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Detection of a Particular Object from Environmental Images under Various Conditions

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Abstract— In a current study of environmental information, it is important to detect the particular object from environmental images under various conditions for security such as navigation system of ships, bird-watching for the prevention of various damages, invaders check and human rescue in the marine casualty. This paper deals with the image processing techniques for the detection of the rescue target as a particular object from environmental images. When a marine casualty occurs, the detection of the rescue target such as life rafts depends on the visual search of human eyes . It is predicted, however, that human eyes sometimes loses its sight and the ability of the detection falls down owing to the long flight and a nasty weather. For a practical purpose of the prompt rescue of human life, the development of the searching support system in place of human eyes is surely required. To realize a new type searching system for the detection of the rescue target, the development of new type image processing techniques in real time manner is undoubtedly important. At the first step of our study, we attempt to develop image processing techniques, in order to detect accurately the rescue target under various conditions.

1. Introduction

Recently, it has been required to detect the particular object from environmental images under various conditions for security such as navigation system of ships, bird watching for the prevention of various damages, invaders check and human rescue in the marine casualty. For security of ship navigation, Hayashi has proposed the detection of the distance between a target and own ship from its image at sea [1] . Sato studies the monitoring of man through the gate in the night using silicon range finder [2] . Yamamoto studies the pigeon tracking system under unprepared condition [3] . In order to apply the image processing for actual rescue activities in the marine casualty, it is important to develop image processing techniques corresponded to the changes of conditions, because the images of the particular object is changed by weather condition, daylight, reflections of lights and so on .

In this paper, we propose to develop the image processing techniques for the detection of the rescue target in the marine casualty. Detection of the rescue target in a marine casualty such as shipwreck depends on the visual search by man as yet. Human eye sometimes loses its sight, because of the long flight and the wide views under the various weather conditions. To detect a small rescue target in the wide sea, a binocular telescope is usually employed for the magnification. In that case, the range of vision for searching becomes narrow and the possibility of oversight will increase. Moreover, S/N ratio between the target and the background (sea surface) decreases due to sunshine reflections, cloud shadows and white crested waves. These factors trouble us to detect the small target. In order to carry out the prompt rescue of human life, the development of searching support system using image processing techniques, in place of the human eye is surely required. On the other hand, marine sports such as a yacht race or a cruising are popularized and simultaneously marine accidents arise along with it. For example, we remember clearly that in 1991 twice shipwrecks of "Taka" and "Marie marine" were arisen at Pacific Ocean. The problems of image processing techniques for detection of the rescue target are summarized in the following. One is the detection accuracy, that is, a very small target must be detected in the wide views over the sea. The other is the processing speed, that is, huge image data must be analyzed in a real time manner. We developed a composite image sensor system [4], [5], [6], but this system is developed for manufacturing and its range of vision is narrow(1 m×1m). We already attempted to extract the image data of the rescue target under a good condition [7], [8], [9]. In this paper, we attempt to develop image processing techniques for the detection of the rescue target under various conditions.

2. Image Processing Techniques

In the actual image data acquired in the rescue activities, the rescue target is very small and the images acquired under various weather conditions have background images such as ships, clouds and white crested waves. It is very difficult to process directly the motion images taken by an airplane, because these images are inferior owing to shakes of an airplane, bad weathers and sensitivities and resolutions of T V camera. Therefor, at the first step, we need the model experiment for the detection of the rescue target under the various conditions. We propose the following four type techniques, corresponding the type of image data taken under various conditions. Figure 1 shows flow chart of image processing.

As the color of rescue targets are orange, sunshine is absorbed in the green band and reflected in the red band. Namely, the image data of the rescue target have low gray level in the green band and high gray level in the red band. When image data have color information, we propose subtraction of the image data between R and G band. When the image data taken in the night or against the light, these image data does not have color information. For these image data, we propose another method as below.

