RELIABLE LOW BANDWIDTH INSHORE SHIP DETECTION VIA WEIGHTED POSE VOTING

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ABSTRACT:
With the rapid development of optical remote sensing satellites, ship detection and identification based on large-scale remote sensing images has become a significant maritime research topic. The proposed method defines the rotation angle pose and the scaling factor of the detected ship to detect the ship with different directions and different sizes. For each pixel on the ship template, the possible poses of a detection window are estimated according to all possible pose-related pixels. To improve robustness to the shape-similar distractor and various interferences, the score of the detection window is obtained by designing a pose weighted voting method. Moreover, the values of some parameters such as similarity threshold and the weight of "V" are investigated. Further, this is enhanced by utilizing efficient bandwidth by using HAAR.

KEYWORDS: Weighted Pose, Inshore, shape-similar distractor, interferences, bag-of-words

INTRODUCTION:

High-resolution optical remote sensing images have become an important research topic in many marine applications. Due to their large scale and high efficiency, such images have been extensively used in ship detection, such as in dynamic harbor surveillance, maritime management, ship rescue and smuggling activity monitoring [1–3]. In particular, ocean-going vessels and inshore ships are considered typical ship detection scenes. A number of previous studies have focused on ocean-going vessel detection, and they usually showed good performances [4–9]. In addition, for inshore ship detection scenes, anchored ships, which are docked in harbor but are not connected to a dock, have similar backgrounds as ocean-going vessel scenes. Given these characteristics, anchored ships were detected effectively in [10,11]. However, in inshore ship scenes, compared with anchored ships, ships berthed at a dock, which are called "docked ships", are rarely focused on. This is primarily because of the high degree of similarity in gray information and textures between the dock and the docked ship, which are almost connected. These factors make it challenging to accurately detect docked ships from harbor regions. SHIP detection is one of the hottest issues in many fields, such as harbor dynamic surveillance, traffic monitoring, and maritime management. According to the complexity of background, the existing ship detection methods are divided into the offshore ship detection and the inshore ship detection. For the offshore ship detection, the gray distribution analysis [1]–[3] or the constant false alarm rate detector [4]–[6] is usually adopted due to the fact that the gray level of the ships is usually higher than that of the sea background, especially in the synthetic aperture radar images. However, due to the various interferences in the harbor scene, it is more difficult to accurately detect the inshore ships compared with the offshore ships. For example, there are many distractors with the similar color, texture, or shape of the ships, such as the docks and the storages. Moreover, the ships are usually moored adjacent to the docks in different directions and scales. Inshore ship detection algorithms can be categorized into two types: model-based and contour-based. The model-based methods are initially proposed for target detection in natural images. To eliminate the interference of the color, texture, and the background, the model-based methods generate discriminative descriptors for the local features of the target from a large number of positive samples and negative samples by the training strategy. Commonly known models include the bag-of-words (BoW) model [7]–[12] and the part-based model (PBM) [3]–[6]. Inshore ship detection refers to the detection of ship targets berthed in the harbor, whereas the offshore ship detection is for ship targets on the sea. Inshore ship detection focuses on the statistic of the number and the type of ships in a harbor. This may be useful to ship management. On the other hand, offshore ship detection is mainly used in maritime surveillance to reconnoiter whether there are illegal fishing boats or warships entering the prohibited sea area. Most recent literatures on ship detection are involved with solutions of the offshore ship detection. Only few reports focused on the inshore ship detection issue. The main reason is that the background in the harbor scene is much more complex than that in the sea. Current detection methods for offshore ships are difficult to precisely detect the ship targets in the complex harbor scene. The proposed inshore ship detection can be described as the problem of designing a special ship detection method which is rotation–scale invariant and robust to the complex background. A possible solution is briefly given as follows. For a given ship template and a tested satellite image, the tested satellite image is separated into overlapped blocks, containing ship templates with the same size. For each block, subsequently called the detection window, the proposed detection method estimates the most probable pose and computes its score. The score is then used to determine whether there is a ship in the detection window. To obtain the most probable pose and the corresponding score of a detection window, the RGA-based pose estimation and the pose weighted voting strategies are developed. The pose of a target is defined and illustrated in Fig. 1, according to the geometric relationship between the ship template and the contour of the detected ships in the satellite image. Fig. 1(a) shows a ship template that is a binary contour

