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IMAGE PROCESSING TECHNIQUE FOR DETECTION OF A PARTICULAR OBJECT FROM MOTION IMAGES

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ABSTRACT

This paper deals with the detection of the rescue target as a particular object from motion images under bad condition. When shipwrecks occur, the searching activities for rescue is done by using an airplane. The detection of the rescue target such as life rafts depends on visual search of human eyes. To detect a small rescue target in the wide sea, searching man must monitor motion sights under the nasty weather. Human eyes sometimes loss its sight and ability of detection falls down owing to the long flight and the nasty weather. To support the searching activities in the case of a marine casualty, we propose motion image processing techniques using improving S/N ratio and dynamic range of the image data of the rescue target in the motion images under bad condition.

1. INTRODUCTION

Forecast of weather or typhoon and investigations of sea bottom and so on have been advanced by developments of image processing pattern recognition and knowledge engineering technologies. Detection of the rescue target in a marine casualty such as shipwreck depends on the visual search by man as yet. Human eyes sometimes lose its sight because of the long flight and the wide views under the various weather conditions. To detect a small 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, in the motion images, S/N ratio between a target and a sea surface as the background decreases due to speed of an airplane, sunshine reflections, cloud shadows and white crested waves. These factors trouble us to detect the small targets. In order to carry out the prompt rescue of human life, 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 shipwreck of "Taka" and "Marine 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 in the motion images 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. One of the effective ways to acquiring the image of particular object accurately in wide views is to employ such a composite image sensor system as we have developed before [1], [2], [3]. However, this system has been developed for manufacturing or assemblies in a factory automation, and its range of vision was only 1 m × 1 m. Moreover, it was developed assuming that the captured images is static and the contrast between a particular object such as mechanical parts and a background is always high. Then two problems mentioned above can not be solved by means of the conventional image processing techniques. In this paper, we attempt to develop image processing techniques for improving the inferior motion images to detect accurately the rescue target.

2. SYSTEM CONFIGURATION

As is already mentioned, it is very hard to detect the small rescue target such as life crafts in the wide sea area where the ratio of S/N between the rescue target and the background sea is extremely inferior. For the prompt rescue of human life, we propose a new searching system by paying attention to color information. The searching system consists of three processes as below.

(1) The first step is to attain the candidate of rescue target in the wide sea area: The image data obtained through the visual sensor such as the TV camera on the airplane is divided into the three primary colors (Red, Green and Blue). In the case of the searching by the airplane, the rescue target becomes very small and background noise such as the sunshine reflections, cloud shadows and white crested waves usually exists. Here, we need to improve S/N ratio in the image data.

(2) The second step is to acquire the magnified image by the zoom control and to extract the characteristics of the rescue target : In order to avoid an overlook, the threshold value for judgment in the first step must be set up at low level. This means that a considerable error exists in this step. Then, the strict judgment whether the candidate involves the rescue target or not is necessary. The image in which the rescue target seems to exist is magnified by the zoom lens and the fresh image data is acquired. After the same subtraction between the R and G bands, we can extract the shape of the target and obtain the characteristics of the target from the binary image data.

(3) The third step is to apply the knowledge database : In order to begin the correct rescue operation, it is necessary to determine the kind of the rescue target by collating the shape or color data obtained in the second step with the knowledge database and to determine the position of the rescue target by using information of the marine chart or the artificial satellite. Here, characteristics of the rescue target (for example, kind, size or shape) must be registered at the knowledge database in advance. If the rescue target exists in the candidate, rescue operation begins immediately. If the rescue target dose not exist, the procedure is returned back to the initial state and the same process is carried out again.

We already attempted to extract the image data of the rescue target with orange color based on static images in the experimental sea(the second step) [4], [5] . To realize such searching system for detection of a small rescue target under various weather conditions, it is very important to develop pre processing technique for improving the inferior motion images. Therefore, we attempt the improvement of the inferior image data acquired under in the model experiment. The third step (construction of a knowledge database) are unsolved subjects in the future and are not referred in this work.

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 Fig.1. It is called that the white yacht with 10 m length is the limit of visual search by human eye, because the speed of the airplane is high and the optical absorption by gas or scattering by air occurs. Moreover, the contrast between target and background (S/N ratio) is low and moving eyesight decreases owing to high speed [6] [7] . It is very difficult to process directly the motion image taken by an airplane, because these images are inferior owing to shakes of the airplane, sunshine reflections, white crest waves under bad weathers and sensitivities and resolutions of TV cameras. And then, in present work, we must make a simulation experiment for the detection of the rescue target from the motion images.

