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The detection algorithm of irregular dynamic objects

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Abstract Using remote sensing data for marine monitoring, marine rescue, marine pollution monitoring which has a broad monitoring area and fast response time, so in the last 10 years, satellite borne or airborne optical and SAR sensor data have been increasingly used in the field of ocean monitoring. However, based on the dynamic video to carry out the study of the detection of irregular debris blocks from the wrecked ship, aircraft is less. To a great extent, it affects the efficiency of maritime rescue. This paper, based on the dynamic objects detection, Color Space Quantization and property of Human Vision System, takes the irregular wreckage patches as research. And a detection algorithm for dynamic objects is developed with the foundation of Lab channels. To verify that, the calculation of the Euclidean distance between the characteristic parameters of irregular wreckage patches and regular floating ones, and the average Euclidean distance is 0.8245 between the irregular1 and the regular while that between irregular2 and the regular is 4.3645. At the same time, the Hausdorff distance was calculated and verified, and the average distance between the irregular block 1 and the regular block was 2.5975. The average distance between the block 2 and the rule block was 13.8962. Experimental results show that the method is consistent with the results of the second methods, which proves that the first method is scientific and operational. Therefore, it can be found that some parameters including divergence, elongation and eccentricity fluctuate dramatically from those in irregular ones to the regular one, which could be extracted to recognize or distinguish the patches. That is why this paper is of importance in marine rescue and detection of objects on the sea surface.

Keywords Ocean background · Dynamic objects · Irregular patches · Image detection

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1 Foreword

China has a long coastline, marine resources are very rich, how to scientific and rational development of marine resources has become an important part of the development of China's economy, as human beings continue to accelerate the development of marine resources, it also brings a lot of problems, Such as: marine environmental monitoring, marine environmental protection, maritime rescue [12], etc. So the marine target detection technology [17] is becoming a important research direction. At present, the importance of sea-surface targets detection has extended into many fields such as customs administration, ship marshaling, ocean environment protection, ocean environment monitoring [5] and marine rescue. For the moment, the methods for sea-surface targets detection are mostly related to radar image as well as both thermal infrared and visible light image.

Crisp adopted the method of radar image and based his research on likelihood ratio test (LRT) detectors [4]. This method not only takes distributed background into account, but also distributed objects in order to reach the optimized detection effect. Attilio G introduced generalized LRT into polar metric radar echo with Gaussian distribution and it proved good [1]. Jin song Zhong adopted the SAR image to detect ships in the automatic radar system by the threshold value with an algorithm called Constant False Alarm Rate [10]. Also he minimized the interference wave as well as the negative effect on false alarm probability. Qiang Luo used the wavelet transform of grey level histogram to segment the images and magnified the difference between ships and the background ocean effectively [3]. Thus the detection accuracy could be improved. In the 8th reference, a method based on fractal character and RCS curve was put forward due to the often appearing feature of punctiform objects resulting from the regular outline of ship in SAR image [9]. Moreover, some researchers try to detect the floating spilling oil from the ship accident with radar image. However, all these researches illustrate that their work focuses on the regular objects like ship or some kinds of oil patch from the spilling. And obviously most of the detected objects are regular ones rather than the irregular ones such as the patches of crashed aircrafts or wrecked ships, which is in more and more serious and urgent demand.

However, the current research on the detection of irregular debris blocks, which are formed by the wrecked ships and aircraft, is less, which greatly affects the efficiency of marine rescue. In this paper, dynamic object detection and color space quantization are used in this paper, and the detection method of irregular moving object is discussed in this paper. In the first chapter, the paper introduces the existing problems in the current ocean surface detection technology. The second chapter introduces the related research work in this paper. In the third chapter, the process of simulation experiment and the function of each module are introduced. In the fourth chapter, the experimental data were processed and analyzed. The fifth chapter introduces the contribution of this paper and the next research plan.

2 Problem formulation

On May 7, 2002, the Northern Airlines plane crashed in the waters of Dalian, On March 8, 2014, Malaysia Airlines Boeing 777–200 aircraft crash, until July 29, 2015 in the Indian Ocean on the French island of reunion found the wreckage of the plane. In recent years, the frequency of ships and aircraft accidents have occurred, so the importance of maritime rescue work is particularly prominent. Ocean target detection technology as the core of the maritime rescue work, the research status is also increasing. At present, the main means of detecting the sea surface environment is the microwave radar and passive infrared, microwave radar imaging distance is far, but there are blind spots in the near distance [25], Passive infrared can make up for the blind area target detection, but can only get the target infrared radiation intensity profile image, can not get the distance information of the target, can not be evaluated on the target space position [24]. Affected by the marine environment, such as the infrared radiation characteristics of the target and the background, will greatly affect the imaging contrast, the detection rate of the impact of sea targets [8]. In order to study the problem of ocean target detection which is the detection of irregular debris blocks from the wrecked ships and aircraft is less, and the imaging contrast is small and so on. The following related research work is carried out in this paper.

