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Delineation of Lithospheric and Hydrosphere Boundary Using Image Processing Technique

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Abstract:
In this work, we have considered the normal 8 bit image, in which there are lithospheric features such as land, mountains, plateaus, grassland etc; and hydrosphere features such as ponds, lakes, sea or coastal region, etc. We have used the integrated techniques of Edge linking, Histograms modelling and convolution methods, to delineate the lithosphere and hydrosphere boundary in any image below 8 bit. We have also used the method of particle swarm optimization (PSO) techniques to cluster the two boundaries for optimum solution.

Keywords **— Lithospheric boundary, Hydrosphere boundary, Convolution, PSO**

I. INTRODUCTION

The earth is a complex system with a huge variety of geophysical processes many of which are interrelated. We want to understand these processes and monitor their evolution over time both at small scales and global scales. And remote sensing from earth orbiting satellites is one of the only ways we can do that effectively repetitively and consistently for long periods of time. The main objective of this work is to find the difference in the lithosphere attributes and hydrological attributes. The lithosphere attributes consists of soil, desert, mountain, roads, terrains, etc. The hydrological attributes consists of ponds, river, lakes, sea, oceans, etc. The attributes have the similar pattern in the pixel of any image undertaken after processing of remote sensing data. This pattern can be analysed using optimization techniques and incorporating of the machine learning technique for optimized result for geological boundary detection. Such result with alternate boundaries with lithosphere and hydrological attributes can contribute great help for flood intensity map calculations or any natural calamities extend calculations.

Flood or Landslide like calamities can be detected by analysing of lithosphere and hydrological attributes and thus, our system can successfully work in this environment with a lot more efficiency.

Flooding is the world's most costly type of natural disaster. Across the developing world, floods can strike with deadly regularity, destroying housing, agriculture and communications. Well in advance of any flood occurring, satellites can help civil protection planners anticipate where a river would be most prone to burst its banks, and take action accordingly. Satellite data can provide highly detailed digital elevation models of areas at risk that can serve as the basis of computerized flood simulations. During a flood event near-real-time images are a management tool for authorities coping with the disaster. One of the biggest problems is obtaining a clear picture of the overall extent of the flood. Wide area satellite images can show an entire flood within a single picture, with radar instruments especially well-suited for differentiating between waterlogged and dry land. A sequence of satellite images can show if the flood is growing or diminishing over time, and highlight further areas coming under threat of inundation. Simply comparing before and after images of the flooded region makes possible a rapid and authoritative damage assessment estimate, factoring in different land cover types to quantify the cost of the flood.

The techniques described herein assume that more than one dataset, preferably three or more, will be combined to produce a colour image. A dataset is defined as a two-dimensional image of a particular waveband, polarization or other distinct characteristics.

The 16-bit image format currently offers only a modest advantage over 8-bit, as 24-bit colour image formats, the dominant standard, allocate only 8 bits each to the three colour channels. While this may sound like a limitation, 24-bit colour images still can generate over 16 million distinct colours, which is more than current monitors can display, it is far more than can be printed. Thus, to some degree, scaling each dataset into an 8-bit grayscale image is an undesirable but unavoidable step. Fortunately, with the careful selection of a scaling scheme, the structure and detail of the original dataset can be retained with one or more scaling solutions. We are using 24-bit colour images which can generate over 16 million distinct colours.

1.1 Satellite Images

Satellite images are not pictures as usually understood. They carry instruments (sensors) to capture and record multispectral data. That sensor records data from a very small portion of the Earth's surface. This small area is referred to as a pixel. Pixel resolution (size of area measured) goes from a few inches

(reading license plates to larger area). The instruments are designed to pick up as much radiation as needed across many bands. Then the image files are created and set back to Earth for processing. Then out of that comes the images or pictures.
Satellite images are one of the most powerful and important tools used by the meteorologist. They are essentially the eyes in the sky. These images reassure forecasters to the behaviour of the atmosphere as they give a clear, concise, and accurate representation of how events are unfolding. Forecasting the weather and conducting research would be extremely difficult without satellites. Data taken at stations around the country is limited in its representations of atmospheric motion. It is still possible to get a good analysis from the data, but because the stations are separated by hundreds of miles significant features can be missed. Satellite images aid in showing what cannot be measured or seen. In addition the satellite images are viewed as truth. There is no chance for error. Satellite images provide data that can be interpreted "first-hand".

Satellites images give a good representation of what is happening at every point in the world, especially over oceans where large gaps in data occur. Data can only be taken at certain points around the world, though, without this data, forecasting would be just as difficult as not having satellites. It is essential to have both. Having the two together gives a much better understanding as to how the atmosphere is behaving and greatly improves forecasting accuracy.

