Effects of Weather on the Performance of Intrusion Detection Sensors

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1. Introduction

Physical protection, which opposes and limits the capabilities of potential adversaries, plays an important role in supporting nuclear non-proliferation [1]. As a part of the physical protection, the use of intrusion detection sensors allows to quickly sense unauthorized access, so that appropriate measures can be taken immediately.

However, the frequent occurrence of false alarms in intrusion detection sensors deteriorates the quality of physical protection. Thus, it is required for intrusion detection sensors to reduce the false alarms [2].

In this research, the performance of intrusion detection sensors depending on weather conditions such as temperature, wind speed, precipitation, and relative humidity was analyzed to investigate continuities between the weather conditions and the false alarms of intrusion detection sensors. For alarm analysis, the weather conditions at an experimental environment and the one-year alarm data from an active infrared (AIR) sensor and a dual-tech sensor were used. The analysis results did not find the clear correlation between the weather conditions and false alarms. However, it showed a possibility that the false alarms could be influenced by a temperature.

2. Materials and methods

2.1 Description of intrusion detection sensors

Two types of intrusion detection sensors widely used at nuclear facilities were investigated. The intrusion detection sensors examined were an AIR sensor (TAKEX, PB-IN-100HF) and a dual-tech sensor (CIAS, PHYTHAGORAS 3TECH).

When it comes to the operation principles of the two intrusion detection sensors, the AIR sensor has a light emitting diode and a receiver. The infrared light from the light emitting diode reflects off of the object coming close to the sensor, and is detected by the receiver. To reduce the possibility of false alarms, the dual-tech sensor combines an AIR sensor and a microwave sensor, and the alarm is activated when both sensors detect an object.

2.2 Weather conditions at the experimental environment

In order to identify continuities between weather conditions and false alarms, the weather conditions at an experimental environment such as temperature, wind speed, precipitation, and relative humidity were gathered and utilized.

As shown in Figs. 1—4, the one-year data of each weather condition were classified by a certain range, and then the number of days according to the certain range of each weather condition were used for alarm analysis.

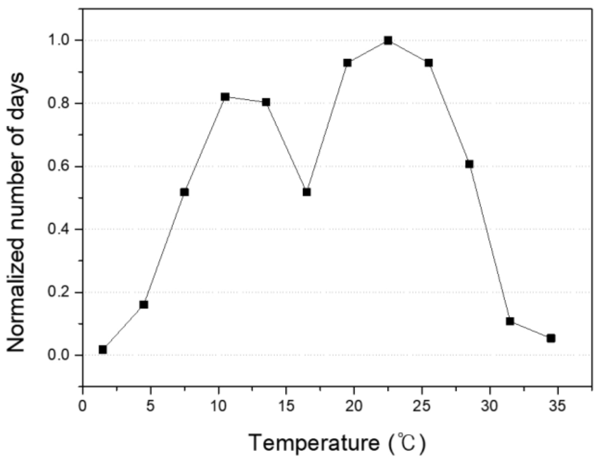

Fig. 1. Number of days with a mean temperature at the experimental environment.

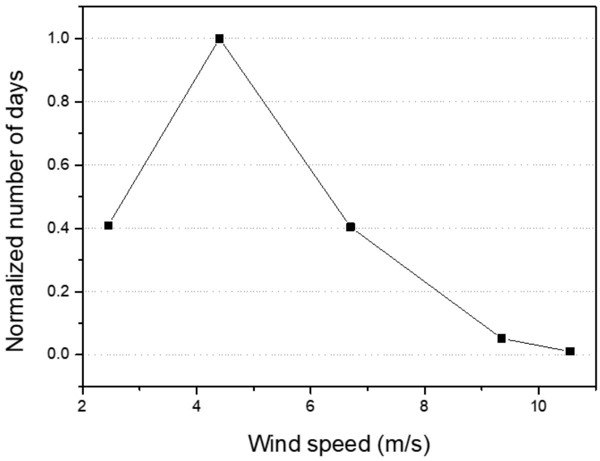

Fig. 2. Number of days with a mean wind speed at the experimental environment.