3 Related work

3.1 Study on the basic characteristics of irregular wreckage patches

Due to the blast, collision and some other kinds of exogenous actions, the wreckage patches from the wrack and air crash would have the following characteristics. As a common sense, some wreckage patches might keep the initial painting patterns while some others could suffer from a series of burning and then explosion, both of which could result in the irregular dead-colored pattern such as the burning spots, oil areas and even some collision-caused deformation [23]. And resulting from the various sizes meanwhile different depth it is in, the wreckage patch could appear the approaching or even similar color comparison with the ocean. Also owing to the heat exchange, the infrared property becomes feebler with time going. Thus, it is quite difficult and almost infeasible to detect irregular patches with no matter low resolution radar image or thermal infrared image because the different depth in water and various materials lead to the less obvious radar diffraction property [6]. Moreover, when it comes to the motion, these kinds of wreckage patches are considered dynamic at the velocity of the ocean current. And after a series of calculation, the dynamic object detection is feasible. Meanwhile, from the perspective of digital image, some parameters such as divergence, elongation, concavity and convexity as well as eccentricity are weightedly [11] composed to describe the irregular wreckage patches.

There are some parameters requiring more detailed explanation. The first one is dispersion. The image is presumed as S and the area is A which is also the pixel of the image. The perimeter is P. So the dispersion is defined as p^2/A. Obviously the dispersion of a circle is 4π, which means circle is the most compact shape. The dispersion will increase with the geometrical shape becoming more and more complex.

Also, the eccentricity is a vital description of the shape. One approach to measure the eccentricity is to calculate the ratio of principal axis to auxiliary axis. Another way is to calculate the inertial principal axis ratio, which is used to count the quality with either the whole area or boundary lines. And Tenenbaum put forward an approximation formula about how to calculate the eccentricity of a random aggregate of points. To obtain the derivation formula, the following steps are necessary.

To calculate the average vectors,

$$x_0 = \frac{1}{n}\sum_{x\in R} x \; y_0 = \frac{1}{n}\sum_{y\in R} y \tag{1}$$

x and y are the coordinates.

To calculate the moment ij (m_{ij}),

$$m_{ij} = \sum_{(x,y)\in R} \left(x_0 - x)\right)^i (y_0 - y)^j \tag{2}$$

To calculate the vector angle,

$$\theta = \frac{1}{2}\arctan\left(\frac{2m_{11}}{m_{20} - m_{02}}\right) + n\left(\frac{\pi}{2}\right) \tag{3}$$

Then the approximate value of eccentricity is

$$e = \frac{(m_{20} - m_{02})^2 + 4m_{11}}{\text{Area}} \tag{4}$$

In this formula, the threem_{11} , m_{02} , $m_{20}$are all moment invariants. They are important parameters about gray level in eccentricity.

Notably, the complexity is of great importance in shape analysis. However, the way to judge or define it depends on too many other features even including some psychological elements like observers' habits or knowledge. Therefore, complexity is extremely difficult to be defined accurately. But still these three aspects are worth considering.

(1) The more curvature maximum on the boundary of S, the more complex it is.
(2) The more changes in the curvature on the boundary of S, the more complex it is.
(3) The more information required defining the object S, the more complex it is. S means the shape of the area considered.

3.2 Research on moving object detection technology

The detection of dynamic objects is one of the cores in computer vision technique. The military applications mainly include detection, guide, early warning, smart aircrafts and robot vehicles [13]. While in civil, it can be used in traffic detection, face recognition and monitoring. Xu et al. [20–22] proposed a technology named video structural description to process the person, vehicles in the surveillance videos.

The detection of dynamic objects aims to extract elements including crew and vehiclesas well as other kinds of objects in motion which are of comparatively great importance from the whole background or image. The common methods or algorithms normally used include frame difference method, optical flow method and background subtraction method [18].

The frame difference method means the basic frame difference in continuous sequence of images between contiguous two frames or among three adjacent ones. And after determining the threshold value, the dynamic objects in image could be extracted based on the difference in threshold value. This method can be used to pinpoint the location of object while the effects could be seriously interfered resulting from the existed overlapped objects in image. Meanwhile, there are some other elements which could affect the frame difference method a lot, such as the time frame difference running and the velocity of the dynamic objects. Lipton from USA put forward the dual frame difference to extract the dynamic objects from the actual sequence diagram as well as to track, recognize and classify dynamic objects. Also, Mr. Li adopted both the tri-frame difference and cross entropy threshold method to detect the dynamic vehicles. And his experiments illustrated that this method worked well to detect the whole object meanwhile with stability and robustness.

