International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 04, 2019
ISSN: 1475-7192

Facial Recognition Payment System: An Effortless Payment Method in Public Transport Sector

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Abstract--- *From the beginning, the traditional way of using public transport in Malaysia is only able to use physical cash to purchase a ticket. The technology nowadays is increase rapidly which transform to make payment from using cash to smart cards to prove their transactions. This transformation can save plenty of time, however, there are still some flaws of current technology. First of all, they will be charged a penalty if passengers have lost their physical ticket or card, and this may cause passengers to pay extra and not be able to arrive at the destination on time. Furthermore, passengers who buying a ticket manually have to wait a very long queue during peak session, such as working hours and public holidays, and this could cause the passenger a lot of inconvenience. To overcome these problems, this paper offers a new technology to enables passengers can ease to use and feel convenience to make payment in public transport by using facial recognition. This new technology was used in other countries, such as the purpose of security, but was never used in Malaysia. This paper also provides the methodology for gathering user acceptance in this new technology using interview and simple random sampling to evaluate the data. Overall, the payment system for facial recognition is the fastest and simplest way to improve efficiency in the public transport ticketing system.*

Keywords--- *Facial Recognition Payment, Biometrics, Public Transport System, Image Processing.*

I. INTRODUCTION

Public transport usage in Malaysia is getting to increase in recent decades under government control and strategy. As revealed by the report card for the 2017 Land Public Transport Commission (SPAD), while train services are becoming increasingly common [2].

However, due to the poor ticketing system, many Malaysians are extremely unhappy with the public transportation system. Passengers need to wait for a long queue during peak hours to buy the ticket or upgrade the payment card. Some of the passengers who lost their ticket or card need to pay an extra penalty fee and that might cause them inconvenience.

With respect to all of the above-mentioned problems, the more efficient payment method can resolve a number of public transport issues. For example, eliminate any physical ticket or card to make efficiency and reduce the likelihood of ticket loss. Therefore, in order to solve these problems, a facial recognition payment system is necessary. This paper presents a background research, collected and process methodology, a proposed system of facial recognition system and the future scope of this system.

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Received: 18 Sept 2019 | Revised: 20 Oct 2019 | Accepted: 20 Nov 2019

II. RESEARCH BACKGROUND

Entering the age of digitalization, various types of cashless payment methods have been developed in many different forms, such as mobile payment platforms (online transferring) and QR Codes payment. With the popularity of mobile payment and such as Google Pay, WeChat Pay, Alipay, Apple Pay, and Samsung, the new payment method has been implemented in facial recognition technology [14].

Facial Recognition is a biometric identification and validation technology that utilizes significant facial purposes of an individual and compare it to the stored digital image in the database. The first system which recognize the key facial landmarks like the distance of the mouth between the eyes were made by Woodrow Wilson Bledsoe during the mid-1960s [8].

After many years of development, facial recognition is getting incredibly popular and powerful in current's market. This technology is implemented into few different fields such as public security, Airports, law enforcement, surveillance, and social media. Furthermore, facial recognition has long been used in criminal justice to resolve crimes and apprehend suspects and using facial recognition in the payment area can simplify all processes for millions of people around the world.

2.1 Public Transport Payment System in Malaysia

For Malaysians, Touch' n Go is mainly used as a physical smart card when paying for public transport, others are the traditional ways such as a physical token or paper ticket. The smart card Touch' n Go can be used in expressway and highway, bus and rail tolls. User can upgrade the card balance through online Touch 'n Go E-wallet, the counter of Centre or any convenience shop. Passengers are required to tap their card on the gates and the ticket fee will be deducted from your card balance automatically.

In the way, passenger can choose to purchase the token or paper when using public transport. At the entrance gate, passengers are required to touch their token to enter a station and insert their token to leave the station in the exit gate [11].

2.2 Implementation of Facial Recognition

To identify unique facial characteristics, a number of steps must be performed by facial recognition system as shown in Figure 1.

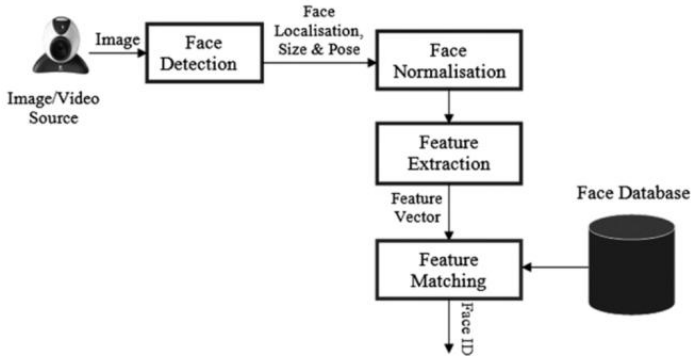

Figure 1: Process of a General Face Recognition System [6]

First, capture an image by using a device such as camera or webcam. The geometry of the face will be detected by facial detection based on filtering other unused things of that image. The geometry of face will be transformed into a normalizes the orientation of the face image such as the same size or pose.

