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Sea Ice Floe Detection And Classification Using Adaptive Clustering

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Abstract: Detection and classification of sea ice floe is very important for understanding physical process in the polar regions. Important thing is to know the shapes, sizes and spatial distribution of ice floes for understanding the physical process. Several image processing algorithms have been applied to samples of sea ice images in order to extract useful information. In this paper we are proposing a method for detecting and classifying the sea ice floe using adaptive clustering technique, which helps in identifying the classification of images which are done with segmentation that is done by adaptive histogram equalization. In order to improve cluster quality adaptive clustering uses external feedback that improves the execution time. Detect the edge of the ice floes by Canny image edge detection method and extract the features and compare the query image features with knowledge base features and classify the result that is done by SVM classifier. Good experimental results demonstrate the feasibility and effectiveness of the proposed method.

Keywords: Adaptive clustering, SVM classifier, Canny image edge detection.

I. INTRODUCTION

The sea ice cover has a significant effect on the Earth's climate system, which is defined as any form of ice that forms as a result of seawater freezing. That covers approximately 7% of the total area of the world's oceans. Exchanging heat, moisturizing, and momentum across the ocean-sea ice-snow-atmosphere interface was limited by the sea ice cover. Therefore, sea ice is both an active participant of the Earth's climate and a sensitive climate indicator. Monitor sea ice evolution and develop methods for automated analysis of climate becomes very important task as sea ice is an active participant of the earth climate and a sensitive climate indicator.

In this paper, our objective is to determine how we can separate the water and the ice part in an ice foes images by applying segmentation and canny image edge detection method. The preservation of the edges is a desired goal in many of the image processing applications. The reason is that the edges of an image are perceptually very significant and convey considerable image information. In other cases of some applications the image structures are characterized by shape measures and a pre-processing stage that does not preserve shapes can make the computed measures useless. However, the task of preserving shapes while at the same time eliminating superfluous details and spurious signals (noise) is both difficult and complex. In this paper will use the modified canny edge detector for detecting the edges of cropped images and will use adaptive clustering method in order to do segmentation of images by using k-means technique explained in methodology portion.

The proposed architecture consists of two phase they are training and testing phase. In training phase initially will consider the cropped ice floe images as input and these images are subjected to pre-processing by applying Adaptive histogram equalization method, in which resizing of images are done. Next, will detect the edges of pre-processed images and from that edge values will extract the features regarding shape and geometric features, these extracted features are trained according to the cropped images of separated water and ice images and save it in knowledge base. This will help for classifier to classify the images according to the edges of stored images.

Next comes to testing phase initially will consider ice floe image as input and these input images are subjected to pre-processing in which resizing of images are done, Next by applying adaptive k- means technique we are going for image segmentation. Once the images are segmented according to their features will apply an image edge detection technique in order t find out the edge properties of images. Next will extract the shape and geometric features by applying boundary extraction method, these features are saved in and feed it to classifiers then SVM classifier will classify whether the features obtained are water images or ice floe images by comparing the results with the dataset which is present in the knowledge base.

II. LITERATURE SURVEY

Jinchang Ren, et al.[1] has proposed effective sar sea ice image segmentation and touch floe separation using a combined multi-stage approach.In this they presented a multi-stage method for the sea-ice SAR image segmentation, which includes edge-preserved filtering for pre-processing, k-means clustering for segmentation and conditional morphology filtering for post-processing. As such, the effect of noise has been suppressed and the under-segmented regions are successfully corrected. Steven Leigh et al.[2] has proposed Evaluation of MAGIC sea ice classifier on 61 dual polarization RADARSAT-2 scenes. The resulting level of performance on this multi-year dataset confirms that the MAGIC system is can readily identify ice from different time periods. The MAGIC system is being considered by the Canadian Ice Service for operational implementation. M. Sharif Chowdhury et al. [3] has proposed a Shape Preserving Edge Enhancement in Remote Sensing Imagery In this paper, they used modified Canny edge detector is used to produce an initial binary edge image and the proposed technique is applied on this binary image to preserve the shape. M. Ali et at [4] has proposed Canny Edge Detector for feature Extraction and Enhancement of Remote sensing Images, in this paper they have proposed the main criteria behind the topic by extracting the edge image properties for remote sensing images, good experimental results shows how effectively they have implemented canny edge detector in their approach.

III. METHODOLOGY

Figure 1 represents the overall architecture of proposed system. The architecture consists of two phase they are training and testing phase. In training phase initially will consider the cropped ice floe images as input and these images are subjected to pre-processing by applying Adaptive histogram equalization method, in which resizing of images are done. Next, will detect the edges of pre-processed images and from that edge values will extract the features regarding shape and geometric features, these extracted features are trained according to the cropped images of separated water and ice images and save it in knowledge base. This will help for classifier to classify the images according to the edges of stored images. Next comes to testing phase initially will consider ice floe image as input and these input images are subjected to pre-processing in which resizing of images are done, Next by applying adaptive k- means technique we are going for image segmentation. Once the images are segmented according to their features will apply an image edge detection technique in order t find out the edge properties of images. Next will extract the shape and geometric features by applying boundary extraction method, these features are saved in and feed it to classifiers then classifier will classify whether the features obtained are water images or ice floe images by comparing the results with the dataset which is present in the knowledge base.