Optical flow method is a method to examine the optical flow features. If everything in an image is static, the optical flow vector is supposed to change continuously in the entire image area [19]. But if there is something moving in the image, then the result would be disparate. Because when something moves in the image, there comes a relevant motion between the object and image, resulting in the difference between the velocity vector of the moving object and that of the background. Thus the dynamic object can be detected easily. Meyer used the optical flow vector which aims to calculate the displacement vector to initialize the dynamic object detection algorithm. And the experiment proved it good. So the strength of optical flow method is the ability to detect the dynamic objects even with the CCD camera rotating. But its weakness is also apparent, which is the complexity as well as the bad performance encountering with noise. As a result, the instantaneous process of the entire frames would be infeasible without some particular hardware, which could increase the cost drastically.

Background subtraction method is based on the frame difference image of detection. But the difference is between the present frame and the background model, which should be established before. In recent years, several scholars came up with some improved algorithms of background subtraction and reached acceptable effects but still some problems. All these problems originate from the sudden change of background especially in some complicated situations. According to the causes of background change, they should be classified into three parts. The first one is the change of illumination including gradual and sudden change of illumination. For instance, a lamp is on. And the reflected light would affect the former background. Also another situation should be included in the first part, which is the projected shadow overlapping the initial shadow. For example, there is overlapped shadow at the sunset in the city. And a visible shadow contains more than one source [15]. It is possible that some other objects can be detected in this shadow like trees and buildings. The second one is the interference of background, like the waves on the ocean surface when the ocean is extracted as a background as well as the slight vibration of camera. The third and the most challenging one is the change caused by the dynamic objects. A ship goes across the ocean and causes waves inevitably. Likewise vehicles or aircrafts could change their own backgrounds unintentionally. All the three causes mention above could just affect a part of the background or change the entire background. That is why the instantaneous update is necessary. With it, the background can adapt itself and a comparatively good model background can be established to eliminate the interference during the image processing.

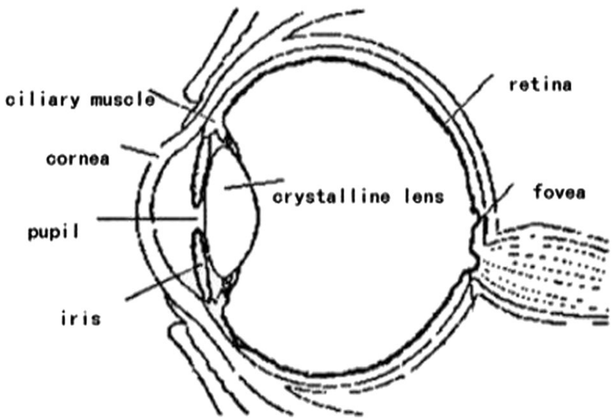
During the detection of dynamic objects, the quality of initial background and instantaneous background update affects the final result directly and critically. In the background subtraction method, ideally, the background holds constant with time going, while actually it is impossible because not only the pixel gray level in area of the dynamic object changes but also in other background area. Therefore, nowadays, in order to improve the background subtraction method, many researchers are devoting themselves to developing different kinds of methods to obtain background and update the algorithm as well as to alleviate the negative effect on dynamic objects from the dynamic background. With their research, some algorithms are set up. The first one is the multi-frame mean, which is an easy and convenient algorithm. However, the calculation result of it is not that accurate and the background cannot be updated instantaneously, which is a fatal drawback for detection of dynamic objects. Another algorithm is called Gaussian mixture model developed from statistics. This algorithm can establish background with high accuracy while the calculation is superfluous and the update of background is too slow. The third one is surendra with the features of comparatively fast calculation, self-adaptation and high accuracy. Besides the different algorithms, some specific situation should be considered. Normally, the frame difference method relies on the difference in gray level. But if the gray level is too small to distinguish, which means contrast ratio is low and object is too similar to the background in gray level, there could be some intact even hollow area in the final result due to the lack of sufficient information. So Yin Ding analyzed the dynamic objects in various color space and the subsequent effect on the algorithm accuracy. It proved that algorithms based on Lab color space have the better accuracy meanwhile less error rate when detecting the dynamic objects.

3.3 Study of human visual properties

Starting from the angle of psychology, the human visual system [7] is organized, relativity and selectivity. In addition, it also has a certain degree of constancy and wrong as the other features. In the beginning of the twentieth Century, the school of thought that the visual organization of the study is very important. In the process of perception, the original information is the choice of processing, and the selection process is organized and systematic, rather than disorderly. It is found that the main performance of the organization is to feel the similarity, proximity, closure, continuity and integrity of several aspects. Figure 1 and 2 are the structure of the human eye diagram and the wrong view of the human eye.

