Featured Articles

Traceable Physical Security Systems for a Safe and Secure Society

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OVERVIEW: In an era of terrorism and serious criminal activity, a strong reliance is being placed on security systems that keep society safe and secure. This in turn requires ways of determining the security of people and property, and the ability to extract relevant information from accumulated data quickly. In response, Hitachi has been studying the functions required to combine high security with convenience, two objectives with conflicting characteristics, at major public facilities where these systems are likely to be installed. The concept of "traceable physical security" is used to ensure people's safety. Hitachi has also built a "multi-perspective search" system that can search collected image data using a variety of different attributes as keys.

INTRODUCTION

WHILE the number of victims of terrorist incidents has been declining over time, the proportion of fatalities has been increasing steadily since 2009, reaching about 30% in 2011. This is because the increasing severity of individual attacks has resulted in more severe consequences. As a result, there is strong demand for enhancing security systems to prevent this.

In many cases, surveillance cameras are used as the primary means of physical security. In 2008, Hitachi announced a large surveillance system that can connect numerous surveillance cameras together via a network and manage them centrally, and that can also perform high-speed searches of large amounts of collected image data[1].

Hitachi also introduced finger vein identification in 2003 to provide a new mode of biometric authentication. The technology is widely used in a diverse range of applications, including access control, personal computer (PC) login, and banking systems.

Hitachi has also been working on the research and development of explosives detection systems that use mass spectrometry, including verifying their robustness in demonstration projects and building up a track record of practical use. The use of this technology in a hand luggage inspection system for airports was announced in September 2013[2].

At public facilities, physical security is utilized to ensure the safety of people and property and, where possible, to prevent criminal activity before it happens. However, combining a high level of security with convenience is problematic. Because the cumbersome procedures associated with strengthening security measures tend to detract from convenience, it is difficult to apply such measures more widely. This means it is necessary to find invisible means of authentication that the public will not find intrusive, and to improve convenience for the people who are not deemed to pose a threat. This article uses the term "unconscious authentication" to refer to methods for authenticating users without their being aware of the process (but who have given their prior consent for this to occur).

Meanwhile, when an incident does happen, there is a need for the rapid extraction of footage that might help resolve the incident from collected surveillance camera video data. Because eyewitness and other information is fragmentary by nature, there is a recognized need for video surveillance systems that can perform rapid searches based on numerous different attributes.

This article describes traceable physical security systems for a safe and secure society, and multi-perspective search.

TRACEABLE PHYSICAL SECURITY

Measures such as biometric authentication and hand luggage inspection are used to ensure the security of people and property at public facilities. However, these measures can be inconvenient if they require checks or

