# Identity Confirmation to Issue Tickets using Face Recognition

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***Abstract***: This paper proposes a system of identity confirmation to issue tickets using face recognition software. This has been socially required to prevent illegal resale, such as ticket scalping. Because illegal resale is a critical problem for popular events in Japan, strict steps are followed for identifying people holding tickets at event venues by visual inspection with ID cards. The task is time-consuming for venue attendants. It is also stressful because ticket holders feel uncomfortable when they are kept waiting. The key points in identification are to verify identities efficiently and to prevent people from impersonating others. The system enables verifying the identity of the purchaser and holder of a ticket by using face recognition software. It was proven effective for preventing illegal resale by confirming 50,324 attendees at a large concert of a popular music group. The average accuracy of face recognition was 90%. The average time for identity confirmation was 7 seconds per person, including guidance to ticket holders. Identity confirmation time was decreased by 30% using visual inspection, and the psychological workload of venue attendants was reduced. Survey results obtained for the attendees showed that 94.6% of them felt it provided more equity in ticket purchasing than methods used before, 83% felt it provided added convenience in identification, and 93.8% felt it would effectively prevent illegal resale.

***Keywords***: Face Recognition, Biometrics, Identity Confirmation, Illegal Ticket Resale Prevention

## 1. Introduction

In today's modern society, where individuals are free to change residences and communicate with others, the communities and organizations to which individuals belong are becoming increasingly complex and diverse. This is happening concurrently with the development of transportation facilities and the spread of the Internet. In a so-called "Gemeinschaft" community, where territories and kinships were linked through friendship, it was not uncommon for all the community members to know each other. But in many of modern society's communities and organizations, the members are not necessarily acquainted with each other. In social life, when individuals exercise the rights they are given or carry out the obligations imposed on them, the actions are assumed to be performed by the people themselves. In many cases, this is verified through the use of such means as ID cards. To legally verify a person's identity requires verifying two points: "The person actually exists (in reality)" and "The person is the one he/she claims to be (identity)"[1]. The foundation of reality is the family register. Daily life has limited situations where "reality" has to be strictly confirmed, but many situations involve having to confirm one's "identity". In modern society, a great many people have their identity confirmed many times in various ways, such as by having their employee ID cards checked when they enter the workplace, by using IT devices in the workplace, and by using personal IT devices while taking advantage of the various IT services associated with them. This personal authentication confirmation is called "identity" and is often used in the same sense as identification. Personal authentication can be divided into three methods: (1) knowledge certification using information only the person in question knows, such as a password or personal identification number, (2) possession certification, i.e., possessions such as an ID card or driver's license, and (3) biometric authentication by confirming a person's fingerprints face, etc. In addition to physical features such as the face and fingerprints, biometric authentication involves authenticating through behavioral characteristics such as voice prints and handwriting. Although knowledge certification and possession certification are already widely used in social life, problems are associated with both. Knowledge certification entails a risk of forgetting one's password or having it become known to others, and possession certification entails a risk of possessions being lost or stolen. Some people also have difficulty in using knowledge certification or possession certification. Many anticipate that biometric authentication can be a means of solving these problems [2][3]. One advantage of biometric authentication is the risk of biological information being lost or forgotten is circumvented, but problems such as authentication accuracy may occur depending on how the information is used. All three authentication methods have advantages and disadvantages in terms of accuracy, cost, and efficiency, so the most appropriate method needs to be used in accordance with the identity confirmation purposes. In some cases, such as the use of bank cash cards, security can be enhanced by combining knowledge certification and possession certification [4].

