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Analysis report of Contributions to Automatic Target Recognition Systems for Underwater Mine Classification

Nidhi Singh[1], Vishnu Dutt Tripathi[2]
[1]M.Tech Scholar, JNCT Rewa (M.P.), singhpariharnidhi47@gmail.com, India;
[2],Asst. Prof., JNCT Rewa (M.P.), vishnu.dutt.0101@gmail.com, India;

Abstract *– A many original contributions to an automatic target recognition (ATR) system, that is applied to underwater mine classification. The classification of real-world empirical targets using sensed imagination into different perceptual categories is one in all the most difficult algorithmic elements of radar systems. The contributions think about feature selection and object classification. First, a complicated filter technique is designed for the feature selection. This filter technique utilizes a unique feature relevance measure, the composite relevance measure (CRM). The contributions consider feature selection and object classification. The design of one classification system that was optimized in 2 elementary aspects: the selection of the classification system and also the selection of the optimal feature subset. ATR system is applied to real synthetic aperture sonar imagination to evaluate its performance.*

Keywords*: Automatic target recognition (ATR), Dempster–Shafer theory (DST), ensemble learning, filter method for feature selection, synthetic aperture sonar (SAS).*

I. Introduction

An underwater mine may be a self-contained explosive device placed in water to destroy ships or submarines. Ocean mines are a serious threat to the security of vessels and human lives for several years. Identification of mine-like objects may be a pressing need for military, and different ocean meets. In mine, countermeasures operations, side scan sonar are used to observe and classify mine- like objects if their sonar signatures are like known signatures of mines. The detection and classification of underwater mines is a very important task, with robust implications for the safety and security of ports, harbors and the open ocean. Mine warfare, as well as the detection and classification of undersea mines, has become very necessary to the U.S. Navy. Sophisticated ocean mines are often deployed at a relatively insignificant value to cause large issues for a battle group due to the difficulties related to their detection and classification. The classification of real-world empirical targets using sensed imagery into different perceptual categories is one in all the most difficult algorithmic components of radar systems. This drawback, popularly called Automatic Target Recognition (ATR), exploits imagery from diverse sensing sources like synthetic Aperture radar (SAR), Inverse SAR (ISAR), and forward-looking Infra-Red (FLIR) for automatic identification of targets. A review of ATR may be found in [1]. SAR image offers the benefits of day-night operation, reduced sensitivity to weather conditions, penetration capability through obstacles, etc. a number of the earlier approaches to SAR ATR will be found in [2]–[6]. A discussion of SAR ATR theory and algorithms is provided in [7]. The Moving and Stationary Target Acquisition and Recognition (MSTAR) data set [8] is widely used as a benchmark for SAR ATR experimental validation and comparison. robustness to real world distortions may be a highly desirable characteristic of ATR systems, since targets are usually classified within the presence of clutter, occlusion and shadow effects, different capture orientations, confuse vehicles, and in some cases, different serial number variants of the same target vehicle. usually the performance of ATR algorithms is tested under a variety of operating conditions as discussed in [7]. In ATR, like every different general image classification drawback, representative features (i.e. target image representations) are acquired from sensed data and assigned to a pre-determined set of categories using a call engine (or, in different words, a classifier). Though the ultimate category decision is formed by the decision engine, the discriminative capability of the options will significantly influence the success of classification. Further, completely different sensing mechanisms lend themselves to differing kinds of useful features. Not surprisingly, initial analysis in ATR focused on the investigation of a spread of feature sets suitable for various domains of application [4], [9]–[11]. Equally necessary to classification accuracy is that the alternative of classifier. The applying of various classifiers to ATR has mirrored advances within the field of machine learning.

II. Theory

II.1. Segmentation

Segmentation techniques that have the potential to classify individual pixels as belonging to background reverberation, clutter, highlights or shadows. This sort of process is usually not involved with whether every pixel belongs to a mine-like object or not, however is usually performed as a prelude to additional advanced detection and classification techniques. For side-scan sonar pictures, segmentation is usually used to separately classify pixels as belonging to highlights, background, or shadow regions before higher level techniques are used to search for mine-like objects. When every pixel has been classified into one in all the 3 decisions, the pixels are usually clustered alongside their neighbors to remove incorrectly classified pixels. There exists a large type of image processing techniques for segmentation and lots of of these are applied to the present drawback.

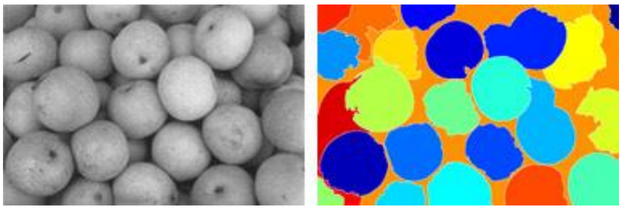

Fig.1 image Segmentation

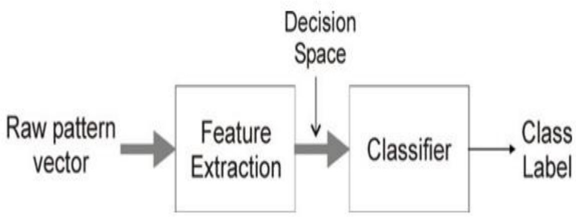

Fig.2 Feature extraction

II.2. Feature extraction

Feature extraction has been always mutually studied for explorative data projection and for Classification. Feature extraction for exploratory data projection aims for data visual image by a Projection of a high-dimensional area. Onto 2 or three-dimensional space, whereas feature extraction for classification usually needs over 2 or 3 options. Therefore, feature Extraction paradigms for exploratory data projections are not usualy used for classification and vice versa. For strong feature extraction, sonar pictures are symbolized by partitioning the data sets based on the data generated from the ground truth.

