Physical Security Systems

OVERVIEW: Since the terrorist attacks of September 11, 2001, in the United States, various steps have been taken around the world to raise the level of security, including anti-terrorist steps, at key facilities and public places where people gather. In that context, the needs are increasing for physical security systems and related equipment. Centered on security systems it developed in the past, Hitachi, Ltd. is now developing new products such as detectors for detecting dangerous objects, personal authentication systems, and inspection equipment using X-ray equipment. The discussion in this paper is centered on security systems Hitachi previously developed but it also presents a summary of the current situation concerning sensors for detecting unauthorized facility access, personal authentication systems, and surveillance cameras, all used in security systems.

INTRODUCTION

SINCE the terrorist attacks in the U.S. on September 11, 2001, terrorist threats have increased around the world. As a result, security measures have been bolstered at key transport facilities such as airports and harbors, as well as at places where people gather, i.e. various events and celebrations.

In that backdrop, Hitachi established a physical security equipment business under the theme "Comfort and Safety." The new business is centered on security systems that Hitachi has developed, installed, and maintained up to the present. Hitachi has also been involved in the field of cyber security, and has much experience in developing and installing many such systems. In fact, Hitachi is one of the few manufacturers able to combine its expertise in the twin fields of cyber security and physical security to provide solutions for total security systems.

Among physical security systems, the emphasis in this paper is on security systems in place at key

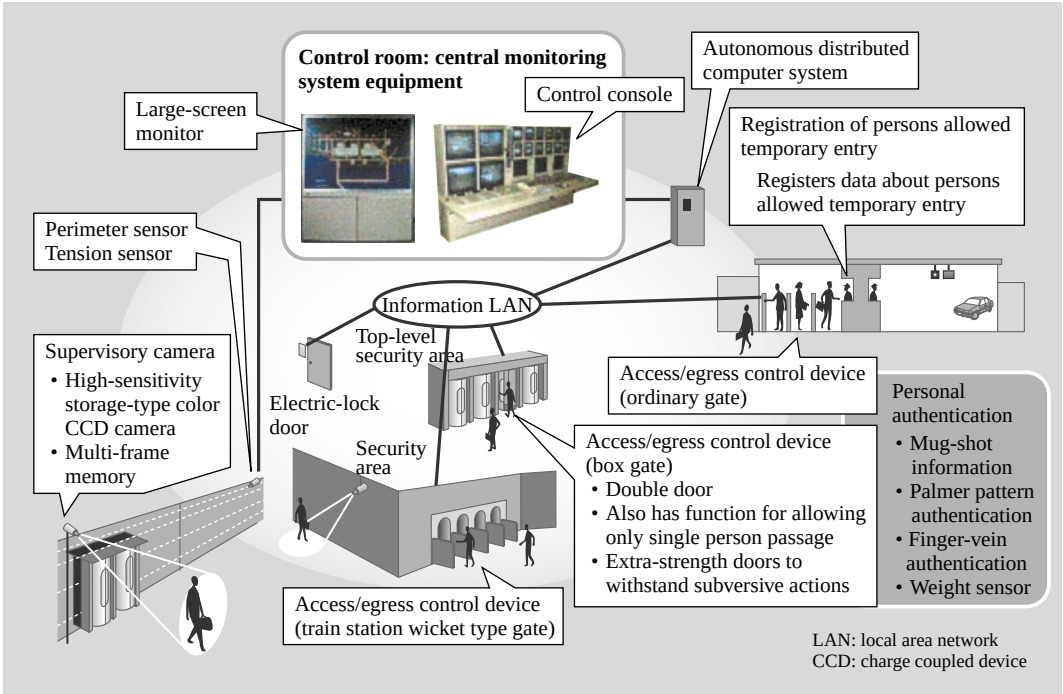

Fig. 1—Outline of Security System. This security system is an access/egress control system comprising: (1) an unauthorized entry supervision system that monitors a facility's perimeter to prevent illegal entry, and (2) a system for controlling access and egress at designated entrances and exits, and (3) a control room for overseeing the first two systems.

TABLE 1. Comparison of Selected Sensors

This table compares the main features of sensors, including their advantages and shortcomings. Since no sensor is perfect in every way, it is necessary to choose sensors appropriately depending on the environment in which they will be used.