When one personally receives a service, such as when using bank terminals and e-commerce, practical authentication can be achieved through knowledge certification and possession certification or a combination of the two. However, let us take an example of a case when a great many people are admitted to participate in an event. In such cases, having a possession such as a ticket or an attendance certificate checked used to be

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enough to gain entry; the need for personal authentication was not seriously considered due to the limited amount of time for admitting all the participants. Many events with high ticket prices had designated seating, so assuming that some tickets may have been counterfeit was not necessary. However, the advent of net auctions in recent years has made it easier to buy and sell tickets at the individual level. This has resulted in an increase in illegal ticket scalping, i.e., tickets being purchased for resale purposes [5][6]. Consequently, event organizers have had to deal with complaints about the risk of malicious acts by undesignated people who take advantage of fans by buying and selling tickets on the Internet. Thus, in many cases, any ticket buying and selling outside of normal sales channels is prohibited. Ticket sales terms now often stipulate that tickets are invalid when people apply for them using a pseudonym or false name and/or false address, or when they have been resold on an Internet auction or a by scalper with profit as the aim. Illegally resold tickets have in fact been invalidated at amusement parks [7] and concert halls [8]. Therefore, identification has become a more important social issue than ever before.

This paper proposes an identity confirmation system using face recognition software to prevent illegal resale. When a ticket is purchased, the system matches a photo of the purchaser's face with the face of the person being admitted to the event to verify that the people are the same. First, we describe the current circumstances and problems involved in identifying ticket purchasers. Then, we present our identity confirmation system and its identification procedure. Next, we report results that demonstrate the system's validity for large-scale events and its ability to identify people attending the events as well as survey results obtained for 241 attendees who were identified by the system in use when entering the events. Finally, we consider the outlook for future problems involved in identifying ticket purchasers.

## 2. Circumstances and problems in identifying ticketholders

The conventional procedure for identifying people holding tickets for popular events is shown in Fig. 1.

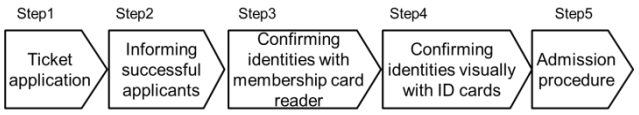


Figure 1 Current ticket identification procedure

Step 1: Tickets to popular events are often sold on a lottery basis at fan clubs or other organizations where membership is registered. People apply for tickets by using their registered member information. Applicants are advised that if they are selected they will, as a measure to prevent illegal resale, be asked to show identification upon entering the event venue to confirm that they actually purchased the ticket.

Step 2: Event organizers notify successful applicants that they have been selected. Because the resale risk is high, applicants may only be notified of their selection and not sent the tickets in advance.

Step 3: On the day of the event, venue attendants use a membership card reader or other means to verify that people entering the venue were successful applicants.

Step 4: Venue attendants ask to see ID cards to ensure visually that the person's face matches the one on the card. This is to guard against illegal resale and cards being lent or borrowed. Acceptable identification generally includes a driver's license with a photo, a passport, a student ID card, or a Basic Resident Register card. For minors or others who do not have identification with a photo, a resident card, insurance card, family register transcript, family register copy, or sealed registration certificate can be used instead.

Step 5: Venue attendants admit entry after confirming identification.

Thus, the identities of ticket purchasers are verified at event venues by authenticating two types of possessions: membership cards and ID cards. The key points in identification are to verify identities efficiently and to prevent people from impersonating others.

### 2.1 Preventing people from impersonating others

Photo-less ID cards make illegal resale and card lending/borrowing relatively easy and reduce the effectiveness of measures to prevent people from impersonating others. There are resellers who will offer ticket-and-resident-card sets or rent out ID cards at high prices. There are also ticket buying and selling sites on the Internet that make offers like "Ticket and photo-less ID card sets available for women in their 20s or 30s. Cards must be returned after the event." Furthermore, an ID with a photo is not necessarily genuine because photos can easily be color copied and superimposed. In fact, a number of sites on the Internet can create an ID card. Consequently, more effective ways to prevent people from impersonating others are required to prevent illegal resale.

