River Basin Extraction from satellite images using Back Proportion Neural Network

[1] Kale Suhas B, [2] Gawali Bharti W,
[1]Assitant Professor, [2] Professor
[1] Department of Computer Science, Balbhim Arts, Science and Commerce College, Beed (M S)
[2] Dr Babasaheb Ambedkar Marathwad University, Aurangabad (M S), India.
[1]ctekbeed@gmail.com, [2] drbhartirokade@gmail.com

ABSTRACT

A river network is usually a system wherever in all the tributaries of the rivers, lakes or streams be a part of to create a basin. The basin includes of the laborious and soft rocks that square measure fashioned by the influence of weather conditions, vegetation and transport of sediments and water. The stream network model identity's the placement of water bodies, determines the causes of floods, deposit, pollution of stream bodies and preventive ways. The pre-processing of the data obtained from the GSI helps to evaluate and investigate the data more accurately and efficiently in predicting the water resources and determining the quality of the water. Some of the problems that are addressed in the proposed research study are caused by the pixel-based indexes leads to an error in the detection of water due to the other occlusions like the cloud shadows and the noise that is incorporated during the image fusion process has to be eliminated for a more enhanced quality of image. The primary aim of the proposed research model are to develop an enhanced multi-temporal pixel level image fusion with advanced image classification technique that detects the changes in the surface of water and demonstrate GIS image segmentation based on convolution wavelet neural network by adding an adaptive filter to further improve the segmentation process. The proposed model will be extended by integrating the other machine learning models to create a hybrid or both can be compared such as SVM (support vector machine), ANN (Artificial neural network) or ML (maximum likelihood) classification. Further, the model is developed by adding filters that completely eliminates the noise and that are more adaptive and robust in nature..
Keywords: — Feature Extraction, NDWI, DME, SVM, BPNN.

INTRODUCTION

A river network is generally a drainage system where in all the tributaries of the rivers, lakes or streams join to form a basin. The basin comprises of the hard and soft rocks which are formed by the influence of climatic conditions, vegetation and transport of sediments and water. The river network model identity's the location of water bodies, determines the causes of floods, sedimentation, pollution of river bodies and preventive methods. It is also important for the analysis of the hydrological features and for water resource management. Digital elevation model (DEM) is implemented to extract the information that helps in the identification of the river networks (Singh et al., 2014). With this, the river location is updated regularly in order to extract the changes of the water bodies by comparing the past and present images taken by the satellite. Various rivers are classified based on their surface homogeneity, structure (parallel or straight contours) and radiometry. The information collected from a digital elevation model is implemented so as to eradicate the geometric and radiometric topographic effects extracted from the synthetic aperture radar (SAR) images. Based on these images, the data related with the river surface is extracted and classified (Sghaier et al., 2017). The basin structure is analysed with the digital elevation models (DEM) using stereo satellite images. These are applied in the real time decision making such as flood modelling, pollution modelling, water supply modelling, stream sedimentation analysis, watershed delineation (Fairfield et al., 1991). The water bodies are observed with the help of remote sensing images and it is of high significance as it provides the information of the water resources available and its ongoing transformations. Image processing of the water bodies helps to control and find the measures related to the water scarcity, pollution, and also predicts the flood occurrence (Zhaohui et al., 2003). Hence, remote sensing data is important in modelling of the geomorphological maps by interoperating the visual images of the satellite. The zonal mapping is investigated using different parameters like ground truth, soil type, hydrological and hydraulic statically collected data from the DEM (Sharaf et al., 2017). Further, the sections in this proposed research development identity's the challenges in modelling of the river network so as to predict the location of the water resources and to evaluate the quality of the water.

METHOD OF EXPERIMENT

River extraction Techniques

Bhandari et al. [1] enhanced the feature extraction technique using normalized difference vegetation index (NDVI) and normalized difference water index (NDWI) that are based on the discrete wavelet transformations and singular value decomposition methods (DWT-SVD). The model was evaluated to analyse the vegetation of the land and water surroundings. The model analyses the multispectral remote sensing images to calculate the vegetation index and water body classification. It was seen from the experimental results that the model had greater efficiency and adaptability than the conventional techniques like decorrelation stretching technique.

Duan et al. [2] proposed a novel technique for extraction of features based on synthetic aperture radar (SAR) image segmentation. It was implemented to the convolution-wavelet neural network (CWNN) and Markov random field (MRF) strategies that are used to produce the final segmental map. The experimental results proved that CWNN showed more effectiveness for image segmentation and the SAR images were protected by retaining its edges and the model proved to be more stable at all times.

Zhao et al. [2] proposed a method to predict the water body location using the remote-sensing images and other features related to the water quality, water flow, and water levels. The images consists of spectral characteristics with geometric features and textural features that are utilized in forming a decision tree for extracting information of the presence of the water bodies. Also, an object oriented model is used for the segmentation of image processing. The pre-processing of the image captured form the remote sensing satellites is refined based on the features. The noise is reduced and the blank spaces during the image fusion were filled. The model was evaluated both quantitatively and qualitatively. The model assisted in obtaining desired results of the flood occurred in Pakistan during 2010, proved to be very efficient and accurate.