There are two types of satellites that orbit the Earth, polar and geostationary. Geostationary Operational Environmental Satellites (GOES) remain above a fixed location on the Earth's surface, approximately 22,500 km above the equator. Because the satellites rotate with the Earth, they always view the same portion of the globe. The polar orbiting satellites, in contrast, orbit at much lower elevations (800-900 km). Their path is 2,400 km wide centred at the orbit path. The polar satellites observe a new path on each orbit. Polar satellites are not as useful to operational meteorologists because they do not continuously view the same area. Geostationary satellites allow meteorologists to view the weather as it develops since they view the same area continuously.

1.2 Use of Satellite Images

Satellite images have many applications in meteorology, oceanography, fishing, agriculture, biodiversity conservation, forestry, landscape, geology, cartography, regional planning, education, intelligence and warfare. Images can be in visible colours and in other spectra. There are also elevation maps, usually made by radar images. Interpretation and analysis of satellite imagery is conducted using specialized remote sensing software. Some of the major uses are listed below.

1.2.1 Land surface climatology

Investigation of land surface parameters, surface temperature, etc., to understand land-surface interaction and energy and moisture fluxes.

1.2.2 Vegetation and ecosystem dynamics

Monitoring of vegetation and soil distribution and their changes to estimate biological productivity, understand land-atmosphere interactions, and detect ecosystem change.

1.2.3 Volcano monitoring

Monitoring of eruptions and precursor events, such as gas emissions, eruption plumes, and development of lava lakes, eruptive history and eruptive potential.

1.2.4 Hazard monitoring

Observation of the extent and effects of wildfires, flooding, coastal erosion, earthquake damage and tsunami damage.

1.2.5 Hydrology

Understanding global energy and hydrologic processes and their relationship to global change; included is evapotranspiration from plants

1.2.6 Geology and soils

The detailed composition and geomorphologic mapping of surface soils and bedrocks to study land surface processes and earth's history

1.2.7 Land surface and land cover change

Monitoring desertification, deforestation, and urbanization; providing data for conservation managers to monitor protected areas, national parks, and wilderness areas

1.3 Challenges in satellite image processing

Satellite image processing has proven to be a powerful tool for the monitoring of the earth’s surface to improve our perception of our surroundings has led to unprecedented developments in sensor and information technologies. However, technologies for effective use of the data and for extracting useful information from the data of Satellite image processing are still very limited since no single sensor combines the optimal spectral, spatial and temporal resolution. The conclusion of this, according to literature, the remote sensing still lacks of software tools for effective information extraction from Satellite image processing data.
The trade-off in spectral and spatial resolution will remain and new advanced data fusion approaches are needed to make optimal use of remote sensors for extract the most useful information. Satellite image processing on board satellites techniques have proven to be powerful tools for the monitoring of the earth’s surface and atmosphere on a global, regional, and even local scale, by providing important coverage, mapping and classification of land cover features such as vegetation, soil, water and forests.
Sensor limitations are most often a serious drawback since no single sensor offers at same time the optimal spectral, spatial and temporal resolution.

1.4 Solution to current challenges in satellite image processing

The objectives of proposed method is to present an advanced method for combination of multi-spectrum RGB images for multi-spectrum image fusion. The proposed method can be the way to analyse the maxima features in a particular image. Image processing on satellites images have frequently been used to contribute to disaster management. The most common, best understood, and operational of these uses is that of weather, satellites for cyclones, storms and, in some cases, flash floods. These systems have certain clear advantages. For instance, there are many orbiting and geostationary satellite services available, and coverage of almost any part of the world is available in small timescales ranging from hours to a few days. Further, imagery from these satellites is relatively cheap or freely available, and the scale of the events roughly matches the resolution of the satellite imagery. Spatial resolution, image extent and spectral characteristics play a large role in determining whether or not a particular sensor or data type is capable of detecting individual hazards, by properly comparing the system into geological and hydrogeological attributes. There are a number of other provision on the ability of a satellite sensor to monitor a disaster. Where imagery cannot be recorded on board the satellite, and where there is no local receiving station coverage or where a local receiving station is not licensed for a particular satellite, data cannot be collected.

For many parts of the world, medium to high resolution remote sensing satellites will only acquire data after the satellite has been programmed to do so. In these circumstances, coverage of the affected area is likely to be delayed and possibly missed. However, when major disasters unfold, most satellite operators will schedule imagery collection, even without confirmed programming requests, either on humanitarian grounds or in the hope of data sales. This all the satellite image processing drawback effects the whole disaster mitigation process, so we are processing the novel techniques to integrate the system by various combination of algorithm with image segmentation technique to amalgamates the geological boundary data with geohydrology data and lithosphere data like HI climb mountains, terrain, sedimentary basin, rifts etc.

II Literature Survey

In this chapter, the previously accomplished work is discussed focusing on approaches used, algorithms and techniques used and gaps or shortcomings where future work can be done.

The quality of modern satellite data, the power of modern computers and the agility of current image-processing software enable the creation of high-quality images in a purely digital form. The combination of these technological advancements has created a new ability to make colour satellite images.