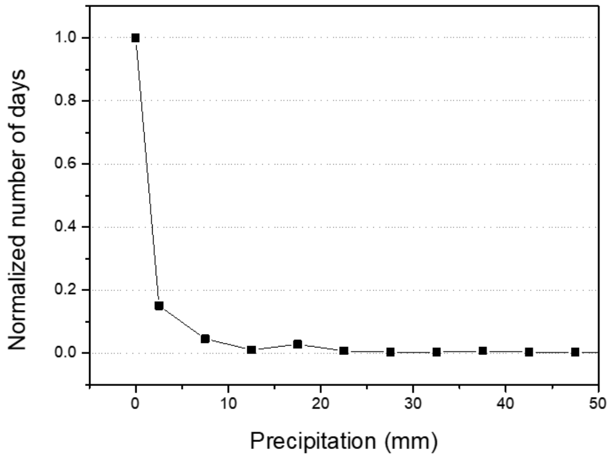

Fig. 3. Number of days with a mean precipitation at the experimental environment.

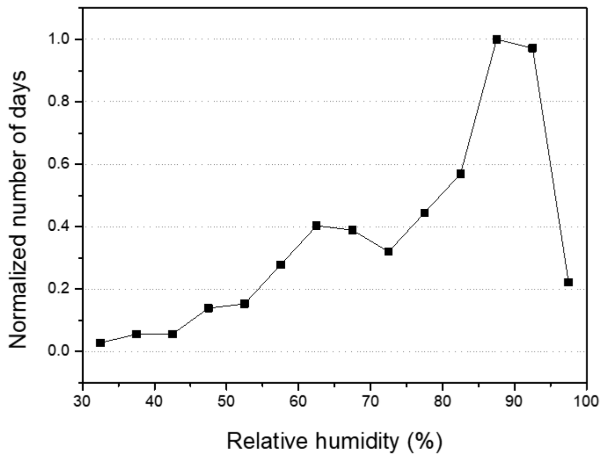

Fig. 4. Number of days with a mean relative humidity at the experimental environment.

However, in the case of precipitation, as described in Fig. 3, the day with more than 50 mm (113.1 mm) of precipitation was excluded because the day was only a day so that the analysis results can be biased.

2.3 Procedure of Alarm analysis

According to weather conditions, the one-year alarm data from the AIR and dual-tech sensors were collected and reclassified. The alarm data were then grouped by the certain range of each weather condition, and were averaged by the number of days that the alarms were activated. Eventually, the average number of alarms from the AIR and dual-tech sensors as a function of weather conditions was used to for alarm analysis.

3. Results and discussion

Fig. 5 shows that a high number of alarms from the AIR sensor were activated between 20 and 25 degrees and the dual-tech sensor made a high number of alarms between 28 and 35 degrees. Thus, it seems that alarms for both sensors are more activated above about 20 degrees.

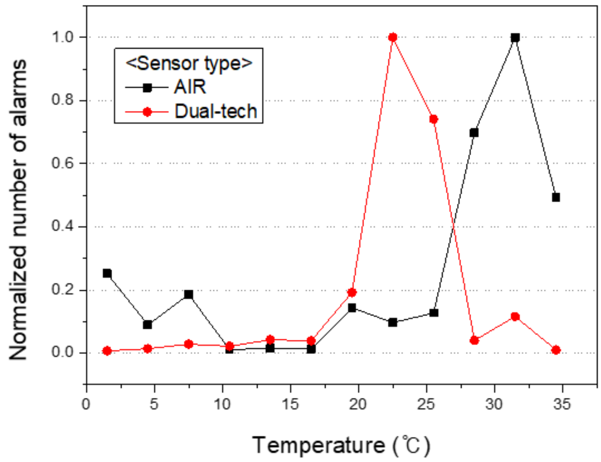

Fig. 5. Number of alarms from intrusion detection sensors as a function of mean temperature.

As presented by Fig. 6, the number of alarms from the AIR sensor tends to decrease as the wind speed increases. Unlike, when the wind speed increases, the number of alarms from the dual-tech sensor increases but with a wind speed of 10.5 m/s drastically decreases. Especially for the dual-tech sensor, as shown in Fig. 2, the number of days with a wind speed of 9─10.5 m/s is highly low that analysis results could be biased. Thus, further research is necessary.

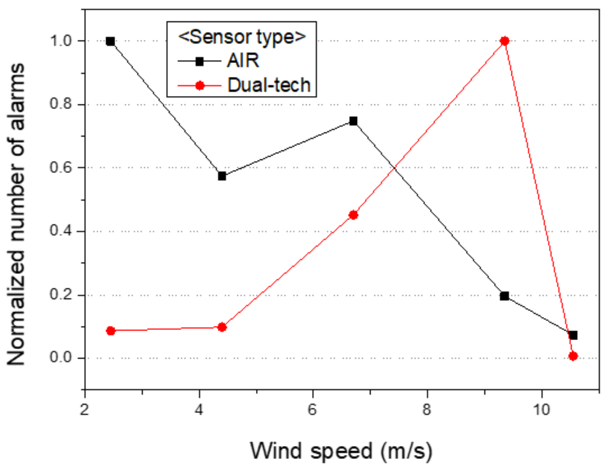

Fig. 6. Number of alarms from intrusion detection sensors as a function of mean wind speed.

