Classification of cloud types for rainfall forecasting

Niyati Salot
Lecturer, Institute of Computer Application
P.D.Pandya Institute Of Computer Application,
Gujarat University, Wadhvan
Email: niyati.salot@gmail.com

Dr. Priya R. Swaminarayan
Professor & Head,
MCA Department Institute of Science and Technology for Advanced Studies & Research
Gujarat Technological University
Vallabh Vidyanagar, Gujarat, India.
Email: swaminarayan.priya@yahoo.com

---**ABSTRACT**--
India, primarily an agriculture-based economy, is largely dependent on the monsoon. The agriculture sector is the backbone of the Indian economy and therefore, monsoon should be considered the backbone of agriculture. It has more impact in the financial & social domain. Because of the cost element and Security issues, in modern age it is now possible to use digital image processing techniques to calculate different parameters that are affect the monsoon or affected by monsoon in global environment. In this method digital images of cloud and sky are taken and stored in common graphic format and apply different methods as cloud screening algorithm or image segmentation method to identify cloud status, sky status or cloud type. After the applying this methods, result will be taken as height, altitude, classification & appearance of the cloud that is used to identifying status of rainfall. And also basic characteristics of cloud as shape, color, texture, edges are also used to get status of rainfall. By applying this simple digital image processing techniques, common people can gather information regarding rainfall status by just taking photograph by their digital camera and utilize this technique.
Keywords – **Clouds, Cloud Type, Independent Component Analysis, Linear Discriminant Analysis, Principal Component Analysis**

1. INTRODUCTION

The main aim of this research is to use digital cloud images to identify rainfall status and cloud type using different image processing techniques. Rainfall must be forecast so that it can be helpful to predict drought and floods. Rainfall would be detected from the type of cloud present in the sky. In this paper our aim is to identify the cloud type. Crops depend on rainfall; and all lives depend on crops. Rainfall also effects on water resources and water usage. Digital images play a vital role in lots of applications in fast moving digital earth. Water covers about 70% of earth's surface and this water evaporates and condensed in to clouds and these clouds create precipitation. Then after precipitation water falls back on the earth's surface. So the water cycle is serious not only to weather, but to life on earth. By natural cloud is as natural as something in atmosphere. The hydrological system is maintained by the water cycle. And this water cycle main water into rivers and lakes which supports a variety of aquatic ecosystem. Water is also important for intensive irrigated agriculture and also for generating electricity. Excess of rainfall is also dangerous because it generates flooding. Floods create destruction of life and property. Thus, rainfall have major role in many aspects of life, so, it's not meaning to identify where rainfall has been occurred and how much it fallen but is necessary to have pre-knowledge about rainfall so management can be done easily and prevent destruction. So rainfall forecast is necessary.

2. INTRODUCTION OF IMAGE PROCESSING

Image processing is a method to improve unprocessed images taken from camera, satellite, aircraft, sensor or pictures taken in normal routine life for various applications. In Image processing input is image like photograph or video frame and output would be image itself or characteristics of that image. An image is an array or a matrix of pixels or small square dots which have its own brightness. An image is defined by $f(x,y)$ where x and y are spatial co-ordinates and the amplitude of is at any pair of co-ordinates at the particular point is called intensity[1]. Gray scale image has intensity between 0 and 255; it is generally called black and white images. It is also called monochrome images. There are two common groups of color Images that are vector graphics and bitmap graphics. Color Images are formed of the number of images.

2.1 Types of method used in Image Processing

There are mainly two methods used in Image processing which are Analog Image Processing and Digital Image Processing.

2.1.1 Analog Image Processing

Analog image processing is worked on analog signals. It does processing on two dimensional analog signals. In this process, images are converted into electrical by changing in to the electrical signal. This processing techniques applied on to the hard copies like print outs, maps and photograph. Its familiar example is television image. The voltage level of the television signal is varies in amplitude. It represents brightness of the image. By changing in the signal, the displayed image appearance is changed. According to amplitude changes image brightness, darkness and contrast ratio will be changed.

2.2.1 Digital Image Processing

Digital image processing manipulates digital images. Digital computer processes on two-dimensional image [2]. In digital image processing technique, image will be converted into numerical representation of object then these numbers will be given to any operation to find out desired result. Digital image is made up of number of components and those components have specific location and value. These components are generally known as pixels, image elements and picture elements.

3. PROCESSING TECHNIQUES OF IMAGE

Image Enhancement – Image enhancement is a process which will convert image in to desire output which is suitable to specific application. Image enhancement techniques example is contrast and edge enhancement, pseudo coloring, noise removal, filtering and sharpening. This technique is useful in extracting feature or to take analysis based on image. This process does not add additional intrinsic detail. This process focuses only on certain specific detail of image [3].

Image Restoration – Image restoration is a process in which image appearance will be changed. This process is based on mathematical and probabilistic model of Image degradation.

Image Compression – Image compression is a process in which will reduce the size of image for the storing purpose.

