KINAC Korea Institute of Nuclear Nonproliferation and Control

Effects of Weather on the Performance of Intrusion Detection Sensors

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Introduction

Characteristics of physical protection

◦ Physical protection opposes and limits the capabilities of potential adversaries.

◦ Physical protection plays an important role in supporting nuclear non-proliferation.

◦ 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 false alarms in such sensors can deteriorate the quality of physical protection.

◦ In this aspect, it is required for intrusion detection sensors to reduce the false alarms.

Purpose of 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.

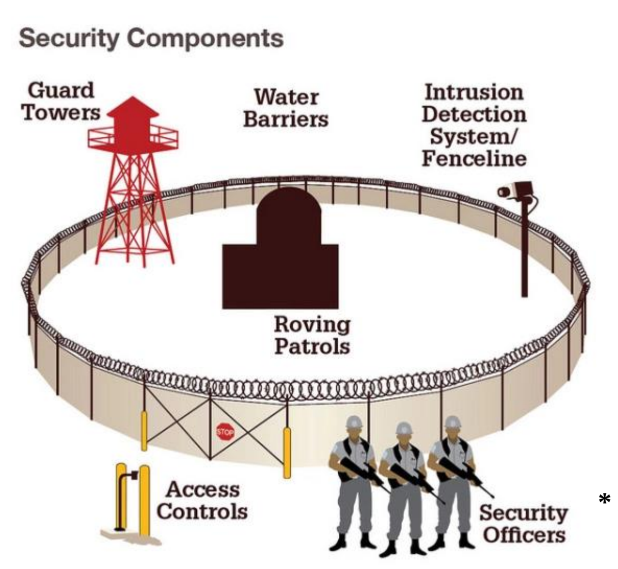

Fig. 1. Security components for physical protection.

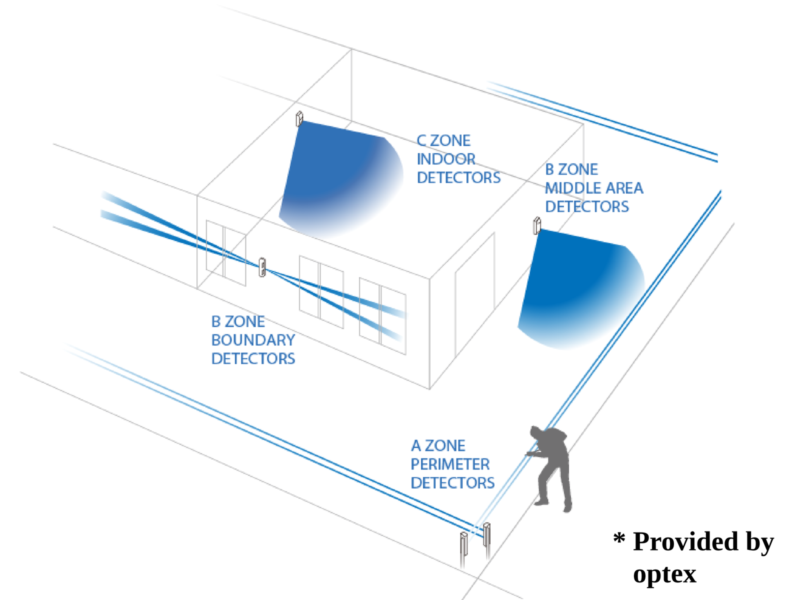

Fig. 2. Schematic of intrusion detection sensors.

Materials and methods

Description of intrusion detection sensors

◦ Two types of intrusion detection sensors widely used at nuclear facilities were investigated.

◦ An active infrared (AIR) sensor (TAKEX, PB-IN-100HF) and a dual-tech sensor (CIAS, PHYTHAGORAS 3TECH) were selected and examined in this study.

◦ The AIR sensor has a light emitting diode and a receiver. The infrared light from light emitting diode reflects off of the object coming close to the sensor, and is detected by the receiver.

◦ The dual-tech sensor combines an AIR sensor and a microwave sensor, and alarm is activated when both sensors detect an object to reduce the possibility of false alarms.

