Adaptive Neural Image Prediction System for Classification of Sediments

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***Abstract*—Sediments classification is required to have the detailed knowledge about sedimentation on the seafloor, river bed, canals, near dam walls etc. Acoustic based systems are recently used for classification of sediments. Most commonly used approach in sediments classification on seafloor or on riverbed are very expensive as this requires dedicated ships, lengthy measurements, dedicated equipment and a labour intensive analysis afterwards. The proposed system uses sediment images as input and adaptive neural prediction system for identifying the type of sediment. The sediments can be classified based on their grain size into different categories such as mud, sand, gravel. The proposed system uses visual properties for classification this makes adaptive algorithm easier to learn and reduces processing time.**

***IndexTerms*—Adaptive neural prediction system, Artificial Neural Network (ANN), sediment classification.**

I. INTRODUCTION

Due to sedimentation there is a probable one percent reduction every year in the total capacity of all reservoirs worldwide [1]. Sediments are formed due to erosion of pre-existing rocks and are result of weathering. These modules of sediments are carried away as solid particles mainly through water flow to their site of decomposition. Sediment such as sand, silt, pebbles are carried away with water into the rivers and ultimately to that river's banks. The river banks are where these sediments get deposited which can block the intakes of reservoirs and damage tunnels and turbines. Increasing in the levels of sediments near the dam can cause the blockage at low-level outlets and hamper their continual operation [2]. The mud-sediments pass into the intake of hydropower causing damage to turbine blades which eventually increases the maintenance costs. Therefore this is one of the reasons we need to classify sediments so that corrective action can be taken before damage of turbines. Another main reason is that the water flow is irregular through the gates of dam; it also takes sediments near the gate wall with it. These sediments can further damage the gates and some protective measure should be taken before the dam gates become weak.

Sediment classification is one of the most challenging and complex pattern recognition problems. The classification problem involves finding an algorithm for classification such that it improves the performance of classification above that of standard algorithms. The sediments can be classified based on their grain size into different categories such as mud, sand, gravel as shown in table 1. The proposed system uses visual properties for classification this makes adaptive algorithm easier to learn and reduces processing time.

II. LITERATURE SURVEY

The previously used approaches for sediment classes information on seafloor or riverbed is to take sediment grabs, cores or dredge samples. These techniques are expensive as they require dedicated ships, lengthy measurements, dedicated equipment and a labour intensive analysis afterwards [3]. Another important limitation of these techniques is that it provides information on point positions only. The alternative methods for sampling consist of employing the data as acquired by acoustic systems. The multi-beam echo-sounder system (MBES) can be used for measurements of seafloor bathymetry or riverbed sediment classification [3]. It is an acoustical mapping system. It measures water depths with a single transmission along a wide swath perpendicular to the ship track.

In general, sediment classification methods using MBES can be divided into empirical or phenomenological and physical or model-based methods [4]. In the empirical methods used for classification uses features that are indicative for sediment type such as backscatter strength or features derived from the bathymetric measurements. This technique classifies the sediments with its own acoustic features into different acoustic classes. The different sediments types that are currently present in the survey area are represented by acoustic classes. Yet, the independent information is needed to assign the sediment type such as gravel, pebble, sand, mud to the acoustic classes [5].

The model based methods used to identify the sediment type maximize the match between measured and modelled signals or its features where the parameters indicative for sediment type are the input to the model [6]. These methods do not require any independent information since it provide the sediment type or properties indicative for sediment type instead of acoustic classes.

Table 1: Classification of the sediments based on grain size.

Grain size	Size class	Sediment name	Image
> 256 mm	boulders	Gravel or conglomerate	
64 - 256 mm	Cobbles		
4 - 64 mm	Pebbles		
2 - 4 mm	Granules		
1 - 2 mm	Very coarse sand	Sand or sandstone	
0.5 - 1 mm	Coarse sand		
0.25 - 0.5 mm	Medium sand		
0.125 - 0.25 mm	Fine sand		
0.063 - 0.125 mm	Very fine sand		
0.032 – 0.063 mm	Silt	Mud or mudstone	
< 0.032 mm	clay		

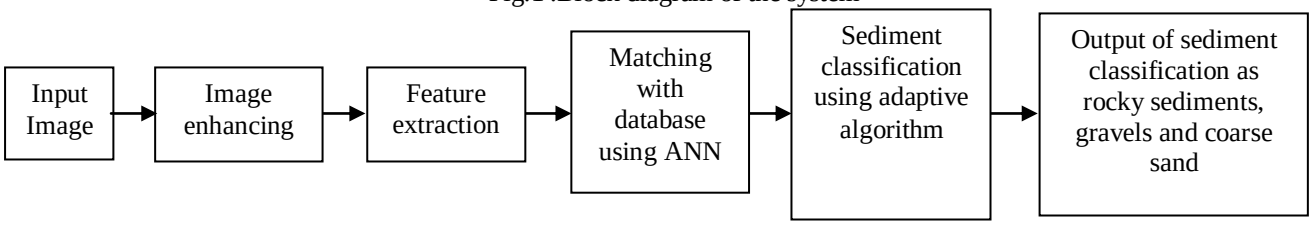
III. System Overview

The sediments can be classified based on their grain size into different categories such as mud, sand, gravel. The particle with greater densities and larger sizes settles down due to gravitational force where as small particles or colloidal materials stay in suspension. The process of sedimentation is also affected by the shape of the particle e.g. particles with round shape will be settled easily as compared to the particles with irregular ones. Sediment classification can also be done using visual properties of sediments. Thousands of different intensities and color shades can be distinguished by a human visual system. Image analysis can be simplified using this information. To describe any particular color three independent quantities are used hue, saturation and value. The dominant wavelength determines hue and saturation depends on the amount of whit light mixed with hue.