Morphological processing – In morphological process the desired object will be extract by using any tool. It is useful in representation and description of the shape. Morphological process has two operations that are erosion and dilation. In Erosion operation foreground pixels are removed without attaching background pixels. In dilation process any foreground pixels added without touches other background pixels.

Image Segmentation – Image segmentation is a process in which image will subdivides into smaller parts or objects. Image thresholding techniques used in this process. After thresholding process binary image will be converted into black and white pixels. Black pixels are actually object and white pixels are the background..

4. COMMON FILE FORMAT FOR IMAGE PROCESSING

Image is the combination of square pixels. It can form in an array or a matrix. Images file contains digital data which have two common groups. Vector graphics contains line art that means it includes geometric shapes. Bitmap graphics contains pixel based images. Bitmap images are taken by any camera, satellite, and aircraft. Some common file formats are:

Binary Images – Binary images have only two possible values of each pixel that are 0 and 1. Each pixel can be black or white. It is also called monochrome image.

GIF Images – The GIF images are 8 bit color images which stores 256 colors. It is generally used for web to display animated image. It stores graphics with few colors so it is useful to store simple diagram, shapes, logo and cartoon-style images. It uses loss less compression techniques.

JPEG Images – The images taken by digital camera are generally stored in jpeg format. JPEG images are stored by .jpeg extension. It uses lossy compression technique. It supports 8 bit grey-scale images and 24 bit color images. It is very efficient file because it can store much information per byte. It is used for web and internet.

TIFF Images – The TIFF images are the standard 24 bit format for publication. TIFF images are not widely used in web. It can handle device specific color spaces so it is generally used in printing business and in OCR. It supports both lossy and lossless compression technique.

PNG Images – PNG images are widely used because it is open source and free. It is created as alternative to GIF because it supports 8 bit palette image and 24 bit true colors and 48 bit true colors. It supports indexed-color, gray scale and true color and optional alpha channel. PNG provides a patent-free replacement of GIF.

BMP Images – In Microsoft windows OS graphic file is stored in the bitmap (BMP) file format. These files are large because they are uncompressed. In basic windows programming BMP files are used. These files does not have true color format [4].

5. CLOUDS AND CLOUD TYPE

From the suns heat small drops of water moves from ground up to the air. When water drops warm up it will be converted in to gas and rise up into the air. This evaporated water is called water vapor. This water vapor rise up higher in to the air and it forms a cloud. When these clouds are full of these small drops it becomes heavy and fallen on to the ground. Clouds are key element of water cycle. Clouds transports water from one place to another on the earth. They are also important to maintain sun's energy in to the atmosphere. The ocean become warmer and evaporates water faster. There are three

different types of clouds. The Fig. – 1 shows how different types of cloud are there in the sky. They categorized into highest level, middle level and lowest into the atmosphere [5].
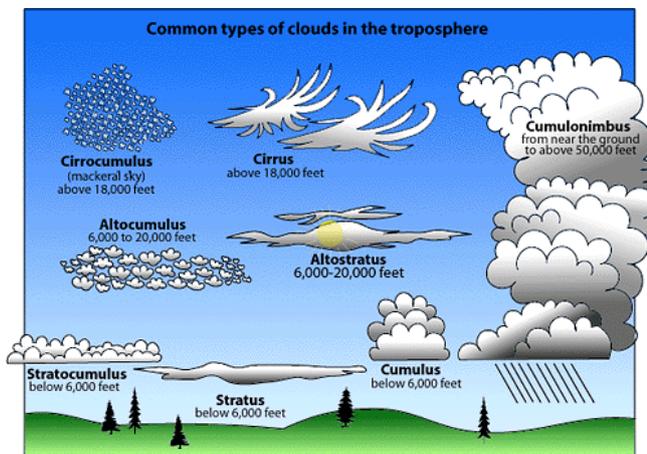

Figure 1: Different types of cloud

5.1 THE HIGHEST CLOUDS:

The highest cloud includes Cirrocumulus, Cirrus and Cirrostratus.

Cirrocumulus: Cirrocumulus clouds are at high amplitude. They are composed of ice-crystal. They are in the series of white patches. They are formed as thin, sheet or layered of patches without shade.

Cirrus: Cirrus clouds are very high in the sky. These clouds are made up of ice-crystal. It formed as white feather and thread like in the sky. These clouds forecast fair weather.

Cirrostratus: These clouds are transparent in color. Their appearance is smooth and whitish veil. They are very extensive, nearly always ends by covering whole sky.

5.2 THE MIDDLE-LEVEL CLOUDS:

The middle level clouds include Altocumulus and Altostratus.

Altocumulus: The Altocumulus clouds which are consist of water drops. These clouds are situated between 6,000 and 20,000 feet at high altitude above the earth. These clouds appeared as parallel strips or rounded masses.

Altostratus: Altostratus clouds are composed of ice crystal and water drops. These are generally gray or blue-gray in color. They are situated between 6,000 and 20,000 feet (2,000 to 6,000 meters) above the earth. It generally covers whole sky.

5.3 THE LOWEST CLOUDS:

The lowest level clouds include Stratocumulus, Stratus and Nimbostratus [6].