Similarity: in a variety of stimuli at the same time, the various stimuli in a certain aspect of similarity, such as size, color, shape and movement, etc., will lead to them to be attributed to a class. For example, a running small animal, because of its various parts of the movement of the body is more similar to the human eye tends to put it in the various parts of the body together.

Fig. 1 Human eye structure



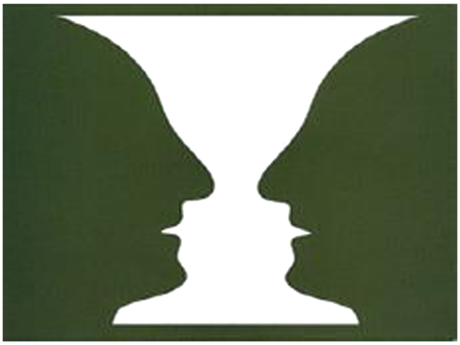


Fig. 2 Visual dislocation map

Proximity: the visual subject to the perception of the scene in some space or a short distance or close to the stimulus, easy as a whole treatment. Such as in the smooth video, we very difficult to determine the interval between the different frames, which is due to the persistence of vision effect, in a way that vision is close to nature.

Closed: when an object of perception although there are for the identification of the characteristics, but these features alone to determine the relationship between objects, visual subject tend to use their experience active complement or reduce the relationship between objects, in order to obtain more meaningful or more logical explanation.

Holistic: refers to the sum of the total perceived greater than part of the perception. Vision is not a simple addition of the observed information, the two is a cognitive activity that is derived from the perceptual and higher than the perceptual. The typical embodiment of the visual integrity of the example is the subjective profile, although the actual contour does not exist, but because of the overall impact of the perception of the contour.

The result of visual perception is not only related to external stimuli, but also affected by experience, emotion and environment. Common visual relativity, including the foreground and background, the contrast of visual perception, etc.

Scene exists in a wide variety of objects, due to the limited human processing information ability, at the same time my wife eye can only selectively feel certain stimuli, and to other stimuli did not respond or only superficial reaction. There are many factors that affect the choice of visual ability, such as the change of the target stimuli, the contrast, the position, the movement and the intensity, etc., but also the subjective factors, such as individual experience, emotion, motivation and interest. In general, the human eye in the observation of a scene, always selective attention to focus on certain content in the scene, and temporarily ignore other content.

Based on the above research, the following simulation experiments are carried out.

4 The simulation experiment and algorithm

4.1 The design of the simulation experiment

In order to examine the irregular patches with comparatively low contrast ratio and support this kind of dynamic object detection in practical engineering in the coming future, this paper, which is based on the algorithm called surendra [2], illustrates the method to model and then calculates the frame difference on the background of Lab color space. And finally it makes the detection of irregular dynamic patches work. The flow in the simulation experiment is showed in Fig. 3.

With the purpose of examining the dynamic irregular patches, a specific process or called contrast test is conducted in this simulation experiment. The Fig. 3 is captured from a video as the 135th frame. In the video, the velocity of all the patches is identical to that of the ocean current considering that the whole sea surface is relative rest within the ken as well as the video time, which means the whole background is regarded as static while the patches move in the velocity of ocean current. According to Fig. 3, there are three patches in total; an upper one is regular while the others are obviously irregular. And the experiment is conducted under the following assumptions. The first one is that the three patches share the same ocean environment. And the second one is that these three are in uniform linear motion synchronously. Last but not least, the length of this video is 15 s with the overall frames of 375 (Fig. 4).

If some other factors such as the loud noise and outstanding illumination conditions even the accidental background interference are considered and should be optimized, median filtering is highly recommended to process the video first. Likewise the video cited here is imported to the module of dynamic object detection after the pre-process mentioned above. Afterwards, the correlated parameters are extracted in the module called data analysis. Finally, the effect of detection should be examined by the performance evaluation module.

4.2 To implement the method for detection of dynamic objects

The algorithms adopted in this module are comprised of the transformation in Lab color space, surendra self-adapting background update method and OTSU self-adapting binary segmentation as well as detection of dynamic objects with updated background. The main idea is illustrated in Fig. 5.

The research content of this paper is the detection of irregular moving objects in the ocean. It belongs to the detection and segmentation of significant targets. The salient object is the product of the system of psychology, the nervous system and the human visual system, people focus on the area as a significant area [14]. Lab is a color space quantization system that is used to close to the human visual model as much as possible, its luminance (L) component is consistent with the perception of brightness for human. In the image processing process, we can use the L component to adjust the brightness contrast, by modifying the a, b component of the color balance of the relevant processing. This process, in the CMY or RGB is not implemented. Based on the above analysis, this paper uses Lab color space quantization technology to deal with the image.