### 2.2 Making verification more efficient

At events attended by many people, it is not uncommon for the people to stand in line to have their identities confirmed. Where this is the case, the aforementioned steps 3–5 need to be performed quickly and efficiently. However, taking thorough measures to prevent people from impersonating others inevitably takes time. Some people stow their identity cards in a shoulder bag, purse, or the like and are unable to access them immediately. Some people bring in a photo-less ID and insist that they are the person in question regardless of obvious differences in age and the like. In such cases, the attendant will need to spend considerable time in verifying the person's identity. In addition, when the waiting time becomes long, some people waiting might start feeling physically unwell or get frustrated at having to wait for so long and start verbally abusing the attendant. This makes the confirmation time longer and increases the mental and physical burden on the attendant. It may also make finishing the identification procedure quickly more important than accurately ascertaining identity. Therefore, the verification procedure must be made more efficient.

One way to achieve such efficiency is to increase the number

of experienced attendants who really know their job, but cost and space problems make this a somewhat unrealistic approach. Because the identification procedure affects many people, the success or failure of the event may hinge on it. Visually confirming the identity (Step 4) is the step that requires the most time and cost, so it must be made more efficient.

## 3. Identification system using face recognition software

Other than the currently used possession authentication, knowledge authentication and biometric authentication can be considered means to prevent people from impersonating others. Knowledge authentication is not effective if the people purchasing tickets and those entering the event match. Biometric authentication is better in this respect because it uses person-specific biological information, but it necessitates selecting an appropriate way to identify the ticket purchaser. For example, both the vein authentication procedure used in financial institutions [4] and the fingerprint authentication procedure used in national and local governments [9] require dedicated biometric information sensors, and having veins or fingerprints registered in advance and checked at event sites is not practical. However, with face authentication, the sensors can use ordinary cameras and achieve better consistency with current identification methods. Examples have been reported for this method, where good accuracy was obtained in a practical way for operation methods [10] and experiment demonstrations [11]. Therefore, to establish a procedure for identifying ticket holders, we have developed an identification system using face recognition software as a way to improve confirmation efficiency and to prevent people from impersonating others. As shown in Figure 2, it registers facial photos when tickets are applied for in Step 1, and it verifies identities by using face recognition software rather than confirming with ID cards in Step 4.

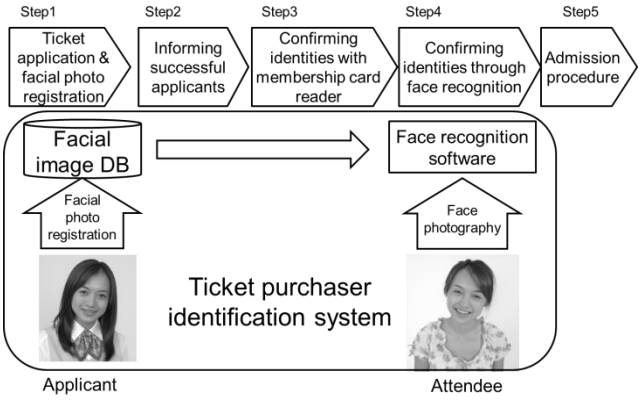


Figure 2 System's ticket identification procedure

Our system performs the following steps to identify ticket applicants and ticket holders.

Step 1: People applying for tickets register their membership information as well as their facial photo. At that time, they are advised of the privacy policy in effect regarding the handling of the photo and other personal information and the verification of their identity on the day of the event. In the same way as for an ordinary ID photo, the registered facial photo is a clearly visible frontal image taken against a plain background. The face must not be obstructed by a hat, sunglasses, mask, scarf, or the like, or by things like excessively long hair or a flashed peace sign.

Step 2: Successful applicants are notified in the usual manner.

Step 3: Successful applicant identities are confirmed by using a membership card reader in the usual manner.

Step 4: At the event, the attendant uses face recognition software to confirm that the photo taken at the time of application and the registered photo show the same person.

