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Face Recognition in Mobile-Based Test Systems Using FaceNet

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***Abstract*—Almost all activities are currently implemented with applications, including the implementation of exams, especially the covid-19 pandemic has caused online exams to have begun to be widely used by various kinds of educational institutions, online exams are carried out generally using computer devices that require a lot of devices and space for infrastructure. This study aims to create an online exam system that is simple and easy to do by utilizing mobile devices. This system utilizes the face recognition feature for security and minimizes the occurrence of fraud. The method used is FaceNet taking an input image quality of 160x160 pixels with an accuracy percentage of 85.7%.**

Keywords—mobile-based test, face recognition, FaceNet

I. INTRODUCTION

The progress of applications in the current era is very fast, almost all aspects of activities carried out by humans have been implemented with applications. One of the activities that are currently being carried out is online exams. Currently, conventional exams with paper media (paper-based tests) have shifted towards computerization or commonly called Computer Based Test (CBT) [1], especially in the community during the Covid-19 pandemic which causes all activities that are usually carried out to be transferred online and one of them is taking exams or tests also online.

Online exams have begun to be widely used by various educational institutions, exams are generally carried out using desktop computers or CBT (Computer Based Test). Computer Based Test (CBT) is a test method where the settings for each response are stored, assessed or both electronically [2]. Computer Based Test itself is an exam that is done on a computer so it does not require paper, pen, or pencil to answer the questions. All written questions and answer sheets are also provided on the computer, so we only need to click on the correct or incorrect answer.

Computer Based Test is widely implemented in various fields such as education and the world of work. In the field of education, it is usually used to determine the highest score for a student or student in mastering one subject or course. While in the world of work, Computer Based Testing is used to determine the basic abilities of a job applicant to facilitate the HRD section in selecting prospective employees. Currently, the use of computer-based tests is also quite widespread in the corporate world. Especially in the recruitment process, where applicants are tested and the results of the exam stages can be quickly obtained [3]. However, the implementation of the CBT exam system involves the need for large computer resources.

The implementation of the CBT system also requires a special room to accommodate the infrastructure, so not all institutions can implement the exam system. This can be overcome by alternative online exam systems, namely online exam systems using mobile devices, mobile systems or mobile applications are software applications made specifically to run on tablets and smartphones [4], [25]. And this online exam is commonly called MBT (Mobile Based Test), and the MBT system will make the exam process much more efficient.

Another problem with online exams is that they allow test takers to cheat. The most common fraud is identity fraud, this is due to weak application security. Cheating can happen early on or during the test [23]. Most systems only identify the user's username and password at login. Passwords and usernames can be easily given to jockeys. The absence of participant identification during the test makes cheating occur during the test, this problem can be overcome by performing face verification at the start of the exam and during the exam.

Face verification is a recognition and matching process. The use of biometrics for recognition systems has the aim of increasing convenience and security, the advantages of biometrics have many benefits and advantages compared to traditional systems such as manual signatures, use of passwords, and PINs [5]. For mobile biometric systems, there are still a few that can be explored more diversely and in-depth to be discussed. Applications with additional security such as facial recognition features will add security and this feature can be applied in the online exam system on mobile to minimize the occurrence of cheating during the exam. Therefore, in this study, the author is interested in discussing and taking other approaches to the online exam system that is currently being carried out today, where researchers are trying to design and make prototypes of mobile-based online exam software that applies face recognition.

