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Water Bodies Mapping in Remotely Sensed Satellite Images

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ABSTRACT: Life on Earth depends on water, yet water resources are severely stressed by the rapid growth of the human population and activities. In arid environments the exploration and monitoring of water resources is a prerequisite for water accessibility and rational use and management[1]. To survey large arid areas for water, conventional land-based techniques must be complemented by using satellite and airborne remote sensors. Surface water systems can be mapped using image processing techniques; this study assessed the benefits of using higher spatial resolution images. This work attempts to provide a solution to detect or map water bodies in remotely sensed aerial images using image segmentation and image morphology techniques, after applying segmentation and morphology techniques to a input images it will highlights the water bodies. The whole work was done on actual satellite images of Tapi River, Bhusawal, Jalgaon, M.S. , India region.

KEYWORDS*:* Remote sensing; segmentation; morphology; threshold; image processing

I. INTRODUCTION

Water resources are sources of water that are useful or potentially useful to humans. It is important because it is needed for life to exist. Only a small fraction of the Earth's water is available as freshwater, water plays a key resource in many economic activities ranging from agriculture to industrial production. At present, water resources are severely stressed and particularly scarce in arid regions of the world. In many arid and semiarid regions, water shortage is a major obstacle to sustainable development and poverty alleviation and the cause of serious conflicts between some countries. Water shortage in arid regions can be further aggravated by the global climate change that is predicted to severely impact these regions. Thus, exploration, mapping, and monitoring of water resources are a prerequisite for the availability, accessibility, fair utilization, and rational management of water resources in arid and semiarid regions.

Many image processing and analysis techniques have been developed to aid the interpretation of remote sensing images and to extract as much information as possible from the images. Remote Sensing refers to the science of identification of earth surface features by measuring portion of reflected or emitted electromagnetic radiation from earth's surface by sensors onboard manmade satellites orbiting around the earth. The output of a remote sensing system is usually an image representing the scene being observed. Many further steps of digital image processing and modelling are required in order to extract useful information from the image, suitable techniques are adopted for a given theme, depending on the requirements of the specific problem[2]. Although digital analysis of remotely sensed data dates from the early days of remote sensing, the launch of the first Landsat earth observation satellite in 1972 began an era of increasing interest in machine processing. Previously, digital remote sensing data could be analyzed only at specialized remote sensing laboratories. Specialized equipment and trained personnel necessary to conduct routine machine analysis of data were not widely available, in part because of limited availability of digital remote sensing data and a lack of appreciation of their qualities[3].

The area selected for water bodies mapping is Bhusawal also spelt as Bhusaval is a municipal council in Jalgaon district in the state of Maharashtra, India. Bhusawal is located on the bank of Tapi river, Tapi River is a river of western India . It is one of the major rivers of west coast river system of India with a length around 724 km. It originates from the Satpura range of hills, Betul district of Madhya Pradesh. The flow of Tapi River covers Maharashtra Madhya Pradesh and Gujarat state and empty into the Arabian Sea[4]. Bhusawal is also situated near the Satpura hills range, and the climatic condition created by this Satpuda hills and Tapi river arrangement makes this area more popular for banana cultivation and other agricultural products, thus the mapping this agriculturally useful Tapi river basin water bodies becomes a very crucial task.

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II. RELATED WORK

The term Remote Sensing is applied to the study of earth's features from images taken from space using satellites. India has strived ahead in the field of remote sensing using satellite and made good use of satellite images. The satellite launching program of our country is one of the most ambitious in the world, and is still continuing to be so in the future as well, the Water Resources Engineers have benefited greatly by using satellite imaging techniques. Remote sensing means assessing the characteristics of a place usually the surface of the earth from a distance. Though this term was coined during the 1960's, similar technology had been practiced earlier like fitting a camera to a balloon and allowing it to float over the earth's surface taking pictures, which may then be developed and interpreted for specific purpose like geology, agriculture, forestry etc. Photogrammetry, which is, taking pictures of the land surface from a low flying aircraft and comparing subsequent pictures to obtain the terrain map, has been extensively used in the last century and many books have been written on the subject, in satellite remote sensing cameras are fitted to the orbiting satellite and are focused towards the earth.