The processed image after remote sensing is interpreted visually or electronically or digitally to extract the information about the illuminated target. Remote sensing systems which measure reflected energy are called passive sensors, which can be used only to detect energy in the present of naturally occurring energy. This can take place only during the time when the sun is illuminating the earth. An active sensor provides its own energy source for illumination.

The sensors emit radiation which is directed towards the target to be investigated; these sensors obtain the information regardless of the time of day. In order to capture the earth's surface the sensors must be paced in a proper platform. Before it was ground-based and aircrafts platforms, nowadays satellite near-polar orbits platform provides a great contribution to remote sensing imagery.

The Multispectral satellite sensor provides digital raster images, that allow us to apply Digital Image Processing (DIP) techniques to develop thematic maps of land use/land cover classes which are essential in many remote sensing applications like forestry, agriculture, environmental studies, weather forecasting, ocean studies, archaeological studies etc.

The use of image processing within the domain of natural hazards and disasters has become increasingly common, due in part to increased awareness of environmental issues such as climate change, but also to the increase in geospatial technologies and the ability to provide up-to-date imagery to the public through the media and internet. As technology is enhanced, demand and expectations increase for near-real-time monitoring and visual images to be relayed to emergency services and the public in the event of a natural disaster. Recent improvements to earth monitoring satellites are paving the way to supply the demand. Techniques needed to exploit the available data effectively and rapidly must be developed concurrently, to ensure the best possible intelligence is reaching emergency services and decision makers in a timely manner.

Usually there are four phases of the disaster management cycle include reduction (mitigation), readiness (preparedness), response and recovery [Cartwright, 2005].

Remote sensing has a role to play in each of these phases, though this paper focuses primarily on its contribution to the response phase. Several different types of natural hazards and disasters assessments can be studied and by analysing of geological boundaries with full efficiency by using various algorithm we can overcome the visualization of satellite images for rescue operations.

2.1Related Work

2.1.1 Damage Identification and assessment using image processing on post disaster satellite imagery

- Aparna Joshi, IshaTarte "Damage Identification and assessment using image processing on post disaster satellite imagery" 2017 IEEE *Global Humanitarian Technology Conference (GHTC). [A R Joshi 2017]*
    - In this paper, SLIC i.e. simple linear iterative clustering is used for segmenting which is a simple method to decompose an image in visually homogeneous regions which is based on spatially localized version of k-means clustering.
    - Random forest algorithm is used for classificationwhich works by creating a set of

decision trees from randomly selected subset of training set, aggregating the votes from different decision trees to decide the final class of the test object. This algorithm has high accuracy results.

- The proposed method has 90% accuracy but it does not support multi-class classification.

2.1.2 Automatic detection of damaged buildings after earthquake hazard by using remote sensing and information technologies

- Aydan Menderes, ArzuErener, GulcanSarp, "Automatic detection of damaged buildings after earthquake hazard by using remote sensing and information technologies" Elsevier 2015 [Menderes 2015]
- Uses DTM i.e. digital terrain model for plain land detection which has workflow of data capture, data preprocessing and DEM generation and concludes with calculation of one or more primary and secondary land surface parameter.
- DSM i.e. digital surface model is used for building, roads detection which is obtained using LiDAR which measures reflected light that bounces off the ground and back to the sensor to obtain elevation of earth's surface.
- The proposed method has 93.64% accuracy however, the quality of result is highly dependent on quality of DSM used.

2.1.3 Building change detection after earthquake using multi-criteria decision analysis based on extracted information from high spatial resolution satellite images

- MiladJanalipour, Mohammad Taleai, "Building change detection after earthquake using multi-criteria decision analysis based on extracted information from high spatial resolution satellite images" Taylor and Francis Group 2016 [MiladJanalipour 2016]
- Adaptive network based fuzzy inference system is used which is a combination of fuzzy systems and neural networks. To address real world problems, ANFIS is extremely useful as it addresses objective knowledge as well as subjective knowledge i.e. knowledge including mathematical models and design requirements.
- Proposed method gives 89.62% accuracy in detecting changed and unchanged buildings pre and post-earthquake but the system does not support expert knowledge.

2.1.4Detection of flooded urban areas in high resolution synthetic aperture radar images using double scattering

- D.C.Mason, L.Giustarini,J. Garcia-Pintado, H.L.Cloke, "Detection of flooded urban areas in high resolution synthetic aperture radar images using double scattering" Elsevier 2014 [D.C. Mason 2014]
- This paper investigates whether urban flooding can be detected in layover region using double scattering between ground surface and walls of adjacent buildings. The method estimates double scattering strengths using SAR image in conjunction with a high resolution LiDAR height map of the urban area.
- A SAR simulator is applied to the LiDAR data to generate maps of layover and shadow and estimate the positions of double scattering curves in the SAR image.
- Flooded curves detected with 100% accuracy and un-flooded curves detected with 91% accuracy but the result is highly dependent on high resolution DSM.