	Fence (vibration) sensor	Tension sensor	Infrared sensor	Passive infrared sensor	Microwave sensor
Mounting	Fitted with bar, or attached to fence	Stands on ground	Stands on ground; two sensors face each other	Hang on side of wall or building wall	Stands on ground; two sensors face each other
Method of operation	Cable interior senses vibration; senses short circuit	Cable senses vibration; senses short circuit	Senses broken infrared beam	Heat sensitive	Microwave detected
Advantages	Because obvious, provides deterrent effect; can be located in specific unauthorized entry areas	Because obvious, provides deterrent effect; can be located in specific unauthorized entry areas	Stable at long distances; installation not obvious; using twin beams, can determine size; using twin beams, little incorrect information	Relatively easy to install; can provide area coverage	Not readily affected by birds, other flying objects; outstanding weather durability
Shortcomings	Rate of incorrect data increases slightly at long distances.	Rate of incorrect data increases slightly at long distances.	Bothersome to install and adjust; needs open area in surroundings	Narrow scope of detection; affected by sun rays and other sources of heat; high possibility of incorrect information	Undetermined area of detection; seriously affected by electromagnetic waves; sensitive to swaying trees or bushes; affected by walls and other obstacles
Scope of sensor operation	Line detection (one dimensional)	Line detection (one dimensional)	Line detection (one dimensional)	Area detection (two dimensional)	Three dimensional
Distance between sensor installations	– 300 m	– 50 m	– 100 m	10 m × 10 m	5 – 100 m
Weather durability	Strong in rain and fog; not so strong in wind, snow, or temperature	Strong in rain and fog; not so strong in wind, snow, or temperature	Strong in wind; weak in rain and fog	Relatively strong in wind, rain, snow, and fog	Strong in rain, snow, and fog; weak in wind
Susceptibility to breaking	Easily broken but detection still possible	If on inside of wall, difficult to break	If on inside of wall, difficult to break	Prone to breaking because located in low position	If on inside of wall, difficult to break
Maintenance	Inspect for physical damage	Inspect for physical damage	Regular cleaning of protective glass	Protective glass, etc., requires regular cleaning	Regular inspections only
Links to cameras	Possible if intervals are short; zoom in also possible	Possible if intervals are short; zoom in also possible	Linking is possible but setting specific positions is not	Linking is possible but setting specific positions is not	Linking is possible but setting specific positions is not
Most appropriate location	Near top of wall	Near top of wall	Inside of wall	Any place inside facility perimeter	Inside facility perimeter but as far from walls as feasible

facilities, particularly on technology and equipment that Hitachi has developed (see Fig. 1). The figure shows the system configuration for important facilities. That includes devices applying technology related to analysis equipment for detecting drugs and dangerous objects, and equipment such as that used in fingerprint verification systems that has been available in the past plus finger-vein authentication system using technology developed for personal authentication. Also introduced is RFID (radio frequency identification) technology for an access control system and X-ray technology for viewing the content of large-size shipping containers.

NEEDS OF KEY FACILITIES FOR SECURITY SYSTEMS

Some key facilities in Japan have had security systems with sophisticated levels of security for years. In many countries the security level at key facilities, centered on the U.S., has been raised recent years. Even facilities that formerly did not use security systems are now planning to install them.

Next, let us describe a security system commonly used in Japan.

OUTLINE OF SECURITY SYSTEM

This is an access-egress control system that

TABLE 2. Comparison of Surveillance Cameras
This table compares selected surveillance cameras. Cameras should be chosen according to their use environment.

		Single-pole rotation, solid-body type camera	Tri-pole rotation solid-body type camera (high magnification rate)	Tri-pole rotation solid-body type camera	day-and night-vision single panel solid-body type camera
Exterior view of camera					
Camera type		Visible light color	Visible light camera	Visible light camera	Near infrared rays, and visible light color
CCD element		1/3" CCD	1/2" CCD × 3	1/2" CCD × 3	1/2" CCD
Resolution		480 TV lines	850 TV lines	800 TV lines	480 TV lines
Visible light sensitivity	Ordinary	1.5 lx	0.009 lx	0.009 lx	0.3 lx (Visible light color)
	Recording	0.02 lx	0.00007 lx	0.00007 lx	0.02 lx (Near infrared rays)
Lens		Zoom lens 16 times 4.5 – 72 mm	33 times 11 – 363 mm	17 times 7 – 119 mm	18 times 8.6 – 154mm
Camera stand		Electric high-speed rotation camera stand Automatic high-speed rotation, horizontal maximum 180°/s	Electric high-speed rotation camera stand Automatic high-speed rotation, horizontal maximum 49°/s	Electric high-speed rotation camera stand Automatic high-speed rotation, horizontal maximum 90°/s	Electric high-speed rotation camera stand Automatic high-speed rotation, horizontal maximum 45°/s
Lighting		Built-in option	Fitted to outside option	Fitted to outside option	Near infrared ray lighting
Mass		13.5 kg	About 70 kg	About 20 kg	About 20 kg
Features		Tracking through high-speed rotation	Fitting for night surveillance	Fitting for night surveillance	Near infrared rays give it high concealment
Aim of installation		Limited to night surveillance of preset area	For wide-area night surveillance	For wide-area night surveillance	For night surveillance of concealment