In [1], an attempt is made to provides an overview of satellite and airborne remote sensing techniques for managing water resources and monitoring drought in arid and semiarid regions, they used data from high-resolution commercial satellites, such as IKONOS and QuickBird, have been used to produce more detailed maps of small freshwater areas. In [2] author reviews the digital image processing techniques for information extraction from high resolution satellite images. In [3] an author describes the basic technological aspects of Digital Image Processing with special reference to satellite image processing; article [3] involves the analysis of multispectral image data and the application of statistically based decision rules for determining the land cover identity of each pixel in an image. In [5] author gives a brief overview of the potential applications of remote sensing in water resources, author includes remote sensing, water resource mapping, hydrology, rainfall-runoff, drought management, flood forecasting and more about water resources management using remote sensing. In [6] the river water level identification is done using support vector machines. In order to achieve this, the input satellite image is preprocessed and subsequently the segmentation is carried out with the aid of the anisotropic diffusion segmentation. Support Vector Machine (SVM) is utilized to identify the river spot in the input image in which contains land also and then the morphological operation is utilized to smooth the image. Consequently, in the testing phase, the image is tested with the SVM for water region identification and also another one SVM is utilized for the identification of the river stage. In [7] an object oriented shadow detection and removal method is used in high resolution remote sensing images, the shadow features are evaluated through image segmentation, where the features of the shadow are obtained with the spectral and spatial characteristics of the image. Histogram based threshold value method is used to detect the suspected shadows in which the false shadows are ruled out and the real shadows get detected.

III. SCOPE OF RESEARCH WORK

Mapping of the surface water bodies using remote sensing techniques finds applications in the areas rainfall-runoff, modeling, irrigation management, flood forecasting, drought monitoring, water harvesting and watershed planning and management. Water resources play an important role in environmental, transportation and regional planning, disaster management, industrial and agricultural production.

The area which is selected for water bodies mapping; agriculture is the major source of livelihood and as we know in India agriculture is the backbone of economic system, water recourse mapping help to provide web and mobile data interfaces to increase the ability of the agricultural community to access and use satellite data in irrigation management.

IV. PROPOSED METHODOLOGY AND DISCUSSION

Proposed algorithm uses the image segmentation algorithm and morphological algorithm to extract water areas from satellite images. Identifications and mapping of the surface water boundaries has been one of the simplest and direct applications of the remote sensing in water resources studies. Optical remote sensing of water resources is based on the difference in spectral reflectance of land and water. Water absorbs most of the energy in NIR and MIR wavelengths, whereas vegetation and soil have a higher reflectance in these wavelengths. Thus, in a multi-spectral image, water appears in darker tone in the IR bands, and can be easily differentiated from the land and vegetation [5], in general water areas and wet lands have the low reflection in near infrared bands of remote sensing images and vegetation has the high reflection. So water areas are always dark areas in the near-infrared images. Thus the gray value

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of the water area is the smallest and vegetation area is the greatest and the rest values of the land area are higher than the river and smaller than vegetation area.