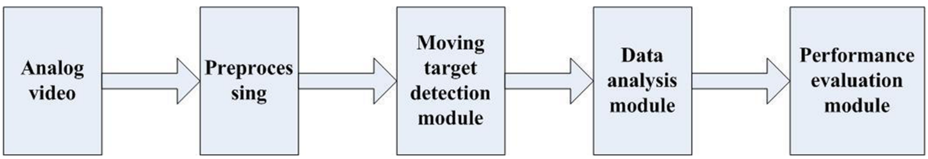


Fig. 3 Experimental general flow chat

First and foremost, every frame in the video should be extracted to be involved in the transformation of Lab color space. The transformation matrix is showed as below.

$$[X, Y, Z]^T = \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{5}$$

$$\begin{cases} L = 116f(Y/Y_0)-16; \\ a = 500[f(X/X_0)-f(Y/Y_0)]; \\ b = 200[f(Y/Y_0)-f(Z/Z_0)] \end{cases} \tag{6}$$

$$f(q) = \begin{cases} \sqrt[3]{q} \quad (q > 0.008856), \\ 7.787q + 16/116 \quad (q \le 0.008856) \end{cases} \tag{7}$$

In these formulas, X, Y, Z, all of which represent a color channel separately in XYZ color space, are called tristimulus values whileX_0,Y_0,Z_0these three tristimulus values are defined as the gray scale in CIE standard. Meanwhile. L, a and b are the metric measure in color space. The range of these three parameters, L, a, b, is finite. L ranges from 0 to 100; a ranges from −127 to 127 so does a. And all the boundary values are available. In the beginning, the first frames from L and a as well as b are extracted as the initial background images after the transformation of color space mentioned before. Afterwards the algorithm surendra is used to update the self-adapting background, which includes the following main steps:

(1) To have the first frame I_0 assigned as their backgrounds;
(2) To select the threshold value T;

Notably, in the second step, the initialized iteration equals one, which means m = 1, while the maximum iterations is M.

(3) To evaluate the frame difference image of the present frame;

$$DB = \begin{cases} 1, \left|I_j - I_{j-1}\right| \ge T \\ 0, \left|I_j - I_{j-1}\right| < T \end{cases} \tag{8}$$

$I_j$means the present frame andI_{j-1}means the former one here.

(4) To update the background image $B_j$with binary image DB.

$$B_j(x, y) = \begin{cases} B_{j-1}(x, y), DB(x, y) = 1 \\ \alpha I_j + (\alpha - 1)B_{j-1}(x, y), DB(x, y) = 0 \end{cases} \tag{9}$$

In this formula, $B_j(x, y)$represents the grey level in the coordinate system of background image. So does DB but in another coordinate system of binary image. And $I_j$is the j the frame whileαdenotes the coefficient of iterations speed. When m equals M, the whole iteration finishes and the real background image as called $B_j(x, y)$can be received. Meanwhile, after running the following algorithm, the Euclidean distance can be available. The algorithm is showed below.

The pixel gray level in single channel is l, which ranges from 0 to l-1. The number of pixels in the gray level l is $N_i$and the total pixels in the image is the sum ofN_i, in which i ranges from 1 to l-1. Also, the threshold value h separates the domain into two parts, the first of which is [0 , h] and the second one is [h + 1 , l-1]. Therefore the between-cluster varianceσ is the function of h.

$$\sigma = f_1 f_2(\mu_1 - \mu_2) \tag{10}$$

In formula (6), the parameters are defined in the way below.

$$f_1 = \sum_0^h \frac{N_i}{N} \tag{11}$$

$$f_2 = \sum_{h+1}^{l-1} \frac{N_i}{N} \tag{12}$$

$$\mu_1 = \frac{\sum_0^h (N_i \times i)}{\sum_0^h N_i} \tag{13}$$

$$\mu_2 = \frac{\sum_{h+1}^{l-1} (N_i \times i)}{\sum_{h+1}^{l-1} N_i} \tag{14}$$

This method makes the between-cluster variance reach the maximum by selecting the optimum thresholding, and then h becomes the threshold value of the image. When the threshold values of all channels are calculated, all the difference images should be binaryzed, and the results are illustrated below.

$$F_{D^i}(x, y) = \begin{cases} 0 & \left(\left|I^i(x, y) - I^i_{-1}(x, y)\right| < T^i_1\right); \\ 255 & \text{(others)} \end{cases} \tag{15}$$

$$B_{D^i}(x, y) = \begin{cases} 0 & \left(\left|I^i(x, y) - I^i_{-1}\right| < T^i_2\right); \\ 255 & \text{(others)} \end{cases} \tag{16}$$

T^i_1andT^i_2represent the self-adapting threshold value of frame difference image and background difference image separately. And then the binary image should be processed with morphology method, after which the dynamic object can be detected.

