# Content Based Satellite Cloud Image Retrieval and Rainfall Estimation

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***Abstract-***In the last decade we witnessed a large increase in data generated by earth observing satellites. But today Satellite Image Retrieval is a big issue to discuss. There is huge amount of research work focusing on the retrieving of images in the image database. One of the most important steps in earlier stages of satellite image processing is cloud detection. Therefore, the satellite cloud images provide a valuable source of information in weather forecasting and early prediction of different atmospheric disturbances such as typhoons, hurricanes and also in the estimation of rainfall. Rainfall is the primary source for water. Rainfall forecasting is important for agriculture and living things. The type of rainfall is predicted by analyzing the size and shape of the cloud images. Shape is important feature in the meteorological satellite images. Different types of clouds have different shapes. The content based image retrieval with the fast and high matching retrieving ability is the need of the day for shape mining. The ultimate focus of this project reports to develop a Content Based Image Processing and Information as well as image retrieval (CBIPR) system using shape feature , for the retrieval of the satellite cloud images and also to forecast the rainfall from the meteorological satellite archival that allows us to study the past weather system and understand the current weather system.

***Keywords***: ***semantic gap, typhoons, hurricanes, aquatic, retrieval.***

## I.INTRODUCTION

Satellite images have become a common component of our daily life either on the internet, in car driving and even in our hand-held mobile handsets. There is new image and video content appearing every second through multiple competing television and internet channels. Manual interaction with this large volume of data is becoming more and more inappropriate, which creates an urgent need for automatic treatment to store, organize and retrieve this content[3][7]. Our needs from the satellite scenes are specific contents. Therefore we need to retrieve images that contain our intended contents. There are other challenges in the field of satellite images itself [2] .These images are georeferenced images, this means that all images form in reality a huge continuous image covering the entire earth surface. It is not always proper to deal with such content as
isolated images Cyclones, earthquakes, floods, droughts and landslides have been recurrent phenomena [2]. Meteorological satellites operated by the Indian Space Research Organization (ISRO) have been collecting meteorological image data for over twenty five years with the launch of INSAT-1B in the year 1983[2] .Clouds are the dynamic phenomena of the atmosphere so its effect on the climate is not known. By the better understanding of the clouds from satellite images, better models can be developed for the prediction of different atmospheric disturbances such as typhoons, hurricanes, dust storms and rainfall etc. The better understanding of the clouds requires the study of the past images, so that a retrieval system can be used to study the historical patterns to study the current weather system. The traditional satellite cloud image search method cannot describe the image contents such as cloud shape and also leads to inconvenience in retrieving images [7]. . Retrieval of data means to get desired data from the database and to reduce the semantic gap. It may image, text, audio or video as per requirement of user. The basic types of retrievals are mentioned in Fig 1.

*A. Image retrieval*

Searching for an image in a vast collection of the images is a difficult task. There is a need of the efficient search tools to browse the large image collection. The two approaches of the image retrieval are the text based image retrieval and the content-based image retrieval.

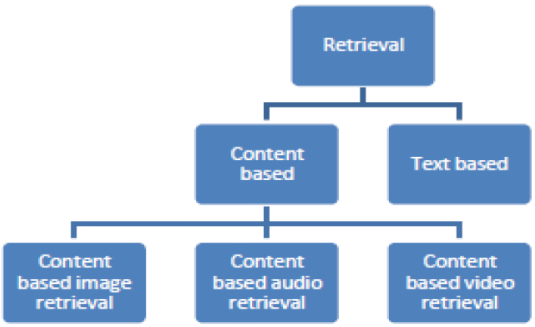


**Fig 1: Types of retrieval**

***B. Text based image retrieval***

This approach relies on the textual descriptions of the images. Each and every image in the database is to be annotated with the textual keywords and the image search is based on these keywords. This method cannot describe the image contents such as cloud shape and also leads to inconvenience in retrieving images[2][3].

***C. Content based image retrieval***

To, overcome the difficulties of the text based image retrieval, a new approach of the image retrieval, Content-based image retrieval (CBIR) has been a major research area for the users of different fields of computer vision, image processing and information retrieval. CBIR system uses colour, texture, shape features for retrieving the images [7][8].

