image Using ICA Algorithm". By Du Huadong, Wang Yongqi, Chen Yaming.
- [3] In 2006 at the", Journal of Advances in Space Research, a paper was published by Chiang Wei, Wei-Chun Hung and Ke-Sheng Cheng, and name of the paper was "A Multi-spectral Spatial Convolution Approach of Rainfall Forecasting Using Weather Satellite Imagery.
- [4] In 2006 at Kenya Meteorological Department, Research paper by Peter S. Masika in "Cloud height determination and comparison with observed rainfall by using meteosat second generation (msg) imageries".
- [5] In the year 2006 October, at Advances in Atmospheric Sciences, Science Press, Shou Yixuan, Li Shenshen, Shou Shaowen and Zhao Zhongming, research on "Application of a cloud-texture analysis scheme to the cloud cluster structure recognition and rainfall estimation in a mesoscale rainstorm process.