Advanced Access Control System with Face Recognition Technology

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Abstract

An entrance control system with face recognition was adopted at the Olympic and Paralympic Games Tokyo 2020 for the stringent verification of visitors' identity at the entrances of all competition venues, the Athletes' Village, the Media Press Centre, and the International Broadcast Centre. More than 700,000 persons were registered, and more than 4 million checks were performed during the Games, with an authentication rate of more than 99.8%.

Keywords : Face recognition, Access control, Facial feature

1. Introduction

In previous conventions, the identity of the participants was verified by visual inspection of photographs of their faces printed on accreditation cards (Terminology) at the entrance for the authorized personnel of each venue and the admission authorization was verified by visual inspection of symbols indicating the admission area, barcodes, and IC tags. This method may overlook unauthorized entry due to identity theft, tampering with tickets, etc. Therefore, the Advanced Access Control System (AACS), which simultaneously verifies identity using a face recognition system and admission authority using IC tags, was introduced at the Olympic and Paralympic Games Tokyo 2020.

This system uses an IC chip embedded in the accreditation card to ensure the authenticity of the card, and facial information linked to the ID stored in the card to verify the owner's identity, thereby realizing stringent security.

This is the first time in the history of the Olympic and Paralympic Games that face recognition technology has been used to verify the identity of each authorized personnel.

Atos was in charge of the total coordination and the authorization check function on mobile devices. Panasonic developed the entrance authorization check function linked to the dedicated face recognition devices, the video camera and IC card reader in the devices and NEC was responsible for the face recognition devices and the face recognition function on the server.

2. Face Recognition Technology

In this section, we will introduce the face recognition technology used in AACS.

2.1 Overview

Face recognition technology compares the face information registered in advance with that of a person facing the device to determine whether the face is that of the registered person. NEC's face recognition system (product name : NeoFace) used in the Games uses proprietary technology to perform the matching using data called facial features, which is digitized facial

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characteristics.

Face recognition is a standard authentication method that people use in everyday life to identify others and a natural authentication method that does not impose a psychological burden on the user. In addition, face recognition is a technology that has been used in various situations in recent years because it uses general-purpose products such as video cameras [(1)], while other biometric methods such as fingerprint, vein, and iris recognition require a dedicated scanning device to collect information.

2.2 Face Detection～Feature Point Extraction

The part of an image containing what appears to be a human face is detected and cropped (face detection). Thereafter, feature points to identify that individual are extracted (feature point extraction) and digitized (Figure 1).

2.3 Face Recognition

Face recognition compares features registered in the database with those for matching and outputs a score of 0 to 1 for the similarity degree. In general, there are two types of biometric authentication : 1 : 1 authentication, in which a specific person in the database is matched with an ID card, and 1 : N authentication, in which the matching features, and not an ID card, are used to check whether a person exists in the database. In the Games, 1 : 1 authentication was adopted for more rigorous identification without making significant changes to previous operations.

Figure 1 Face Detection～Feature Point Extraction

Terminology

Accreditation Card An identification card issued by IOC or IPC to authorized persons, which works as an entrance pass to the staff area. Identity number, photo, name and the areas allowed access to are printed, and an IC chip is embedded to prevent forgery.

Intelligent Auto Function An intelligent and automated function used to tune the parameters of the Panasonic camera to meet the various lighting conditions.

VAO, Venue Accreditation Office The office established at each venue to reissue accreditation cards and reregister facial features.

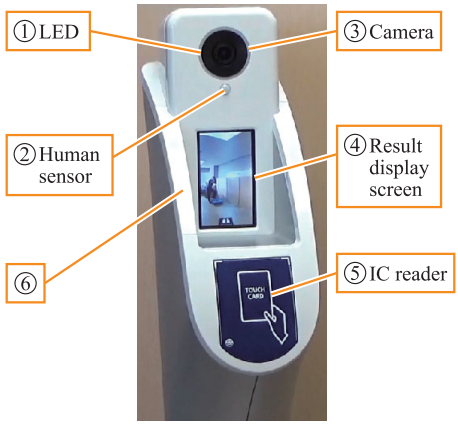
3. Features of the Dedicated Face Recognition System

3.1 Configuration

Figure 2 shows an overview of the exterior and an enlarged view of the console of the face recognition device.

① is an LED light that turns on when a person approaches to attract the subject's attention and make them face the camera. ② is a motion sensor that turns on the LED light in (1) when it detects a person. ③ is a Panasonic camera with an intelligent auto function [(Terminology)] that captures high-quality face images even in various shooting environments, such as back-

(a) Overview of the exterior



(b) Enlarged view of the console

Figure 2 Overview of the Exterior and an Enlarged View of the Console of the Face Recognition Device (©NEC Corporation)

light and nighttime. ④ is the result display screen. Before the ticket is held up, a mirror image is projected to encourage the subject to face the camera. After the ticket is held up, the authentication result is displayed. ⑤ is where the accreditation card is touched and it has a built-in IC Card Reader. The LEDs ⑥ on both sides of the screen are embedded with three-color lights so that the security staff standing behind the device can easily see the authentication results.

3.2 Universal Design

Athletes taller than two meters participate in the Olympic Games, and athletes in wheelchairs were present at the Paralympic Games. In order to capture high-quality facial images of both athletes with the same device, the height and elevation angle of the camera were calculated. Because wheelchair users are often accompanied by their caregivers, the images were captured to recognize two people with faces at different heights consecutively. The lower part of the device is designed to be narrow so that a wheelchair can easily pass through.