2.1.5 A review of road extraction from remote sensing images

- Weixing Wang, Nan Yang, Yi Zhang, Fenping Wang, Ting Cao, PatrikEklund, "A review of road extraction from remote sensing images" Elsevier 2016 [Weixing Wang 2016]
- This paper firstly analyzes road features, road model, existing difficulties and interference factors for road extraction. Secondly, the principle of road extraction, advantages and disadvantages of various methods and research achievements are briefly highlighted.
- Conclusion states that single method is not enough to get optimal results of road extraction thus various methods need to be combined in order to be used in real applications.

2.1.6 A robust anisotropic edge detection method for carotid ultrasound image processing

- Jose Rouco, CatarinaCarvalho, "A robust anisotrophic edge detection method for carotid ultrasound image processing" Elsevier 2018 [Jose Rouco 2018]
- The proposed method uses anisotropic Gaussian derivative filters along with non-maximum suppression over the overall artery wall orientation in local regions. The anisotropic filters allow using a wider integration scale along the edges while preserving the edge location precision. However, this usually results in false edges being detected near convex contours and isolated points.
- The use of non-maximum suppression over pooled local orientation is proposed to solve the false edges issue. The resulting edges are more continuous and precisely located.

- The result is clearly better than previous methods but still generates false edges near isolated and high curvature contour.

2.1.7 Depth edge detection by image-based smoothing and morphological operations

- Syed Mohammad AbidHasan, KwangheeKo, "Depth edge detection by image-based smoothing and morphological operations", Elsevier 2016 [Syed Mohammad 2016]

- The principle of Median filtering is used, which has a renowned feature for edge preservation properties. The edge detection is done on Canny Edge detection principle and was improvised with morphological operations which are represented as combinations of erosion and dilation.

- The method gives better results compared to results of previous methods. However this method works in multiframe applications with effective frame rates. But the frame rate does not reach up to real time level.

2.1.8 Identification of Satellite image by using DP clustering algorithm for image segmentation and clustering

- S. Sowmiya, S.P. Yazhini, "Identification of Satellite image by using DP clustering algorithm for image segmentation and clustering" JCHPS 2017 [S. Sowmiya 2017]

- The steps carried out in this paper are preprocessing, image segmentation and clustering. Preprocessing is done by using 2D-DWT (discrete wavelet transform) in order to remove unwanted noise, corrects intensity, enhances edges and adjusts contrast. Image segmentation and clustering is done by using DP clustering algorithm.

- Proposed system has higher accuracy than existing system as results imply. However, it has drawback of over segmentation.

2.1.9 Object Recognition based on image segmentation and clustering

- S. Thilagamani, N. Shanthi, "Object Recognition based on image segmentation and clustering" Research Gate 2011 [S. Thilagamani 2011]

- The proposed method is divided into two processes. The first process deals with detecting object parts into several clusters. All these cluster centers form the visual words. The second process deals with over segmenting the image into super pixels and formation of larger sub region using mid-level clustering algorithm, since it incorporates various information to decide the homogeneity of a sub region.

- It gains better results than previous methods but can identify single object only.

2.1.10 An algorithm for coastline extraction from satellite imagery

- DejanVukadinov, RakaJovanovic, Milan Tuba, "An algorithm for coastline extraction from satellite imagery" [DejanVukadinoy 2017]

- The proposed method is based on Canny edge detection and threshold. Proposed algorithm consists of five main steps viz. image extraction, histogram matching, Gaussian blur filter, locally adaptive threshold, edge detection.

- The system is tested using different artificial island of Dubai coastline. Though the images are very complex, results obtained are accurate. But the system has delineation errors.

2.1.11 Seismic Attenuation Characteristics along the Hi-CLIMB Profile in Tibet from Lg Q Inversion

- Chandrani Singh, M. Shekar, Arun Singh, and R. K. Chadha"Seismic Attenuation Characteristics along the Hi-CLIMB Profile in Tibet from Lg Q Inversion",Bulletin of the Seismological Society of America, Vol. 102, No. 2, pp. 783–789, April 2012, doi: 10.1785/0120110145
- The proposed method is based on Lg coda Q modeling and inversion method using convolution models.
- Period of analysis is very high, and data collection time need be short for more accuracy of the data.

2.1.12 A review of the status of satellite remote sensing and image processing techniques for mapping natural hazards and disasters

- Karen E. Joyce,1* Stella E. Belliss,2 Sergey V. Samsonov,1 Stephen J. McNeill2 and Phil J. Glassey1, "A review of the status of satellite remote sensing and image processing techniques for mapping natural hazards and disasters", Progress in Physical Geography 33(2) (2009) pp. 183–207 DOI: 10.1177/0309133309339563.
- This paper addresses a number of data types and image processing techniques used to map and monitor earthquakes, faulting, volcanic activity, landslides, flooding, and wildfire, and the damages associated with each.
- It is not possible to recommend a single data type or processing solution that will work under all conditions.