Our work is to recognize the type of cloud and to estimate rainfall. Rainfall plays an important role in the water cycle by providing water to the surface of the Earth. Rain sustains agriculture and provides water to streams, which is important for aquatic life and navigation. Excess rainfall, however, can be quite hazardous by causing flooding, which is a significant threat to both life and property. Because of the important role of rainfall in many aspects of life, it is not only worthwhile to observe where rainfall has occurred and how much has fallen but also to forecast rainfall [20].

The purpose of this project is twofold: to recognize the type of clouds with certain methods and to estimate rainfall from certain observations. The goal of this work was to develop two seemingly unrelated projects that could be related through future work. The steps used in this process are Data collection, Cloud Information, Rainfall Status. The main objective of the paper is to recognize the type of cloud and estimate rainfall using certain features from the digital cloud images [20][22].

## II. METHODOLOGY

***A. Feature Extraction***

The most important module in the development of a CBIR system is the feature extraction module, because the efficiency and accuracy of any image retrieval system depends on the feature extraction module. There are different types of clouds in the atmosphere; broadly categorized these are high level clouds, middle level clouds and low level clouds, these clouds can be better identified in infrared satellite images[2].

***B. Shape Feature Extraction***

Shape is an important feature of image retrieval; it is a local or region feature of an image and is closed to the human perception as humans can better recognize the shape of an object[2][10]. There are two types of Shape descriptors, contour based shape descriptors and the region based shape descriptors, the former deals with the contour or boundary of an object in an image and the latter deals with the contour and the interior of the boundary also [19].

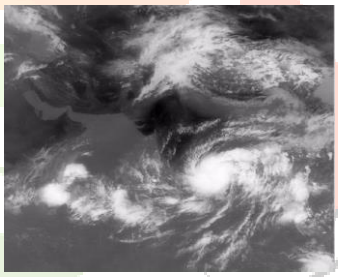

Fig 2.1: infrared satellite image

In this project, the image processing and image morphological operations are used to extract the shape feature from the images .the image in fig 2.1.1 is converted into binary image, to remove the noise. The foreground contains the TC cloud patterns and the clouds of the similar gray levels which are set to 1 and the background contains all the other clouds and is set to 0, the appropriate value of 0.94 is chosen as a threshold value to convert the satellite infrared image to the binary image. Figure 2.1.2 shows the converted binary image of the satellite image in Figure 2.1

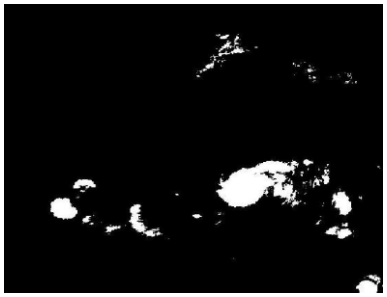

Fig 2..2: Binary image of the infrared satellite image using threshold value 0.94.

***C. Morphological Operations***

Morphological operations produce an output image in which each pixel is based on the comparison of the input image and neighbourhood[2] .Morphological operators relay on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images [9].

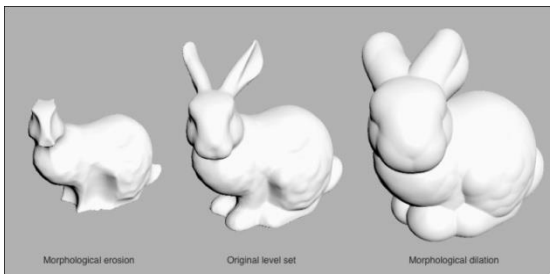


**Fig 2.3 example of morphological operation**

The above figure describes the morphological erosion and dilation operations performed on an image. This reveals the concept of morphology as change in characters of an original images .The word morph as change convey about the changes in shapes. The morphological operators that are used in the matlab are discussed below and their method of implementation is also observed. The morphological operators perform various operations on the original images pixels there by it change the shape.

***D. Strel Function***

The strel operator is defined as structural element it is also a morphological operator [2]. Morphological techniques probe an image with a small shape or template called a **structuring element**. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. Some operations test whether the element "fits" within the neighbourhood, while others test whether it "hits" or intersects the neighbourhood [9].

***E. Properties of binary dilation:***

Here are some properties of the binary dilation operator: It is translation invariant.
It is increasing, that is, if A$\subseteq C$, thenA $\oplus$ B $\subseteq B\oplus$ C.