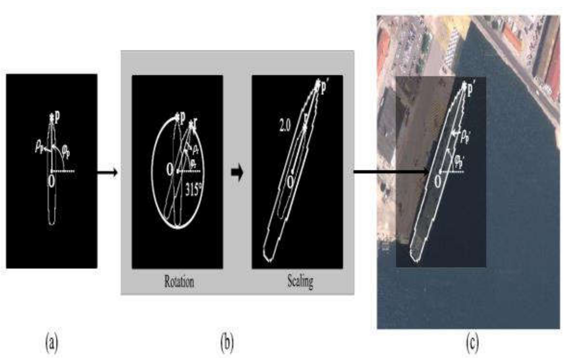


Fig. 1. Relationship between the ship template and the target ship contour in a satellite image. (a) Ship template. (b) Geometric relationship including rotation and scaling. (c) Satellite image of the harbor scene giving a detection window of a ship. The direction of the ship template is defined to be straight up. Fig. 1(c) shows a satellite image including a ship whose center locates exactly on the center of a given detection window. The contour of the detected ship, marked by a white solid line, is similar to that of the ship template; but its direction and size are different. Note that the direction and size of the ship template can be changed by rotation and enlarging. For example, as shown in Fig. 1(c), the contour of the detected target ship in the detected window can be obtained by rotating the ship template 315° counterclockwise on the center O and then enlarging it twice of its origin size, as shown in Fig. 1(b). In other words, the pose of a detected ship can be described by a rotation angle α and a scaling factor λ related to the ship template. The pose of a detected ship can be defined by a 2-tuple vector (α, λ) where α is the counterclockwise rotation angle in the range of $[0, 360°)$ and λ is the scaling factor which is larger than 0. For instance, the pose of the detected ship in a given detection window shown in Fig. 3(c) is g = (315∘, 2). A pair of special pixels is required to obtain the pose of a detected ship in a detection window whose center coincides with that of the detection ship. Consider the ship template and the target ship contour in Fig. 1. A pair of pixels (p, p_) represents the start and the end positions of the rotation and scaling process. p is on the ship template and p_ is on the contour of the detected ship. For this special relationship, the pixel p_ on the contour of the detected ship is called the pose-related pixel of pixel p on the ship template or (p, p_) is a pair of pose-related pixels. According to the geometric process in Fig. 1(b), pixel p first translates to pixel r and then pixel r translates to pixel p_. The angle between pixel p and pixel r is the rotation angle of the pose, while the ratio of the radial distances between Op_ and Or is the scaling factor. Suppose that the indices of pixel p, pixel r and pixel p_ in polar coordinates centered on pixel O, be (ϕr, ρp) and (ϕr, ρr), respectively. The pose of the detected ship can be expressed by g = (ϕr − ϕp, ρp_/ρr). (2) The radial angle of a given pixel is represented by ϕ and the radial distance by ρ. The radial angle of pixel r is equal to that of pixel p_, while the radial distance of pixel r is equal to that of pixel p. Then (2) can be rewritten as g = (ϕp_ − ϕp, ρp_/ρp). (3) It follows from Fig. 1(b) that each pixel on the ship template goes through the same rotating and scaling process to become the corresponding pixel on the contour of the detected ship. That is, the pose of the detected ship can be calculated according to any pair of pose-related pixels. Although there are many pairs of pose-related pixels between a ship template and a detected target ship, the poses calculated by any pair of pose related pixels are similar since they represent the pose of the same object. The characteristic of the defined pose combining with a pose weighted voting strategy can be used to design an effective inshore ship detection method. The diagram of the proposed inshore ship detection method is shown in Fig. 2. The

detection process mainly includes three stages: 1) the RGA-based possible pose estimation; 2) the pose weighted voting; and 3) the score-map post processing. RGA-based possible pose estimation is to find out the most related pixel pairs for the detection. Since the estimation is executed on a target pose that describes not only the direction but also the scale, the proposed method achieves rotation–scale invariance. The pose weighted voting process is to collect the evidences of the detected target from the related pixel pairs obtained in the former process. "V"-shaped structure weighting and outline continuity evaluation are added in the voting, so that the proposed method is robust to the shape-similar distractors and complex background. Finally, the detection result is outputted by the score map post processing.