2.1.13 Time-lapse seismic modelling of CO2 fluid substitution in the Devonian Redwater Reef, Alberta, Canada

- Taher M. Sodagar and Don C. Lawton,"Time-lapse seismic modelling of CO2 fluid substitution in the Devonian Redwater Reef, Alberta, Canada

"Geophysical Prospecting doi: 10.1111/1365-2478.12100

- The system has lot of integration of algorithm, and the result are dependent upon the quality of input data.

In this chapter we thoroughly studied related work and approaches used in earlier work in this field. It will be used as a guideline to design proposed system design and deciding which areas need improvement and how it can be achieved. In this chapter we thoroughly studied related work and approaches used in earlier work in this field. It will be used as a guideline to design proposed system design and deciding which areas need improvement and how it can be achieved. Some major shortcomings like being able to detect only single object at a time, over segmentation and high input dependency are targeted to be overcome in proposed method by using most effective algorithms in terms of accuracy and performance.

III Proposed Method

This chapter gives detailed information about the problem being addressed and algorithms and techniques that will be used and how they are suitable for gaining expected result, detailed design and flowchart are presented.

3.1 Problem Statement

Floods cause large scale damage to life and the rescue measures are widely unplanned without any proper guide as to where the water levels are high and which areas were flooded first and need to be on the priority list for rescue operation/relief measures. These are the things we have to evaluate through our Image Processing technique by differentiating different spectrum of waves and analyzing different features of particular location. The exact timeline of which region got flooded first can provide useful information to rescue teams to follow and save as many lives possible by starting from the most affected regions first rather than rescuing from the periphery.

3.2 Project Objective

The Objective of this research work, is to integrate the converted satellite data towards interpreting the simultaneous result for geological boundary and spectral boundary for any satellite image. The flooded region can be identified using the spectral boundary by clustering the like pixels data with histogram convolution and particle swarm optimization model together; to easily differentiate between land-water, water-Greenland and Greenland-land boundary.

3.3 Architecture and Working of System

The proposed system works in four major steps viz. pre-processing, segmentation, histogram and convolution generation and clustering. The segmentation is performed and its result is used to generate histogram and is convolved. The histogram and convolution model of input is supplied to Particle swarm optimization algorithm which does optimization and clustering.

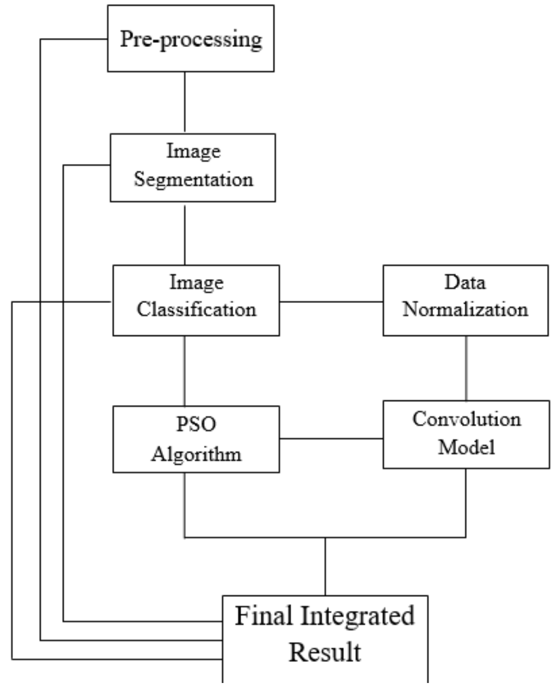

Fig 3.1 Architecture of proposed system

3.3.1 Working

- Preprocessing will be carried out on input image in order to remove noise.
- Segmentation of image will be analyzed.
- Integrate the segmentation, enhancement and resolution result with the particular images convolution model and histogram model.
- Convolution and histogram model of the particular image will be the input for particle swarm optimization technique for land-water, water-greenland and greenland-land boundary.
- Technically they are done by differentiating lithosphere attributes such as land, rift, desert, mountain etc with respect to hydrosphere attributes such as ponds, lakes, basins, coastal areas etc.
- Then clustering is carried out on the received data or image.
- Then a dynamic raw image will be generated which can easily differentiate between land-water, water-greenland and greenland-land boundary.

3.4 Algorithms Used

3.4.1 Edge Detection

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. It will be used in proposed method for image segmentation and detecting discontinuity. Fig 3.2 shows original image on left side and result after edge detection on right side.

Fig 3.2 Edge Detection

Edge detection includes a variety of mathematical methods that aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. The same problem of finding discontinuities in one-dimensional signals is known as step detection and the problem of finding signal discontinuities over time is known as change detection. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction. [Umbaugh,Scott E 2010]

Although certain literature has considered the detection of ideal step edges, the edges obtained from natural images are usually not at all ideal step edges. Instead they are normally affected by one or several of the following effects:

- Focal blur caused by a finite depth-of-field and finite point spread function.
- Penumbral blur caused by shadows created by light sources of non-zero radius.
- Shading at a smooth object

3.4.2 Histogram and Thresholding

Image thresholding is a simple, yet effective, way of partitioning an image into foreground and background. This image analysis technique is a type of image segmentation that isolates objects by converting grayscale images into binary images. It will be used in proposed method to handle images with high contrast. Fig 3.3 shows how histogram of image changes after its transformation.