It is commutative: If the origin of *E* belongs to the structuring element *B*, then it is extensive, i.e., A$\subseteq A \oplus B$ .

It is associative, i.e.,$(A \oplus B) \oplus C = A\oplus(B\oplus C)$. .
It is distributive over set union
From the Figure 2.1.2 it can be seen that there is still noise in the image, all the noise has not been completely removed after converting satellite image in Figure 3.1.1 to binary image using an appropriate threshold value. The boundary pixels are also scattered, the boundary of a satellite image is not properly defined.

*F. Opening and Filling*

The morphological operation **opening** is used to remove the small objects from the image while preserving the shape and size of the larger objects in an image.

Fig 2.4 shows the binary image after the morphological opening operation on the binary image in Fig 2.2.

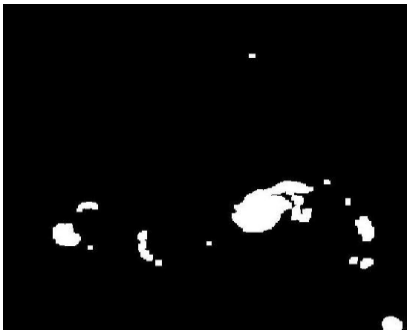

**Fig 2.4 Binary image after the morphological opening operation**

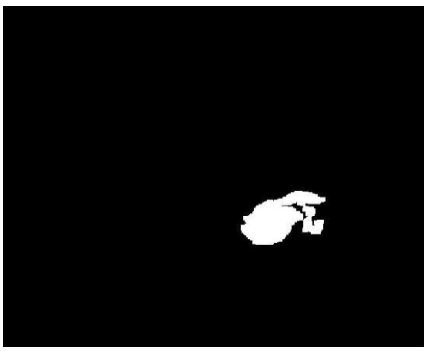

**Fig 2.5 Extracted TC from the satellite image**

Due to experiments on the satellite images used, it is assumed that the TC contains at least 1500 pixels. All the other objects are removed that contains fewer than 1500 pixels. Figure 2.4 shows the binary image having objects that contains more than 1500 pixels.
There remain gaps in the TC as Figure 2.5 to fills the gaps inside the object the morphological operation filling is performed. The output of the **filling** operation is presented in Figure 2.6.

**Fig 2.6 Extracted TC after the morphological filling operation**

*G. Edge Detection*

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness[11]. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision[12].
Fig 2.7 shows the boundary of the extracted TC

**Fig2.7 boundary of extracted TC**

*H. Canny edge detector*

The canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. The general criteria for edge detection includes:-

1. Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible
2. The edge point detected from the operator should accurately localize on the center of the edge.
3. A given edge in the image should only be marked once, and where possible, image noise should not create false edges [12].

**2.7.2 Process of canny edge detection algorithm**

The Process of Canny edge detection algorithm can be broken down to 5 different steps:

1. Apply Gaussian filter to smooth the image in order to remove the noise.
2. Find the intensity gradients of the image.
3. Apply non-maximum suppression to get rid of spurious response to edge detection.
4. Apply double threshold to determine potential edges.

5. Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

## III. IMPLEMENTATION

### *A. Database collection:*

The satellite images are provided by Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC). The dataset is provided in the hierarchical data format .h5 format. This data was imported in the Integrated GIS software for rescaling and exported to tif format for the further processing in Mat lab.

Earth Observation Systems of ISRO for Atmosphere and Ocean Monitoring have been providing continuous data since 2000. The Bhopal Earth Station (BES), at Space Applications Centre, Ahmadabad was established and an operational set-up was positioned in 2006 for data acquisition, data products generation and data dissemination. This service was established through the Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC) (http://mosdac.gov.in). MOSDAC archives and disseminates data from satellites like INSAT, KALPANA-1, Ocean sat, Megha-Tropiques and SARAL. MOSDAC also hosts and disseminates weather related information services and alerts over Mobile devices.

The portal provides a variety of products and services on a wide spectrum of applications comprised of weather forecasting, cyclone prediction and other vital ocean and atmospheric parameters needed by national/international forecasting agencies, research organisations, educational institutions, individual researchers and students for advanced research.

Considering the current trend and the future requirement, MOSDAC has moved towards next generation web infrastructure from web site to content management system with advanced capability for visualisation of data, integration with decision support system, location based services, products disseminated as Open data.