The binary image after difference calculus has many small holes and isolated points in the target area, and there are some broken contour lines. So morphological filtering is needed. The basic idea is that: First, a morphological structure element is fixed, and the isolated noise points

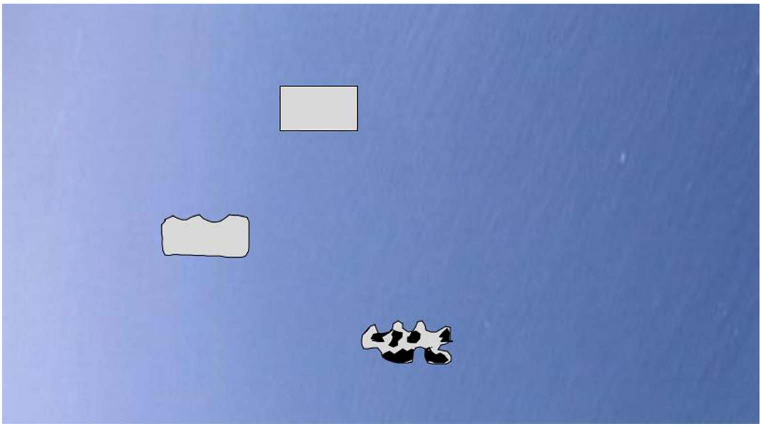


Fig. 4 The 135th frames of experimental video

are filtered through the corrosion template. And then use the same size of the expansion of the template filter, to deal with the fracture or hole part, and to realize the aim of image analysis and recognition. Two basic operations are performed on the image: dilation and erosion. The main function of the expansion is to increase the number of pixels of the target to fill the holes and bridge cracks. Corrosion is the inverse operation of the expansion, it is the role of the elimination of the target image of isolated points and unnecessary connection. After morphological processing, the moving objects are obtained.

When the moving object is detected, the model can be used to calculate the Euclidean distance, which is the real distance between two points in 2 dimension or three dimension even n-dimensional space.

In the two-dimensional space, the formula is

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \tag{17}$$

In the three-dimensional space, the formula is

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2} \tag{18}$$

And the formula can be extended to the n-dimensional space.

$$d = \sqrt{\sum_{i=1}^{n} (x_{i1} - x_{i2})^2} \tag{19}$$

Table 1 The characteristic parameter of 125th frames

Type	Rectangle degree	Dispersion	Eccentricity	Roundness	Second moment	Solidity
Regular	0.9478	18.2892	0.7681	0.6674	25.6432	0.9875
Irregular 1	0.9125	17.4670	0.7245	0.6406	23.2532	0.9652
Irregular 2	0.4756	13.9560	0.9024	0.8534	17.6985	0.5431

Table 2 The characteristic parameter of 175th frames

Type	Rectangle degree	Dispersion	Eccentricity	Roundness	Second moment	Solidity
Regular	0.9512	18.2912	0.7638	0.6688	25. 3225	0.9856
Irregular 1	0.7548	19.2639	0.7184	0.6475	24.1253	0.9766
Irregular 2	0.4876	14. 6023	0.9349	0.8317	16.4860	0.5389

Thex_{i1}andx_{i2}mean the i-dimensional coordinates. Often, the Euclidean distance describes the similarity between two vectors. If the distance is small, it means that the two vectors are quite similar.

In this paper, the morphological characteristic parameters of moving objects are constructed as the feature vector space, and then the Euclidean distance is calculated.

In order to verify the reliability and scientific of the method, this paper also calculates the Hausdorff [16] distance between the characteristic parameters of the irregular block and the block, The basic calculation model is as follows:

First, through the detection method, get spots of n which is P_i(i=1,2,…,3,n),for moving targets which are not merge with the background. For each spot, extract **t** feature vector index (such as rectangle degree, degree of dispersion, eccentricity, etc), Then n spots are weighted approach according to the weight of the area. Get a center dot “**J**” spot characteristic index space, recorded as:$A = \{J_1, J_2, \cdots, J_t\}$; The characteristic index space of the moving object without camouflage is recorded as:$B = \{O_1, O_2, \cdots, O_t\}$. Their Hausdorff distance is defined as:

$$\mathrm{H(A, B)} = \max(\mathrm{h(A, B)}, \mathrm{h(B, A)}) \tag{20}$$

$$\mathrm{h(A, B)} = \max_{\mathrm{a}\in\mathrm{A}} \min_{\mathrm{b}\in\mathrm{B}} \|\mathrm{a}-\mathrm{b}\| \tag{21}$$

$$\mathrm{h(B, A)} = \max_{\mathrm{b}\in B} \min_{\mathrm{a}\in A} \|\mathrm{b}-\mathrm{a}\| \tag{22}$$

Where$\|\bullet\|$is defined on the point set A and B some distance norm, it is desirable to different forms.