includes a surveillance system for preventing unauthorized access to specific facilities from outside and a system for checking the credentials of persons entering the facility via authorized gates. A third system oversees and integrates the first two systems.

The unauthorized access surveillance system has detector sensors located near the fence or other barrier that marks the perimeter of the facility's property, as well as surveillance cameras for viewing the areas the sensors cover.

The access-egress control system has equipment installed at the gates or doors where visitors are authorized to enter or leave the facility. It includes ID card readers for confirming the information on ID cards concerning the credentials of persons entering the facility.

The control room is fitted with television monitors for monitoring the various systems, computers for displaying various information, and a control console containing the various operation buttons and switches.

TABLE 3. Comparison of Selected Cards
This chart compares selected types of cards. In the future, the use of smart cards is expected to be mainstream, because of their data security capabilities.

	Prevention of counterfeiting	Data volume	Cost
Bar code	×	×	◎
Electromagnetic cards	△	△	◎
IC cards	◎	◎	△

◎ : good △ : not so good × : bad

Unauthorized Access Surveillance System

The unauthorized access surveillance system uses various kinds of sensors for surveillance of unauthorized access. It is necessary to select the most appropriate sensors depending on the surrounding environment, the prevailing weather of the particular location, and other factors. Table 1 provides a

TABLE 4. Comparison of Personal Authentication Equipment
This table compares selected personal authentication devices. Hitachi has developed an easy-to-use device that is also difficult to trick with counterfeits.

Confirmation of organism	Size of device	Weight of features of object being examined	Areas of application	Future tasks
 Fingerprint minutia	Per square centimeter	Points per feature	Access/egress control	Access control, wet skin, dry skin
 Hand geometry	Per every 10 square centimeters	Size of palm, length, proportion	Access/egress control	Miniaturization of device
 Iris	50 × 20 × 20 cm	Pattern of iris	Access/egress control	Miniaturization of device
 Face	About 3 × 3 × 10 cm (camera)	Shape of face, location of eyes and nose	Access/egress control	Lighting, shooting angle, interference of background
 Voice	About 30 mm × 15 ϕ (microphone)	Voice wavelength, speed of sound generation, for visitor access/egress/leaving early control	Access/egress control	Susceptibility to health condition
 Signature lines	Square centimeter (tablet)	Order of lines, writing speed, and shape of letters for access control	Access control	Countermeasures for forged signatures
 Finger vein	Per square centimeter	Shape of vein	Access/egress control	Susceptibility to health condition

comparison of unauthorized access sensors. Even among sensors based on the same principle, there is a need to consider adding to them a sensor check function, or a detector function to prevent tampering.

Various types of surveillance cameras are available, as seen in the comparison in Table 2. Cameras should be selected and used depending on the lighting conditions at their locations as well as the objects they are monitoring. It is also necessary to design the cameras appropriately, such as selecting the camera cases and the platforms to which they will be fitted.

It is important to check the related surveillance camera as soon as feasible after a sensor unit transmits a signal. Among the various methods of doing so Hitachi uses a network based on autonomous distributing for ensuring fast transfer of signals. Utilizing frame memory, meanwhile, a method is used for memorizing still images when a sensor transmits signals.

A wide spectrum of reasons can be input for causing the sensors to transmit signals. For confirming that the sensors are working properly, moreover, a system is used that checks each sensor at least once a day. All such data are stored as log files and can be accessed at any time.

Access/egress Control Systems

Access/egress control systems fit into either of two general categories: card systems, and gate systems.

Table 3 shows a representative type of card system. Magnetic cards were mostly used at first in these control systems but IC cards, with their large capacity and high level of security for stored data, can be expected to become the mainstream products in the future. For methods such as those using disposable cards, many types of two-dimensional disposable bar-code cards are available and can be expected to be used. As introduced in another article of this issue, there is new type of a card used as an access control system that combines RFID (radio-frequency identification) and infrared raditation.

