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SAPE Database Building for a Security System Test Bed

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1. Introduction

Physical protection to prevent radiological sabotage and the unauthorized removal of nuclear material is one of the important activities.

Physical protection system (PPS) of nuclear facilities needs the effectiveness analysis[1, 2]. This effectiveness analysis of PPS is evaluated by the probability of blocking the attack at the most vulnerable path.

Systematic Analysis of Physical Protection Effectiveness (SAPE) is one of a computer code developed for the vulnerable path analysis. SAPE is able to analyze based on the data of the experimental results that can be obtained through the Test Bed.

In order to utilize the SAPE code, we conducted some field tests on several sensors and acquired data. This paper aims at describing the way of DB (database) establishment.

2. SAPE code program

SAPE is a program to evaluate effectiveness of physical protection systems by the tile-map. Language of Visual Basic 6.0 was used and it is compatible with Windows 2000, XP, Vista OS, etc. Through advantage of the language features of Visual Basic6.0, the user interface has been implemented in the Windows GUI [3].The overall configuration of the program is shown in the block diagram of Fig 1. Largely, it is divided into input, analysis, output module. Input module reads the object named Facility vector model, and analysis module finds the vulnerable path by using the Heuristic Algorithm after the object is converted to the mesh (Tile-map object). Finally, output module shows this result on the screen and draws vulnerable path graph and sensitivity graph.

As shown in the Fig 1, the squares are an object of object-oriented programming and the ellipses are a collection of subroutine modules. If precise location information may be reflected in the protective facility using this algorithm, it is possible to intuitive and precise evaluation.

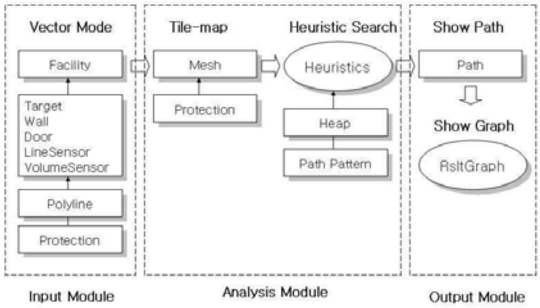

Fig. 1. Block Diagram of SAPE

3. Overview a Test Bed

The test bed is currently operating for several tests. The basic structures are shown in Fig 2. The dimensions of the system itself are 15 by 15m. The fences are 4m wide and 3m high. There is a control box which can observe, collect, and analysis sensor data just as one would perform at a real facility. The test bed surface is gravel, because it is an ideal surface material and it is also used at real facilities. Component specifications are similar to those found at real facilities.

It has fences, infrared sensors, fence disturbance sensors, CCTV cameras, and security lights (similar to the type used at real nuclear facilities) etc. The sensors can be movable for finding optimum design of each facility.

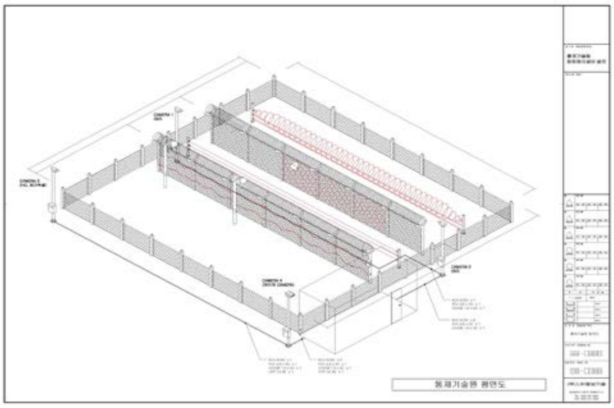

Fig. 2. Test Bed layout

4. Data Production

Pd (Probability of Detection) of the each facility is used for SAFE code input data. We checked the operation of the infrared sensor, fence disturbance sensor, passive infrared sensor, dual tech sensor before testing the Pd. Each sensor was able to confirm that there is no error through alarm margin, total beam block test etc. [4, 5].

Intruders would try various types of intrusion such as crawling, climbing a fence in order not to be detected. Depending on the type of intrusion, the Pd test of each sensor conducted over 20 times.

Pd test of the infrared sensor, dual technology sensor involves crawling, rolling, walking, running test. While conducting the intrusion simulation, one of the testers monitored alarm condition. Fence disturbance sensor involves climbing fence, cutting fence fabric test. This test was conducted by changing the height of installation of sensor line and the location of intrusion. Passive infrared sensor is very sensitive to movements in the detection area. Therefore, walk test perpendicular to the sensor and horizontal to the sensor were performed.

5. Results

Each sensor probability of detection can be determined by calculating the number of tests and the number of alarm occurrences. The test results about the Pd are divided to five grades.

As you can see in Table I, the infrared sensor has generally high probability of detection to the types of intrusion. But the infrared sensor needs to be installed in accordance with a valid height of installation. If the infrared sensor is installed too low, nuisance alarm breaks out because of the snow, weeds and so on.

Depending on the type of intrusion, fence disturbance sensor has considerable difference in Pd. In particular, it is very different depending on height of installation. The height of installation of the sensor line is negligible when it comes to the detection of climbing. But the height of installation is no longer negligible when trying to detect the intrusion by cutting the fence fabric. The installation of sensor lines over 1.4m from the ground should be prohibited for robust fence disturbance sensor.

Passive infrared sensor has a lower Pd compared to other sensors. In particular, Passive infrared sensor has problem with detection when it comes to the detection of perpendicular moving.

Dual tech sensor achieves absolute alarm confirmation while maintaining a very high probability of detection. It is important to know that when two sensors (infrared, microwave) are logically combined, the probability of detection of the combined detectors will be more than the PD of the individual detectors.

Table I: Estimates of Detection Capability

Intrusion mode	Probability of Detection			
	Infrared	Fence Disturbance	Passive Infrared	Dual Tech
Crawling	H	N/A		VH
Rolling	H	N/A		VH
Walking	VH	N/A	M	VH
Running	VH	N/A		VH
Climbing	N/A	H	N/A	N/A
Cutting	N/A	M	N/A	N/A

Key: VH = Very High (↑ 95%)
H = High (↑ 90%)
M = Medium (↑ 85%)
L = Low (↑ 80%)
VL = Very Low (↑ 75%)
N/A = Not applicable

6. Further work

In order to get the database to input the SAPE code, we have tested the probability of detection of sensors. To improve SAPE code credibility, we need to more additional tests such as nuisance alarm rate, probability of correct assessment, various intrusion modes.

The nuisance alarm rate needs to be tested in a variety of weather conditions. And it can be obtained from nuclear facility alarm analysis. Nowadays, the test methodology is studied.

After the establishment of SAPE code database, we could make the recommendations for installing and evaluating physical protection components.

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