Block diagram

We proposed a system using artificial neural network for classification. Proposed algorithm uses feed forward neural network. Input for the algorithm is image of sediment obtained by setting camera at fixed distance. Flow chart for the algorithm is shown in fig.1. This algorithm is basically divided into two parts. In the first part of the algorithm training of neural network will be done while in the second part classification of sediments will be done. That is the features are extracted in the second part and these features are given to Artificial Neural Network (ANN). The feed forward network will classify the sediments by trying to find out the match in his database.

Fig.1 .Block diagram of the system



Flowchart

The flowchart is as shown below in fig.2:

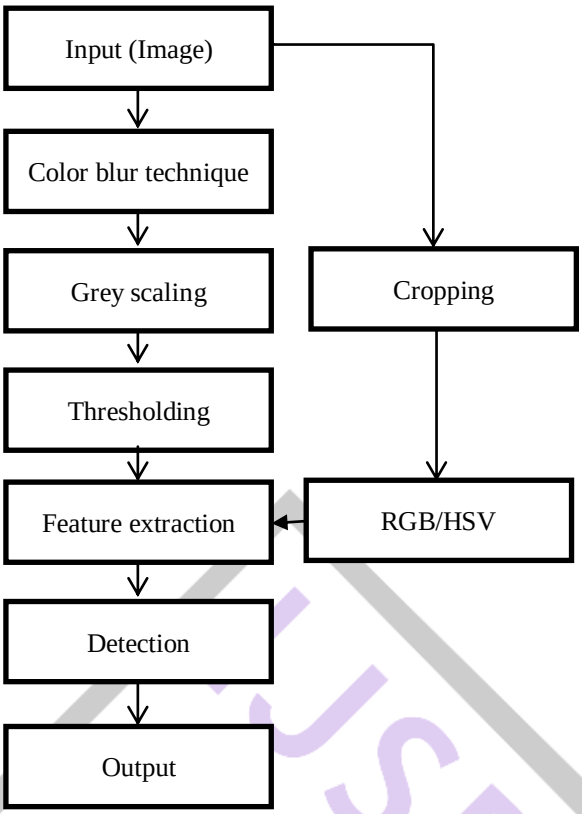
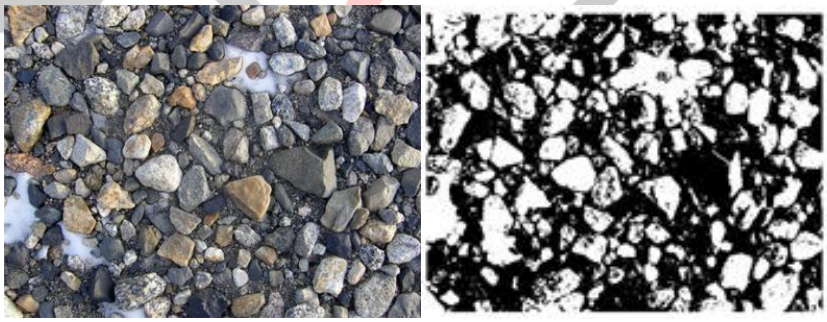


Fig.2 Flowchart of the system

1) Input image: the input to the system is the sediment image. The image of sediments is captured by using a camera.
2) Blur: While capturing the image it may get blur, due to variation in sharpness the object under observation may not be clear. Edges are made smooth by applying color blur technique. This technique uses averaging filter. It calculates average values of R, G and B and assigns that value of the central pixel.
3) Grey scale: Grey image separates the background from the image as the background contains higher grey scale value thus it get easily separated from the sediments. Grey scaling converts 24-bit image into 8-bit image.
4) Thresholding: The value of grey scale above which all the pixels value are assign to zero is threshold value. This will convert the grey scale image into 2-bit image i.e. binary image. The input image and the image after thresholding are shown in fig.3.



(a)(b)

Fig.3 (a) Input image, (b) After thresholding

5) Feature Extraction: Using Blob detection area and size of sediments and using HSV properties color features are exacted.
6) Detection: Using feed forward networks the algorithm is designed to detect the sediment by trying to find out the match in his database.

IV. ADVANTAGES AND APPLICATION

As the proposed system uses images of sediments as input and processing is done by adaptive neural prediction system; this technique is faster and cheaper as it does not requires any dedicated ships, instruments as required in sonar system used for classification. For classification of sediments adaptive algorithm uses visual properties, this makes the adaptive algorithm easier to

learn and processing time is reduced. The classification of sediments has an important application for Navy and Marines as they operate in shallow water for mine burial, landing etc. and other security purposes. It can also be used for monitoring the sediments in rivers, water reservoirs for protection against flood, environmental safety and directly protecting soil erosion.

V. Conclusion

The sediments are classified based on their visual properties. By using artificial neural network the effort of designing algorithm is reduced. As compared to the conventional algorithms this technique is faster and cheaper. Depending on the sediments class the dam gates can be controlled.

VI. Acknowledgment

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