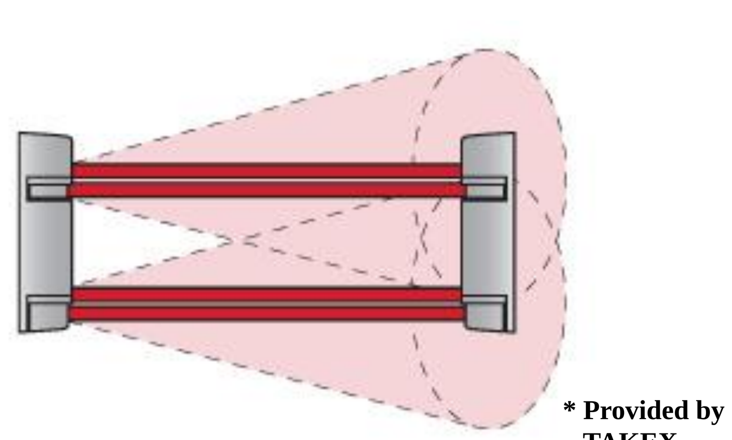

Fig. 3. Schematic of an AIR sensor.

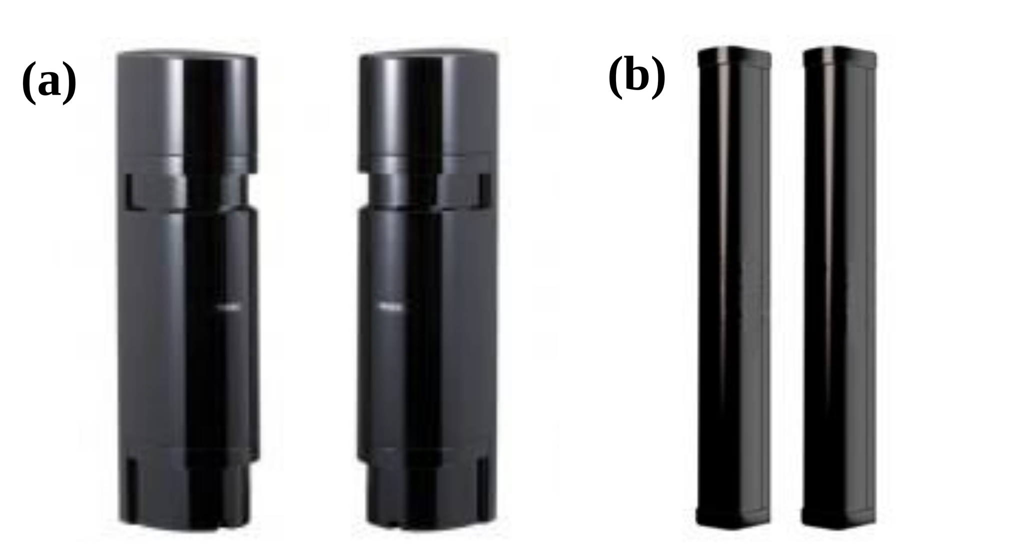

Fig. 4. The products of intrusion detection sensors : (a) TAKEX, PB-IN-100HF, and (b) CIAS, PHYTHAGORAS 3TECH.

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. 5−8, 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 were used for alarm analysis.

◦ In the case of precipitation, 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.