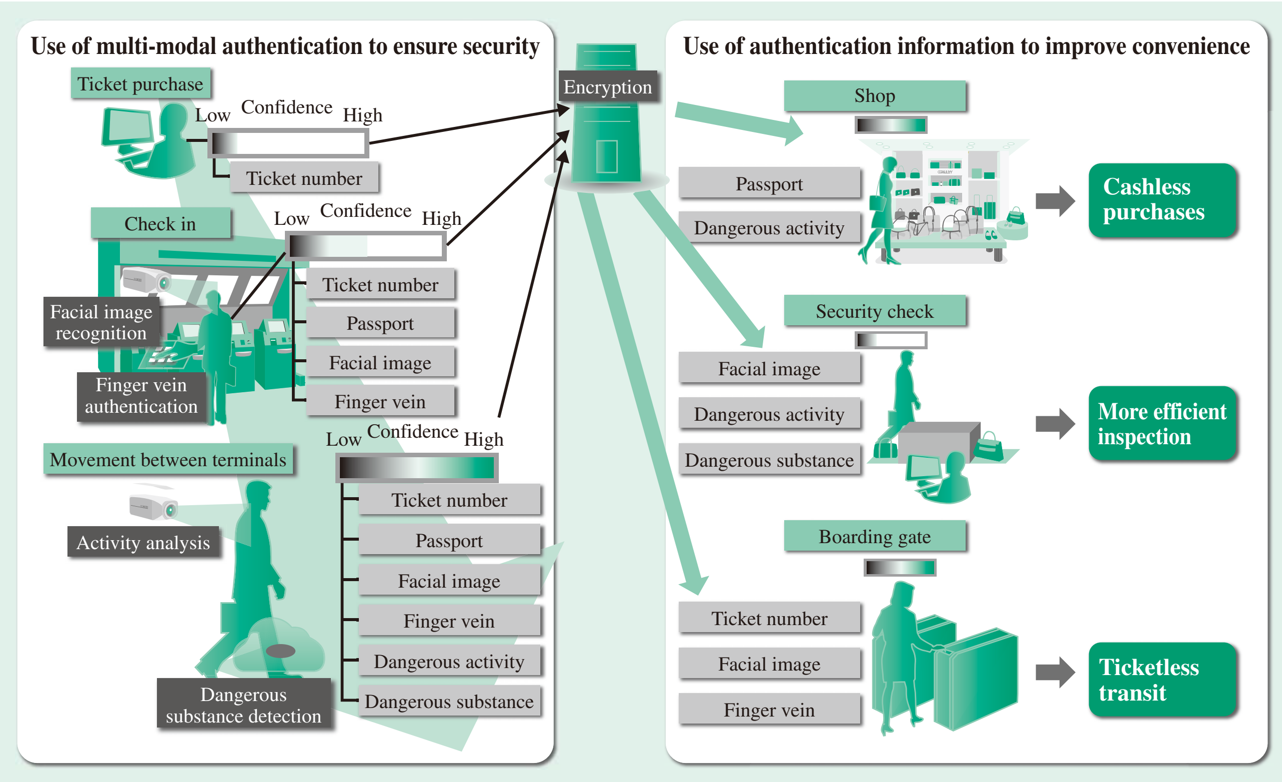

Fig. 1—Concept of Traceable Physical Security.
The requirement is to combine use of multi-modal authentication for security with the use of the authentication information to improve convenience.

other actions that interrupt the flow of people, causing queues to form. Accordingly, the ideal solution is to use unconscious authentication techniques for visitor screening. If it is possible to use a number of different modes of authentication or inspection, and to modify the level of security applicable to individuals as needed, convenience can be enhanced by expediting services for members of the public who pose no threat. This concept is called “traceable physical security,” and is summarized in Fig. 1. The implementation of traceable physical security involves a combination of touch panel finger vein authentication and facial image recognition for biometric authentication, together with explosives detection systems capable of sampling from multiple points for hand luggage inspection and the use of surveillance cameras for hand luggage tracking.

Biometric Authentication

A variety of biometric authentication techniques exist based on different biological attributes, with facial recognition being the most commonly used mode for unconscious authentication. In practice, however, the accuracy of facial image recognition remains inadequate for use as a single-mode unconscious authentication technique. Accordingly, an alternative option is to achieve the level of accuracy required in practice by using it to identify individuals in combination with an authentication mode such as finger vein recognition that has proven its accuracy in practical use.

However, finger vein recognition cannot currently be described as an unconscious authentication technique because it requires the user to place their finger in or on a scanner. In response, Hitachi has looked at the possibility of reading a user’s finger vein pattern without their being aware of the process by doing it as part of some other activity. The device shown in Fig. 2 generates infrared light to read a person’s finger vein pattern while they use a touch panel of the sort that might be found on an automated teller machine (ATM), ticket dispenser, or check-in kiosk. The device consists of a projector and camera contained inside a housing. The display image is projected onto frosted glass, and the built-in camera is used to detect where on this image the user touches their fingertip to the glass. By identifying where the user touches the glass, the system acts as a touch screen input device. The user’s finger vein pattern is read by the built-in camera by shining infrared light onto their finger from an above-mounted light-emitting diode (LED) when they touch the glass.

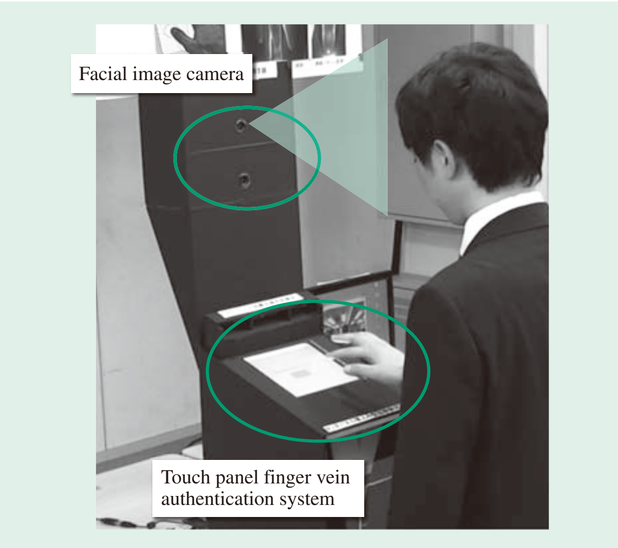

Fig. 2—Touch Panel Finger Vein Authentication System.
Finger vein authentication is performed while the user operates a touch panel, during which time a facial image is also captured.

As the user is unaware of this happening, the system can perform unconscious authentication while they use the touch panel.

Once finger vein recognition has completed, an image of the user's face is captured by a camera mounted at the top of the housing, and the facial image linked to the user's identity. This allows people within the surveillance area to be identified with a high level of accuracy, with the facial image captured when the person entered the facility used as a template. Because recognition is performed on a recently acquired facial image, this also has the advantage of minimizing the impact of factors such as aging or cosmetics. This facial image recognition technique has already been used in applications that include simple gate management and signage.

Explosives Detection System with Multi-point Sampling

This system uses the principle of mass spectrometry to detect substances such as ingredients contained in explosives adhering to people or property. Hitachi has previously developed gateway-style detection systems. However, these are unable to detect suspicious substances in open spaces. The new system, in contrast, sequentially draws air samples into the mass spectrometer from a number of pipes installed around the area being monitored to identify the location of suspicious substances. Unfortunately, a drawback with this approach is that the time taken to sample all pipes one after the other makes it difficult to detect substances quickly. To overcome this, the samples are taken from a number of pipes at the same time, using a different combination of pipes each time. The resulting mass spectrometry signal is then subject to a signal processing technique called "compression sensing." This technique can identify the location of a dangerous substance from a short-duration signal and thereby achieve rapid detection of substances in the area being monitored without requiring a large number of expensive mass spectrometers.