II. RELATED WORKS

A. A Sukmandhani & I. Sutedja produced a prototype system for face recognition as validation of the examinee's absence before carrying out the exam using the eigenface method [6]. S. Prathish, A. Narayanan & K. Bijlani created an intelligent system of examinee monitoring, which processes the results of video and audio captures by taking pictures of the examinees to infer the possibility of cheating from the examinees [7]. SHI Jun, LI Hui, GU Hang & ZHOU Li-dong designed a face recognition system for examinees, as

well as the ease of examination of exam results by invigilators. [8]. Mika Tandililing showed the output in the form of an online examinee validation system display that can be accessed directly using a desktop computer, validating examinees with a face recognition system using the haar cascade method and eigen face vector [9]. Hendro Fj Lami & Stephanie Imelda Pella presented modeling the participant identification system automatically on an online-based test activity, a raspberry pi- based deep learning method is used in the participant's face recognition process to adapt to existing datasets [10]. Haruno Sajati, Astika Ayuningtyas & Dwi Kholistyanto created a computer-based test application that verifies the faces of examinees with the eigenface method. [11]. Ferry Cahyono, Wirawan, and Reza Fuad Rachmadi created a facial recognition system with a facenet for company attendance [12].

III. METHOD

The proposed system is an online exam system made on a mobile basis to make it easier and more efficient for examinees to take online exams. The designed system will perform face validation of the examinee at the time of starting the exam. The initial stage is to identify the data of the participants, this process will be carried out in the admin system section, the face identification process will be carried out using the FaceNet method, then the results of the facial signature will be stored in the system database, the process in the admin system can be seen on Figure 1.

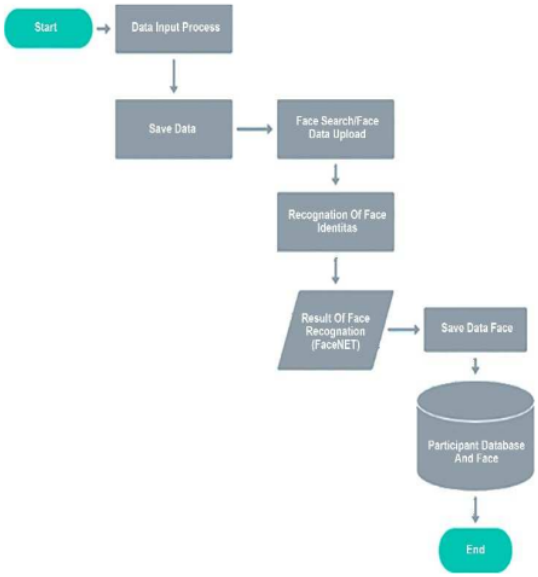

Fig. 1. Flowchart Admin Process

After the process of storing data and face signature, the user or system examinee will validate the face that matches the initial data in the database. This validation will be performed when starting the exam and when the exam is running. If the face validation is successful, the participant will be directed to the test question section. During the exam every minute the system will again validate the face to identify whether the examinee is still the same person, if the validation is not appropriate then the system will dismiss the exam. The process on the user's system can be seen in Figure 2.

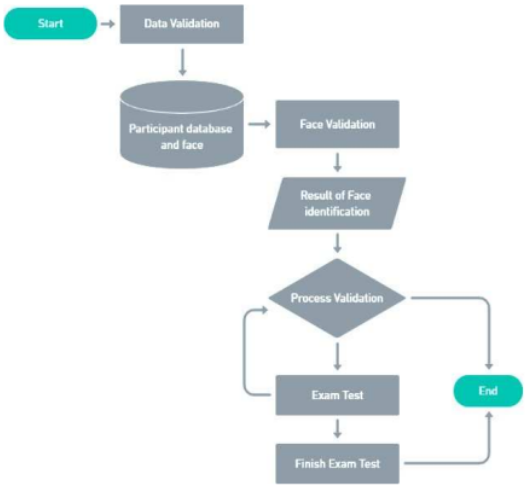

Fig. 2. Flowchart Participant Process

A. *Face Recognition System*

Face recognition is one of the biometric technologies that has been widely applied in security systems in addition to retinal recognition of the eye, fingerprint recognition, and iris of the eye. In its application facial recognition uses a camera to capture a person's face and then compared it to a face that has previously been stored in a specific database. [13]

Face recognition involves many variables, such as source image, image processing image, extracted image, and profile data of a person. It also requires a sensing device in the form of a camera sensor and a method to determine whether the image captured by the webcam is classified as a human face or not, as well as to determine the profile information that matches the image of the face in question. [14]

The system for recognizing faces in this study began with processing through the face registration feature of the examinees with a smartphone camera of each participant as shown in Figure 3.