1) Subtraction between the R and G band: We use this technique for the image data having a clear color data, and only image data of the rescue target can be extracted by eliminating

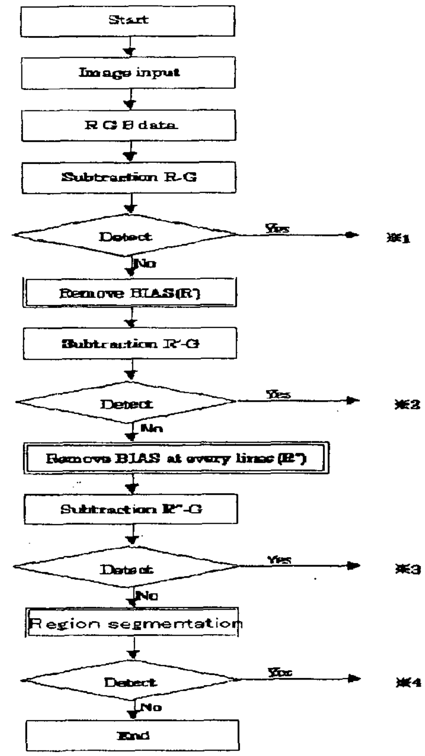


Fig.1 Flow chart of image processing

the background data such as the sea surface. At the same time, contrast against the background (S/N ratio) can be improved, because the background noise such as reflections of sunshine, clouds and white waves is white and then they have high gray level both in the R and G band. It is notable that subtraction technique is also effective to exclude background white noise and other background data.

2) Remote bias at all lines: When the background gray level is different in two bands and the difference is uniform over the scene, we give the same remote bias at all horizontal lines, in order to adjust the background gray level in both bands to be the same. We carry out subtraction between the R and G band after this adjustment.

3) Remote bias at every line: When the background level is different and the difference is not uniform over the scene, we adjust the background gray level at each horizontal line to get better results. We calculate the difference of gray level between the R and G band at each line and add this counts to the lower level . After this adjustment at each horizontal line, we do subtraction between two bands.

4) Region segmentation: When the image data does not have

color information in the case such as images taken in the night or against sunshine light, we try to detect the rescue target by region segmentation.

3. Model Experiment

In the case of the rescue in the Pacific Ocean, the rescue party watches the sea surface at 5.4 km beyond from an airplane flying at 300 m height with a speed of 100 m/s as shown in Figure 2. It is called that the white yacht with 10 m is the limit of visual search by human eyes, because of the optical absorption by gas, scattering by air, low contrast between target and background (S/N ratio), decrease of moving eyesight in high altitude and so on [10], [11]. So, small targets such as life rafts or floats etc. cannot be recognized without a binocular telescope.

As one of examples, let us suppose the rescue in the Pacific Ocean as is already mentioned in section 1. If we take a picture of a yacht with 10 m at 5.4 km ahead through the TV camera(1/2 inch CCD image sensor) with 525 scanning lines and the 35 mm focal length as shown in Figure 3, a searching view becomes to be 987 m in horizontal and 741 m in longitude from the equations. And then the image data of the yacht have several scanning lines.

$$W=6.4L/f, \quad H=4.8L/f \quad (1)$$

where L (m) is the distance between the rescue target and TV camera, W(m) the width of the acquired image, H(m) the highness of the image and f(mm) the focal length of lens.

As an example of the rescue target, we selected the buoy with orange color(the bottom diameter is 3m and the highness is 3.5m) in the Yoshiura bay. Figure 4 shows the marine chart and Figure 5 shows the photograph of this buoy. The distance between the buoy and TV camera is about 650 m by