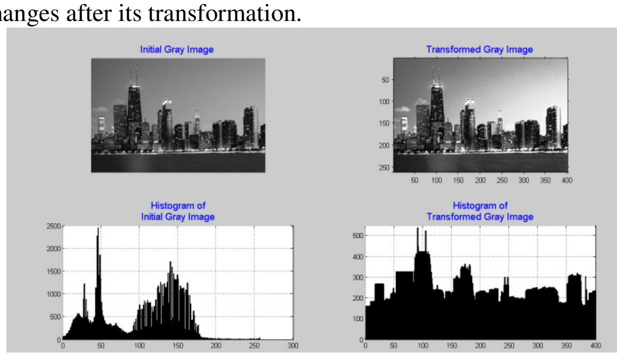

Fig 3.3 Histogram of initial and transformed image

To make thresholding completely automated, it is necessary for the computer to automatically select the threshold T. Sezgin and Sankur (2004) categorize thresholding methods into the following six groups based on the information the algorithm manipulates (Sezgin et al., 2004):

- Histogram shape-based methods, where, for example, the peaks, valleys and curvatures of the smoothed histogram are analyzed
- Clustering-based methods, where the gray-level samples are clustered in two parts as background and foreground (object), or alternately are modeled as a mixture of two Gaussians
- Entropy-based methods result in algorithms that use the entropy of the foreground and background regions, the cross-entropy between the original and binarized image, etc.[Zhang, Y. (2011).]
  Zhang, Y. (2011). "Optimal multi-level Thresholding based on Maximum Tsallis Entropy via an Artificial Bee Colony Approach". Entropy. 13 (4): 841–859. doi:10.3390/e13040841.
- Object Attribute-based methods search a measure of similarity between the gray-level and the binarized images, such as fuzzy shape similarity, edge coincidence, etc.
- Spatial methods [that] use higher-order probability distribution and/or correlation between pixels
- Local methods adapt the threshold value on each pixel to the local image characteristics. In these methods, a different T is selected for each pixel in the image.

3.4.3 Convolution Model

In convolution, one of the input array is gray level image. Second array is usually much smaller and is also two dimensional and is known as kernel. The convolution is performed by sliding the kernel over the image, generally starting at top left corner. Each kernel position corresponds to a single output pixel, the value of which is calculated by multiplying together the kernel value and underlying image pixel value for each of the cells in kernel and then adding these numbers together. It will be used in proposed method because it can achieve blurring, sharpening, edge detection and noise reduction. Fig 3.4 shows how a single pixel is mapped during convolution process using kernel.

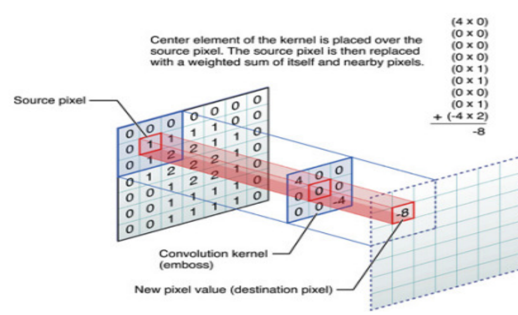

Fig 3.4 Convolution of image

There are several possible notations to indicate the convolution of two (multi-dimensional) signals to produce an output signal. The most common are:

$$c = a \otimes b = a * b$$

We shall use the first form $c = a \otimes b$, with the following formal definitions.
In 2D continuous space:

$$C(x,y) = a(x,y) \otimes b(x,y) = \int_{-00}^{+00}\int_{-00}^{+00} a(\chi,\zeta) b(x-x, y-\zeta) d\lambda d\zeta$$

In 2D discrete space:

$$C[m,n] = 0[m,n] \otimes b[m,n] = \sum_{j=-00}^{+00}\sum_{k=00}^{+00} a[j,k] b[m-j, n-k]$$

- **Properties of Convolution**

There are a number of important mathematical properties associated with convolution.
* Convolution is commutative.
$c = a \otimes b = a \otimes b$
* Convolution is associative.
$c = a \otimes (b \otimes c) = (a \otimes b) \otimes c = a \otimes b \otimes c$
* Convolution is distributive.
$c = a \otimes (b + d) = (a \otimes b) + (a \otimes d)$
Where *a, b, c*, and *d* are all images, either continuous or discrete.
Parseval's theorem (2D continuous space) [Parseval 1806]is : Parseval des Chênes, Marc-Antoine Mémoiresur les sériesetsurl'intégrationcomplètedd'uneéquation aux différencespartielleslinéaire du second ordre, à coefficients constants" presented before the Académie des Sciences (Paris) on 5 April 1799.