Fig. 3. Face Registration

This face signature registration will be processed using the FaceNet method. FaceNet is a model developed by Schroff, et

al. [15] that can be used for face recognition, verification, and clustering. FaceNet includes a deep convolutional neural network with 22 layers that produces an embedding output of 128 numbers, as seen in Figure 4.

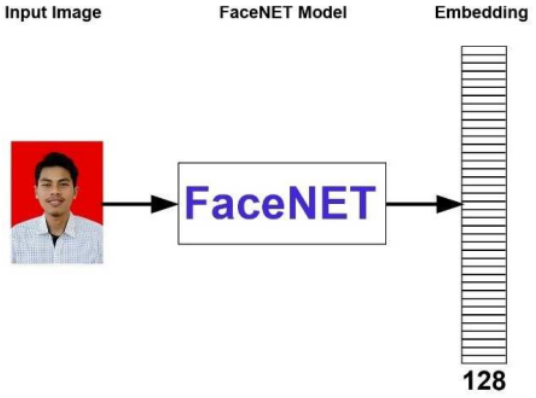

Fig. 4. Facenet embedding 128 number

FaceNet takes an image of the person's face as input and outputs a vector of 128 numbers which represent the most important features of a face. In machine learning, this vector is called embedding. Why embedding? Because all the important information from an image is embedded into this vector. Basically, FaceNet takes a person's face and compresses it into a vector of 128 numbers [16].

B. Comparing Image

After registering the face and participant data is complete, when taking the exam, participants again do face detection to log in and the system will adjust the participant's face data that has been previously registered, as seen in Figure 5.

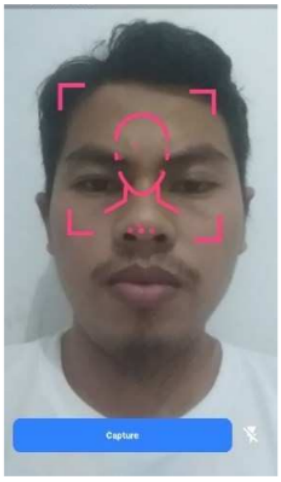

Fig. 5. Login system

The face recognition process on the FaceNet system and workflow is solved by equation (1).

$$\frac{1}{2}\sum_{1}^{128}\sqrt{(s+v)^2} \quad (1)$$

Where s is the signature face that has been stored in the database and v is the value of the newly logged face. From the equation above, comparing 128 numbers from the processed model from FaceNet that has been saved and who is trying to log in, this model can be seen in Figure 6.

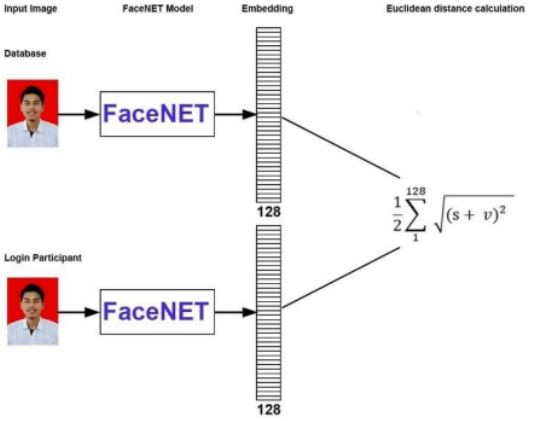

Fig. 6. Image Comparation

C. Mobile Test System

If the participant login process has been carried out and the system detects that the participant's data is following the database, the system will then direct the participant to complete the questions that have been prepared in the application.

