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Side scan sonar image augmentation for sediment classification using deep learning based transfer learning approach

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Abstract

Object detection in underwater acoustics especially sea floor object has been overwhelming mission chiefly owing to strident environment of sonar images as well as because of visibly existing sonar images. Side Scan Sonar is the primary sensor for Autonomous Underwater Vehicles to perform survey on sea water. Hence, we are using this SSS images for categorizing several objects like sand, mud, clay, graves, ridges and sediments in underwater sea through any size subsequent to training. We applied two-layer CNN architecture to train the model as well as we utilized three pre-trained network models such as VGG-19, ResNet50 and EfficientNet model for evaluating the performance of the model based on training and validation accuracy measures. Moreover, we utilized deep learning based transfer learning approach in which the parameters are tuned for classifying the images into sediments, clay, mud, stones etc. Our experimental outcomes shows that pre-trained EfficientNet model generates better accuracy of 100% after fine tuning the parameter in object recognition along with classification using SSS images.

Introduction

For underwater investigation and imagery, SSS expertise has been utilized for over three decagons. Archaeology, security and defence, seabed categorization, and ecological investigation are some of the applications for side-scan sonar. Data collecting has become more automated in modern years because to the introduction of autonomous underwater equipment. Convolutional Neural Networks have been extensively utilized in several researchers with categorization and object detection in underwater acoustics in current years. Huo et al. [9] anticipated semi-synthetic data production approach for categorizing sonar images into several objects like mud, clay, mine, rock, etc. Also, they applied pre-trained model namely VGG-19 also fine tuning the data which attains 97.76% accuracy in object classification in underwater. The architecture proposed by [9] is depicted in Fig. 1.

The main objective of the proposed work is mentioned as follows:

- To gather Side Scan Sonar dataset taken from underwater acoustics seafloor.
- To perform augmentation technique for construct the categorization models which helps to categorize sonar datas into rock, mud, clay, sand and some other related minerals.
- To introduce the pre- trained the neural network model such as VGG-19, ResNet50 and also EfficientNet model for evaluating training and validation accuracy
- To detect the metal mine objects such as rock, mud, clay and sand from seafloor images and classification of the image using transfer learning.

The major challenge is inadequacy of sufficient Side Scan Sonar data sets required for training the proposed models. Data augmentation is used to build the classification models.

Section snippets

Related work

During 1998, Bull et al. [10] estimated reflection co-efficient from Chirp data and they applied whether it is applicable to archeological studies. Yan Song et al [27] applied deep learning based CNN especially Markov Random Fields for segmenting the SSS images into several objects like sand, clay, mud etc. Qin et al. [18] proposed deep learning based Convolutional Neural Networks as well as CIFAR-10 based grayscale for pre-train the model to accomplish features relocation including enhancement

Underwater seafloor SSS image dataset

Authors build a real and synthesis dataset from seafloor sidescan sonar images. The dataset used in this project is built by using data augmentation techniques such as rotation, translation, scaling, and cropping can be employed to increase the size of the available dataset [25].

The details about training and testing samples portion for each objects such as rock, mud, clay, sand, sandwaves and sandridges from underwater SSS images are listed in Table 1.Here, we have taken SS sonar data from sea

Proposed CNN architecture and transfer learning approach

Here we are introducing two CNN based architecture for identifying minerals like objects such as mines, rocks, sand, clay, mud, gravels etc in underwater sea acoustics using side scan sonar images. They are two-layer neural network based model as well as deep learning based transfer learning algorithm.

Evaluation of metrics

Based on evaluation on metrics such as training accuracy, validation accuracy, training loss and validation loss, we undergo classification of objects in underwater sea using SSS images. The evaluated metric are described below.

Training accuracy: Accuracyis defined as metric so as to usually express how the deep learning approach executes diagonally every section. This may helpful while every potions having identical significance. Accuracy is estimated as the ratio among the number of correct

Experimental outcomes

The explanation behind fine tuned of parameters is that relocating VGG-19 deep learning based approach may execute fine through pre-training VGG-19 model on EfficientNet model which comprises of plentiful objects, the trained VGG-19 already learnt adequate parameters for detecting several types of underwater acoustics objects. By means of fine tuning the VGG-19 scheme, the object weights are rapidly attuned that is appropriate for SSS images. In this work why we are not using shallow CNN since

Conclusions

The main target of this mission is to use side scan sonar images from a sub bottom profiler system to identify and segment sedimentary objects such as mines, rocks, clay, and mud that are positioned a few meters beneath the seabed. This will help with many underwater domain applications, especially metal mine detection. Also, we established that some deep learning based network model such as VGG-19, ResNet50 model were pre-trained and then fine tuning on CNN based EfficientNet model generates

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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