A ROBUST METHOD FOR SHIP AND WAKE DETECTION

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ABSTRACT

In Maritime Surveillance SAR Oceanic images play an important role in naval operations, marine environmental protection and geophysical process. But SAR images suffer from speckle noise due to its coherent image acquisition mechanism, which makes us very difficult to find the target region in the ocean for extracting its features.Developed a software module for extracting ocean features from SAR image with three modules. One, preprocessing module which is designed for reduction of speckle noise using various enhancement and filtering process. Two, Vessel detection module which helps to find total number of vessels and distance between vessel using, morphological operations. Finally, Wake detection module leads to detect the wake line using line detection algorithm such Hough and Radon transforms.

I INTRODUCTION

Maritime surveillance by high resolution SAR images has been investigated since 80's. Mostly researches have been focused on ship detection, i.e. the detection of bright pixels over dark background, based on thresholding approaches [1]-[2] or sub-looks analysis [3]-[4]. More recently, it has been investigated the possibility to detect the ship wake on SAR images, both for an additional validation of ship presence and for estimating ship velocity. Two techniques have been proposed for estimating ship velocity by wake-related parameters: (a) the measurement ofazimuth shift [5] and (b) the spectral analysis along the Kelvin cusps wake, which are the most external bright linear features composing the ship wake [5].

Since wakes appear in SAR images as dark or bright lines, algorithms for wake detection can be seen as linear-features detection algorithms. To this end, Radon Transform [7] is typically used. It can be interpreted as an operator converting straight lines in the input image to points in the Radon domain. Consequently, one bright (dark) linear feature in the input image leads to one peak (trough) in the Radon domain. Different strategies have been proposed to detect peaks or trough in the Radon Domain. Copeland [9] proposes a localization of the Radon Transform performing the intensity integration over a line segment, instead of a line. Tunaley [10] suggests to adjust manually the size of the input image tile to have the same size of the wake, in order to maximize the peak associated to the wake, before the application of the Radon transform. After the tile selection, Rey et al. [8] proposes to apply a threshold, whose value depends on the mean value and the standard deviation of the Radon transform. Zilmann [6] provides an interesting approach to this problem.

II RELATED WORK

The detection method foresees to identified the five candidate wake features, which are then investigated by properly merit indexes to classify them as features really related to wake. For sake of clarity, this section summarizes the method steps. Extensive details are included in [11]-[12]. Since the method is conceived to validate the ship presence and, in the affirmative case, estimate its route, it is applied after a preliminary screening phase, in which the candidate ship positions are identified [1]-[2]. Then, an image tile is cut out around the ship, whose dimensions are fixed accordingly to the typical length of wake features. The tile is the input of the detection algorithm, as shown in the flow-chart of Figure 1. The ship-centered tile shows the bright pixels relative to the ship return pixels and to the land signature as well as the bright disturbances, imaged within a distance of about one ship length aft, due to ship propellers. The wake at this stage, called "propeller" wake, together with the ship and land returns, has to be removed since they lead to bright sine curves in the Radon domain, affecting the successive detection phases. Differently than Rey et al. [8], the integration path is constrained to ignore the bright returns from ship, propeller wake and land.. The latter can be estimated by Eq.1 [10], where R and V are the radar platform slant range and velocity and vv+,-. is the maximum expected ship velocity along the slant range direction, estimable on the basis of vessel traffic statistic in the imaged area and platform incidence angle. Similarly, the area affected by land returns are identified by land masking and ignored by integration process.

The Radon transform is then restricted between two sine curves [10] both to reduce computational time and to detect only peak relative to the wakes of the ship under investigation, imposing $s \leq \delta az_{max}\sin\theta$.

The proposed method foresees successive detection steps (Fig. 1). Firstly, the turbulent and one narrow-V wakeare identified in the Radon domain as the peak and the trough with angulardistancelessorequalto4°andprovidingthemaximum difference between their Radon Transform values. From a computational point-of-view, it is performed scanning the domain with a window and selecting the window in which is maximum the difference between the maximum and the minimumvalue.Thewindowdimensions($\Delta\theta$,Δs)areproperly set following theseconsiderations:

- Peaks and trough of real radar data are represented by a cluster of pixels, instead of a single dot, and each of them occupies an extended but limited area in the Radon domain. Therefore, the window dimension in θ ($\Delta\theta$) is chosen equal to $4°+\delta\theta$, where $\delta\theta$ includes the discretization step and the appearance of the peak and the trough as a cluster ofpixels.

- Referring to Figure 2, the maximum shift along the s-direction between the turbulent and the narrow-V wake canbeestimatedas: $\Delta s_{max} \approx \delta az_{max}\Delta\theta+\delta s$, where δs includes the appearance of the peak and the trough as a cluster ofpixels.Fig. 2. Turbulent and narrow-V relative geometry.Whentheturbulentwakedirection(θ_t,s_t)andonenarrow-V wake direction (θ_{v1}, s_{v1}) are known, the second narrow-V wake is identified as the peak (maximum Radon Transform value) within$\Delta\theta$fromθ_t,ontheoppositesidewithrespecttothefirst narrow-Vwake.Indetails,if$\theta_{v1}>\theta_t$,itresultsthat$\theta_{v2}<\theta_t$.Being $s=f(\sin\theta)$ as shown in Fig.3, s_{v2} could be both larger or smaller than s_t depending on $\theta_t$value.