Step 5: The admission procedure is carried out in accordance with the face authentication results.

The face recognition software and the confirmation procedure the attendant follows at the site (Steps 3–5) are described in the following subsections.

### 3.1 Face recognition software

The face recognition software the system uses is the internationally reputable commercial product NeoFace [12]. The face recognition process is outlined in Figure 3. In the process, registration images are compared with collation images to determine whether they show the same person [13]. Our system compares registered images of applicants with collation images of people entering the event site. First, face detection is performed by detecting and processing facial areas for each image. Next, the facial feature points of the detected areas—the eyes, nose mouth edges, and so forth—are processed to carry out facial point detection. Finally, the obtained facial point positions are used to normalize the size and positions of the facial areas and to measure their similarity, and the collation process is carried out for the registered and the collation images.

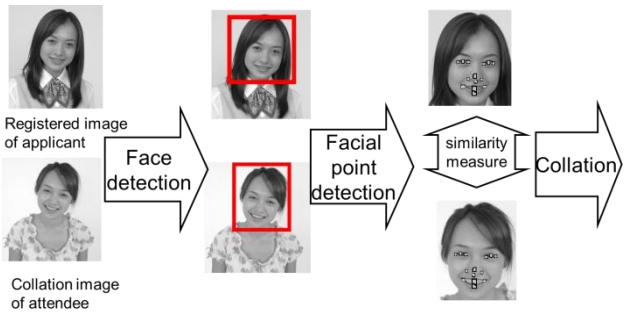


Figure 3 Outline of face recognition process

The face recognition software was implemented in a commercially available AGT10 tablet terminal (Figure 4). The terminal is built into a rear view camera (15 Megapixels) with an autofocus function. Its basic specifications are CPU: ARM Cortex ™ -A9, RAM: 1 GB (DDR2), and FLASH ROM: 8 GB (eMMC). The platform is an Android ™ 4.1 [14].

Figure 4 External view of AGT10 commercial tablet terminal

An applicant's facial image information is copied to the tablet terminal in advance, and the terminal alone performs the face recognition process. The rear view camera in the terminal takes a photo of the subject. Then, the face recognition process displays a message to that effect along with the detected facial area in a square frame (Figure 5 left). After about 0.5 seconds, the recognition result is displayed. If recognition is achieved, a "Recognition confirmed" message appears (Figure 5 middle). If recognition is not achieved, a "Recognition not confirmed" message appears (Figure 5 right).


Figure 5 Display screen of face recognition software

### 3.2 Confirmation procedure

An event attendant performs the confirmation procedure using the equipment shown in Figure 6, comprising a card reader, display monitor, and tablet terminal implemented with face recognition software.

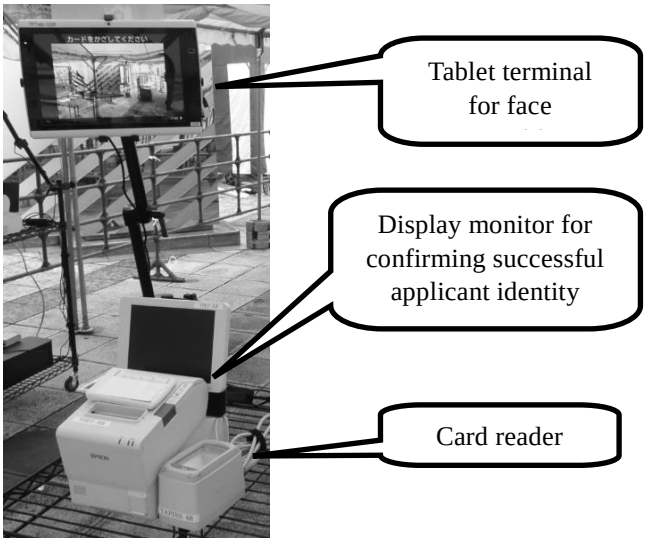


Figure 6 Event venue equipment

(1) Attendees' membership cards are placed on the card reader and the monitor screen confirms the attendees are successful applicants. The screen displays the face images that were registered at the time of application.
(2) The attendant explains the identification through a face recognition process to the attendees and instructs them on where to stand directly in front of the terminal.
(3) The attendant executes the face recognition process using the terminal to confirm the attendees are those who applied for the tickets.
(4) If identification is confirmed, the attendee is admitted entry.
(5) If identification is not confirmed, the face recognition process is repeated or identity is confirmed by direct visual inspection.

