Evaluation of the "StrikeGuard" Lightning Alarm Sensor Using Lightning Location System (LLS) Lightning Data

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Abstract

StrikeGuard detects the magnetic field signal and the optical signal generated by a lightning discharge and generates lightning alarms indicating three levels of the danger. It is said that StrikeGuard can detect thunderstorm danger more accurately and output fewer false alarms when compared with conventional lightning alarm sensors. We installed a StrikeGuard sensor at Sankosha Corporation's Sagami Techno Center and compared its lightning alarm information with LLS data from the Japan Lightning Detection Network (JLDN). During an evaluation this summer, we confirmed that StrikeGuard output appropriate alarms 30 to 60 minutes before lightning occurred near the Sagami TC. We also confirmed that StrikeGuard generated alarms for 100% of the lightning detected by the JLDN at a distance of 10km or less from the sensor. Therefore, we have concluded that StrikeGuard is a practical sensor that provides sufficient performance as a lightning alarm sensor.
Keyword: LLS, Thunderstorm, Lightning alarm, Magnetic field signal

1. Introduction

We installed the new "StrikeGuard" lightning alarm sensor at our company's Sagami Techno Center (Sagami TC), and we continue to operate it now in order to evaluate the sensor's performance. StrikeGuard detects the magnetic field signal and the optical signal generated by a lightning discharge, and outputs an alarm to inform people of the approach of a thunderstorm. Also, it outputs fewer incorrect alarms when compared with other conventional lightning alarm sensors and can detect the danger of thunderstorms more accurately. We analyzed the lightning alarm information from StrikeGuard using the lightning data from the Lightning Location System (LLS), evaluated its performance, and report the results of our investigation here.

2. StrikeGuard Description

StrikeGuard consists of a Sensor that is installed outdoors and Receiver that is installed indoors (Fig. 1). The Sensor is powered by a lithium battery so it doesn't require an external power supply. The Receiver is powered by an AC power supply. However, the Receiver is equipped with an inner backup battery that allows it to operate continually at the time of an AC power failure. The Sensor is connected to the receiver through a fiber optic cable so it is completely isolated electrically from the indoor equipment. The StrikeGuard specification is shown in Table 1.

Table 1: StrikeGuard Specification

Item		Specification
Sensor	Size	660mm (W) x 770mm (H) x 660mm (D)
	Weight	1.35 kg
	Battery	Lithium battery
Receiver	Size	340mm (W) x 137mm (H) x 41mm (D)
	Weight	1.7 Kg
	Battery	1.5VDC x 4 (CK14 or LR14) for backup
	Power supply	100VAC

The Sensor detects the magnetic field change and the optical pulse of a lightning discharge and outputs this information to the Receiver. The latest signal processing lightning discrimination technology prevents Sensor false alarms. The Receiver receives the data from the Sensor and outputs three levels of lightning danger alarms (Table 2). In order to inform people, the Receiver causes an LED to flash, outputs an audible alarm, and can operate external relays.

Furthermore, by connecting a PC to the Receiver, lightning alarm information can be displayed in real time enabling the viewer to visually understand the movement of the thunderstorm. It is also possible to archive and analyze lightning information in detail.

Table 2: Lightning alarm danger levels

State	Meaning
CAUTION	Thunderstorm approaches less than about 32 km
WARNING	Thunderstorm approaches less than about 16 km
ALERT	Thunderstorm approaches less than about 8 km

StrikeGuard is a new lightning alarm sensor developed in the U.S.A. Currently, 150 or more systems are used effectively around the world at golf courses, amusement parks, stadiums, factories, energy plants and other facilities.

3. StrikeGuard Evaluation

3-1. StrikeGuard Installation

We installed StrikeGuard at the Sagami TC, and we have been collecting real thunderstorm lightning alarm information for evaluation since November 2004. Sagami TC is located in Kanagawa Prefecture on the Kanto Plain (Fig. 2).

Because StrikeGuard detects the magnetic field signal and the optical signal generated by lightning discharges, it is necessary to install it in a suitable place where interference with those signals is not a problem. However, StrikeGuard uses the magnetic field signal so the installation location requirements are much more flexible than for lightning sensors that use the electric field signal. This is one of the strong advantages unique to StrikeGuard. We installed StrikeGuard on a fence on the roof of a two-story building at the Sagami TC.

3-2. LLS data for evaluation

To evaluate the lightning alarm information from StrikeGuard, we used LLS data from the JLDN (Japan Lightning Detection Network). The JLDN is the only system that offers lightning location data for all of Japan. It is owned and operated by Franklin Japan Corporation, a private weather company. The JLDN observes thunderstorms in Japan and the surrounding area in real time using a network of 29 sensors (Fig. 3).

3-3. Lightning alarm information analysis

Many thunderstorms passed through the Sagami TC area this summer, and StrikeGuard always output lightning alarms correctly in each case. We analyzed the lightning alarm information on July 7th and report the results below.