Hand Luggage Tracking

To ensure safety, there is a need to identify the route taken through the facility by each item of hand luggage and the people who handle it. Accordingly, Hitachi has studied an approach to ensuring safety based on the results of hand luggage tracking using this system.

At important facilities, it is common to require the inspection of hand luggage when someone enters a restricted area. This involves placing the item on a belt conveyor and checking it using an X-ray machine, explosives detection system, or other sensors. By installing a camera on top of this inspection system to photograph the luggage, it is possible to obtain comparatively reliable images of the item being checked. These luggage images can then be used as a basis for presenting a visual representation of the route traveled by the item up to this point. The surveillance cameras installed at the facility are used to perform continuous detection of movements by people or hand luggage, and this information can be used to register the image data for objects that resemble hand luggage in a similar image search engine. This search engine is then used to perform a search based on the color characteristics of the hand luggage image captured at the luggage inspection system to identify matching image sections that are then used to recreate the route taken by that particular item. The safety of the luggage can then be assessed by comparing this route with the results from the explosives detection system with multi-point sampling described above. The image data from the route taken by the luggage can also be used to check for suspicious actions such as the luggage being handed from one person to another.

Integrated Viewer

The results from the authentication, detection, and recognition systems described above are collated in an information system and displayed in turn on an integrated viewer (see Fig. 3). The viewer can display a map overlaid with the locations of people as they

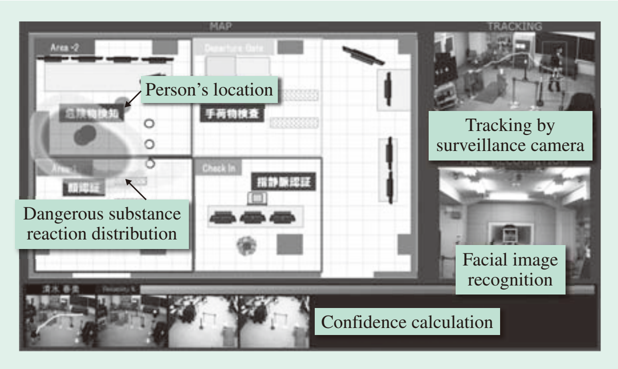

Fig. 3—Integrated Viewer.
The viewer displays the location of people at a facility, estimated distribution of dangerous substances, surveillance camera video, and facial image recognition.

Fig. 4—Authentication Viewer.
The screen displays authentication results from each area in turn.

are tracked though each area of the facility, and with the estimated distribution obtained by explosives detection. It can also be used to view video from surveillance cameras. The authentication viewer shown in Fig. 4, meanwhile, can display the results of authentication for a visitor at each area within the facility. It can also show the authentication mode used to identify them in each case, the attribute information obtained, and a confidence estimate based on these authentication results. In this way, the system provides centrally managed information on who is present at the facility, their current location, and confidence estimate (degree of suspicion).

MULTI-PERSPECTIVE SEARCH

Information needs to be assessed rapidly when an incident occurs in order to minimize damage and prevent any further criminal activity. This requires an ability to quickly retrieve the necessary information from the large amounts of image data collected by surveillance cameras. There was also a recognized need for general-purpose search functions able to utilize fragmentary and diverse information from witness reports as search keys. In response, Hitachi has developed a technique for searching collected video based on attributes such as a person's clothing or movements. This is called "multi-perspective search." Fig. 5 shows an example screen.

In addition to comparing facial images, the multi-perspective search also considers the color of the head, mouth, upper body, lower body, and hand luggage, and the route traveled. For example, it is possible to search for a person wearing a blue shirt and black trousers and carrying a green bag on their back, and who passed through a corridor. This works by tracking a person in the collected image data and using the results to register the characteristics of each partial image in the search engine. The colors of each part are then specified to the search engine as keys so that it can search for images that contain the matching colors. The route traveled by the person (obtained by the tracking function) is also registered in the search engine and linked to the corresponding images. When the operator requests a search using a particular route as a key, the search engine returns video for the similar route. This makes it possible to conduct an investigation using a variety of information provided by witnesses by combining these search results.

Fig. 5—User Screen for Multi-perspective Search.
The screen displays the result of a search performed using attributes of the upper body, lower body, luggage, and route traveled as keys.

CONCLUSIONS

This article has described traceable physical security systems for a safe and secure society, and multi-perspective search.

The use of more sophisticated physical security systems is seen as having potential for helping prevent terrorism and serious criminal activity. To meet this demand, Hitachi has implemented traceable physical security systems that combine unconscious authentication, detection systems, and other components, and also multi-perspective search, which can perform a diverse variety of searches on collected video. Hitachi intends to continue trialing these prototypes with a view to their commercialization. Among the challenges facing security systems are those of privacy and information leaks. In the future, Hitachi also plans to incorporate information protection technologies and to formulate strict operational rules to ensure that these problems do not arise in actual operation.

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