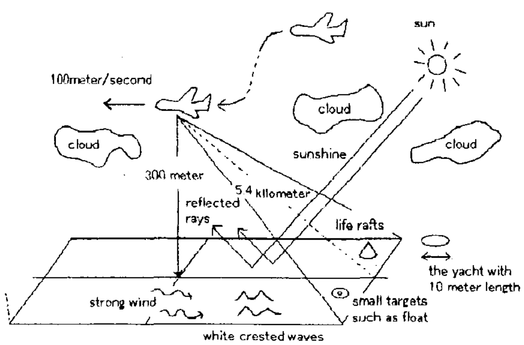


Fig.2 Illustration of searching activities

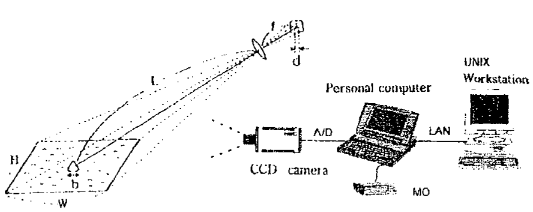


Fig.3 Model experiment

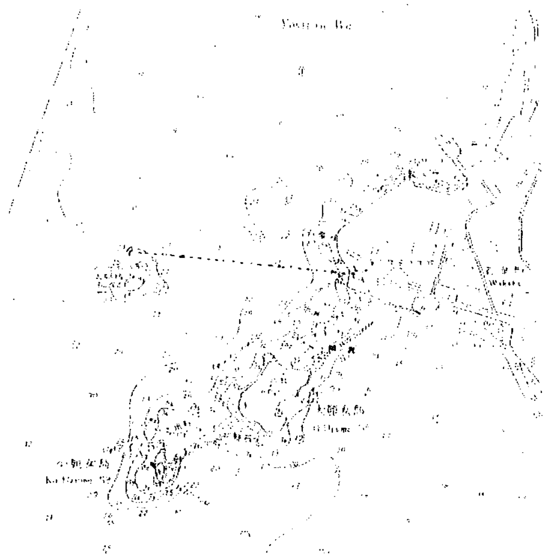


Fig.4 Marine chart of Yoshiura bay

Fig.5 The scene of model experiment sea

calculation on the marine chart. In this scene the rescue target is scanned with 16 cm scanning resolutions. The image data of the rescue target acquired with above conditions have 8 pixels in the width and 6 pixels in the highness. This is sufficient to try the image processing.

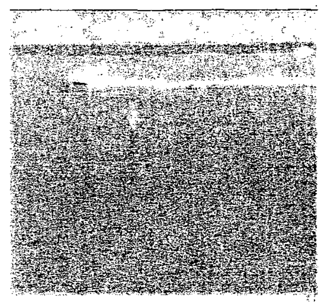
Since the aim of the present study is to develop the image processing techniques, in order to detect the rescue target under various weather conditions, we attempt to acquire four kinds of image data of the rescue target under the different conditions. The first image data was taken on a fine day. The second image data was taken under a rainy and fog weather and the range of vision is below 1000 m. The third image data was taken in the night. The fourth image data was taken against the light. We make an attempt to detect the rescue target from these image data recorded at the memories of the computer. To realize such a searching system for detection of the rescue target under various conditions, the development of a new type image processing in a real time manner is undoubtedly necessary.

In the model experiment, the image data taken under various conditions are stored in the video tape or the memory of the camera. The image data is digitized into 256 levels at an 512×512 array of points for each of the red, green and blue components. These image data are transferred to the computer for performing the processing of image data.

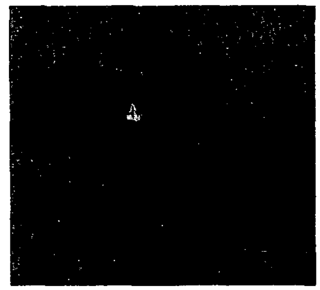
4. Results and Discussion

1) The first image data: In this image data, we can detect clearly the signal difference between the R and G band. Therefore we use subtraction between two bands. Figure 6(a) shows the original image data, and Figure 6(b) shows the subtracted image data between the R and G band. The white crested waves are excluded efficiently.

2) The second image data: We can see dimly the image of the rescue target in the original data as shown in Figure 7(a). Image data of the rescue target have different low gray level in both bands as shown in Figure 8. And we can not extract the rescue target by subtraction between the R and G band. In the green band, we can find more deep gray level, as compared to the red band. Although this image data is taken under a rainy and fog weather, it is considered that the camera detects a small signal of color information. And then we can find the difference of signal level between the R and G band. Therefore, we can detect the signal of the rescue target by adjusting the background level. If the difference of the background level is uniform over the scene, we add a fixed gray level (for example:

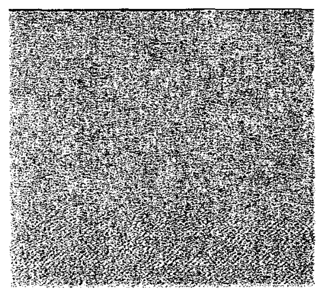


(a)

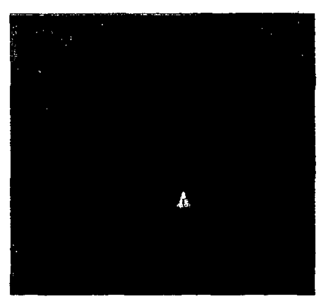


(b)

Fig.6 The image data was taken on a fine day



(a)



(b)