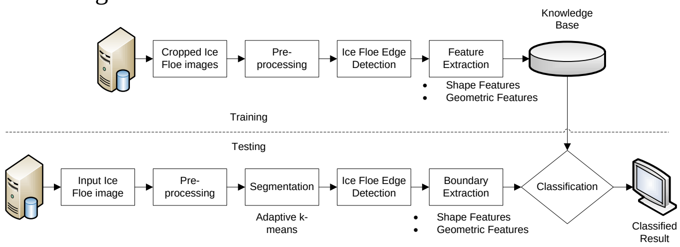
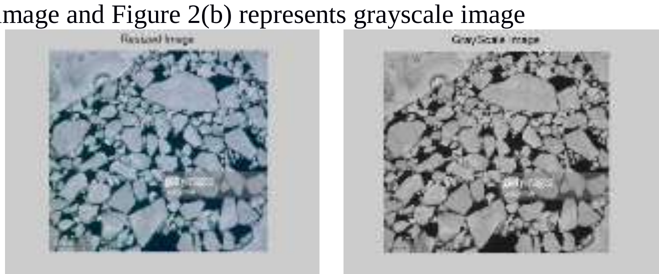


Figure 1: Block Diagram of proposed system

A. PRE PROCESSING

Pre-processing is mainly used to enhance the contrast and to adjust the size of the image, removal of noise and isolating objects of interest in the image. In this paper we are using adaptive histogram equalization method for pre processing part. Pre-processing is any form of signal processing for which the output is an image or video, the output can be either an image or a set of characteristics or parameters related to image or videos to improve or change some quality of the input. This process will help to improve the video or image such that it increases the chance for success of other processes.

Figure 2 represent the preprocessed image from the input cropped image as shown below, Figure 2(a) represents resized image and Figure 2(b) represents grayscale image



(a) *(b)*

Figure 2: (a) Resized image; (b) Gray scale image

B. CANNY EDGE DETECTION ALGORITHM

Now in industry Canny edge detector is considered as the standard edge detection algorithm. There are many steps need to fallow in the canny edge detector, initially with a two dimension Gaussian we need to smoothen the pre processed image, next take the gradient of an particular input image, then suppression is done through non-maximal, then edge threshold is calculated. The next step is to extract edges from cropped

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image which we have considered for our experiment and process the resulting edge information to obtain quantitative geometric measurements of cropped images of sea ice floe. The edges are detected by the canny edge algorithm. Using the gradient kernel approach image gradient magnitude is calculated in horizontal direction. G_x and vertical direction G_y for each pixel. And the direction of the pixel is measured by

$$\theta = \arctan\left(\frac{G_y}{G_x}\right) \quad (1)$$

Threshold values such at the higher threshold value (HIV) and lower threshold value (LTV) are selected from the histogram of the image in order to detect the edges of an cropped images accurately for further procedure to take place. After that verification is implemented by using these threshold values against each pixels respectively by using Non maxima suppression as given below.

- ✓ Pixel is taken as edge pixel when the gradient of the pixel is greater than the HIV.
- ✓ Value is also considered as edge pixel when the gradient is lie between high and lower threshold value.
- ✓ Pixel is declared as non edge pixel when gradient value is lower than the LTV.

This lower and higher threshold values are verified by the observation of the experiments. These two threshold values are used for to detect large edges and to find the small edges.

Figure 3 represent the image after applying canny edge detection algorithm shown below

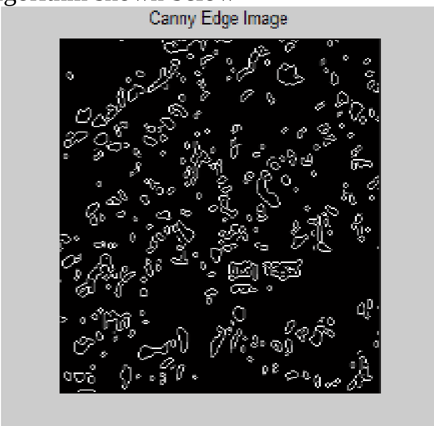

Figure 3: Canny edge image

C. FEATURE EXTRACTION

In order to get more effectiveness in the cropped image which we considered ad pre-processed, we are going for feature extraction such as shape features and geometric features

Shape features must have essential properties such as:

- ✓ Identifiability: Shapes which are found perceptually similar by human have the same features that are different from the others.
- ✓ Translation, rotation and scale invariance: These properties should not affected by the location, the rotation and the scaling changing of the shape.
- ✓ Affine invariance: The affine transform performs a linear mapping from coordinates system to other coordinates system that preserves the straightness and parallelism of lines. Affine transform can be constructed using sequences of translations, scales, flips, rotations and shears. The extracted features must be as invariant as possible with affine transforms.
- ✓ Noise resistance: When it comes to noise features must be robust, i.e., they must be the same whichever be the strength of the noise in a give range that affects the pattern.
- ✓ Occultation invariance: The feature of the remaining part should not change compared to the original shape when some parts of a shape are occupied by other objects.
- ✓ Statistically independent: two features must be statistically independent. This represents compactness of the representation.
- ✓ Reliability: The extracted features must remain the same when we are deals with the same pattern for long time.