### ***B. Algorithm***

The basic steps involved in the proposed CBIR system include database processing and creation of database, comparison and shape retrieval. Sequential steps of the proposed algorithm are as follows.

Step-1: Read the query image from the database by mentioning its correct path, assign it to a variable and display the image.
Step-2: Resize the query image.
Step -3 Apply masking operation.
Step-4: Convert the query image from red green blue (rgb) to gray.
Step-5: Apply the filtering operation on the query image.
Step-6: Convert the resultant image to binary image.
Step-7: Apply structuring element (strel) function on the image and converting to desired shape.
Step-8: Now perform opening and then filling operations.
Step-9: The canny edge detection is performed on the image and no. of the ones are calculated and stored in the array or excel sheet.

Step-10: This process is performed on the whole data set images and the values that are extracted from them are stored in the array or excel sheet.

Step-11: Sorting the images according to their values and comparing the query image with the database images and displaying the multiple images which are similar in their shape[16][18].
Step-12: The boundary value of a query image is greater than the original image than there is more rain fall if the boundary value of a query is less than the original image than there is less rain fall.

## IV. RESULTS AND DISCUSSIONS

### ***A. Retrieval of Relevant Cloud images***

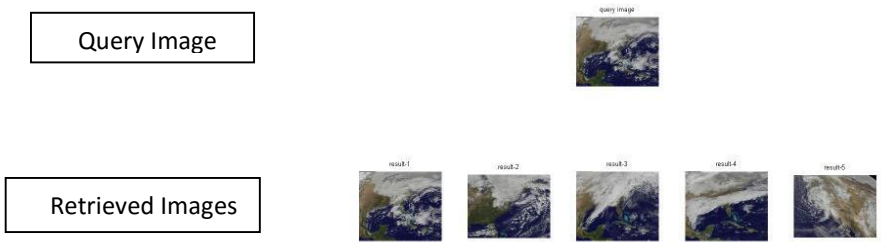


**Fig4.1: retrieving relevant cloud images**

The above images are taken as samples from the database . There are twenty different kinds of each image in the database we need to retrieve them by using above discussed approaches.

*B. Retrieving tropical cyclone images*


**Fig4.2: retrieving relevant cyclone images**

The above images are taken as samples from the database. There are twenty different kinds of each image in the database we need to retrieve them by using above discussed approaches.

*C. Rainfall Forecasting*

CLOUD IMAGE 1 CLOUD IMAGE 2

**Fig4.3 Cloud images**

EDGE OF CLOUD 1 EDGE OF CLOUD 2

Fig 4.4 Edge of Cloud images

TABLEI Rainfall Estimation

| s.no. | image | No.ones | output |
|---|---|---|---|
| 1 | Cloud1 | 35231 | Low Rainfall |
| 2 | Cloud2 | 6548 | High Rainfall |

The above figures (4.4) and Table shows the comparision of two cloud images by finding their number of ones are used to estimate the rainfall.

V.CONCLUSION AND FUTURE SCOPE

This project presents an approach to retrieve the images from the datasets using shape feature extraction. CBIR is used to search a specific image from a large database. By this CBIR technique we are able to retrieve the satellite cloud images from large image database and also describe the image contents with the help of morphological operations [2]. The time and efficiency becomes the major factor as we increase the properties for image retrieval this can be overcome by just calculating the properties of all the images in the data set once and store them in a database so that we can use that data whenever we want so that the time for retrieval can be minimized [4]. Accuracy can be improved [5].

This project reports a detailed survey on rainfall forecasting using shape. Some of the researchers used satellite images of cloud. And some of the researchers used digital image processing technique which is cheaper technique. Researchers have applied different algorithm on cloud. However in these methods some of the drawbacks have been founded. This paper is used in reference for the further development of rainfall forecasting by using shape analysis. This also gives a conclusion that the forecasting techniques that use Content- based cloud image processing and information retrieval (CBIPR), based shape feature extraction algorithm [22].

In future, the accuracy can be increased by using other transforms like curvelet, contourlet etc [23]. The parameters like dew point, temperature, wind direction, humidity and precipitation can be included to increase the performance. Certain specific rainfall estimation algorithms can be used for getting the result in a dynamic way.

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