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# Underwater cable detection in the images using edge classification based on texture information

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ABSTRACT

In this paper, a new approach is proposed for detection of an underwater cable, which makes an Autonomous Underwater Vehicle (AUV) capable for automatic tracking. In this approach instead of traditional image segmentation, first, edges of the images are extracted. Then they are classified using Multilayer Perceptron (MLP) neural network and Support Vector Machine (SVM) using texture information. Then the edge points belonged to the background information are removed and the remaining ones are used for the next processes. Finally, the filtered edges are repaired by morphological operators and are fed into the Hough transform for cable detection. Some texture information methods are used for feature extraction but the results confirm that the 2D Fourier transform in combination with MLP network is the best method for edge classification in this environment. Hough transform, is used in two strategies, which in the first one, the whole information of the edges in the image, are used for line detection, and in the second approach because of curve like shape of the cable, a center part of the image, is used for line detection. In the experiments, many different scenes was used for testing the cable detection algorithm, which first method, resulted to good accuracy but the second one, provided better recognition rate for the cable detection task.



## 1. Introduction

Recently, investigation and monitoring of underwater objects such as cable or pipeline are done using underwater vehicles. One of the most useful underwater vehicles is Remotely Operated Vehicle (ROV), which is controlled by an expert user inside a ship. Efficient usage of ROV needs long vessels that increases the cost of its usage. The vessels, limit the using of ROV and how it moves. So these days, AUV is used more than ROV. AUV doesn't need the power cables and other vessels, also having extra maneuver ability that makes it useful and more efficient than ROV, in some missions [7].

The abilities of AUV depend on intelligent algorithms which by using information of different sensors, make appropriate decisions and guarantee good actions of underwater vehicle in various situations. For the most successful animals in the nature, eyes gather enormous information of the environment for the brain and play very important role in the life of creatures. So the vision sensors especially cameras, can play essential role for autonomous vehicles such as AUV. Vehicles can be automatic using image coming from the camera and fusion of that with the data taken from other sensors and processing of them by a computer. For example, underwater pipeline or cable tracking for monitoring and maintenance, can be done automatically by AUVs.

For self-tracking, cable or pipeline objects must be detected using camera information and machine vision methods. Other sensors such as sonar and magnetic, can compensate weaknesses of cams and be useful for more precise detection. Computer vision methods are utilized for image analysis and understanding. But they consist of several stages which often starts with segmentation and divides image into some separated parts. Then the different segments are investigated for shape, form and other structural features. They often are classified by traditional methods such as Hough transform or pattern recognition methods. In the last step, the object localization happens and the AUV's control system, gives appropriate commands to thrusters to move the vehicle and track the object.

The traditional efficient segmentation algorithms, use both texture and color information to produce an image with some homogeneous parts. They are normally time consuming approaches. But

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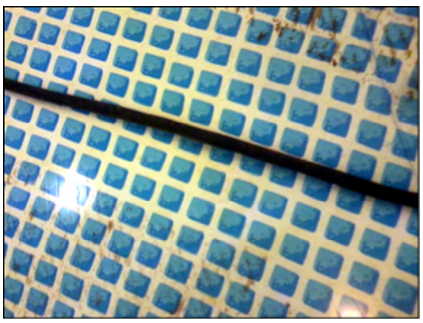