$$E = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} |a(x,y)|^2 dxdy = \frac{1}{4\pi^2}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} |A(u,v)|^2 dudv$$

Parseval's theorem (2D discrete space):

$$E = \sum_{m--\infty}^{+\infty}\sum_{\pi--\infty}^{+\infty} |a[m,n]|^2 = \frac{1}{4\pi^2}\int_{-\pi}^{+\pi}\int_{-\pi}^{+\pi} |A(\Omega,\Psi)|^2 d\Omega d\Psi$$

This "signal energy' is not to be confused with the physical energy in the phenomenon that produced the signal. If, for example, the value *a[m,n]* represents a photon count, then the physical energy is proportional to the amplitude 'a', and not the square of the amplitude. This is generally the case in video imaging. Given three, two-dimensional signals *a, b,* and *c* and their Fourier transform *A,B,* and *C:*

$$c = a \otimes b \xleftrightarrow{F} C = A \bullet B$$

and

$$c = a \bullet b \xleftrightarrow{F} C = \frac{1}{4\pi^2} A \otimes B$$

In words, convolution in the spatial domain is equivalent to multiplication in the Fourier (frequency) domain and vice-versa. This is a central result which provide not only a methodology for the implementation of a convolution but also insight into how two signals interact with each other—under convolution – to produce a third signal. We shall make extensive use of this result later.

If a two-dimensional signal $a(x, y)$ is scaled in its spatial coordinates then:

$$If\ a(x,y) \rightarrow a(M_x \bullet x, M_y \bullet y)$$

$$Then\ A(u,v) \rightarrow A(u/M_x, v/M_y)/|M_x \bullet M_y|$$

If a two-dimensional signal $a(x, y)$ has Fourier spectrum $A(u,v)$ then:

$$A(u=0, v=0) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} a(x,y) dxdy$$

$$a(x=0, y=0) = \frac{1}{4\pi^2}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} A(u,v) dxdy$$

- If a two-dimensional signal $a(x, y)$ has Fourier spectrum $A(u,v)$ then:

$$\frac{\partial a(x,y)}{\partial x} \xleftrightarrow{F} juA(u,v) \qquad \frac{\partial a(x,y)}{\partial y} \xleftrightarrow{F} jvA(u,v)$$

$$\frac{\partial^2 a(x,y)}{\partial x^2} \xleftrightarrow{F} -u^2 A(u,v) \qquad \frac{\partial^2 a(x,y)}{\partial y^2} \xleftrightarrow{F} -v^2 A(u,v)$$

3.4.4 Particle Swarm Optimization

In a PSO system, a swarm of individuals (called particles) fly through the search space. Each particle represents a candidate solution to the optimization problem. The position of a particle is influenced by the best position visited by itself (i.e. its own experience) and the position of the best particle in its neighborhood (i.e. the experience of neighboring particles). When the neighborhood of a particle is the entire swarm, the best position in the neighborhood is referred to as the global best particle, and the resulting algorithm is referred to as a gbest PSO. When smaller neighborhoods are used, the algorithm is generally referred to as albest PSO.
PSO will be used in proposed method because, it is simple to implement, has high efficiency and does not overlap and mutate.
Particle swarm optimizers (PSO) are population-based optimization algorithms modeled after the simulation of social behavior of bird flocks [Kennedy, Eberhart,1995], [Kennedy, Eberhart,2001].

Kennedy, J.; Eberhart, R.C. (2001). Swarm Intelligence. Morgan Kaufmann. ISBN 1-55860-595-9.

In a PSO system, a swarm of individuals (called *particles*) fly through the search space. Each particle represents a candidate solution to the optimization problem. The position of a particle is influenced by the best position visited by itself (i.e.

its own experience) and the position of the best particle in its neighborhood (i.e. the experience of neighboring particle.

When the neighborhood of a particle is the entire swarm, the best position in the neighborhood is referred to as the global best particle, and the resulting algorithm is referred to as a *gbest*PSO. When smaller neighborhoods are used, the algorithm is generally referred to as a *lbest*PSO [Y. Shi, R. Eberhart,1998].

Shi, Y.; Eberhart, R.C. (1998). "A modified particle swarm optimizer". Proceedings of IEEE International Conference on Evolutionary Computation. pp. 69–73.

The performance of each particle (i.e. how close the particle is from the global optimum) is measured using a fitness function that varies depending on the optimization problem.

Each particle in the swarm is represented by the following characteristics:

xi : The current position of the particle;

vi : The current velocity of the particle;

yi : The personal best position of the particle.

