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IMPLEMENTATION OF FACE SIMILARITY USING TINY FACE DETECTOR

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Abstract
The development of cloud technology and Software as A Services (SaaS) applications is happening very expeditiously. Many applications are currently used by users using cloud technology, including the Human Resources (HR) application. The problem arising from cloud-based HR applications is regarding the issue of validity, especially when doing attendance so that it cannot be entrusted or represented by others. In this paper, it is explained how to maintain the validity of attendance in cloud-based HR applications by looking at the level of face similarity using tiny face detector.

Keywords: *Face Similarity, Face Detector, Cloud Computing, SaaS, HR Application*.

1.0 INTRODUCTION

The development of cloud technology is currently so expeditious that numerous present applications make use of cloud technologies such as Gmail, Skype, Trello, Whatsapp and others. Some applications that use cloud technology intended for business purposes use SaaS which is able to provide convenience for its users due to the low cost of the Pay As You Go payment system, in which users only need to pay for the resources they use [1].

SaaS-based cloud applications can also be applied to HR applications [2]. The HR application is able to provide services for various companies at once in one server while maintaining the confidentiality of each company's data so that it would not be able to be accessed by other parties. It is most likely to happen owing to the fact that not all companies are able to build their own HR applications for several reasons such as Insufficient cost to provide servers and other support, The absence of human resources who are experts in the field of HR application development, Inability to understand how to build applications, A substantial risk of failure of application development.

The problem arising from cloud-based HR applications is the authentication problem when doing attendance. Attendance is done using a smartphone in order to maintain the mobility and flexibility by using an identity card. However this is constrained by the issue of validity as the identity card can be entrusted to others. It can also be equipped with a Personal Identification Number (PIN) after scanning the identity card but the PIN can also be notified to the closest person.

To overcome this issue, the cloud-based HR application avails as a smartphone device of carrying out the attendance process. As authentication, latitude and longitude coordinates using GPS are applied to determine the location of doing attendance and taking photos in doing attendance so that it can be compared with registered photos of employees. This study discussed how to compare 2 photos, the registered photo and the one taken in doing attendance to look for the level of similarity using Tiny Face Detector [3] combined with the ResNet-34 architecture to describe faces which are obtained as feature vectors [4][5].

2.0 RELATED WORK

Software as a Services is an application model or software made by a vendor and operated for use by the customers through the Internet. SaaS is a solution for small and medium business because of the low cost and ability to meet the needs of its customers. SaaS is currently growing so rapidly and is increasingly needed seeing that it is considered more profitable than traditional software. (I. C. Resceanu, C. F. Resceanu, and S. M. Simionescu in the journal entitled "SaaS solutions for small-medium businesses: Developer's perspective on creating new SaaS products") [6].

In the paper of "Research on Key Technology in SaaS", it is explained that some of the advantages of SaaS are among others [2] :

- Low and effective cost.
- Ease of implementation.
- No need to provide large infrastructure
- Increasing productivity and ability to be accessed from anywhere

There have been many applications implementing this, such as Customer Relationship Management, Accounting, Point of Sales, and others.

The use of HR applications in the form of large-scale SaaS provides services for a large number of employees while at the same time creating other challenges, one of which is about employee authenticity. Such large number of employees raises its own problems in terms of registration, authentication, data access, mobility and flexibility. As in "The Research on SaaS Model Based on Cloud Computing" paper, it is mentioned that there is a problem on security in SaaS because data is stored centrally on a server that is accessed by assorted customers or companies at once [7]. The use of the QR-Code as an employee identity card makes it easy for employ registration as there is no need to register email or anything else to access their personal data.

Referring to "Cloud based shopping guide system using qrcode" paper, QR-Code is used because it can store a lot of data in a structured manner and has resistance to damage and dirt [8]. QR-Code is one of the two-dimensional symbology techniques [9] which was created by Denso Wave in 1994 that can be used to store data. Data stored can be read using a smartphone camera making it easier for users. Some convenience offered by QR-Code are:

- Large data storage capacity
- Small print-out size
- Damage and dirt resistance
- Readable from various directions

The use of photos for authentication purpose when doing attandance ensures that attendance data is valid and not represented by others [10][11][12]. Checking photos one by one by HR department staff when doing attendance requires a lot of time and effort. Therefore, this study discussed on how to compare 2 photos, the registered photo and the one taken when doing attendance, to look for the level similarities using the Tiny Face Detector.