- if$\theta_t<90°$,$\theta_{v2}<90°$and,consequently,s_{v2}issmallerthan s_t, being in the ascending phase of sinecurve;

- if $90°<\theta_t<90°+\Delta\theta$, θ_{v2} could be larger or smaller than 90°ands_{v2}iscomprisedbetween$s_t-\Delta s$and$s_t+\Delta s$

- if $\theta_t>90°+\Delta\theta$,$\theta_{v2}>90°+\Delta\theta$ and, consequently, s_{v2} is larger than s_t, being in the descending phase of sine curve; | |

Sin curve:

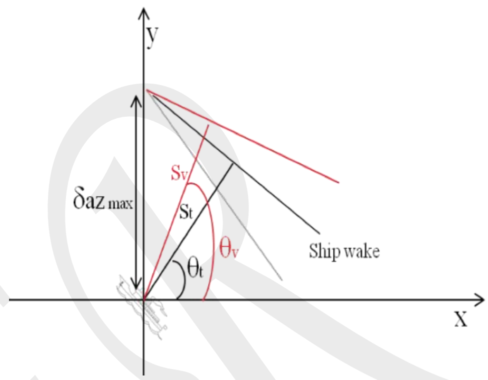
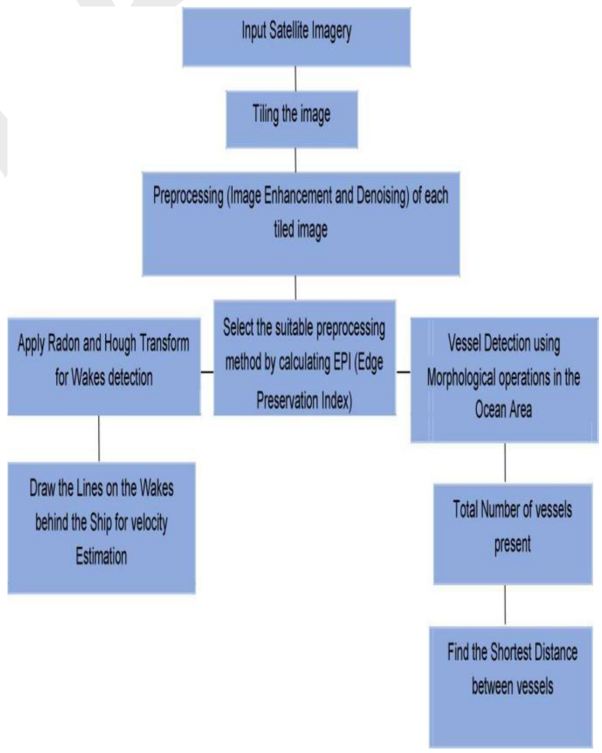


Fig.1 SINE CURVE



Block diagram

III PROPOSED METHODOLOGY

Three methods of processing ship detection:

- Preprocessing
- Vessel Detection
- Wake Detection

PREPROCESSING

Image Enhancement:

Image enhancement belongs to image preprocessing methods. The main objective of image enhancement is to process the image (e.g. contrast improvement) so that it is better suited for further processing or analysis. This method is based on subjective image quality criteria. Here, no objective mathematical criteria are used for optimizing the processing results.

Histogram Equalization

Histogram equalization is a typical strategy for improving the presence of pictures. Assume, a picture which is relevantly dull. At that point its histogram would be skewed towards the lower end of the grey scale and all the picture detail is packed into the grey end of the histogram. It improves the differentiation of pictures by changing the qualities in a force picture with the goal that the histogram of the yield picture roughly coordinates a predefined histogram (uniform appropriation as a matter of course) [6]. The picture would turn out to be much clearer.

Median Filter

Median is a non-linear filter that replaces each pixel by the median of all pixels in the neighborhood in windows (i.e. 3*3, 5*5, 7*7, 9*9).That means all pixels within the neighborhood are sort by gray value, and take the median of the group as a neighborhood center pixel output value. In other words it is derived from the maximum-likelihood estimation principle by assuming the signal is contaminated by additive noise as well as multiplicative noise. The quality of the filter depends on the size of window.

VESSEL DETECTION

Using SAR Image, the number of ships in the ocean region are detected by using thresholding and morphological operations. It is useful for representation and description of region shape. The objective of using morphological operations is to remove the imperfections in the structure of the image.

Dilation: The estimation of the yield pixel is the greatest estimation of the considerable number of pixels in the information pixel's neighborhood. In a twofold picture, if any of the pixels is set to the value1, the yield pixel is set to 1.Filling of openings of certain shape and size is given by the auxiliary component

Erosion: The estimation of the yield pixel is the base estimation of the considerable number of pixels in the info pixel's neighborhood. In a parallel picture, if any of the pixels is set to 0, the yield pixel is set to 0. Expulsion of structures of certain shape and size is given by the basic component.

