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Radiation Dose-Rate Extraction from the Camera Image of Quince 2 Robot System using Optical Character Recognition

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1. Introduction

In the case of the Japanese Quince 2 robot system, 7 CCD/CMOS cameras were used. 2 CCD cameras of Quince robot are used for the forward and backward monitoring of the surroundings during navigation. And 2 CCD (or CMOS) cameras are used for monitoring the status of front-end & back-end motion mechanics such as flippers and crawlers. A CCD camera with wide field of view optics is used for monitoring the status of the communication (VDSL) cable reel. And another 2 CCD cameras are assigned for reading the indication value of the radiation dosimeter and the instrument [1]. The Quince 2 robot measured radiation in the unit 2 reactor building refueling floor of the Fukushima nuclear power plant. The CCD camera with wide field-of-view (fisheye) lens reads indicator of the dosimeter loaded on the Quince 2 robot, which was sent to carry out investigating the unit 2 reactor building refueling floor situation. The camera image with gamma ray dose-rate information is transmitted to the remote control site via VDSL communication line. At the remote control site, the radiation information in the unit 2 reactor building refueling floor can be perceived by monitoring the camera image. To make up the radiation profile in the surveyed refueling floor, the gamma ray dose-rate information in the image should be converted to numerical value.

In this paper, we extract the gamma ray dose-rate value in the unit 2 reactor building refueling floor using optical character recognition method.

2. Acquisition of Radiation Dose using Camera

In the case of Quince 2 robot [2], a typical gamma ray dose rate acquisition method using CCD camera is shown in Fig. 2.

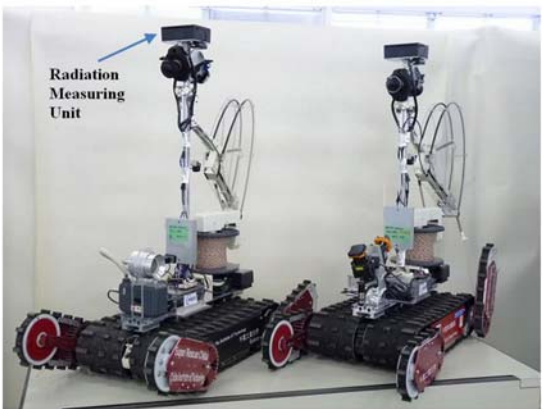

Fig. 1. Japanese Quince 2 (left) and 3 (right) robot.

Fig. 2. Radiation measuring unit of the Quince robot

Fig. 3. Gamma ray dose-rate in the unit 2 reactor building refueling floor

As shown in Fig 3, the gamma ray dose-rate in the unit 2 reactor building refueling floor by Quince robot 2 is 211.3 mSv/h (inside red rectangle area). The 211.3 mSv/h (dose rate) is acquired by the Panasonic camera as shown in Fig. 2. To make up the radiation profile in the surveyed refueling floor, the gamma ray dose-rate information in the image should be converted to numerical value.

3. Optical Character Recognition

To extract the numerical value (dose-rate) from the camera image, we used optical character recognition method [3]. To understand of the gamma ray dose-rate information in the surveyed refueling floor of the unit 2 reactor building, we used AVI movie file provided by TEPCO also. Typical pattern (character) recognition techniques consist in three modules, which are preprocessing, feature extraction and classification, as shown in Fig. 4. In the preprocessing stage, we go to process our input image, for example size normalization, conversion color to gray image, and noise elimination. At the next feature extraction stage, we convert our preprocessed image to a characteristic vector of features to classify. And finally, we get the feature vectors and classify an input feature vector with a classification method as knn.

We used 1000 images, 100 images of each number. And we trained 100 images of each number.

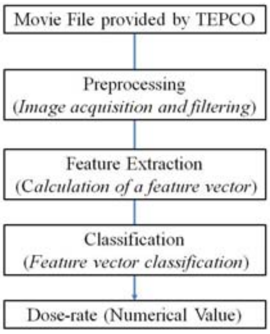

Fig. 4. Optical character recognition sequence

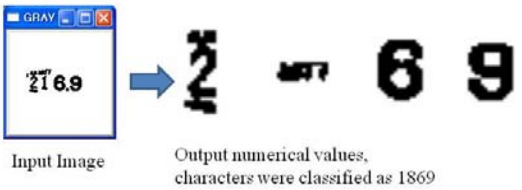

Fig. 5. Optical character recognition result (bad case)

Fig. 5 shows optical character recognition results of the CCD camera image. The leftmost character (2) of input image as shown in Fig. 5 is recognized as character (1). And the rightmost character (9) of the image is correctly characterized as 9. The camera with wide field-of-view (fisheye) lens reads the most significant indication value of dosimeter as the most distorted vision due to the fisheye lens distortion. When the more sophisticated image processing algorithm is not used as shown in Fig. 5, the pattern (character) recognition result is not reliable. And the other problem when executing the optical character recognition is the stability of the camera mounting base. When the Quince robot moves back and forth, the camera mount base did not absorb the vibration shocks due to robot's motion. So, the ROI (region of interest) baseline of the indication value of the dosimeter in the image was moved. The unstableness of the camera mount base leads to the character classification error. To overcome these problems described in the preceding clauses the more sophisticated image processing techniques are needed.

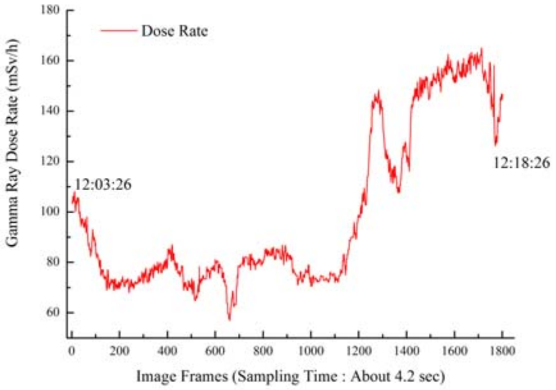

Fig. 6. Gamma ray dose rate profile resulted from the Quince 2 robot's investigation missions (survey radiation in the unit 2 reactor building refueling floor)

Fig. 6 shows the processing results of optical character recognition method using movie file provided by TEPCO. From the gamma ray dose rate profile as shown in Fig. 6, we can draw out radiation map in the region surveyed by the Quince 2 robot, if we have known the robot's navigation (GPS) coordinates. Also, from the movie file provided by TEPCO, we can find out intermittently displayed speckles due to the high dose-rate gamma ray irradiation (about 200 mSv/h dose rate).

5. Conclusions

We have extracted the gamma ray dose-rate value in the unit 2 reactor building refueling floor using optical character recognition method. To understand of the gamma ray dose-rate information in the surveyed refueling floor of the unit 2 reactor building, we used AVI movie file provided by TEPCO. When the Quince robot moves back and forth, the camera mount base did not absorb the vibration shocks due to the robot's motion. So, the ROI (region of interest) baseline of the indication value of the dosimeter in the image was moved. This unstableness of the camera mounting base leads to the character classification error.

[1] http://www.tepco.co.jp/nu/fukushima-np/
[2] http://roboticstaskforce.wordpress.com /
[3] http://blog.damiles.com/basic-ocr-in-opencv/