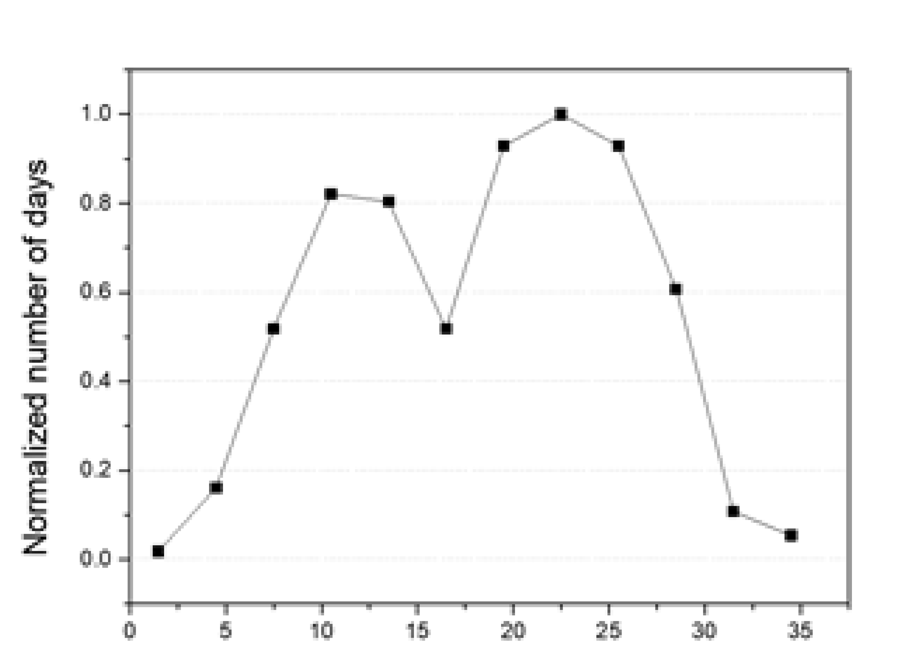

Fig. 5. Number of days with a mean temperature at the experimental environment.

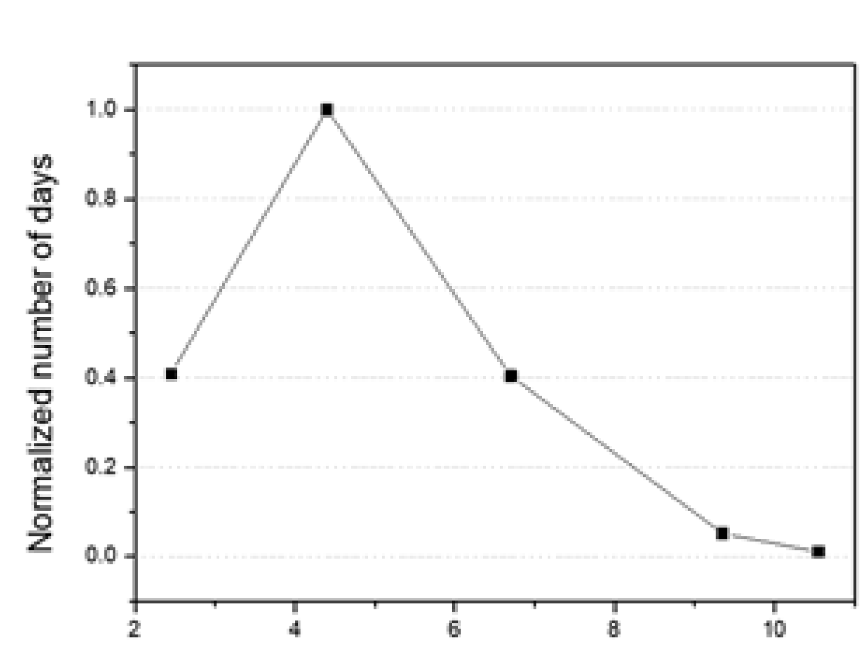

Fig. 6. Number of days with a mean wind speed at the experimental environment.