WAKE DETECTION

Wake is the trace produced by any object that is moving at or near the water surface. It develops around and directly behind the ship and it appears rather complex, composed by different elements like both bow and stern waves, but also eddies, currents and foam. The wake contour depends on numerous factors like the actual shape of the ship, its speed, wind intensity and direction, and several other aspects, but it becomes quite universal about three ship lengths behind the ship.

By using radon transform, one can detects the maximum peak values from the input image. From that maximum peaks, draw the line in the input image. The Radon transform is widely used to detect ship wakes in synthetic aperture radar (SAR) images. Ship wakes have linear features in the image, and they correspond to peaks in the Radon transform. Therefore, the ship wakes can be detected by searching for peaks in the Radon transform. Likewise, detect the ship wakes edge line using radon maximum peaks and radon lines. The line parameter can also be detected using Hough transform.

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform. The classical Hough transform was concerned with the identification of lines in the image, but later the Hough transform has been extended for identifying the positions of arbitrary shapes, most commonly circles or ellipses .

IV SIMULATION RESULTS

To implement our methodology in the simulation, we are going for the MATLAB schematic software tool. This was implemented as in the below figure.

Fig.2 Preprocessing Image

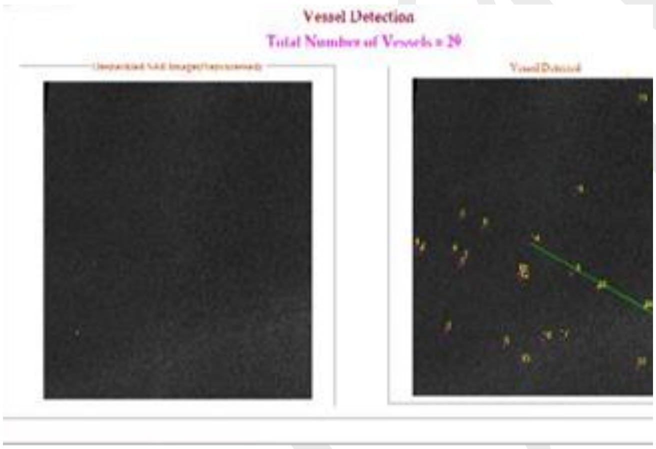


Fig.3 Vessel Detection

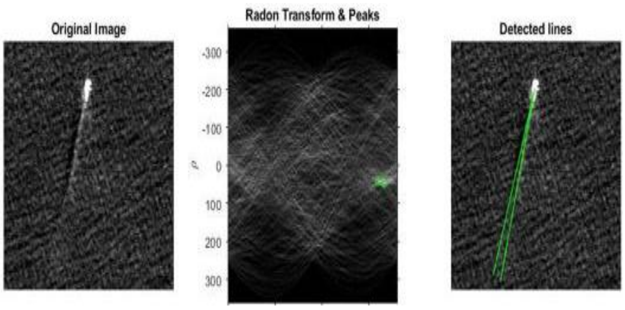


Fig.4 Wake Detection

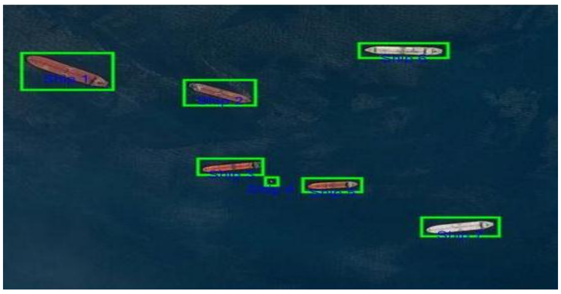


Fig.5 Result

Result

MSE = 0.000026

RMSE = 0.005100

PSNR = 45.848350

Edge Preservation Index = 0.902634

Speckle Diff = -14.902006

CNR = 106.662726

Ship Number	Width(meter)	Length(Meter)
1	13.5	21.9
2	9.3	17.1
3	6	15.6
4	3	1.2
5	5	14.1
6	5.4	21.3
7	6.9	18.6

Tabulation

V CONCLUSION

This project focused on the information exploitation from the satellite imagery (Synthetic Aperture Radar (SAR) and Optical imagery) of ocean regions. Since the speckle in SAR images degrade the quality of images, that made us to implement suitable filters to reduce the noise and also preventing important information such as wakes edges. Using morphological operations detected the vessels from the preprocessed images and also bounded the vessel area using relevant bounding box. Wake detection method was implemented using two line detection algorithms namely Radon transform and Hough Transform for both SAR and Optical Imagery. Finally from our analysis, noticed that radon transform gives precise results than hough transform and also calculated wake angle and wavelength from the detected wake lines to estimate the velocity of the vessel. All the methods are tested and verified using reference images available in the literature. The GUI design and entire algorithim.

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