5 Result analysis

The result shows that the whole system discussed above can detect the irregular dynamic objects. And one conclusion here is8 that the motion itself is a significant feature, especially in

Table 3 The characteristic parameter of 225th frames

Type	Rectangle degree	Dispersion	Eccentricity	Roundness	Second moment	Solidity
Regular	0.9466	18.3032	0.7578	0.6594	25.4534	0.9810
Irregular 1	0.8956	16.8956	0.7396	0.6532	23.7538	0.9722
Irregular 2	0.4898	12.8865	0.9478	0.8412	17.0356	0.5213

Table 4 The characteristic parameter of 275th frames

Type	Rectangle degree	Dispersion	Eccentricity	Roundness	Second moment	Solidity
Regular	0.9506	18.2845	0.7546	0.6696	25.6405	0.9880
Irregular 1	0.9036	17.0584	0.7351	0.6358	23.1357	0.9356
Irregular 2	0.4895	13.4595	0.6786	0.8154	16.5768	0.5117

the detection of channel b, in which the regular object shows what it is while the irregular ones manifest some dynamic and transforming dots which hardly could reflect theirs initial shapes. Take the tinted regular patch under the background of light-blue ocean as an example, the luminance difference between objects and background are too tiny to distinguish in channel L. So it is inaccurate to reflect the outline of the objects in channel L so is it in channel a, because of the indiscernible luminance difference between objects and background. In order to explain this circumstance meanwhile considering the spatial confined, Figures 6a-f show the six frames in the detection of dynamic objects.

With the purpose of guaranteeing the validity of the detection, statistics about dispersion and eccentricity of both regular and irregular ones showed in the sequence diagram is enumerated in this paper based on Matlab with function scalled bwlabel and regionpros. Tables 1, 2, 3 and 4 shows the relevant statistics of the 125th、175th、225th、275th frame (Figs. 5 and 6).

If the irregular patch shares similar parameters with the regular one, the Euclidean distance and the Hausdorff distance should be small. Otherwise, the long Euclidean distance and Hausdorff distance means that it is barely possible that the patch belongs to the crashed plane or wrecked ship.

According to the Euclidean distance calculated, it turns out that the average Euclidean distance between irregular 1 and the regular is 0.8245 while that between irregular 2 and the regular is 4.3645, At the same time, the Hausdorff distance was calculated and verified, and the average distance between the irregular block 1 and the regular block was 2.5975. The average distance between the block 2 and the rule block was 13.8962, It shows that when the degree of dispersion, extension length and eccentricity of the irregular block are relatively small, the Euclidean distance and the Hausdorff distance of the characteristic parameters of the original block are relatively small.

To ensure the reliability of this method, the relevant coefficient between regular and irregular patches is calculated in this performance module.