Two thunderstorms approached the Sagami TC from the northwest on July 7th. The location of each lightning discharge in the area surrounding the Sagami TC from 13:00 to 19:00 is shown in Figure 4. StrikeGuard generated 268 alarms during this period. The number of StrikeGuard alarms in each fifteen minute interval during those six hours is shown in Figure 5. As the first thunderstorm approached, StrikeGuard output "WARNING" and "CAUTION" alarms at around 13:00. Approximately 30 minutes later, lightning occurred near the Sagami TC. When the second thunderstorm approached, StrikeGuard output a "CAUTION" alarm at around 15:30. Sixty minutes later, lightning occurred again near the Sagami TC.

Next, we compared StrikeGuard lightning alarm information with data from the LLS. We selected discharge locations reported by the LLS from 13:00 to 19:00 that were less than 50km away from the Sagami TC. We plotted those discharges in Figure 6 and used the following symbols to show the corresponding StrikeGuard output. ◊ means NO alarm, ■ means CAUTION, ▲ means WARNING, and ● means ALERT in this figure. Our analysis showed that StrikeGuard generated alarms correctly as the thunderstorms approached the Sagami TC.

4. Conclusion

In this paper, we described our analysis of StrikeGuard performance using LLS lightning data from July 7th and showed that StrikeGuard detected approaching thunderstorms and issued alarms accurately 30 or 60 minutes before lightning occurred close to the Sagami TC. We have also confirmed the sensor's accurate performance using LLS lightning data from other dates.

During the period of our analysis, StrikeGuard output alarms for 100% of the lightning discharges reported by the LLS that were located less than 10km from the Sagami TC. In addition, StrikeGuard did not generate any false alarms during any of our tests. Therefore, we have concluded that StrikeGuard is a practical lightning sensor that is sufficient to provide prompt warning of lightning danger.

Reference

[1] M. Matsui, A. Sugita "The comparison between the IKL map and the thunderstorm day map by JLDN", The 2nd Asian Lightning Protection Forum, pp.10-14, 2004

Fig. 1: StrikeGuard Sensor (left) and Receiver (right)

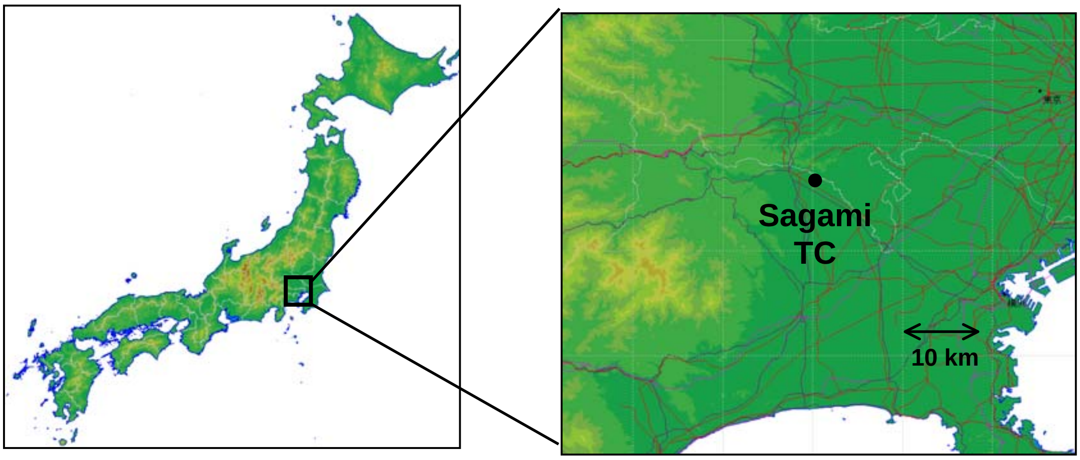

Fig. 2: The Location of the Sagami TC (left: Japan, right: Sagami TC area)

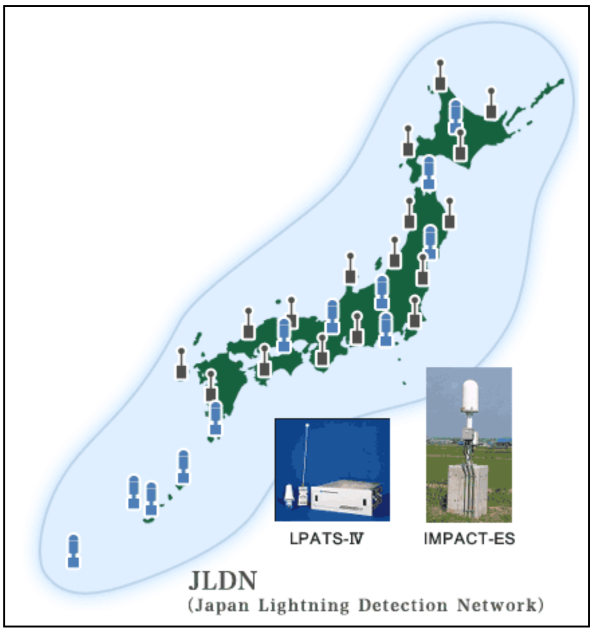

Fig. 3: JLDN (Japan Lightning Detection Network) [1]