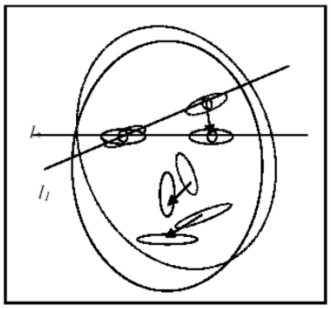

Figure 2: Facial Normalization [10]

As shown in Figure 2, $l_1$is the original position which the face position is placed in right sided of that image. The face position is change to center as l_2 after processing the facial normalization. Facial normalization is an important step in facial recognition as it reduces the effect of useless, interferential and useless information such as background, hair and cloth [10].

After the image has been standardized, the face extraction feature will take place. The extraction of the feature generates a mathematical representation called a biometric template or biometric reference. There are several methods, such as model-based techniques and 3D Morphable model, that are used for person face extraction features [13].

At the last step, implement an algorithm to make a decision either is match with exist face or new face through an identity database.

2.3 Advantage and Disadvantage of Facial Recognition

Compared to other techniques like fingerprint, iris recognition and DNA, facial recognition is one of the simplest and fast biometrics. Fingerprints recognition requires that people place their hands on a fingerprint reader for a few seconds. It requires people to accurately position their eyes in the front of the iris scanner in the iris recognition. DNA can recognize identify by human sample such as nails, sperm, blood, hair and etc. However, face recognition systems invisibly take pictures of the faces of people as they enter a defined area. It will bring convivence for the user because it is easy, and the end user requires no physical interaction.

There is taking a very fast seconds in capture image, and the subjects are completely unaware of the process in most cases. People do not feel that their privacy is invaded or monitored [6].That's because deploying and implementing. In addition, verification/identification processes for face detection and face match are very fast. It's currently on the iPhone X and a number of smart phones even in laptops and over successive few years which will expect the overwhelming majority of smartphones to own it.

In fact, Facial recognition systems still have some problem which limit their effectiveness. Facial recognition has lower accuracy to identify a person compare with fingerprint recognition, iris recognition or DNA [5]. For example,

facial recognition difficult to identify a twin which look very similar but fingerprint recognition, iris recognition or DNA can provide an accurate result.

In addition, facial recognition systems and technologies are based on either 2D or 3D facial appearance representation. Changes in the lighting, the hair of the person, the age, and whether the person wears glasses affect an issue in 2D recognition. In the other side, the 3D image acquisition technologies come with higher cost compare with 2D [5].

2.4 Challenges of Facial Recognition

Humans can easily identify a person based on the face, but the computer have many difficulties to perform fully automatic face recognition.

Face recognition must posit with different lighting conditions, Large pose differences, facial expressions, make-up, hair changes in the digital photography of the user [6]. Some of the problems and factors that can have a significant impact on recognition performance that can be classified into four categories.

A major face recognition challenge is how to **recognize the person who look alike** between each other like twins. To add on to the idea, [4] highlighted how to recognize the style a feature extractor and go-between that may will increases interclass variations between two people with low interclass variations, like between lookalikes or identical twins.

Figure 3: Twins with different Express [4]

For example, Figure 3 showed two pairs of twins in similar image quality under different expression. These are quite difficult for human eyes to identify the two others, even in the system of facial recognition.

The appearance of wrinkles and the relaxation of facial muscles will change the facial structure and texture with the increase in age; According to [3], face challenges are not a rigid object and images can be taken from a wide variety of facial perspectives. Intrapersonal image variations such as age, expressions, and styling had to be robust in face representations while identifying variations in social image between completely different folks. Similarly, reference [6] also agreed that expression, facelifts, makeup, and hairstyle is directly affected to the recognition based on their experiment shown on Figure 4.