Stratocumulus: Stratocumulus clouds are very low and they are in grey color. They are looks like cell and sometimes they are in a row and spread out in the sky.

Stratus: Stratus clouds are very low. They are in grey color. It displays as the fog in an environment. They don't reach at the ground. They generally cover whole sky. Light mist or drizzle is occasionally linked with stratus cloud.

Nimbostratus: Nimbostratus clouds are dark gray. Continuous snow or rain is linked with nimbostratus cloud. They generally cover whole sky and disappears its edges.

6. EXTRACTION TECHNIQUES

6.1 INDEPENDENT COMPONENT ANALYSIS (ICA)

Clouds are made up of ice components and water drops. And the some clouds which can not contain any of things those are create fog. So to identify the types of cloud multivariable techniques must to use. Independent component analysis technique is statistical method which is used to identify data reduction or pattern recognition. The main goal of ICA is to find the linear transformation. ICA is a method which originates from the statistics for decomposing complex dataset into independent sub-elements. ICA can analyze data which is originated from many different applications like digital image, database, document and economic indicators. ICA's main advantage is it is powerful technique because this method is capable of identifying fundamental elements or components. It's another advantage is it provides accurate solution of co-efficient. It has also some limitations like it doesn't reflect time delays so it is not suitable for speech. [7]

6.2 LINEAR DISCRIMINANT ANALYSIS (LDA)

Linear Discriminant Analysis is another technique for classification of data. This technique is generally used for dimensionality reduction and data classification. This method is generally used in the cases when within class frequencies are unequal. This technique's performance has been evaluated on arbitrarily generated data. This technique maximizes the proportion of between class variance to within class variance. LDA is applied for resolving classification problem in speech recognition. LDA mostly used in dimension reduction methods for face recognition system. There are some advantages of LDA is, it reduces error rates. It can work with multiple dependent variables so that to identify clouds it can be helpful. It has easier interpretation between different groups. However, it has some limitations and assumption like it assumes equal variance in each group but in real world it is not possible. LDA assumes relationship between variable is linear but it is not feasible. LDA is extremely sensitive to outliers. [8]

6.3 PRINCIPAL COMPONENT ANALYSIS (PCA)

Principal component analysis is another statistical technique which is provide powerful tool for pattern recognition and data analysis. It is frequently used in signal processing to the data dimension reduction and data correlation. To identify type of cloud- image enhancement and image compression techniques must to use. For both of this work PCA is most suitable method. It reduces the

number of features that is used to represent data, so it will remove unnecessary elements from the clouds. Its main advantage is its dimensionality reduction includes providing a simpler representation of the data, reduction in memory, and faster classification. There are limitations of PCA that relate to sampling rate relative to scene dynamics. In scenes with high intrinsic temporal variability, sampling frequency must at least meet the Nyquist criterion, but PCA works better when there is a high degree of temporal autocorrelation. [9]

7. PROPOSED SYSTEM

Fig.–2 shows proposed system for the identification of cloud type. Digital image of cloud is used as an input in our proposed system. After that applied threshold and segmentation operations on this digital image of cloud. The outcome of threshold and segmentation operations is feature extraction. Feature extraction is of three types, they are general, geometric and texture. In General feature, we can identify whether cloud contains ice or water droplets. If water droplets are there in cloud then identify the size of cloud. With the help of geometric property, we can identify the height of cloud and thickness of cloud. So cloud type is dependent on its height. It can also identify the temperature of cloud. The texture feature includes characteristics of cloud surface. Combining of these three feature extraction technique we can identify the type of cloud.
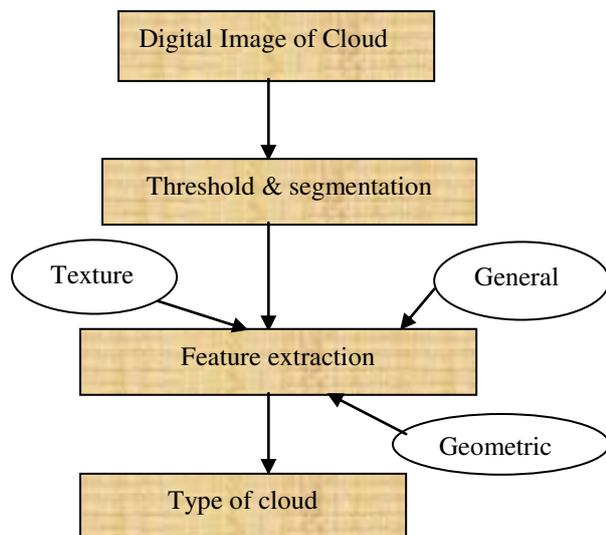
Figure 2: Proposed System for identification of cloud type

8. CONCLUSION

The rainfall estimation is necessary for the economic growth and social life. As shown in our proposed system, we can estimate rainfall by finding type of cloud. For the identification of type of cloud, we can apply different types of extraction methods such as ICA, LDA or PCA. These three extraction methods help us to recognize different properties and features of digital image. And once we identify the types of cloud, we can easily forecast about rainfall.

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