Real-Time Detection of Intruders by Surveillance Camera

Background

Many surveillance cameras are used in facilities that must be kept secure such as electric power plants for security, maintenance, and observing machine conditions. The number of surveillance cameras in use has recently increased in proportion to an increasing number of remote-controlled equipments. Human operators are now physically unable to constantly monitor these cameras. Advanced automated surveillance systems that can augment or replace human operators must therefore be developed. Such automated surveillance systems need to be able to detect target objects such as human intruders in real-time *1. The machine learning technique that distinguishes backgrounds and intruders is indispensable for the development of the automated surveillance system. However, for intruder detection, existing methods using the machine learning technique can't work in real-time.

Objectives

To develop an intruder detection method that works in real-time using the machine learning technique.

Principal Results

1. Development of new intruder detection method

The developed method uses monitoring lines that are settled around the facilities in advance instead of monitoring area to perform high-speed detection of intruders. The method mainly consists of the three processes: "line monitoring" process using brightness change on the lines, "priority decision" process using movements on the lines, and "intruder detection" process using pattern recognition of the machine learning technique (Fig.1). The developed method is a software program and simple to build into the existing surveillance system because of less computational complexity.

(1) Line monitoring
In advance, human operators set the several monitoring lines to an image. Change points of brightness are automatically extracted on the monitoring lines.

(2) Priority decision
The monitoring lines are divided into a constant area. The divided areas are given their priority by the passing speed of moving objects such as intruders.

(3) Intruder detection
Pattern recognition of intruder detection is applied only for the higher priority areas. The judgment rule of the pattern recognition was made using about 2,500 human body images and about 9,000 background images by the machine learning technique. When intruder is not found in the higher priority area, the priority level of the area sets lower position in "weight update" process (Fig.1).

2. Verification of the developed method

Figure 2 shows an example of intruder detection results for an image. Table 1 shows the experimental results by forty-seven intruders who crossed the monitoring lines. The number of detection errors in the line monitoring process was thirty-seven and the errors were eliminated except for one in the intruder detection process. Finally, the proposed method detected all intruders correctly and the processing speed was thirty images per second *2. The experimental results indicate that the proposed method can be used to develop the advanced surveillance system.

Future Developments

Field tests of the developed method will be performed using existing surveillance cameras at power plants, substations, and wireless relay stations.

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Reference

C. Nakajima, 2005, "Real-time detection of intruders by existing surveillance camera", CRIEPI Report R04007 (in Japanese)

*1 : Video-rates of 30 images per second (30fps)
*2 : Computer: Pentium4, 2.4GHz, Image capture: IEEE1394.

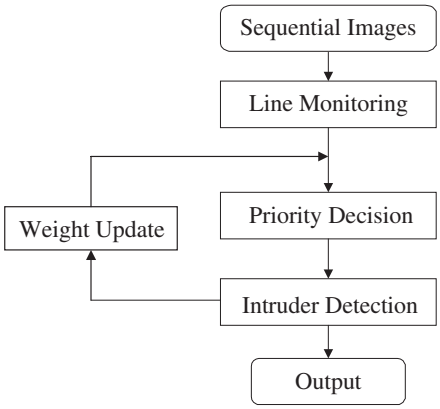

Fig.1 Outline of the intruder detection method

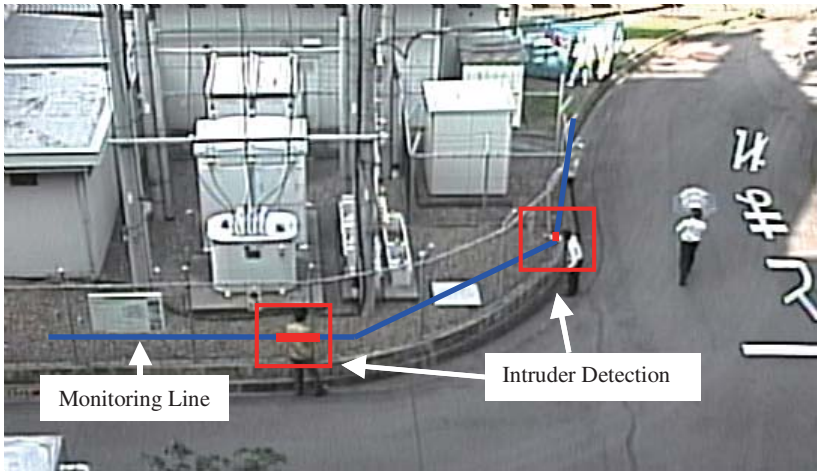

Fig.2 An example of intruder detection for an image

Table 1 Experimental results by the proposed method

The number of test images was 34,800 (about nineteen minutes).

	Correct detection	Detection error	Miss-detection
Line Monitoring	47 times (1905 images)	37* times (166 images)	0 time
Intruder Detection	47 times (1796 images)	1** time (3 images)	0 time
Final detection results (Forty seven intruders)	All intruders who crossed the monitoring lines were detected by the method at video-rate.		

*: Detection errors were caused by brightness changes of sunlight, clouds, and fence shakes.

**: A pole near the fence was detected as an intruder.