In the paper entitled "Finding Tiny Faces", it is explained that to do a face search in an image it is essential that we see the image scale and resolution [3]. Differences in scale and resolution require different approaches from each image to get the face object [13] with good accuracy. ResNet-34 architecture was used to perform face descriptions into feature vectors which can be calculated by Euclidean distance between 2 faces so that the level of similarity between those two faces is known [4][5].

3.0 EXISTING SYSTEM

The HR application in present analysis is cloud-based using an identity card with a QR-Code for authentication process when doing attendance. The QR-Code contains employee ID data that is encrypted using Advanced Encryption Standard 128 bit (AES-128) to maintain data confidentiality [14].

Then it is equipped with a PIN encrypted using repeated Message-Digest Algorithm 5 (MD5) to guarantee the PIN confidentiality [15] and avoid the theft of PIN using the sniffing or other processes. PIN is used to maintain data validity [16] so the attendance can only be done by the owner of the card itself, but the PIN can also be notified or entrusted to the closest person.

Therefore, it is equipped with taking photos of faces when doing attendance to be matched with registered photos of employees in order to keep the attendance data valid.

3.1. Issue in existing system

Checking the photos of faces when doing attendance and the ones registered is done manually by viewing it one by one. Only to validate the presence of employees, doing so takes time and effort. If the number of employees is 100 people, the HR department staff must check 100 photos of faces every day and if those are added up in 1 month or 20 working days, there are 2,000 photos of faces that must be checked for validity.

4.0 PROPOSED MODEL

This study discussed on how to check the photos of faces when doing attendance and the ones registered, by the system using the Tiny Face Detector, to detect or get only the facial part of the photo [3] then combining them with the ResNet-34 architecture to describe the face obtained into a feature vector containing 128 values [4] afterwards the Euclidean distance between the feature vector of the registered photo of faces and of the one taken when doing attendance was calculated so that the level of similarity was known [5]. The benefit is that the work of HR department staff on checking photos of faces can be significantly reduced.

4.1. Experiment

This study discussed on how to check the photos of faces when doing attendance and the ones registered, by the system using the Tiny Face Detector, to detect or get only the facial part of the photo [3] then combining them with the ResNet-34 architecture to describe the face obtained into a feature vector containing 128 values [4] afterwards the Euclidean distance between the feature vector of the registered photo of faces and of the one taken when doing attendance was calculated so that the level of similarity was known [5]. The benefit is that the work of HR department staff on checking photos of faces can be significantly reduced.

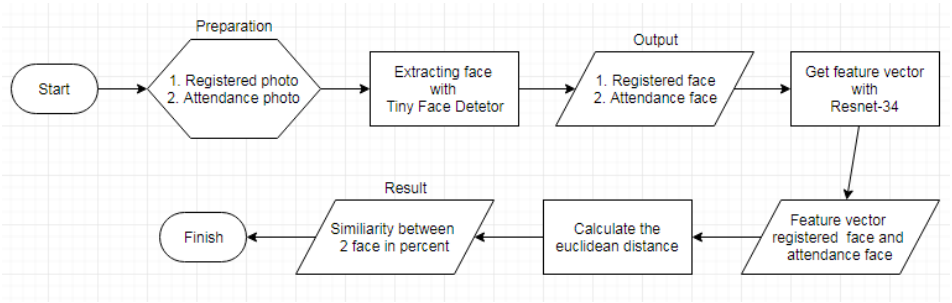

Figure 1. Face similarity checking.

The facial extraction on pictures were done using Tiny Face Detector by applying ResNet-101 algorithm. The process of facial extraction was affected by image scale and resolution. The difference in scale and resolution required the algorithm to apply different approach on each image. The result of facial extraction can be seen in Figure 2.