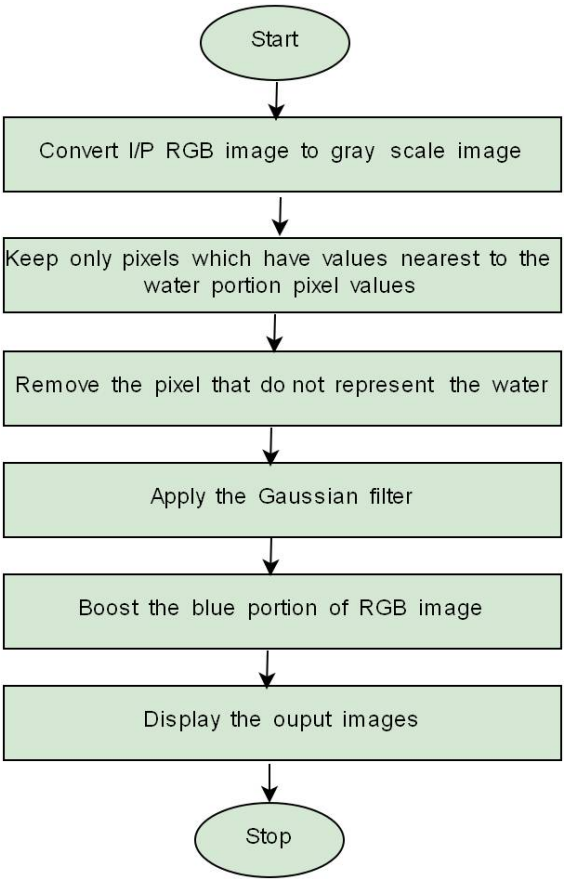

Fig. 1 : Flow chart of proposed algorithm

Figure 1 shows flow of proposed algorithm, the input image is a RGB jpeg color image as shown in figure 2; to perform morphological operation the given image is first converted into gray-scale image as shown in figure 3, in figure 3 it is clearly seen that the water area has different pixel intensity value than surrounding objects, For a gray-scale images, the pixel value is a single number that represents the brightness of the pixel, in selected input image the watery area is represented by pixel values less than 85. In the next stage by applying thresholding method each pixel in an image is replaced with a white pixel if the image intensity is less than threshold value 85 as shown in figure 4, thresholding is the simplest method of image segmentation; thresholding can be used to create binary images. After thresholding the morphological area opening operation is performed on binary image as shown in figure 5, morphology is used to study geometric structure of images, the basic morphological operations namely dilation, erosion, opening, closing are used for detecting, modifying and manipulating the features present in the image based on their shape. In mathematical morphology, opening is the dilation of the erosion of a set by a structuring element, together with closing, the opening serves in computer vision and image processing as a basic workhorse of morphological noise removal, opening removes small objects from the foreground usually dark pixels of an image. The blur and mask in the image is created by applying Gaussian low pass filter and blur filter as shown in figure 6. At the end by using linear combination of images the blue part of RGB image is enhanced and busted to highlight the watery area of an image as shown in figure 7.

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V. EXPERIMENTAL RESULTS

The program code for proposed algorithm is designed, executed and tested for satellite image taken from Google Earth services.

Fig. 2: Input Image (Colour RGB)

Fig. 2 shows the image which is taken as input image for designed algorithm, the image is of 523 by 883 by 3 RGB colour image. The selected area is located at 210 04'15.11"N 750 46'12.49"E and image is taken from 32543 ft eye altitude, the input image covers nearly 10 square kilometres of land area and 4.49 Kilometres of Tapi river basin.

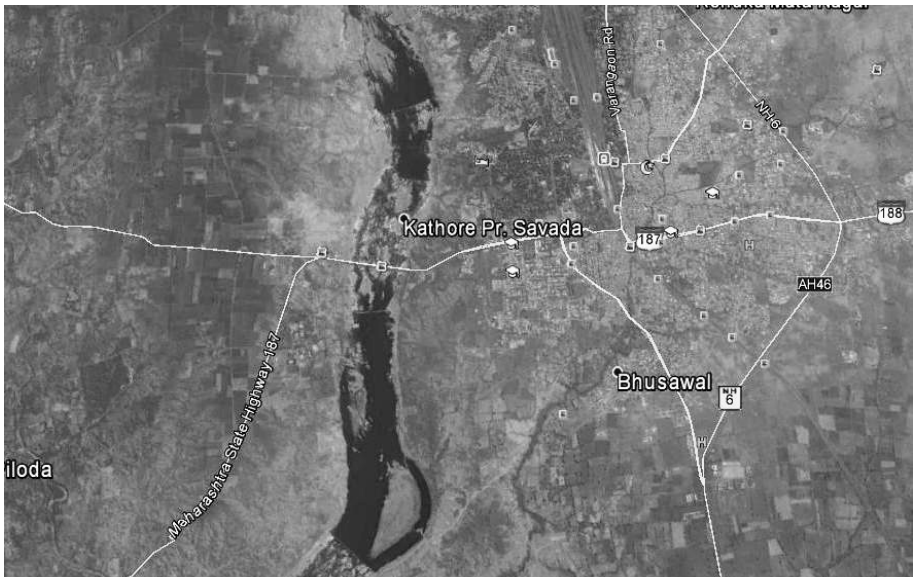

Fig. 3: Gray Scale Image

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Fig 3 is a gray-scale image of selected input satellite image, which contains only gray level components, in a gray-scale image dark portion is represented by lower intensity values whereas the bright portion is represented by higher intensity values