## 4. Demonstration of ticket identification system

### 4.1 Identification at a concert venue

The system was utilized for a July 26, 2014 pop music concert at Nissan Stadium (Yokohama, Kanagawa Prefecture). The equipment (Figure 6) was installed just behind the baggage inspection site at the stadium's east, west, and north gates. Temporary tents (Figure 7) were set up, and the equipment was installed in 120 locations. Face recognition was performed for 50,324 attendees over two days. The weather was mostly sunny, but the area became dark temporarily due to a thunderstorm. Face recognition was performed only for ticket applicants and not for people attending with them. The recognition rate achieved was 90%. Examples where recognition was not achieved are shown in Figure 8. The recognition failed in these cases because the people had their eyes closed (left), were not looking directly forward (middle), or had hair covering their face (right). There were also cases where the darkness due to the thunderstorm was a factor.

The confirming process took 6 seconds on average or 7 seconds if we included cases where recognition was not achieved. Where visual identification was required, this rose to 10 seconds. This was 30 percent more efficient than visually confirming identification through comparison with conventional ID cards, the time for which rose to 10 seconds. No cases of people impersonating others were reported for this event.

Figure 7 Attendees being identified through face recognition

Figure 8 Recognition failure cases

### 4.2 Concert attendee survey

A photo of an attendee being admitted after undergoing the identification procedure is shown in Figure 9. Surveys for such attendees were conducted in which they were asked to respond to four questions about the system's equity in ticket purchasing and three questions about its convenience in identification. The 241 survey respondents are broken down by age and gender in Figure 10. The survey results are shown as percentages in Tables 1–7.

Figure 9 Recognition system admitting attendee

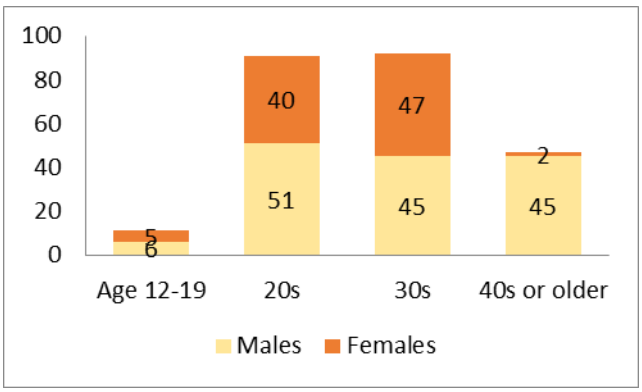


Figure 10 Survey respondents by age and gender

**(1) Equity in ticket purchasing**

To the question, "Should there be more equity in ticket purchasing?" (Table 1), 91.7% of the respondents said either "Definitely yes" or "Yes, I think so."

**Table 1.** Should there be more equity in ticket purchasing?

| Responses | % |
|---|---|
| Definitely yes | 66.4 |
| Yes, I think so | 25.3 |
| No, I don't think so | 6.2 |
| Definitely no | 2.1 |

To the question, "Does the system provide more equity in ticket purchasing than methods used before?" (Table 2), 94.6% of the respondents said either "Yes, much more", "Yes, somewhat more", or "It may; I'm not sure."