Shape feature representation as a binary function is given below

$$f(x,y) = \begin{cases} 1 & \text{if } (x,y) \in D \\ 0 & \text{Otherwise} \end{cases} \quad (2)$$

Where D is the domain of binary shape

$$\text{Centroid } (g_x, g_y) = \begin{cases} g_x = \frac{1}{N}\sum_{i=1}^{N} x_i \\ g_y = \frac{1}{N}\sum_{i=1}^{N} y_i \end{cases} \quad (3)$$

N is the number of point in the shape.

D. ADAPTIVE K-MEANS CLUSTERING

In order to generate a segmented image knowing the number of classes in the beginning itself the popular K-means clustering method is deployed in this paper. According to the criterion of minimizing the Euclidian distance between feature vectors this clustering method is implemented, the fused features must be necessarily normalized. The normalization should comply with a rule that each feature component should be treated equally for its contribution to the distance. This method is implemented to prevents certain features from dominating distance calculations merely because they have large numerical values. As the feature vectors for segmentation are spread due to the presence of subclasses, it can be quite inappropriate to normalize the feature vector to be of zero mean and unit variance. This paper uses a linear stretch method to normalize each feature component over the entire data set to be between zero and one. As the number of texture features used for fusion is overwhelmingly larger than the number of tonal features, it is reasonable to assign different weights to cases where the texture and tonal features are combined so that the contribution of tonal features is similar to that of texture features.

E. SVM CLASSIFIER

SVM stands for Support vector machines. In order to achieve the optimal separating hyper-plane in the higher dimensional feature space, SVM first maps the input vector into a higher dimensional feature space. Furthermore, a decision boundary, i.e. the separating hyper-plane, is determined by support vectors rather than the whole training samples and thus is extremely robust to outliers. Exactly an SVM classifier is designed for binary classification. That is, to separate a set of training vectors which belong to two different classes. Note that a decision boundary similar to the support vector i.e. training samples. To provide the required mapping to ice-water labels a soft-margin SVM classifier is used. An SVM works by computing a linear decision boundary in a high dimensional space using the subset of labelled training samples near the decision boundary (called the support vectors). The SVM decision boundary equation is

$$f(x) = \sum_{\forall i} y_i \, \alpha_i K(x_i, x) \quad (4)$$

Where $K(x_i, x)$ Kernel function is defined by

$$K(x_i, x) = \exp(-\gamma |x_i - x|^2) \quad (5)$$

Then according to the result which we stored in the knowledge base at training phase SVM classifier will classify the segmented image by comparing it with cropped image.

IV. EXPERIMENTAL RESULT

The experimental result for the above discussed methodology is discussed in this section. Figure 4 represents the overall experimental results. Figure 4 (a) represents input image this image is preprocessed and will get Figure 2(a) and 2(c) i.e. resized and gray scale image respectively. Next will apply canny edge detection will get canny edge image as shown in figure 3 and Figure 4(b) represents histogram equalization image, next will perform segmentation by k-means algorithm will finally get extracted images as shown in Figure 4(c).

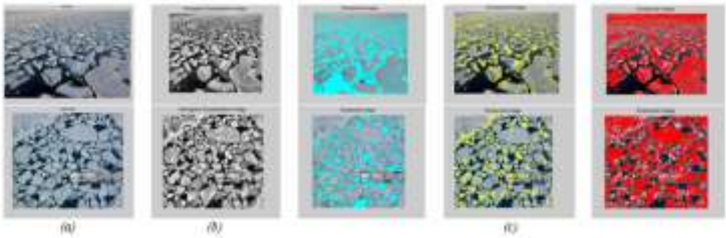

Figure 4: (a) Input image; (b) Histogram equalization; (c) Extracted images

V. CONCLUSION

This paper proposes a new model for detecting and classifying the sea ice floe using Adaptive clustering and SVM classifier. The philosophy behind the proposed approach is to separate the water image and the ice floe image from the segmentation of the images by applying k means algorithm.. On the basis of result from feature extraction the SVM classifier classifies the type of our input image. Extensive experimental results verify the efficiency of the proposed system and demonstrate that the proposed approach is superior to other approaches to recognize the efficiency.

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