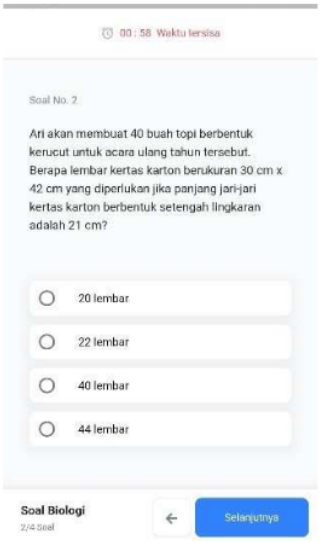

Fig. 7. Mobile Test System

IV. Result And Discussion

In this paper, a Mobile based test application is proposed to facilitate the implementation of the test by increasing the security of the examination by using the face recognition feature. The use of mobile applications is taken as a step in minimizing the use of large computer resource requirements as well as the use of special rooms to accommodate infrastructure.

This mobile-based test application is the latest innovation compared to previous research which mostly uses a computerized system, with each method used, the mobile-based test system developed uses the FaceNet method in identifying the faces of examinees, the research takes participant data from Hasanuddin university students as a sample to conduct the exam.

Advances in Information and Communication Technology (ICT) and the potential for its use in the field of education broadly, is expected to be able to open up space, benefits and convenience for schools especially for teachers and students. With the development of the online exam system, it is hoped that it can replace the exam system paper-based and can be implemented repeatedly and can be accessed by students using internet and intranet networks both during class hours and outside school hours [24].

In the development of the program code, the author took samples of participants' picture based on their quality, because in the use of FaceNet image quality affects the accuracy of FaceNet detecting face suitability, which can be seen from the percentage results of image training, ranging from 40x40 pixels to 256x256, the percentage of success as shown in Table 1.

TABLE I. PERCENTAGE OF FACE DETECTION FROM IMAGE QUALITY

A rcentage from image quality	
#pixels	*val-rate*
1,600	37.8%
6,400	79.5%
14,400	84.5%
25,600	85.7%
65,536	86.4%

After seeing the results of the use of image quality, then in this system, we write on the program listing to review images with a quality of 160x160 pixels or 25,600 pixels with a percentage of 85.7%, taking into account the speed and storage capacity on the system and looking at the quality of the smartphone used.

Face recognition has been an active research topic since the 1970s. Given an input image with multiple faces, face recognition systems typically first run face detection to isolate the faces. Each face is preprocessed and then a low-dimensional representation (or embedding) is obtained. A low-dimensional representation is important for efficient classification [21]. Challenges in face recognition arise because the face is not a rigid object and images can be taken from many different viewpoints of the face. Face representations need to be resilient to intrapersonal image variations such as age, expressions, and styling while distinguishing between interpersonal image variations between different people [17].

FaceNet is a neural network that maps faces one becomes Euclide space (a collection of the geometrical point) which will be the geometrical point determine the value to measure the level of facial similarity. So, if the faces are more similar it will make the value gets smaller, and vice versa if the face the more different will produce a greater value. Where the formula used for Facenet is the formula L2Norm and Cosine Similarity [18].

Face detection methods play an important role in the successful implementation of applications related to faces as the center of analysis. The performance results from face detection will be carried out in the next process such as determining facial landmarks, face recognition, facial expression recognition. Failure in face detection is the initial failure to analyze comprehensively [19], [22].

Identification accuracy is influenced by several factors. Results accuracy testing shows that the shooting angle face affects the identification results. In testing at which the author identifies with the light level that different, the author's face failed to be identified. It shows that the light level also affects the identification results [20].

V. CONCLUSION

This online exam system based on mobile is a solution to facilitate the implementation of exams, where this system is simpler and does not require a lot of devices, supported by facial detection that adds security to exam activities in this system. The use of the FaceNet method makes face detection easier with the image quality in this system taking and resizing it to 160x160 pixels with a percentage of 85.7% so that it can be concluded that this program works well and accurately.

In the future, this research can be continued by developing a mobile system design that is more simple and interactive, accelerating face detection by paying attention to the quality of the smartphone used.

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