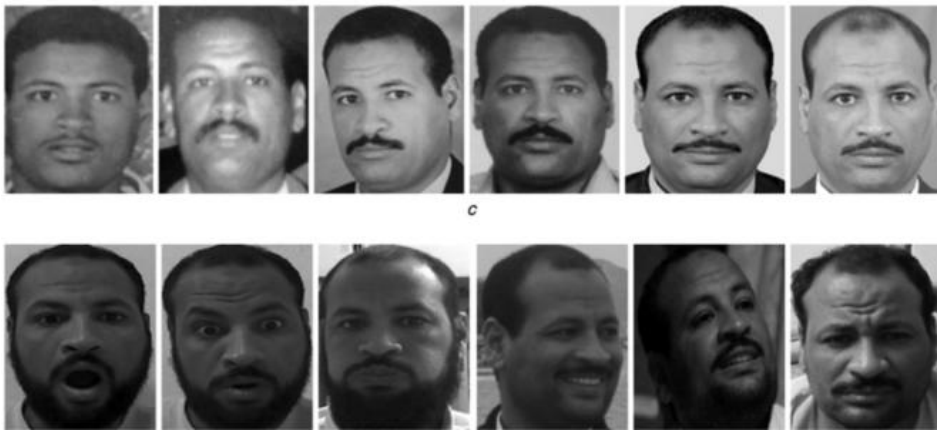

Figure 4: Example of Challenges of Facial Recognition [6]

In the addition, the other challenges of facial recognition are **different illumination**, viewing angle, and angle of ingestion, grayscale distortion and angular rotation of the image, which reduces image quality and increases recognition difficulty. Reference [13] mentioned that the low resolution, light, a variation in the person's poses, and illumination variation are some challenges of facial recognition based on their experiment as shown as Figure 5.

Figure 5: Example of Illumination Variations [6]

Hence, there are still a lot of challenges such as the robustness level shown by recognition of the human face that we need to achieve. These questions and problem for the technology promise to persist this technology in the future for a long time [7].

2.5 Implementation of Smile Pay in China

Tech giants in China like Alibaba and Tencent have made many huge investments in this sector over the past five years, predicting the significant growth of facial recognition in China [14].

In 2017, Alibaba closed a US$ 227 million deal with Sense Time, a facial and image recognition technology-specialized AI startup. In the same year, an ambitious project "Smile to Pay" from Alibaba which enable customers to sign up for their Alipay application, allow for facial recognition and voila or a 3D camera at the Point-Of-Sale store will capture user's picture and payment will be made with user's linked account [12].

Figure 6: "Smile to Pay" in KFC restaurant in Hang Zhou [14]

Alibaba is working with Hangzhou's KFC stores to launch the "smile to pay" service. By smiling in front of self-serving screens, customers can order their meals. Alibaba has been pushing its vision of the future of commerce, which globalization this technology in everywhere.

III. Problem Statement

In Malaysia, there are only two types of payments available in the public transport system, which are paying through cash, and the infrared light technology in a card. Hence, it occasionally caused a long queue, particularly during peak hours. After purchasing the ticket, the passengers are given a prove, usually either a token or a paper ticket, to show that the passengers are eligible to use the public transport. For the passengers who are using the token and the card payment, they are required to use the same token or card used when entering and exiting the public transport stations. It caused inconvenience when the passengers lost the given token, or the card used when entering the public transport system.

IV. Aims and Objectives

The main aim of this research paper is to propose a facial recognition payment system integrated in public transport system to increase the efficiency in ticketing.

- To reduce the use of paper or token in ticketing by electronic method.
- To enhance the security by tracking the faces of all the passengers
- To eliminate the possibility of losing physical tickets by transforming the physical ticket into electronic form.
- To increase the efficient of the ticketing system by capture passenger image when entering the public transport ticketing system.
- To improve the accuracy of ticketing system by digitalize the transaction record in the ticketing system.

V. Research Questions

The research questions for this study were:

1. How does the facial recognition payment affect a society and environment?
2. What is the advantage of facial recognition payment in public transport?

Received: 18 Sept 2019 | Revised: 20 Oct 2019 | Accepted: 20 Nov 2019

3. How does the ticketing system assist passengers without any obstacles on board public transport?
4. What is the purpose of facial recognition payment in public transport?
5. What is the difference between traditional public transportation tickets and facial recognition payments?

VI. SIGNIFICANCE OF WORK

This study will redound to the benefit for passenger, driver and operator.

Passenger: They can save time without queue to purchase ticket or top up their card balance in counter. Besides, passenger will not have the concern of losing their ticket and card.

Driver: They can reduce the hassle to return the cash balances to the passenger and help them to manage their time to reach next destination on time.

Operator: They can accurately calculate the overall result without losing the ticket and cash. In the addition, they can provide useful information when a criminal case occurred with the help of the new technology.