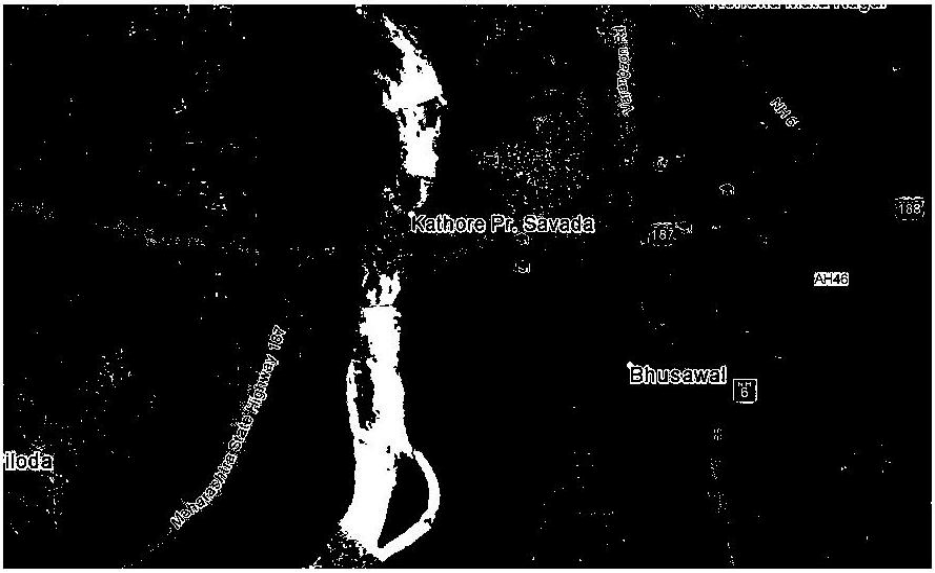

Fig. 4 : Threshold Binary Image

Fig. 4 shows the threshold binary image, binary image is obtained after applying the threshold to the gray-scale image; the water portion pixels of gray-scale image which is represented by the intensity value less than 85 is replaced with the only white colour and the remaining pixels are replaced by black colour values, binary image contains only 0's and 1's.

Fig. 5: Morphologically Open image(erode & dilated)

Fig 5. is an eroded and dilated image, which obtained after morphologically opening the binary image fig. 4, it removes the white portion which does not represents the water.

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Fig. 6 : Filtered and Blurred

Fig. 6 is obtained by applying the Gaussian low pass filter and blur filter to the morphologically opened image, which highlights the area which has maximum water contents, Gaussian low pass filter and blur filter is generally used to remove noise from the images.

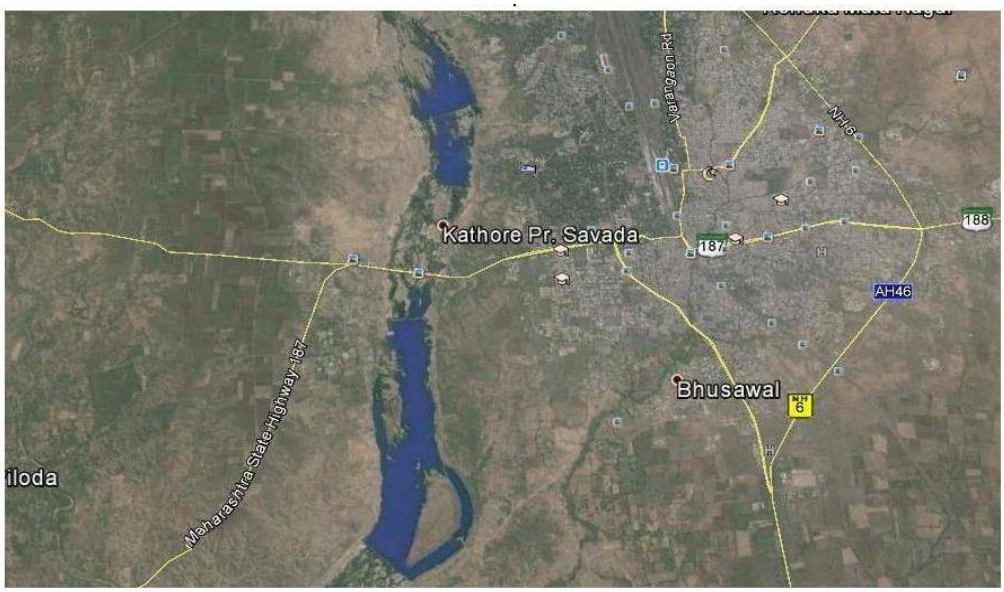

Fig. 7: Output Image showing water in Blue channel

Final output image is shown in fig.7; it shows water area which is represented blue colour channel, the blue channel is achieved by using the linear combination of images. The blur filtered portion shown in fig. 6 is enhanced to show the water area.

VI. CONCLUSION AND FUTURE WORK

The results shows the proposed algorithm works better, the output image shows the river area containing water. This water mapping has lots of application in manufacturing industries, agricultural industries, household application and

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etc. Image processing algorithm processed large amount of data, while processing proposed algorithm generates numbers of images this will generates huge amount of data and will lead to slow processing of algorithm, parallel and distributed computing techniques can be used to reduce the processing time.

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BIOGRAPHY

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