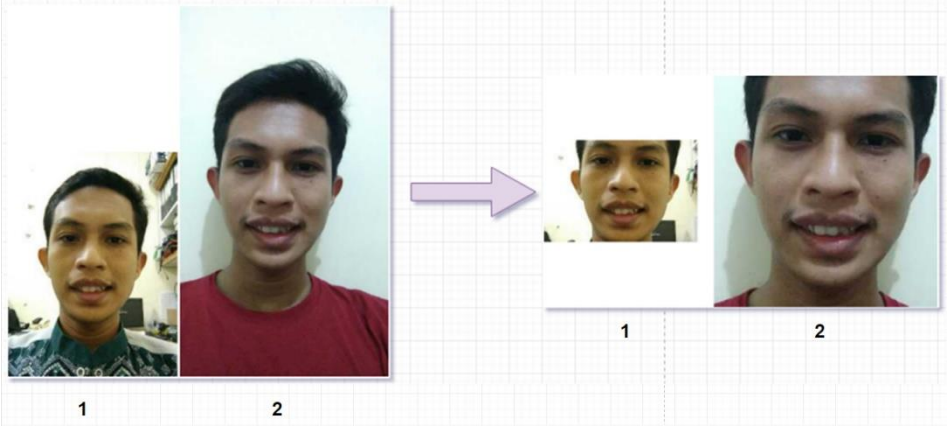

Figure 2. Facial extraction.

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Table 1. Feature vector of figure 2.

No	[Array1]	[Array2]	[Array 2] - [Array 1]	([Array 2] - [Array 1])^2
0	-0.14447557926177979	-0.19207099080085754	-0.047595411539078000	0.0022653231995742000000
1	0.11196058988571167	0.11160042881965637	-0.000360161066055006	0.0000001297159935018 79
2	0.02861916273832321	0.021205171942710876	-0.007413990795612990	0.0000549672595174342 00
3	-0.015065371990203857	0.007194666191935539	0.022260038182138000	0.0004955092998702420 00
4	-0.024370040744543076	-0.0701330378651619	-0.045762997120618000	0.0020942519054616900 00
5	-0.13576354086399078	-0.052939850836992264	0.082823690026998000	0.0068597636296882500 00
6	-0.017348239198327065	-0.03753421828150749	-0.020185979083180000	0.0004074737515465810 00
7	-0.16639378666877747	-0.17644670605659485	-0.010052919387817000	0.0001010611882179480 00
8	0.1257554292678833	0.14479932188987732	0.019043892621994000	0.0003626698461980390 00
9	-0.08703630417585373	-0.04344864562153816	0.043587658554315000	0.0018998839782475500 00
10	0.35434556007385254	0.3081943988800049	-0.046151161193848000	0.0021299296795405500 00
11	-0.07974910736083984	-0.025890452787280083	0.053858654573559000	0.0029007546724739500 00
12	-0.15088264644145966	-0.15572135150432587	-0.004838705062866040	0.0000234130666854055 00
13	-0.13967272639274597	-0.1296411156654358	0.010031610727310000	0.0001006332137842800 00
14	-0.03745845705270767	-0.07229360193014145	-0.034835144877434000	0.0012134873186318200 00
15	0.14764052629470825	0.1792815923690796	0.031641066074371000	0.0010011570623227100 00
16	-0.20509953796863556	-0.1926601529121399	0.012439385056496000	0.0001547383005837760 00
17	-0.09650269150733948	-0.12271568924188614	-0.026212997734547000	0.0006871212502313670 00
18	-0.03596490994095802	-0.03995189443230629	-0.003986984491348010	0.0000158960453342495 00
19	-0.019480878487229347	-0.049516063183546066	-0.030035184696317000	0.0009021123197418760 00
20	0.05080690234899521	0.026805775240063667	-0.024001127108932000	0.0005760541024991110 00
21	-0.09684406220912933	-0.06739363074302673	0.029450431466103000	0.0008673279135396300 00
22	0.027918212115764618	0.04918185994029045	0.021263647824526000	0.0004521427188054690 00
23	0.09656740725040436	0.118704654276371	0.022137247025967000	0.0004900570588868400 00
24	-0.03147360682487488	-0.03590265288949013	-0.004429046064616000	0.0000196164490424905 00
25	-0.3499656319618225	-0.30473971366882324	0.045225918292999000	0.0020453836854450300 00
26	-0.10079628974199295	-0.05519077554345131	0.045605514198541000	0.0020798629253133300 00
27	-0.19119499623775482	-0.1558082103729248	0.035386785864829900	0.0012522246138433300 00
28	0.07757526636123657	0.09211805462837219	0.014542788267136000	0.0002114926905827480 00
29	-0.021376408636569977	0.012219508178532124	0.033595916815101000	0.0011286856266471900 00
30	-0.03485643491148949	-0.058494821190834045	-0.023638386279345000	0.0005587733058915260 00
31	-0.024578632786870003	-0.02038509212434292	0.004193540662527990	0.0000175857832882757 00
32	-0.1734093725681305	-0.22576047480106354	-0.052351102232933000	0.0027406379050030000 00
33	-0.0880252942442894	-0.08505244553089142	0.002972848713398040	0.0000088378294727523 50
34	-0.03789081797003746	-0.013538720086216927	0.024352097883821000	0.0005930246713432000 00
35	0.019166525453329086	0.07349900156259537	0.054332476109266000	0.0029520179601639600 00
36	-0.044894780963659286	-0.021388422697782516	0.023506358265877000	0.0005525488789237640 00
…	…	…	…	…
127	0.06252226233482361	0.09398404508829117	0.031461782753468000	0.0009898437740264180 00