The authentication result screen (result display) for visitors is also designed to be easily recognized by visitors from all over the world, as shown in Figure 3.

Figure 3(a) shows the screen displayed when a visitor is asked to enter the venue after both face recognition and entrance authorization have been verified successfully. Figure 3(b) is the screen displayed when face recognition fails, and the user is asked to touch their card and face the camera again. Figure 3(c) is the screen displayed when an alternative way is required to verify the visitor's identity for reasons such as when face recognition fails three times consecutively, using up all the attempts.

3.3 Security Measures

The device is prevented from tipping due to earthquakes or human collisions by using a steel base plate with a 50 cm radius and setting the centre of gravity at the bottom to achieve a tipping angle of 27.0° to 27.9° from left to right and 26.9° to 27.7° from front to back. These values are sufficient to withstand an earthquake intensity of upper 5.

The device is secured with screws that can only be opened with a special driver to prevent theft from inside, and the SSD of the device is encrypted so that it can be read only by the device's motherboard. The facial features are deleted from the device when a match is found or four seconds have elapsed. Even if the facial features are leaked, they cannot be decrypted by other devices. In this way, multiple layers of physical, hardware, and software security measures have been implemented.

4. Statistical Information

4.1 Number of Registrants

The number of registrants for accreditation was 420,000 for the Olympic Games and 310,000 for the Paralympic Games, an increase from 280,000 for the London 2012 Games and 230,000 for the Rio 2016 Games.

4.2 Authentication Rate

The flow of the face authentication portion, excluding the authority check portion, is shown in Figure 4. The person is allowed to enter if the matching score exceeds the threshold in three attempts. If the face recognition

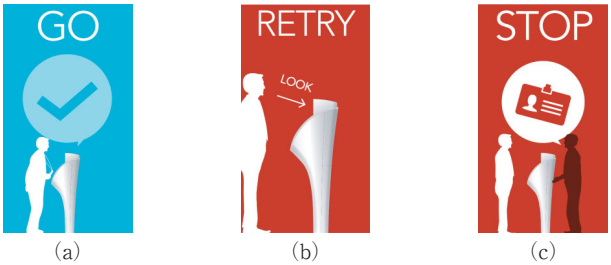


Figure 3 Authentication Result Screen (©NEC Corporation)

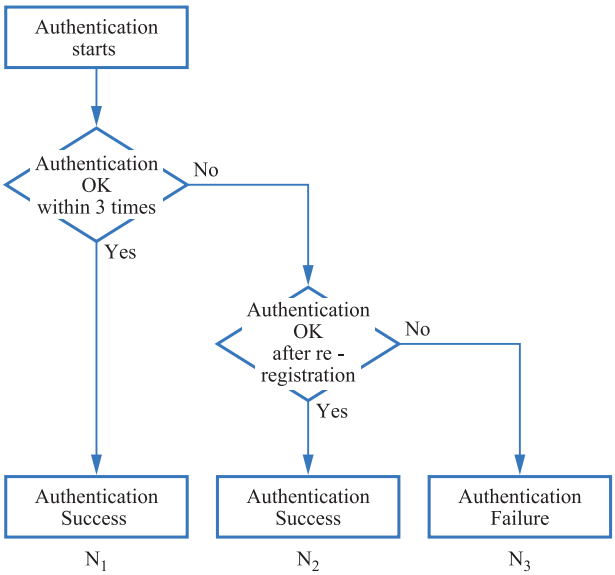


Figure 4 Flow of Face Authentication

Table 1　Authentication Rate of Face Recognition

	Olympic Games	Paralympic Games
N_1	2,729,680	1,058,260
N_2	80,575	22,799
N_3	4,734	2,025
Total	2,814,989	1,083,084
Authentication rate *	99.83%	99.81%

* The authentication rate is defined as $(N_1+N_2)/(N_1+N_2+N_3)$.
Period
Olympic Games　July 21 to August 8, 2021
Paralympic Games　August 25 to September 5, 2021

fails three times consecutively, it is considered that the poor quality of the registered image is the reason, and she or he is requested to go to VAO (Venue Accreditation Office) (Terminology) for more careful identity verification with other documents such as the passport and register the facial features to the server again. The person is allowed to enter if the face recognition succeeds after registering the facial features again (N_2). If the person is not recognized as an authorized person, she or he is not allowed to enter, and it is counted as a recognition failure (N_3).

Table 1 shows the number of cases for the Olympic and Paralympic, respectively.

The statistics show no significant difference between the Olympic and Paralympics, and both have achieved an authentication rate of more than 99.8%. It should be noted that N_3 does not indicate the actual performance of face recognition since it includes cases where a person other than the registered person, such as a vendor, came to the venue and was refused entry.

Although it is difficult to compare the results with those of past Games, which used visual identification, there were almost no queues at the Tokyo Games, which was observed at the entrances for visitors to past Games, suggesting that this system contributed to strict identity verification and improved the throughput.

4.3　Failure Rate

During the preparation period before the Olympic Games, there was a malfunction due to an overcurrent in the network equipment caused by a lightning strike, but no hardware or software failures or malfunctions were reported from the servers in the data centre and the face recognition devices installed at the venues during the Olympic and Paralympic Games.

5. Conclusion

Since the beginning of the proposal in 2016, we received strict reviews from the IOC, the Tokyo Metropolitan Government, and the Tokyo 2020 Organising Committee, and have achieved a high authentication rate and zero failures due to careful tuning of parameters and operational design through demonstration experiments and test events. We want to once again express our gratitude to the Security Bureau of the Organising Committee for their efforts.

References

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