RGA-BASED POSSIBLE POSE ESTIMATION:

It is very difficult to detect a ship and its pose in a detection window. That is because we do not know whether there is a ship in the detection window and which pixel is on the contour of the detected ship in terms of the pose of a ship. According to

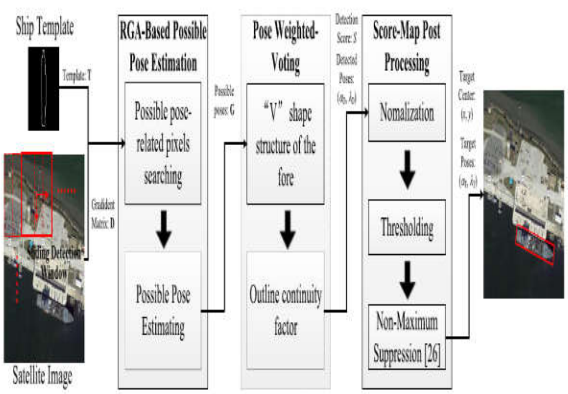


Fig. 2. Diagram of the proposed inshore ship detection method

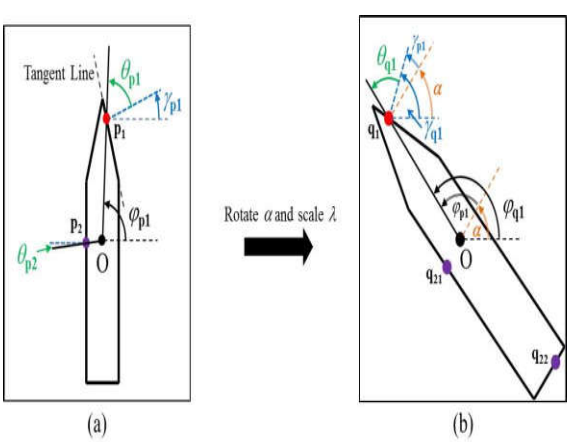


Fig. 3. RGA of some pixels on a ship template and a rotating-scaling one. (a) RGA of a pixels p1 on the ship template. (b) RGA of a pixels q1 on the rotation–scale template and some edge pixels with same RGA

the pose definition and computation described in Section, the pose of a ship can be computed if a pair of pose-related pixels (p, p_) are obtained. For a pixel on the ship template, it is very difficult to accurately find its pose-related pixels in the detection window especially in the complex backgrounds. Fortunately, we can find a set of possible pose-related pixels instead. In the proposed method, several possible pose-related pixels of each pixel on the ship template are searched based on RGA and used to estimate the possible pose of the detection window.

Possible Pose-Related Pixels Searching:

For each pixel on the ship template, the possible pose-related pixels are searched by designing a matching algorithm based on the RGA. The RGA describes the relationship between the location and the local feature of the edge pixels [26]. For a pixel p on a given template, the RGA θp is defined as the angle between the radial line and the gradient line. Let ϕp and γp be, respectively, the radial angle and the gradient angle of the pixel p referenced [26]. The RGA θp can be calculated as $\theta p = \mathrm{mod}(\phi p - \gamma p, \pi)$. (4) For example, the RGA of a pixel p1 on a ship template shown in Fig. 3(a), denoted by θp1, is the angle between the radial line [see the black solid line in Fig. 3(a)] and the gradient line[see the blue dashed line in Fig. 3(a)]. Obviously, the RGA is a rotation–scale-invariant descriptor for edge pixels [26]. Fig. 3(b) shows a rotation–scale version of Fig. 3(a), where the ship template is rotated α and scaling λ. The corresponding pixel of the pixel p1 is marked q1. Itcan be observed form Fig. 3 that both of the radial angle ϕq1 and the gradient angle γq1 of the pixel q1 are changed with the rotation. However, according to the geometric knowledge, there is relationship between ϕq1 and ϕp1, that is, $\phi q1 = \phi p1+\alpha$. There is a similar relationship between γq1 and γp1, namely, $\gamma q1 = \gamma p1 + \alpha$. Therefore, the RGA of the pixel q1 calculated by (4) is equal to that of the pixel p1 in Fig. 3(a), that is, $\theta q1 = \theta p1$. On the other hand, for some pixels on the ship template, the number of the corresponding pixels whose RGA are same is more than one. It can be seen from Fig. 3 that the pixel p1 has only one corresponding pixel q1 but the pixel p2 has two corresponding pixels (q21 and q22) whose RGAs are equal to that of the pixel p2. This indicates that different edge pixels on the ship template may have a different number of corresponding pixels. For each pixel p on the ship template, all possible pose related pixels is defined as the pixels in the detection window, whose RGAs are similar with that of the edge pixel p. Let T be the ship template and TE be the set of the pixels with the value of 1, that is TE = (i, j) | T(i, j) = 1. Let D be the gradient amplitude matrix of the detection window (see [26]) and DE be the edge pixel set in D whose gradient amplitude is larger than a given threshold ε, namely, DE = (i, j) | Dg(i, j) ≥ ε, where Dg represents the gradient amplitudes of D. The possible poserelated pixel set Cp of an edge pixel p in TE can be described as follows: Cp = {q | | θp − θq | ≤ ε, q ∈ DE}, p ∈ TE (5)where θp and θq are, respectively, the RGA of pixel p and pixel q calculated by (4), and ε is a similarity threshold