As one of the example, let us suppose to take a picture of a yacht with 10 m length 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 Fig.2, a

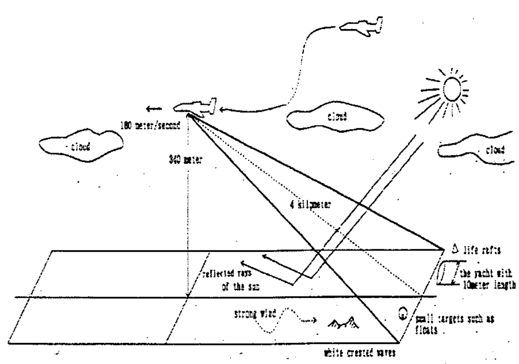

Fig.1 Illustration of searching activities

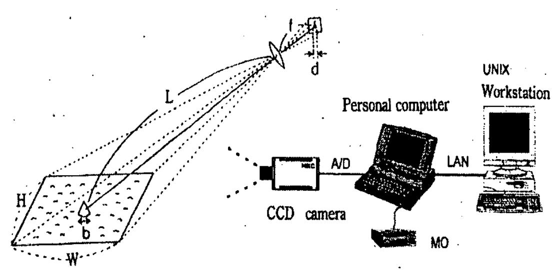

Fig.2 Model experiment

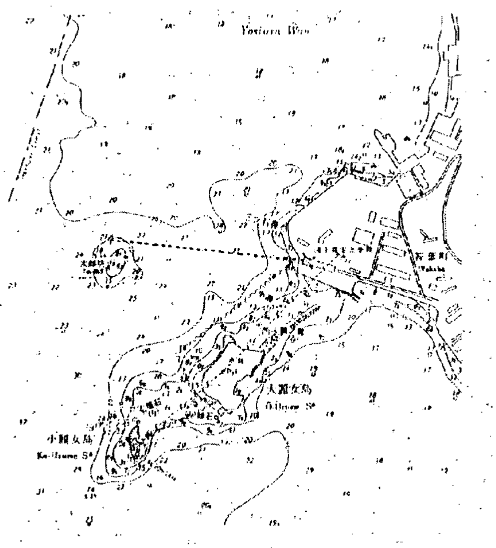

Fig.3 Marine chart of Yosiura bay.

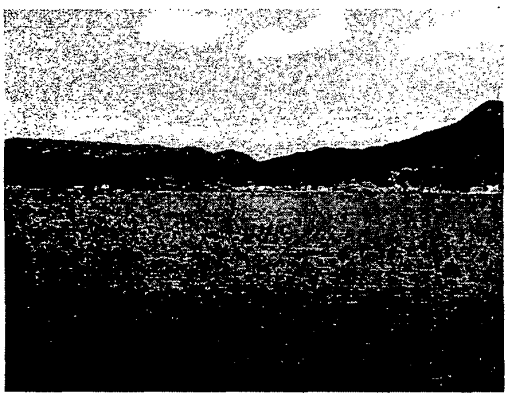

Fig4 The scene of model experiment sea

searching view becomes to be 987 m in the width and 741 m in the highness from the equations. And then the image data of the yacht have several scanning lines.

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

where L (m) is the distance between the rescue target and the TV camera, W(m) the width of the acquired image, H(m) the highness of the image and f(mm) the focal length of the 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. This experimental sea is in the front of Maritime Safety Academy. Fig.3 shows the marine chart and Fig. 4 shows the scene in the experimental sea. The distance between the buoy and the TV camera is about 650m by calculation on the marine chart. The rescue target acquired with above conditions has 8 pixels in the width and 6 pixels in the highness. This is enough to try the motion image processing.

Since the aim of the present study is to develop the preprocessing techniques for the motion image processing in order to detect the rescue target based on inferior images taken in the model experiment, we attempt to acquire a series of image data of the buoy, moving the camera with human hands under bad weather, and get the inferior image data.

4. METHOD 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 levels in green band and high gray levels in red band. Therefore, we propose subtraction of the image data between the R and G bands at the first stage of the searching system. The image data of the target can be extracted by eliminating the image data of the sea. In the actual rescue activities, motion images taken by an airplane are inferior under bad conditions such as shakes of an airplane, waste weathers and lack of dynamic range in the image data. And then we need the preprocessing of motion image data. In order to apply subtraction techniques of image data between the R and G bands, it is important to improve the inferior motion images as the first step of image processing. For the prompt of the human life, it is required to process the motion image data at real time manner.