Next, let us discuss access/egress control gates. These gates are particularly effective when the number of authorized persons entering/leaving a facility increases above a certain level, thus making manual control difficult. There are various types of gates. Those providing the highest level of security use extra-strength doors, while the simplest gates are like the passenger wickets at train stations. The most important point concerning gates is that their functions differ widely depending on whether they are manned or not. If a gate is unmanned, the card used will have to include

Fig. 2—Access/egress Control Gate.
These gates are integrated with a function to detect tags on products to prevent shoplifting.

a function for authorizing passage of each person, and the gate will have to be designed so that it cannot be easily bypassed, such as by climbing over it.

Fig. 2 shows an acess/egress control gate with a function for checking the carrying out of valuables. In the future, the system is expected to be utilized for goods control using RFID.

For the purpose of identifying the persons passing through an unmanned gate, personal authentication devices can be used.

Table 4 compares selected personal authentication devices. Hitachi has developed an easy-to-use device that is also difficult-to-trick with counterfeits. It enhances live finger recognition, for example, by using finger vein authentication.

Hitachi decided to develop a device that enhances live finger recognition by using finger-vein authentication because it provides a low error rate and meets with little resistance from users. The use of this device is expected to expand in the future.

Personal authentication devices will become more familiar to a wider audience as they are gradually used more often in financial institutions and for purposes such as verifying passports.

An important point in access/egress control systems is the ability to know at all times where persons are inside a facility after having been granted access. Knowing the location of persons inside a facility:
(1) prevents double usage of their cards, and
(2) allows a quick search and pinpointing of each person's whereabouts if an emergency situation develops.

In order to know the whereabouts of all persons inside a facility at all times, the central system utilizes an autonomous distributed management system for high-speed processing.

Control Room

The control room includes television monitors for confirming images sent from the unauthorized entry surveillance system cameras. Each person in the control room should be in charge of no more than 3–4 television monitors, and the monitors should always display images from the surveillance cameras in predetermined cycles. When a sensor transmits a signal, the system automatically switches to the images being sent from the related surveillance cameras.

In the most up-to-date systems, frame memory is used for constantly memorizing images from each of the cameras cyclically. When a sensor transmits a signal, the constant cyclic monitoring is stopped, the image on the related monitor at the time the sensor signal was sent is confirmed, and the cause of the signal is correctly determined.

Related to the access/egress control system, the console in the control room is fitted with buttons for operating each gate and has monitors connected to surveillance cameras that monitor the gates and their surrounding areas. It is especially important to establish a method for confirming whether or not an ID card belongs to a specific person when an error is generated at a control gate related to confirmation of a person's access qualifications.

SYSTEMS IN FUTURE

Devices for Detecting Dangerous Objects

Key facilities are expected to increase their level of security in the future, and they might add explosives and chemicals among the hypothetical threats. For those reasons, it will become more important in future systems to include devices for detecting dangerous objects.

Ideally, bulk-type X-ray devices and trace-type devices for detecting dangerous objects should both be utilized. Hitachi is developing products in both categories, and in the future will provide solutions that integrate new products into security systems used up to now. The bulk-type X-ray devices and trace-type devices are introduced in another article of this issue.

X-ray Equipment for Use in Inspecting Motor Vehicles

As a product for more effective inspection of motor vehicles that enter the precincts of key facilities,

Hitachi is currently developing X-ray equipment for viewing an entire vehicle at one time.

Other Equipment

Other equipment that might be mentioned is an image-processing sensor included in the group of sensors for surveillance of unauthorized entry.

When image-processing sensors are used outdoors, special care should be taken in choosing the installation location in areas where it frequently snows or is foggy. Such installations are not easy but when successful the sensors are quite effective.

Also, as the use of electronic passports and electronic driving licenses becomes more widespread, the use of personal authentication systems is also expected to increase. Hitachi is therefore continuing its development of such systems.

CONCLUSIONS

As described above, Hitachi has developed a variety of security systems including bulk-type X-ray using new technology and trace-type devices for detecting dangerous objects. Moreover, in the field of access/egress control, we have developed an access-control system that utilizes RFID and infrared radiation and a finger-vein authentication system making Hitachi one of the new manufactureres that can provide a total physical security system.

It was said in the past that systems and their equipment became more difficult to use when the level of security was increased. For its part, Hitachi will continue to develop systems and equipment that will be easy to use even as the level of security is increased.