BLURRING EFFECT REMOVING USING

In blurring, we simple blur an image. An image looks more sharp or more detailed if we are able to perceive all the objects and their shapes correctly in it. For example. An image with a face, looks clear when we are able to identify eyes, ears, nose, lips, forehead e.t.c very clear. This shape of an object is due to its edges. So in blurring, we simple reduce the edge content and makes the transition form one color to the other very smooth.

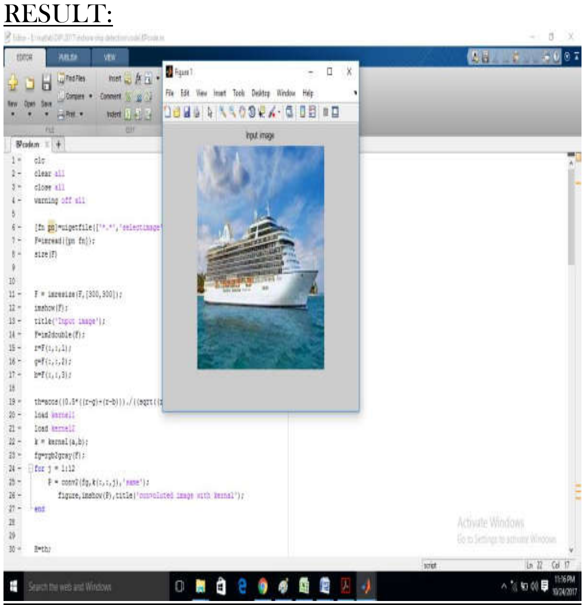
Types of filters: Blurring can be achieved by many ways. The common type of filters that are used to perform blurring are.

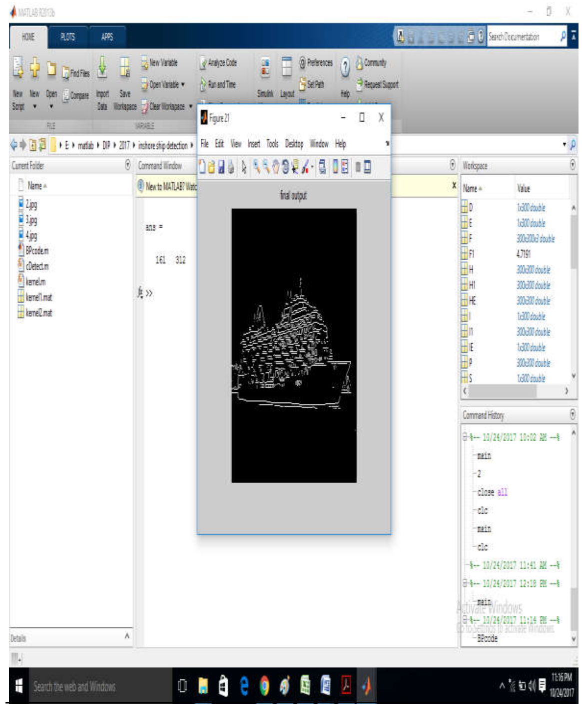
Mean filter

- Weighted average filter
- Gaussian filter

Out of these three, we are going to discuss the first two here and Gaussian will be discussed later on in the upcoming tutorials.

RESULT:





CONCLUSION:

Experiments on large-scale harbor remote sensing images verify that the proposed method is effective and robust when applied to unsatisfactory scenes. Compared with typical methods, the proposed method also achieves better detection results. This method aims at rapidly getting the berthing situation of inshore ship from interested port by using a wide range of remote sensing images. Especially, some situations that traditional information acquisition methods could not deal with (such as non-cooperation) would suit our method. The experimental results indicate that the proposed method is rotation– scale invariant and robust to the shape-similar distractor interference as well as to the complex backgrounds. The results also demonstrate that the proposed detection method outperforms four other start-of-the-art detection methods.

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