Manjusree et al. [6] analysed the hydrological data from the observation of satellite images for assessing the inundation of frequency, severity of flood hazards, etc in the north Bihar of India. The research study investigated the spatial distribution of flooding and creation of systematic flood which was evaluated from the spatial distribution of geographical information system (GIS). The model had the potential to analyse the historical data for flood hazard prediction and it also prepared a zonal map in spite of lack of well-distributed hydrological information. The model was effective for flood disaster management which mitigated the flood activities for the flood prone zones.

Sastry et al. [22] identified the process, pattern, magnitude and possibility of impacts of desertification based on the inter-disciplinary socio-economic resource data inputs from the satellite images. The researchers proposed a desertification model by integrating the multi-variate principal component and GSI information collected from the remote sensing satellites. The model was successful in predicting the natural calamities in Bellary region of North Karnataka like droughts, backwardness, over irrigation, land degradation, siltation, water pollution or haphazard mining.

Garg et al. (2017) evaluated the spectral angel mapper (SAM) technique and spatial spectral contextual image analysis to quantify the turbidity of natural lakes in India like the Chilika Lake or Odisha Lake. SAM technique was mostly adopted for the geological applications like the mineral mapping and also to predict the quality of water. The model determined the turbidity of the water using the information of multispectral remote sensing data by using the techniques like normalized difference turbidity index (NDTI), band ratio or regression model. It was found that the spectral analysis produced quantitative estimation of the turbidity of water than NDTI.

Sahoo et al [10] predicted the potential of destruction caused by the tropical cyclones using power dissipation index (PDI). The research study attempted in evaluating the coastal vulnerability index (CVI) for Odisha coast, which is highly effected by the tropical cyclones in the Bay of Bengal region. Hence, the study aimed in determining the total average CVI by summing the PVI, socio-economic factors, and environmental vulnerability that is extracted from the GSI. The model proved to be very effective in the coastal zone management for the prevention of cyclones.

Selvarani et al. [12] carried out a study on the Noyyal river basin that concentrates on modification of the remote sensing images and GSI data considered as the finest tools in the department of hydrogeology. The model assisted in monitoring and preserving the underground water resources based on the geomorphology and other associated parameters.

Kaliraj et al. [4] integrated a remote sensing and GSI technique were implemented by collaborating permeability, infiltration capacity and recharge potential zone in detecting the locations of water resources. The model has the significance in advising the site-specific, cost-effective artificial recharge structures in the upper basin of the Vaigai river basin such as the ponds, dams, water absorption trench (WAT) that will reduce the water scarcity for the surroundings.

Rao et al. [7] analysed the six gradual evolution in the Godavari delta with distinguished avulsions formed by the cyclic shifts of delta lobes. The lobes were analysed and the patterns of the Godavari delta were observed. The results revealed that during the Holocene the coast has been evaded by few centimetres that submerged the delta into a destruction phase.

Kannammal et al. [5] proposed a novel model for classifying the land based regions based on the geographical features, using an object based segmentation and robust local textural patterns that are extracted from the remote sensing. The process of distinguishing the object was based on the local texture patters so as to realise various patterns on the land. The model used is support vector machine (SVM) that classifies the land objects using multi-scale segmentation. Further, the model is developed by using the real time data and also is applied for change detection of the water bodies especially of the flood regions.

Method

The model follows some of the steps such as the image pre-processing of the remotely sensed data, image fusion technique using adaptive filter, image quality assessment, image classification technique, detection of water quality based on the classification of Artificial neural network using back proportion neural network (BPNN) algorithm. Hence, the images captured by the remote sensing satellite from the Godavari River basin are classified and evaluated for predicting the change in the water surface and its quality and finally the system's accuracy of the proposed model is verified. The different surface water quality parameters (SWQP) like the turbidity, total suspended solids (TSS), chemical oxygen demand (COD), biological oxygen demand (BOD) and dissolved oxygen (DO) analyses the quality of water sample collected from various water resources.

1. Image pre-processing

The images captured from the satellites are pre-processed for further evaluation as shown in figure-1. After pre-processing of remotely sensed image data, the corrected satellite spectral information is considered for further investigation.

2. Prediction of water regions and its quality evaluation

The steps involved in predicting the quality of water are as follows:

1. Image fusion- High resolution pixel fusion of multi-temporal and multispectral images captured from the geographical information system (GIS). The quality of the image is improvised by incorporating an adaptive filter like the Laplacian filter to convert the low-resolution image to high resolution image.