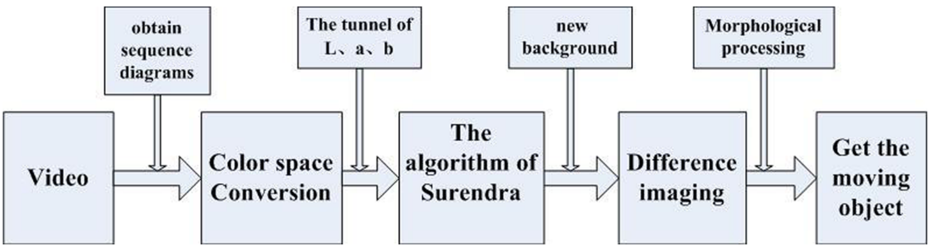


Fig. 5 The main idea flow chart of algorithm

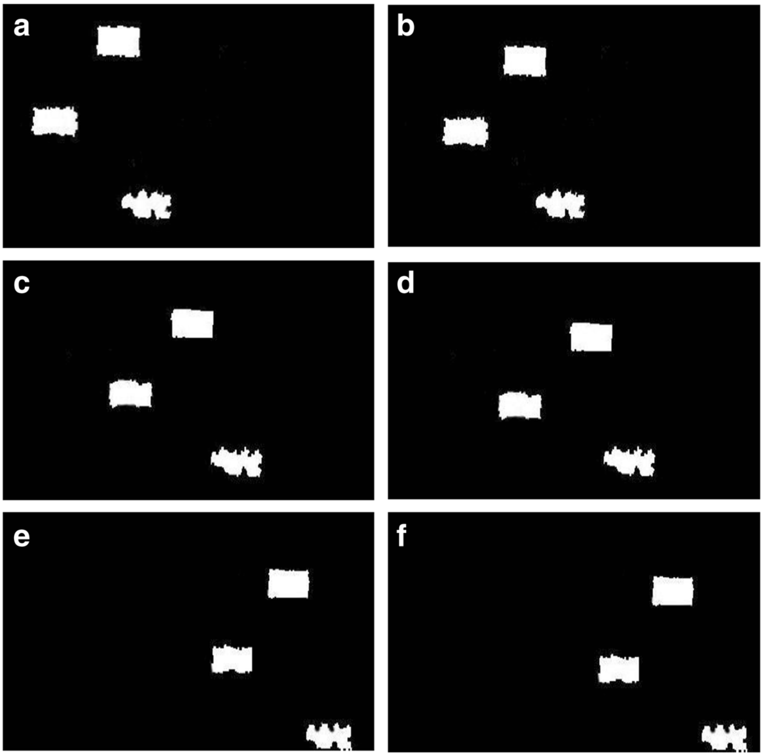
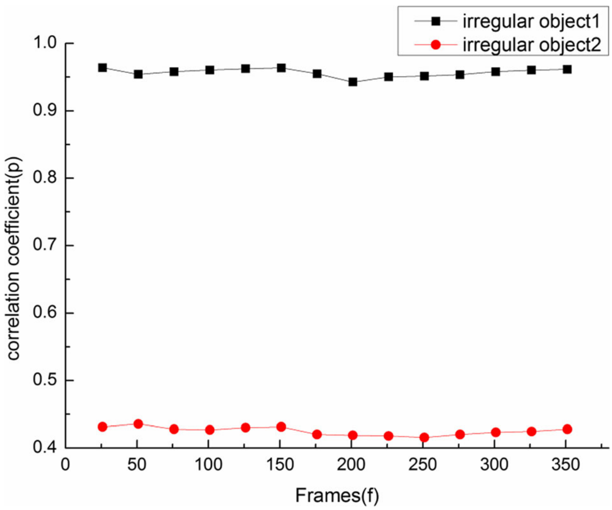


Fig. 6 The sequence diagram of moving patches detection

In the performance module, the regular patch image is named as S and the size of it is $M \times N$. Another irregular patch is named as g and the size is $m \times n$. Moreover, $S_{x,y}$ represents the

Fig. 7 The correlation coefficient curve of irregular patch and regular one



sub-block, whose upper-lift corner is $(x, y)$and scale is same with g. Then relevant coefficient between those images can be calculated. The definition of $\rho(x, y)$is:

$$\rho(\mathrm{x}, \mathrm{y}) = \frac{\sigma\left(\mathrm{S}_{\mathrm{x,y}}, \mathrm{g}\right)}{\sqrt{\mathrm{D}_{\mathrm{x,y}}\mathrm{D}}} \tag{22}$$

And $\sigma(S_{x\,,\,y}, g)$is the covariance of $S_{x\,,\,y}$and g meanwhile $D_{x\,,\,y}$is the variance of $S_{x\,,\,y}$.

$$D_{x,y} = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{x,y}(i,j) - \overline{S_{x,y}}\right)^2 \tag{23}$$

D is the variance of g.

$$D = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(g(i,j) - \overline{g}\right)^2 \tag{24}$$

$S_{x,y}$represents the gray level of the binary image $S_{x\,,\,y}$ and g represents that of g. The relevant coefficient from 1st to 375th frames can be calculated by programs.

Figure 7 shows the correlation coefficient curve of irregular patch and regular one. According to the curve, the correlation coefficients are changing with patches dynamic. The correlation coefficient between the irregular block 1 and the regular block is range from 0.93 to 0.96, The correlation coefficient between the irregular block 2 and the regular block is range from 0.41 to 0.44, compared with irregular block 2, the former is more similar to the regular block 1, it has a high probability of belonging to the wrecked ship, aircraft. At the same time, the reliability of the method is verified. Euclidean distance or Hausdorff distance is smaller, the irregular block and the standard block is more similar.

6 Conclusions

At present, the detection of objects on the sea surface focuses mainly on regular ones or ships which can be found through obvious different images in radar or infrared. Also, there are some methods to detect the oil patches on the sea surface. However, there are few researches on the irregular dynamic patches and instantaneous detection. So this paper, based on the detection of dynamic objects and color space quantization, takes the irregular wreckage patches as research. After synthetic applications of sequence diagram de-noising processing, Lab color space transformation, surendra self-adapting background update and OTSU self-adapting binary segmentation, a detection algorithm of irregular dynamic objects on ocean surface is preliminarily established. By comparing the Euclidean distance between irregular patch and regular one, conclusion can be drawn that the comparatively small Euclidean distance is closely related to the high similarity of the two patches, which is represented by the comparatively big correlation coefficient. When it comes to the big correlation coefficient, it means the possibility that the object comes from the crashed plane or wrecked ship is small. So they are not related closely to each other. After a series of simulation experiments, the detection algorithm can be regarded as valid and reliable. However, more researches need to be done to establish a database of all these parameters about patches. And if it is possible, the next research would be related with their performance in the blast about mechanics. And more time and assistance will be devoted to the research about the adaptation of different objects in the algorithms especially considering the variety of irregular patches as well as the huge number of different aircrafts and ships.

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