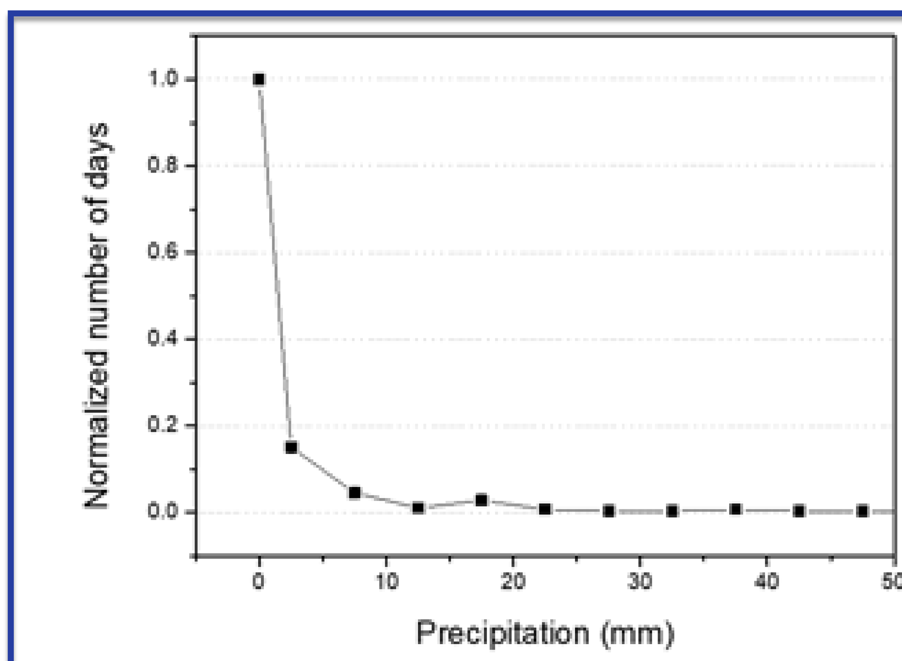

Fig. 7. Number of days with a mean precipitation at the experimental environment.

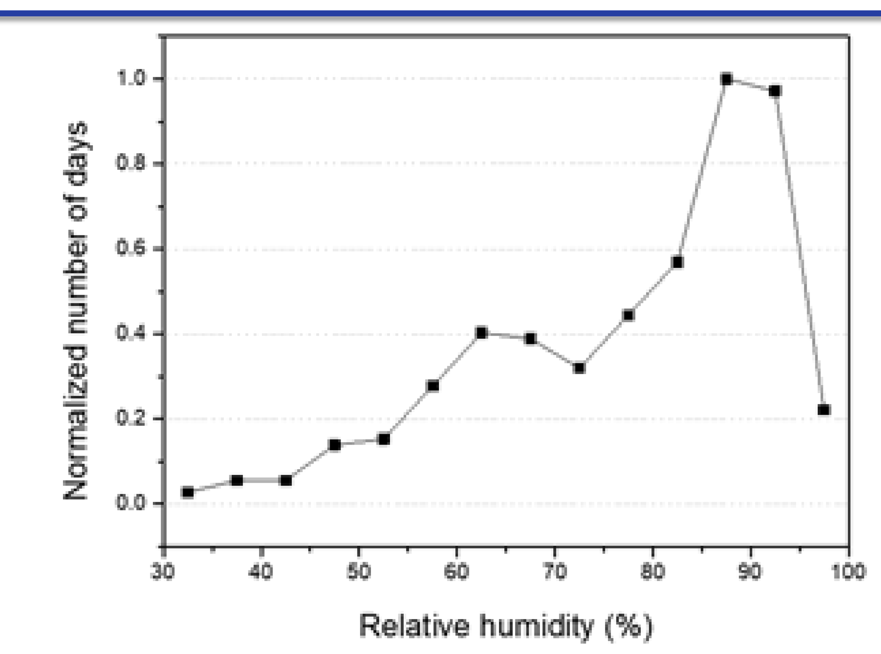

Fig. 8. Number of days with a mean relative humidity at the experimental environment.

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 alarms were activated.

◦ Eventually, the average number of alarms from the AIR and dual-tech sensors as a function of weather conditions was used for alarm analysis.

Results and discussion

Effects of temperature on the sensor performance

◦ As shown in Fig. 9(a), a high number of alarms from the AIR sensor were activated at 20−25 ℃, and the dual-tech sensor made a high number of alarms at 28−35 ℃.

◦ It seems that alarms for both sensors could be more activated above 20 ℃.

Effects of wind speed on the sensor performance

◦ As presented in Fig. 9(b), 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.

◦ For the dual-tech sensor, especially, as shown in Fig. 6, the number of days with a wind speed of 9−10.5 m/s is highly low that the results of alarm analysis could be biased.

Effects of precipitation on the sensor performance

◦ As described in Fig. 9(c), 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.

◦ Considering that the alarm data with a precipitation of more than 2.5 mm is insufficient as indicated in Fig. 7, the correlation between precipitation and false alarms is not clearly identified.

Effects of relative humidity on the sensor performance

◦ As shown in Fig. 9(d), 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 shown in Fig. 8, the correlation between relative humidity and false alarms is not clearly represented.

Limitation

◦ The alarm data were not enough to fully confirm the relationship between weather conditions and false alarms because only one sensor was utilized, and the number of days according to each weather condition was not uniform.