II.3. Detection

Mine detection drawback is to simply assign a threshold to the mapped options, based on the premise that the object ought to be brighter (i.e., have a stronger reflected signal) than the background of a sonar image. This approach works well for a relatively plain background, but a textured background might encounter several false positive mine locations. Recent mine detection ways have made use of advanced signal process techniques.

III. Method

A novel extension of the sequential forward selection (SFS) and the sequential forward floating selection (SFFS) methods, which mitigates their main limitations, the nesting. The best alternative at each iteration a set of D options is stored in system. The performance of the so-called D-SFS and D-SFFS is tested on simulated and real data, significantly outperforming the standard algorithms part. The methods are also used for designing an ADAC system for mine hunting based on two extensive databases of synthetic aperture sonar images. The main contributions of thesis are summarized as follows. The non-optimal simple classification systems, each of them based on a single type of descriptors (algorithm fusion), a single optimized classification system combining multiple feature types is proposed.

A complete ATR system contains four steps as shown in Fig. 4: mine-like object (MLO) detection, image segmentation, feature extraction and mine type classification. A range of techniques has been developed for the purpose of target detection in the literature and they can be applied to the first step of MLO detection. If sufficient amounts of target examples are available, techniques such as supervised detection, template matching and matched filters can be applied.

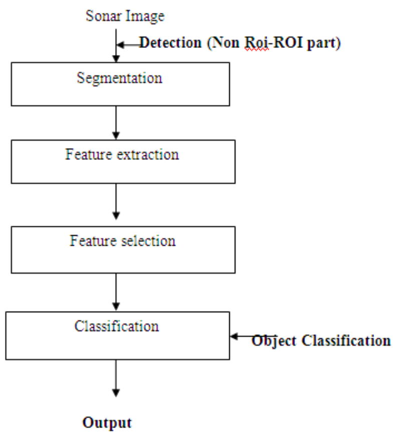

Fig.3 Proposed Method

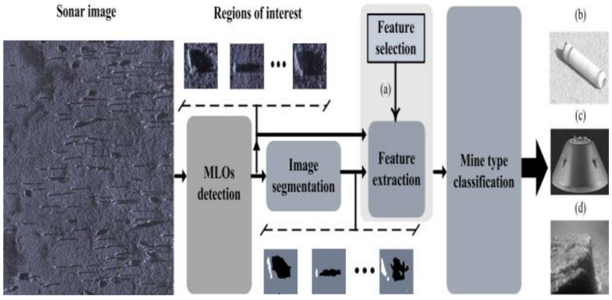

Fig.4 Typical processing chain of the ATR system, the feature extraction step uses the results of both MLO detection and image segmentation as its inputs

IV. Result

The simulation results of the proposed system are following:

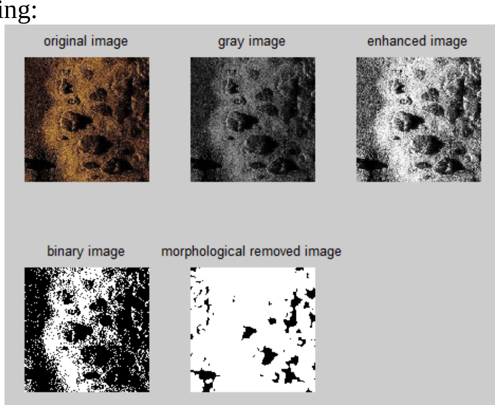

Fig.5 Five initial image in the figure

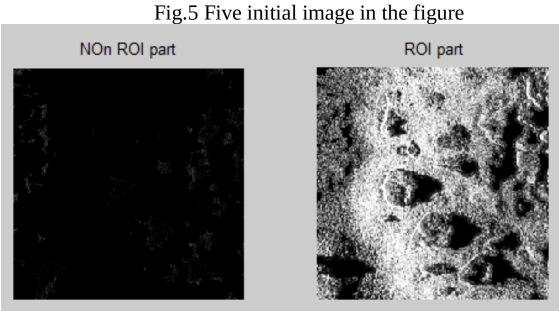

Fig.6 Non ROI and ROI part of the input image

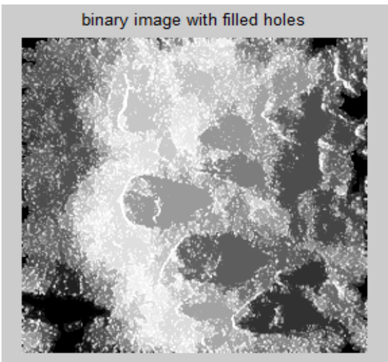

Fig.7 Binary image with filled holes

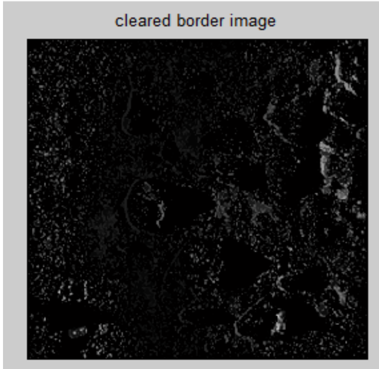

Fig.8 Border of the image

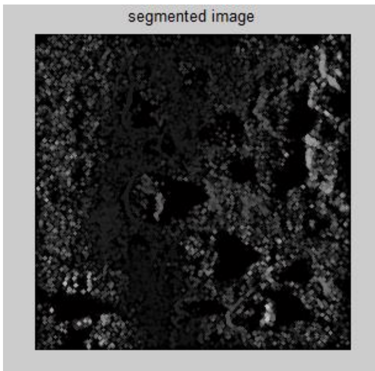

Fig. 9 Segmented image of input image

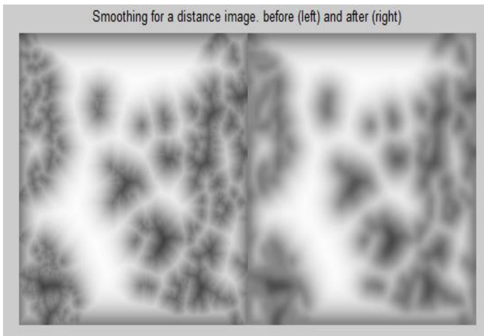

Fig.10 Smoothing for distance image

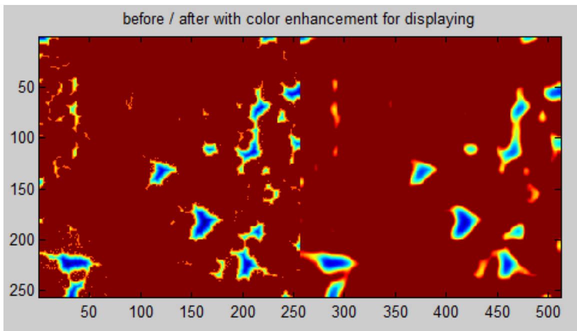

Fig.11 Color enhancement

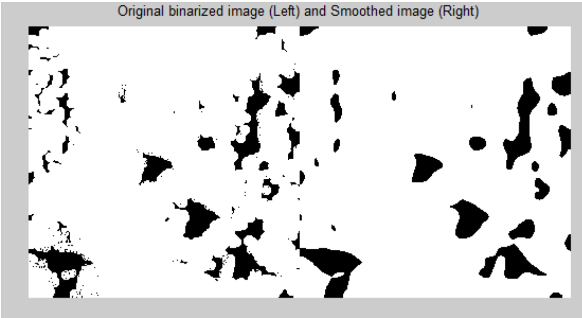

Fig.12 original binarized and smoothed image

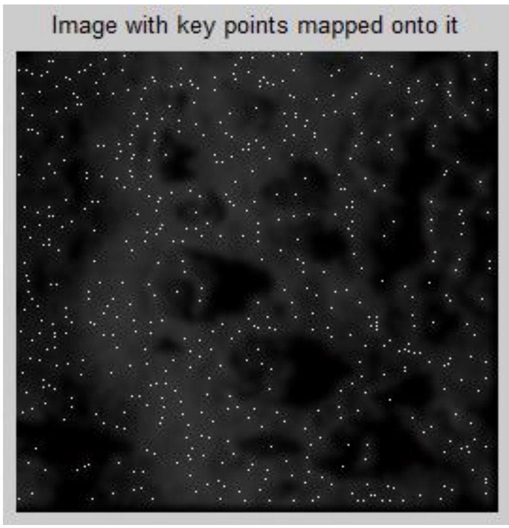

Fig.13 image with key points

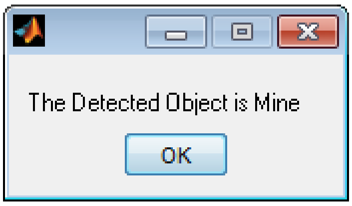

Fig.14 object detection

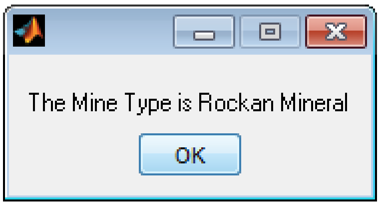

Fig.15 original material

V. Conclusion

In this paper, the problem of underwater mine classification in synthetic aperture sonar imagery has been considered. The automatic detection and automatic classification system is adopted to solve this problem. A modified expectation-maximization approach is applied to the image segmentation in regions of interest and the spatial correlation between pixels is tackled with Dempster-Shafer theory based clustering.

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