**Table 2.** Does the system provide more equity in ticket purchasing than methods used before?

| Responses | % |
|---|---|
| Yes, much more | 36.5 |
| Yes, somewhat more | 39.4 |
| It may; I'm not sure | 18.7 |
| No | 5.4 |

To the question, "Why does the system provide more equity in ticket purchasing than methods used before?" (Table 3) the offered responses were, "It makes illegal resale harder", "It makes getting tickets easier", "It cuts down on scalping", and "It reduces problems for ticketholders."

**Table 3.** Why does the system provide more equity in ticket purchasing than methods used before?

| Responses | % |
|---|---|
| It makes illegal resale harder | 85.4 |
| It makes it getting tickets easier | 59.6 |
| It cuts down on scalping | 47.4 |
| It reduces problems for ticketholders | 13.2 |

To the question, "Does the system effectively prevent illegal resale?" (Table 4), 93.8% of the respondents said either "Definitely yes" or "Yes, I think so."

**Table 4.** Does the system effectively prevent illegal resale?

| Responses | % |
|---|---|
| Definitely yes | 55.2 |
| Yes, I think so | 38.6 |
| No, I don't think so | 4.1 |
| Definitely no | 2.1 |

**(2) Convenience in identification**

To the question, "Is the system more convenient than having the attendant verify ID cards and the like visually?" (Table 5), 83% of the respondents said either "Definitely yes" or "Yes, I think so."

**Table 5.** Is the system more convenient than having the attendant verify ID cards and the like visually?

| Responses | % |
|---|---|
| Definitely yes | 36.9 |
| Yes, I think so | 46.1 |
| No, I don't think so | 11.6 |

| | |
|---|---|
| Definitely no | 5.4 |

To the question, "Why do you think the system is more convenient?" (Table 6) the offered responses included, "It smoothens the admission procedure", "It makes showing an ID card unnecessary", and "It shortens the waiting time."

**Table 6.** Why do you think the system is more convenient?

| Responses | % |
|---|---|
| It smoothens the admission procedure | 63.0 |
| It makes showing an ID card unnecessary | 42.0 |
| It shortens the waiting time | 38.0 |
| It makes showing the attendant personal data unnecessary | 24.5 |

To the question, "Why do you think the system is not more convenient?" (Table 7) the offered responses included, "It makes the admission procedure longer", "The attendant is not used to using it", "I'm concerned it might not recognize me correctly", and "I'm concerned about how it will handle my personal data."

**Table 7.** Why do you think the system is not more convenient?

| Responses | % |
|---|---|
| It makes the admission procedure longer | 73.2 |
| The attendant is not used to using it | 31.7 |
| I'm concerned it might not recognize me correctly | 31.7 |
| I'm concerned about how it will handle my personal data | 26.8 |

## 5. Discussion

### 5.1 Preventing people from impersonating others

People purchasing tickets at websites were well aware that the registered face images of ticket applicants would be matched with the facial images of people attending the event when they entered the venue. Under these conditions, there were no reports about people attempting to impersonate others at the event.

Survey results obtained for 241 people who had seen the system in use when entering the event showed that 94.6% of them felt the system provided more equity in ticket purchasing than methods used before. Various reasons were given for this, among them, "I think it will help prevent illegal resale (female, 30s)", "I think it will actually make me feel easier about the competition involved in purchasing tickets (male, 40s)", and "It's disadvantageous because it will prevent me from giving tickets to acquaintances, but it's a good system because it will help to control the illegal resale and scalping of tickets (male, 30s)." Survey results showed that 93.8% of the respondents felt it would effectively prevent illegal resale.

The system's performance has been widely reported in the mass media [5][17]. In addition to the aforementioned pop music concert, it has been used to perform face recognition for 26,859 people at the Saitama Super Arena on December 24–25, 2014, for 33,434 people at Fukuoka Yahoo! Auctions Dome on April 4–5, 2015, and for 38,563 people at Shizuoka Stadium ECOPA on July 31–August 1, 2015. In fact, since the aforementioned pop music concert, it has been used more than 20 times for large scale events [16]. No cases of people attempting to impersonate others were reported for any of these events. This is indicative of the system's effectiveness in improving equity in ticket purchasing and deterring or preventing illegal resale.