◦ Moreover, it is difficult to prove that the false alarms were activated only by weather conditions.

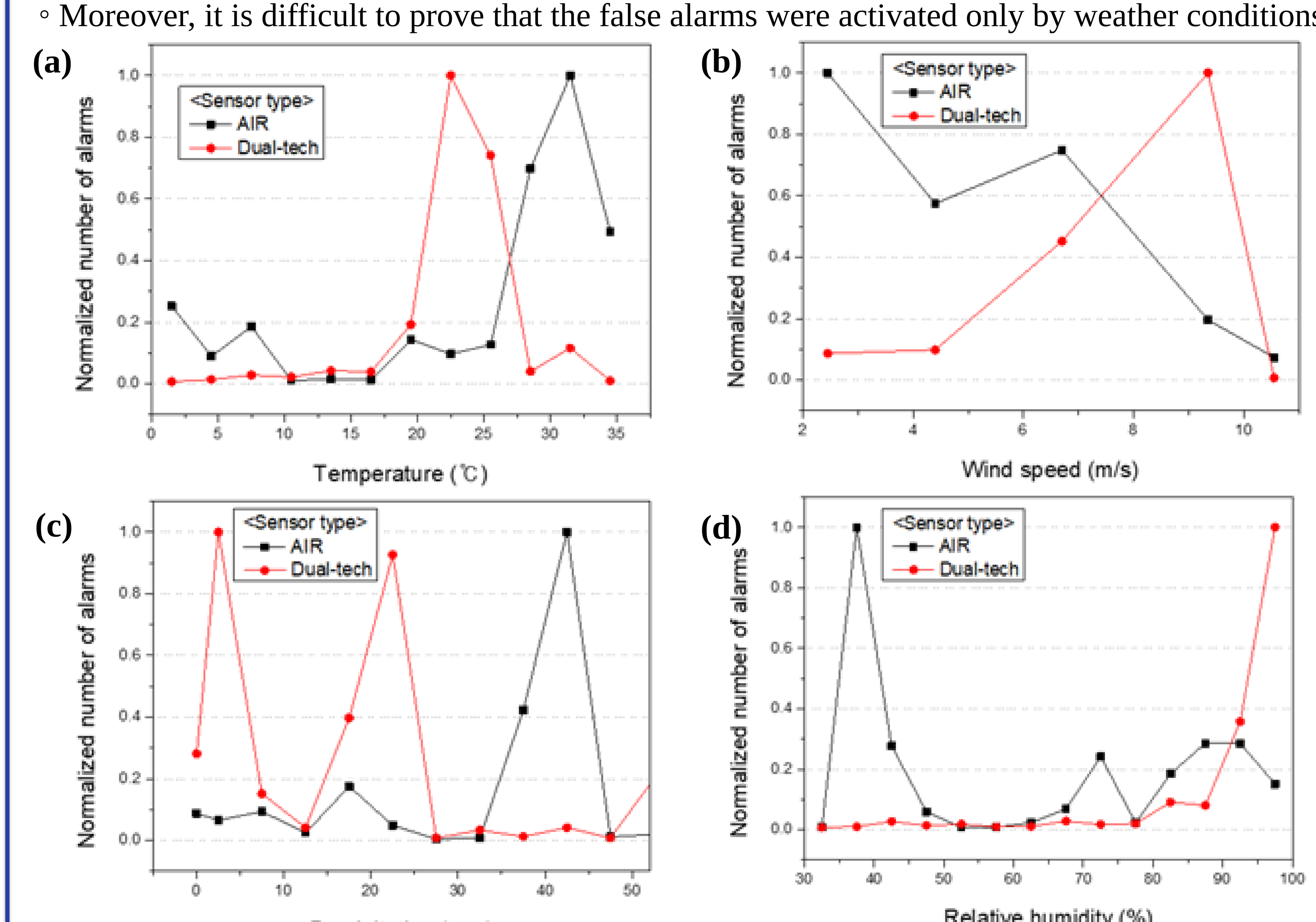

Fig. 9. Number of alarms from intrusion detection sensors as a function of (a) mean temperature, (b) mean wind speed, (c) mean precipitation, and (d) mean relative humidity.