**Fig. 1.** A sample image of a cable inside the pool of water.

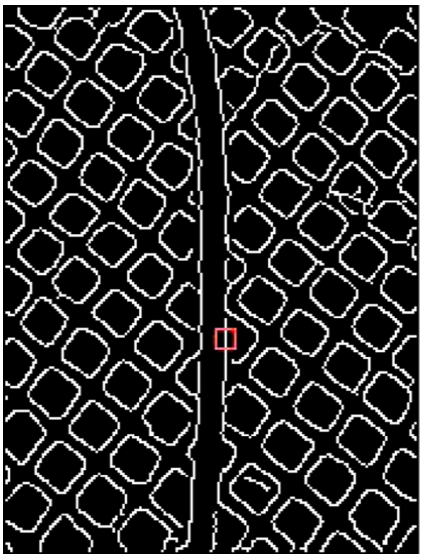

**Fig. 2.** Edge classification by texture information of local adjacency.

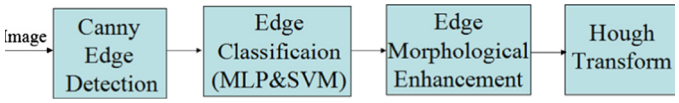


**Fig. 3.** Different steps of cable detection using ECHT approach.

in this paper, an approach without partitioning the image is proposed. It uses just a small part of edge information for Hough transform to recognize cable's lines. In this method, first the edge information are extracted using canny edge detection algorithm. Then the edges are classified using MLP and SVM classifiers and the cable edges, are fed into the Hough transform to localize two lines of the cable.

Experiments were done in a pool included a cable inside it, in MRL lab of Qazvin Islamic Azad University (QIAU). Fig. 1 shows a sample image of the mentioned test environment. The next section provides information about the related and previous works. The Section 3, introduces the main idea of this paper and in Section 4 we show some results of using the proposed approach for cable detection. The paper is concluded in Section 5.

## 2. Related works

In recent years, several researches have been done for automatic underwater cable and pipeline detection for investigation and monitoring applications. However, because of special shape and structure, there are some limitations of using different methods of machine vision for shape, texture and color detection, then recognition of an object as a cable or pipeline. The most important property of a cable or pipeline that can be considered is the two straight lines in their structures. There is no guarantee of existence of similarity of color and texture in the whole part of a cable or pipeline because of underwater environments. For these reasons, researchers have focused on the form and the shape of these objects. Different groups have proposed different methods based on edge information for detection lines of a cable or pipeline such as [10] for tracking power cables and [12] for pipeline inspection in a network of pipelines, also in [3] for monitoring of telecommunication cables. In [17] a method based on statistical information of images, is given for detection of underwater pipelines. A system for helping human operators in the inspection of pipelines was also implemented in the University of Ancona [17]. In this case, the system detected the pipes and some other accessories connected to them using statistical features obtained from selected parts of the image in the position of the cable. In [13], a visual servoing method, was proposed for automatic control and tracking. Using texture classification in [11], authors used a method for cable localization. Authors in [1,9], proposed a complicated approach with several stages. In the first stage, segmentation of images was done,

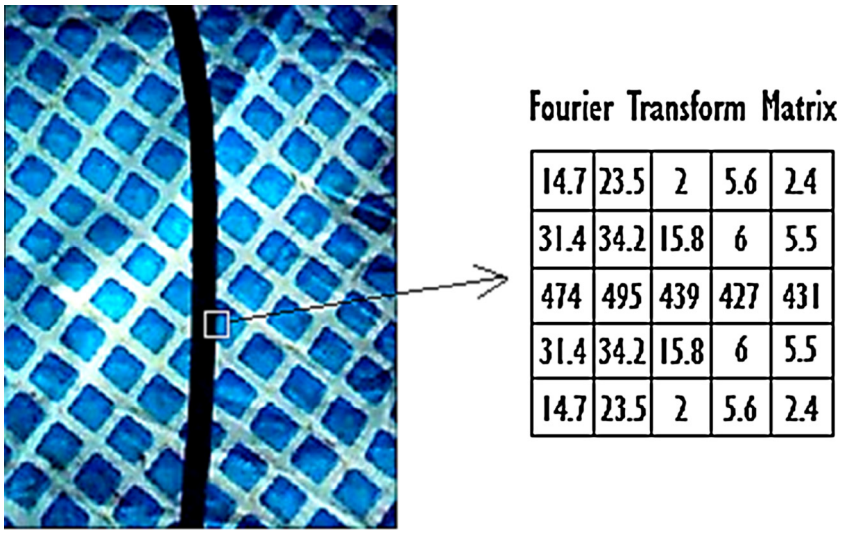


**Fig. 4.** A sample of feature extraction using the Fourier transform.