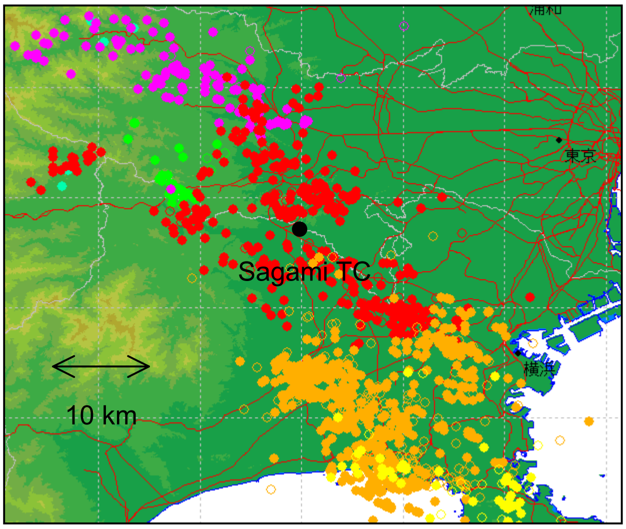

Fig. 4: Lightning locations near the Sagami TC from 13:00 to 19:00 on July 7th
(●:13~, ●:14~, ●:15~, ●:16~, ●:17~, ●:18~)

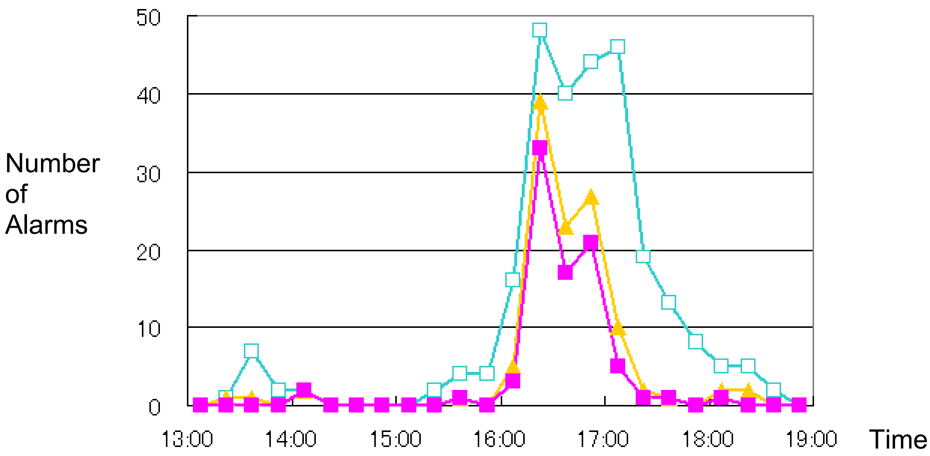

Fig. 5: The number of StrikeGuard alarms in 15 minute intervals
(- □ - : CAUTION, —▲—: WARNING, —■—: ALERT)

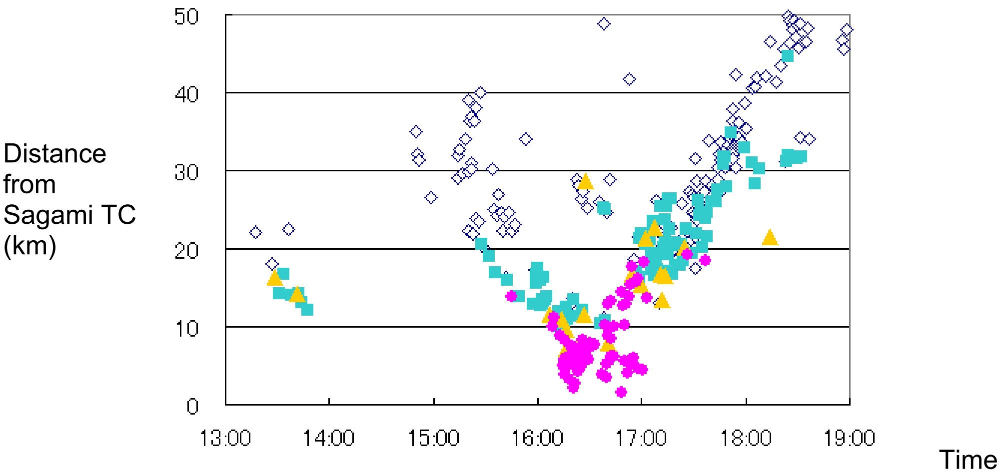

Fig. 6: LLS data and StrikeGuard Alarms
(: No alarm, ■: CAUTION, ▲: WARNING, ●: ALERT)