For each iteration of a PSO algorithm, the velocity ***vi*** update step is specified for each dimension j= 1..*Nd*, where *Nd*is the dimension of the problem. Hence, *vij*represents the j^{th} element of the velocity vector of the i^{th} particle. Thus the velocity of particle *i*is updated as using the following equation:

$$v_{i,j}(t+1) = wv_{i,j}(t) + c_1 r_{1,j}(t)(y_{i,j}(t) - x_{i,j}(t)) + c_2 r_{2,j}(t)(\hat{y}_j(t) - x_{i,j}(t))$$

Where *w* is the inertia weight [Y. Shi, R. Eberhart,1998], $C_1$and $C_2$are the acceleration constants and r_{1j} €[0,1]and r_{2j} €[0,1].

The position of particle *i*, ***xi***, is then updated using the following equation:

$$x_i(t+1) = x_i(t) + v_i(t+1) \quad (2)$$

The algorithm can be summarized as follow [MohdAfiziMohdShukran, Yuk Ying Chung, Wei-Chang Yeh, Noorhaniza Wahid and Ahmad Mujahid Ahmad Zaidi,2011]:

1) Initialise: Initialise parameters and population with random position and velocities.

2) Evaluation: Evaluate the fitness value (the desired objective function) for each particle.

3) Find the gbest: If the fitness value of particle i is better than its best fitness value (pbest) in history, then set current fitness value as the new pbest to particle i.

4) Find the gbest: If any pbest is updated and it is better than the current gbest, then set gbest to the current value.

5) Update position: update velocity for each particle by applying equation (1) and (2).

In relation to PSO the word convergence typically refers to two different definitions:

Convergence of the sequence of solutions (aka, stability analysis, converging) in which all particles have converged to a point in the search-space, which may or may not be the optimum,

Convergence to a local optimum where all personal bests p or, alternatively, the swarm's best known position g, approaches a local optimum of the problem, regardless of how the swarm behaves. It has been shown by [Clerhorn 2014] that these simplifications do not affect the boundaries found by these studies for parameter where the swarm is convergent.

Cleghorn, Christopher W (2014). "Particle Swarm Convergence: Standardized Analysis and Topological Influence". Swarm Intelligence Conference.

3.6 Applications

3.6.1 Disaster mitigation planning and recovery

The result of a natural calamity can be devastating and at times difficult to assess. But disaster risk assessment is necessary for rescue workers. This information has to be prepared and executed quickly and with accuracy. Object-based image classification using change detection (pre- and post-event) is a quick way to acquire damage assessments data. Other similar applications using satellite imagery in disaster assessments include measuring shadows from buildings and digital surface models.

3.6.2 Agriculture Development

With increasing population across the world and the need for increased agricultural production there is a certain need for proper management of the world's agricultural resources. To make this happen it is first necessary to obtain reliable data on not only the types, but also the quality, quantity and location of these resources. Satellite imagery and GIS (Geographic Information Systems) will always continue to be a significant factor in the improvement of the present systems of acquiring and generating agricultural maps and resource data. Agriculture mapping and surveys are presently conducted throughout the world, in order to gather information and statistics on crops, range land, livestock and other related agricultural resources.

3.6.3 3D GIS

3D city models are digital models of urban areas that represent Terrain surfaces, sites, buildings, vegetation, infrastructure and Landscape elements as well as related objects belonging to urban areas. Their components are described and represented by corresponding two-dimensional and three-dimensional spatial data and geo-referenced data. 3D city models support presentation, exploration, analysis, and management of tasks in a large number of different application domains. 3D GIS is the instant and effective Solution for larger and remote locations where manual survey is next to impossible. Various urban/ rural planning departments require 3D GIS data like, Drainage, Sewerage, water supply, Canal Designing BIM and may more.

3.6.4 Providing base map for graphical reference and assisting planners and engineers

The amount of details that an orthoimagery produces using high resolution satellite imagery is of immense value as it provides a detail image of the selected area along with its surrounding areas. As maps are location-based they are specifically designed to communicate highly structured data and to give a complete picture about the whole world. There are numerous applications of satellite imagery and remote sensing data. Today nations use information derived from the satellite imagery for government decision making, civil defense operations, police and Geographic Information Systems (GIS) in general. These days, data captured through Satellite Imagery has become mandatory and all government plans are to be submitted on the basis of Satellite Imagery data.

IV Conclusion

The proposed method is designed considering the shortcomings and guidelines of existing methods for satellite image processing techniques. Its output will be used for mitigation and rescue operations in natural calamities like flood. The proposed method can be the advanced way to analyze the maxima features in a particular image. It will analyze the basic segmentation of image, and then integrate the segmentation, enhancement and resolution result with the particular images convolution model and histogram model. This convolution and histogram model of the particular image will be the input for particle swarm optimization technique for land-water, water-Greenland and Greenland-land boundary.

The results obtained from proposed method will be a great measure for predicting and analyzing impact of floods. It will help rescue teams to address high alert areas first so, minimum or no loss of life will be achieved.

In future, the method can be modified to be used for coastline detection, urbanization, deforestation and earthquakes.

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