VII. METHODOLOGY

The objective of qualitative studies is to ensure a higher level of understanding and qualitative data collection methods. In this study, data such as case study, interviews, observation and sampling data are collected.

Before starting development, case study is necessary to analyze the background, related issue, and method of the facial recognition system. For instance, "Smile to Pay" in China is a kind of facial recognition payment system. Observing the on-site development made it possible to see the actual progress of a similar system that was actually taking place. It could help the researcher to develop this system effectively.

By observing, the directions of the passenger's faces can be identified when the passenger enters and leaves the stations. This information is necessary for the camera's location.

Since this study would adopt qualitative data collection techniques which would be obtained through structured interviews. This interview involves the person in charge of public transport to investigate and identify the environment. The size of the area can be known through the interview with the person in charge of public transport stations. It can help in decide the number of cameras in the stations to be set up. Furthermore, another interview involves a total of 1000 people to investigate the acceptance of new technology and what their need is.

Because for Malaysian facial recognition technology is a quite new technology and everybody has the chance to use public transport. Simple random sampling will be used in this situation.

SWOT analysis will be applied after gathering all data. The researcher will examine the system's strengths and weaknesses, and how to influence those to take advantage of the opportunities and threats that exist in the market.

VIII. OVERVIEW FOR THE PROPOSED

First of all, a large face database was needed to store individual face samples for facial recognition.

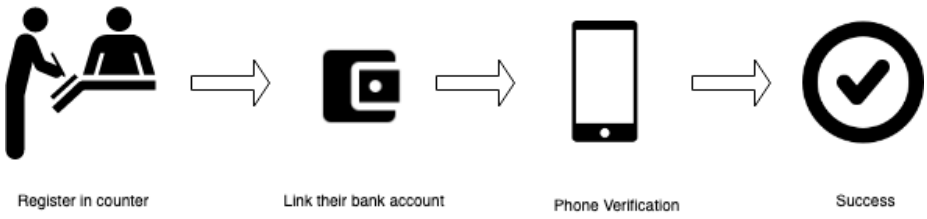

Figure 7: Registration Steps in Facial Payment System

Passengers need to register a new account in the public transport counter and connect to their bank account. Children under 12 years of age will connect to their bank account with their parent. There is also an option to check the phone number for additional security when processing the registration. That only has to be registered once in life unless the passenger has any changes to their personal information.

Besides, some 3D cameras should set up at the entrance of public transport to capture the face of the passenger in the facial recognition system. The cameras which prepared by the department of public transport must good quality and the same illumination. A large network also needed to connect to the face database during process the validation in the ticketing system.

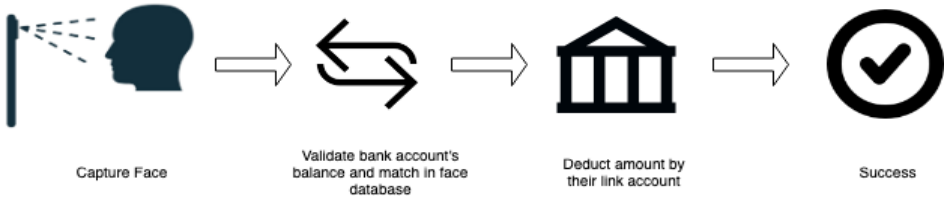

Figure 8: Process in Facial Recognition Payment in Public Transport

When entering the entrance of facial recognition payment system, the passenger just needs to stand in front of self-ticketing to prove their identity. Facial recognition system will capture the image of the passenger and validate identification and deduction of the amount from their bank account. Facial recognition payment system will work with the bank to process the deduction of the amount using the API. In the entire process, it only takes a few seconds.

IX. CONCLUSION

In a nutshell, the facial recognition payment system is one of the methods in dealing with the long queue issue, efficient issue and security issue in the current state of public transport ticketing system. However, it has its own limitation, such as large storage for face database, expensive 3D cameras and the high speed of network connection. It could cause the higher cost of transforming traditional ticketing system into a facial recognition system. But the processing time is believed to be improved in the future. Besides that, this database can be integrated with the Internet of Things (IoT), in tracking the whole ticketing system to make the transactions more accuracy.For future, this facial recognition payment system can be integrated with the government which connect database for other purpose such as hospital reservation and ATM machine to make the processing more efficient. With the large data has gathered in this system, it can collaborate with other fields such as hospital reservation and ATM machine which

sharing the face database to minimize the resources and make the processing more efficient. All in all, it creates a new possibility for the development of facial recognition technology.

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Received: 18 Sept 2019 | Revised: 20 Oct 2019 | Accepted: 20 Nov 2019