Fig.7 The image data was taken under a rainy and foggy weather

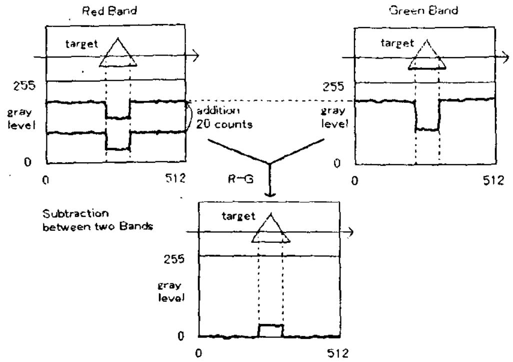
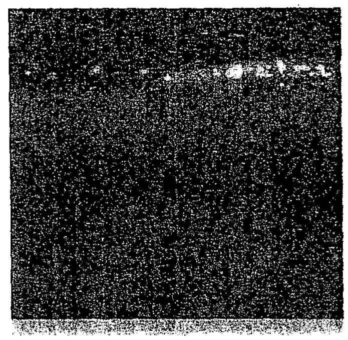


Fig. 8 Illustration for adjustment of the background data between two bands

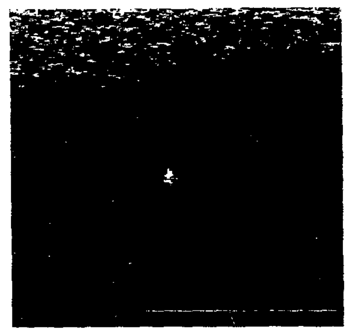
20 counts) to the red band and carry out subtraction between the R and G band. However, the difference of background level is not uniform in every horizontal line, because of the difference of absorption length by fog. In this case, we calculate the difference of background level at every horizontal line and adjust the background level at each horizontal line. By these processing, we can detect clearly the rescue target under a bad condition such as a rainy and fog day. Figure 7(b) shows the better result.

3) The third image data: In the night, human eye can not catch the image of the rescue target. However, a high sensitive TV camera can catch the image data of the rescue target, as sown in Figure 9(a). The sea surface is bright owing to the light of the city. On the other hand, the gray level of the rescue target is low in both bands, as compared with the sea surface. Image data of the rescue target does not have color information, and we can not find the difference of the level between both bands. In this case, we can not apply subtraction technique. As image data of the rescue target has gray level histogram in the low level, we can detect the rescue target based on the region segmentation, paying attention to the threshold level of the rescue target. Figure 9(b) shows the result.

4) The forth image data: This data was taken against the sunshine light on a fine day. In this case, image data of the rescue target does not have color information, and we can not find the difference of the level between two bands, because the dynamic range of the rescue target in this image becomes very narrow due to the intense sunshine. In the original data the sea surface is very bright and the rescue target has the low level as shown in Figure 10(a). We can detect the rescue target as shown Figure 10(b), using the above method.

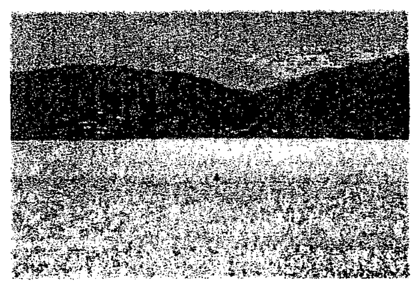


(a)

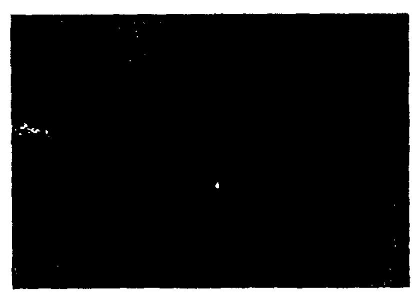


(b)

Fig.9 The image data was taken in the night



(a)



(b)

Fig.10 The image data taken against the sunshine

5. Conclusion

For a practical purpose of the prompt rescue of a human life, we have proposed the image processing techniques, in order to detect the rescue target from the image data acquired under the various conditions. At the first step of the study, we deal with the rescue target in an experimental sea and significant results are obtained as follows.

(1) For the image data having color information, the background image data are efficiently excluded and S/N ration of the target against background is improved by subtraction of the image data between the red band and the green band.

(2) The detection of the rescue target from the image data acquired under a bad weather condition is performed effectively by means of the image processing techniques.

(3) For the image data in the night or in the counter light, the rescue target is detected by means of region segmentation.

It is concluded, therefore, that the image processing technique proposed in this study is an effective method for detection of the rescue target under various conditions. To realize the searching system for the actual rescue activity, further studies are desired; the construction of the control system of the visual sensor with high resolution and also the knowledge database system of the rescue target.

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