2. Image Quality technique- To evaluate the alignment of the fused images for highlighting the transformation of the water bodies. This is done by visual interpretation.
3. Image classification- The images are classified using Back proportion neural network algorithm based Artificial neural network which is implemented to extract and map the changes in the selected geographically study area. The quality of water is evaluated in terms of various surface water quality parameters (SWQP) and the images are classified using Back proportion neural network algorithm based Artificial neural network. Artificial neural network is adopted as it performs well with small set of training data and is resistant to noise. It also facilitates the data to learn by patterns. Artificial neural network consists of four layers: input layer, intermediate layers, pooling layer, and the output layer as shown in the figure-2. The regions of water surface change and the quality of water are extracted from the output layer of the Artificial neural network. The data is segmented into three data sets such as the training data set, validation data set, and testing data set. These data sets are trained and tested with the reference parameters so as to find the presence and quality of the water in the water bodies.

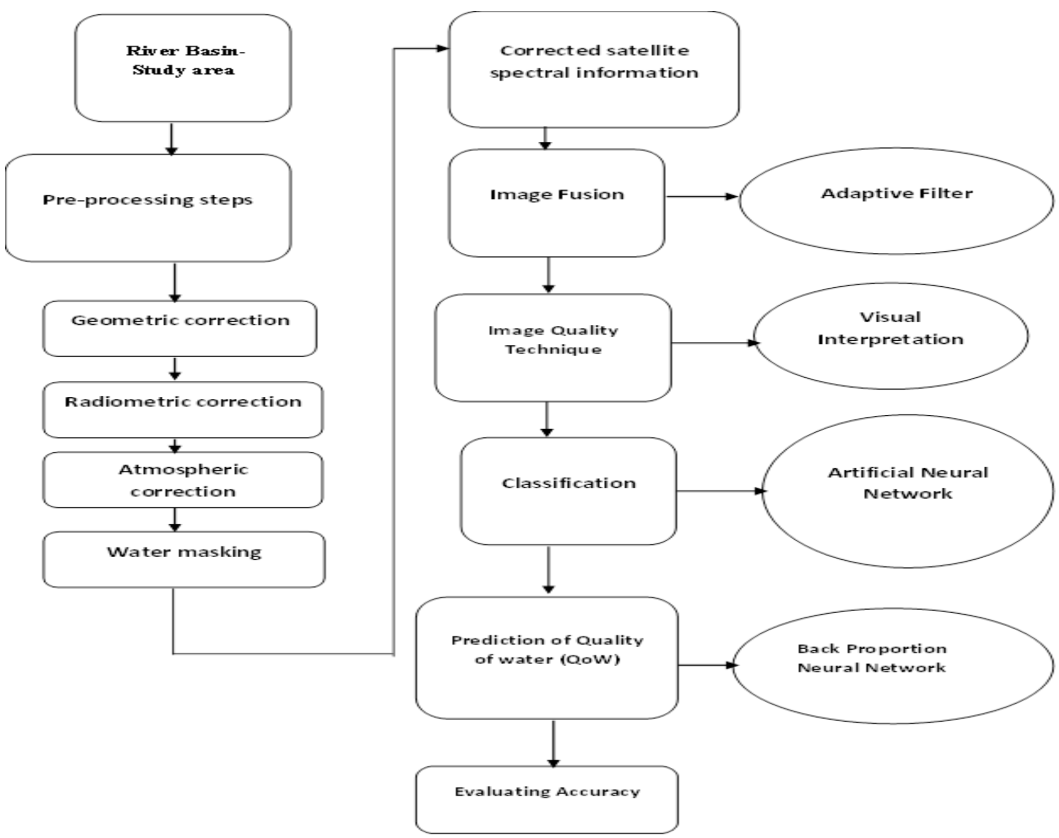

Figure 1: Flow chart of the proposed methodology

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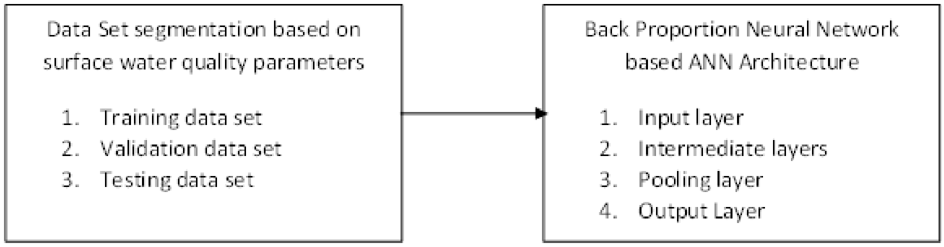

Figure 2: Flow chart of the proposed Back proportion neural network (BPNN) algorithm.

CONCLUSION

The proposed Back proportion neural network algorithm reduces the computational time and efficiently control's the learning process by implementing an appropriate learning rate to achieve minimum error. The segmentation of data set can be improvised by adopting a filter in the design. Also, a wavelet pooling layer is incorporated into the artificial neural network architecture so as to reduce the noise associated for analysis of images.

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