From the point of view on improvement of S/N ratio and dynamic range in motion images and real time processing, we propose the following processing. Fig.5 shows flow chart of image processing, and Fig. 6 shows image data sampling, transformation and superposition of the rescue target.

a) Input of the motion image data: In the model experiment, a sequence of the motion image data is stored in the video tape or the memory of the camera. The image data in each frame is digitized into 256 levels at an 512× 512 array of points for each of the red, green and blue components. In this work we deal the color image data.

b) Image data sampling and transformations of the rescue target :

Image data of the rescue target has a different position in each frame in a sequence of motion image data, and it is need to make geometric transformations for the image data of the rescue target in each frame. In order to add the image data of the rescue target in each frame, we detect the coordinate of the center of gravity in the rescue target.

c) Calculating the mean of gray levels of many image data: The sampled image data are arranged with the same coordinate of the center of gravity. Therefore, it is possible to add each image data of the rescue target. This method is

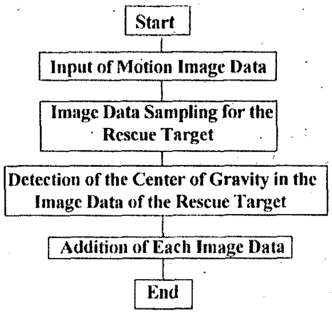

Fig.5 Flow chart of image processing.

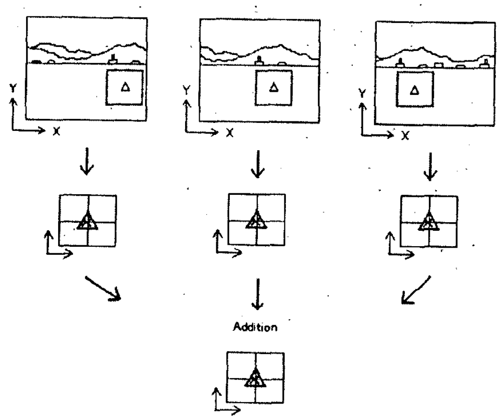

Fig.6 Example of sampling, transformation and superposition of image data of the rescue target.

effective for a random noise such as sunshine reflections and white crested waves.

d) Application of filters: In order to improve the S/N ratio and the dynamic range of the rescue target in the image data, we try to apply various filters for the added image data. This is effective to get better results.

5. RESULT AND DISCUSSION

In the model experiment, we get a sequence of the inferior image data. Fig.7 shows an example of one frame in a sequence of image data. Fig.8 shows the result of addition of each frame data. S/N ratio and dynamic range is improved by this processing. The image data taken in the model experiment and in the actual activities some times have the dark red color, because of conditions such as bad weathers and exposures of the TV camera. In these image data we can detect the small difference between the

Fig.7 Example of one frame of motion images.

Fig.8 Added image data

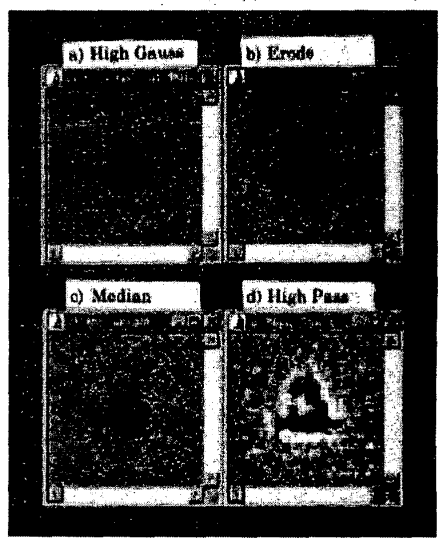

Fig.9 Result of application of filters.

R and G bands. The improvement of S/N ratio and dynamic range is effective to detect accurately this small signal difference. The added image data has gradation in the edge of the rescue target. To improve the gradation we try to apply the various filters for added image data. We applied median filter, high gauss filter, erode filter, high pass filter and other filters for the added image data. Fig.9 shows results of application of various filters. In median filter a little gradation in the edge of the rescue target is observed. In high gauss and erode S/N ratio and dynamic range of the rescue target in the image data is improved. In high pass the image data of the rescue target is enhanced and at the same time the background data is enhanced. In the case of the monitoring by human eyes through TV monitor, this filter is effective. By these image processing technique, it is possible to detect the rescue target by subtraction technique between two bands based on the improved motion image data.

6. CONCLUSION

We have proposed the method of image processing techniques for the detection of the rescue target in the motion images, in order to contribute the prompt of human life in the rescue activities and proved its usefulness. At the first step of the motion image processing, we deal with the preprocessing for the improvement of the inferior image data taken in the model experiment and significant results are obtained as follows.

1) S/N ratio and dynamic range of image data taken by TV camera is improved by adding image data in each frame.

2) The edge of the rescue target was improved by the application of the various filters for the added image data.

It is concluded, therefore, that the image processing technique is an effective method for detection of the rescue target based on motion image data. To realize the searching system for the actual rescue activities, further studies are desired; the development of image sensor with high sensitivities and high resolution and searching system with the control apparatus of image sensors and also knowledge database of the rescue target.

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