Fig. 7 describes that the number of alarms from the AIR sensor is relatively high with precipitation between 32.5 and 47.5 mm. However, the graph curve of the number of alarms from the dual-tech sensor is not regularly changed. As indicated in Fig. 3, the alarm data with a precipitation of more than 2.5 mm is insufficient because most of the days in a year recorded the 0 mm of precipitation. Therefore, the correlation between precipitation and false alarms is not clearly identified. Likewise, further study is required.

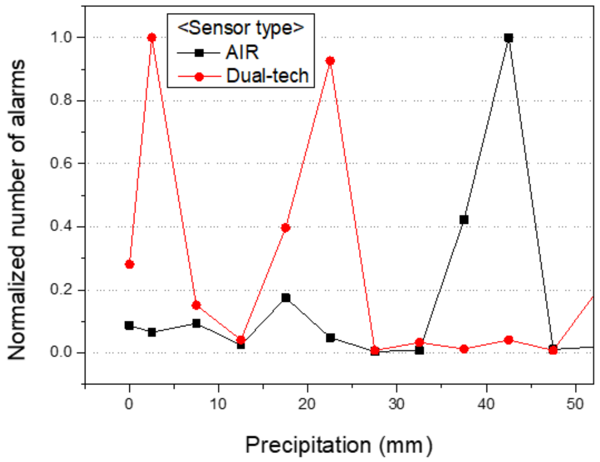

Fig. 7. Number of alarms from intrusion detection sensors as a function of mean precipitation.

For the relative humidity, Fig. 8 shows that the number of alarms from the dual-tech sensor tends to be high with a relative humidity of more than 90%. Unlike, the AIR sensor activated more alarms with a relative humidity of 40%. Considering that the number of days with a relative humidity of 40% is not sufficient, as described in Fig. 4, the correlation between relative humidity and false alarms is not clearly represented. For that reason, additional study is needed.

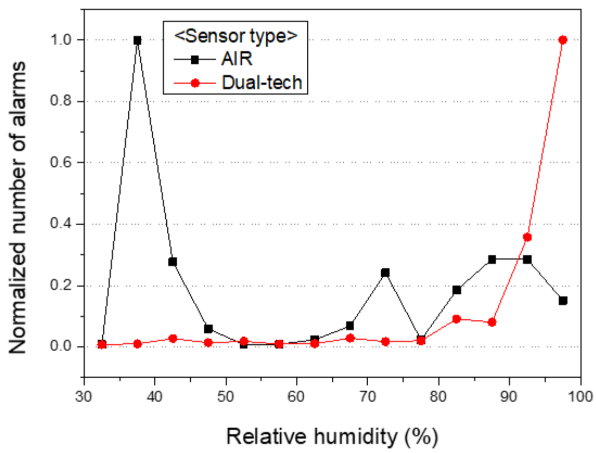

Fig. 8. Number of alarms from intrusion detection sensors as a function of mean relative humidity.

In general, this study has limitations that the alarm data were not enough to fully confirm the relationship between weather conditions and false alarms because only one sensor was utilized to acquire the alarm data respectively, and the number of days according to each weather condition varied. Furthermore, it is difficult for intrusion detection sensors to prove that the false alarms were activated only by weather conditions. To make up for such limits, further research will be conducted with more sensors by controlling environmental factors other than weather conditions.

4. Conclusions

In this study, the changes in the alarms of intrusion detection sensors were examined depending on weather conditions. For the alarm analysis, the weather conditions such as temperature, wind speed, precipitation, and relative humidity and the alarm data from the AIR and dual-tech sensors were used. The analysis results did not find the evident correlation between the weather conditions and the false alarms, but it showed a possibility that the false alarms could be affected by a temperature.

REFERENCES

[1] International Atomic Energy Agency, “Nuclear Security – Measures to Protect Against Nuclear Terrorism”, GOV/INF/2005-GC(49)/INF/6, 2005.
[2] J. D. Williams, “Intrusion Detection Sensors”, SAND78-0644C, 1978.