### 5.2 Making verification more efficient

With the face recognition process, the identity confirmation time took 7 seconds on average. This was 30% more efficient than the time required for a visual identification with a conventional ID card. It also reduced the psychological workload for the event attendants. Most of the attendants were part-time workers who had to identify 500 to 1,000 people per day visually. Verbal exchanges with attendees and other factors put a high psychological workload on the attendants, and many of them said they likely would not do such work at future events because of these exchanges and other related factors. According to the event organizers, the identification by the face recognition system makes it easier for them to find part-time attendants who will continue to do such work at future events.

Survey results obtained for 241 people who had seen the system in use showed that 83% of them felt the system provided added convenience in identification. Various reasons were given for this, among them, "It eliminates problems and makes the admission procedure smoother (male, 40s)" and "It frees me from having to show my ID card (male, 40s)." The opinion that "I hope it will be used for future concerts (male, 20s)" was also expressed. This indicates the system is also able to reduce the psychological burden on event attendees. However, some attendees did not feel the system provided added convenience. Reasons given for this included "It makes the admission time longer (male, 30s)", "People wearing hats, makeup, and the like might not be recognized and be denied entry (male, 40s)", and "Having my photo taken embarrasses me (female, teenaged)." The opinion that "Increasing the number of lanes or hiring more experienced attendants might help to shorten the lines (male, teenaged)" was also expressed. Even though the system's identity confirmation time is 30% shorter than that for the conventional method using visual inspection, it must be shortened even more. The system needs to be further streamlined to meet the expectations of a greater number of people.

### 5.3 Future issues

To make the system's identity confirmation process more efficient, we should consider ways to improve its operating environment and face recognition method. The operating environment can be improved by installing lighting to compensate for insufficient lighting at the site. We could also make the system more efficient by finding ways that would improve the understanding and cooperation of users. There have been cases at event sites where attendees' photos were taken but their identity could not be confirmed because they had their eyes closed, because they were not directly facing the camera, or because their hair was obstructing their face. The problem was often compounded because the attendant was unable to give the attendees a good explanation as to why their identity could not

be confirmed. Providing prior information relevant to face recognition, at the ticket application time or other times, would enable facial photos to be taken appropriately. In the future, attendee understanding can be expected to increase as the face recognition process and systems such as ours become more widespread. However, event attendants will need to explain to attendees more effectively how their photos taken on the day of the event will be handled to alleviate their concerns.

We plan to study the possibilities of introducing a "walk-through" system as a way to improve face recognition. This system would involve photographing people as they approach the equipment head on and admitting entry if facial recognition succeeds [11]. Having people photographed as they approach would save them from having to stop to have their photos taken and thus reduce waiting time [16]. We will attempt to develop a practical way in which this can be done.

## 6. Conclusion

We have developed an identity confirmation system using face recognition software and used it at large scale events to verify its effectiveness in suppressing illegal ticket reselling and in preventing people from gaining entry by impersonating others. It carries out its face recognition process for ticket applicants and event attendees, enabling it to decrease identity confirmation time by 30% using visual inspection and also to reduce the psychological burden on the event attendants. Survey results obtained for 241 people who had seen the system in use when entering an event showed that 94.6% of them felt it provided more equity in ticket purchasing than methods used before, 83% felt it provided added convenience in identification, and 93.8% felt it would effectively prevent illegal resale. However, opinions were expressed that it could be made more efficient so as to reduce admission time.

Because the system performs face recognition using a camera mounted on a single tablet terminal, it can accommodate up to 100,000 people at large scale events by providing as many terminals as needed. To further streamline the identification procedure, in the future, we plan to improve the performance by introducing ways to explain the procedure to users more clearly and also by introducing a "walk-through" system.

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