Calculation of Euclidean distance between the two feature vectors use the following formula.

$$d(p,q) = d(q,p) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \ldots + (q_n - p_n)^2}$$

$$d(p,q) = d(q,p) = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

The Euclidean distance is always between 0.00 - 0.99 because 128 values of the feature vector is always within the range. Euclidean distance was then converted into a percentage of similarity using the following formula :

$$Similarity\ (\%) = (1 - d(p,q)) \times 100$$

If the percentage of similarity is more than 50% then the attendance is valid and the photo icon is marked blue; if it is less than or equal to 50% then the attendance is invalid and the photo icon is marked red. HR department staff can carry out follow-up actions such as re-checking or canceling the invalid attendance. The mark on photo icon can be seen in figure 3.

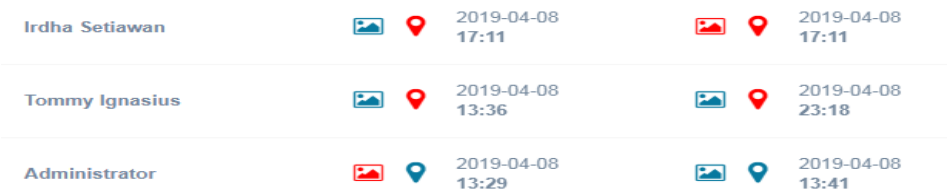

Figure 3. Marking photo icon.

The whole process applies the Javascript programming language so users only need a supported browser [17] to do the face checking. The display users see when doing the face checking is presented in figure 4.

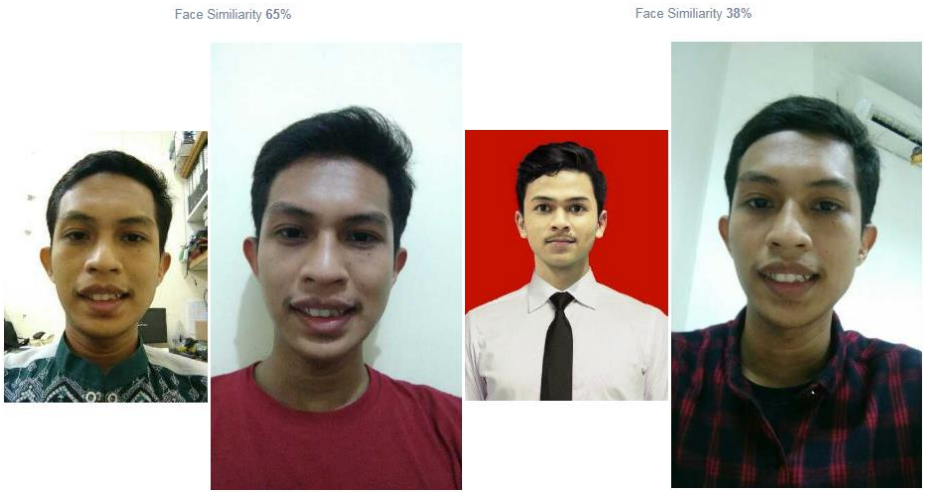

Figure 4. Face similarity.

5.0 RESULT AND DISCUSSION

After conducting a test using 52 pairs of photos of faces of employees with each of whom having 1 registered photo of face and 1 photo of face when doing attendance, a total of 104 photos of faces were obtained; From the test, the result of accuracy was 83% with a precision level of 100% and a recall rate of 81%. Table 2 explains the details of the test results.

Table 2. Result.

	True Valid	True Invalid	*Class Precision*
Pred. Valid	39	0	*100%*
Pred. Invalid	9	4	69%
Class Recall	*81%*	*0%*	

Here are some things that cause the level of accuracy to decrease :

- The errors in face orientation of photos, as in figure 5.

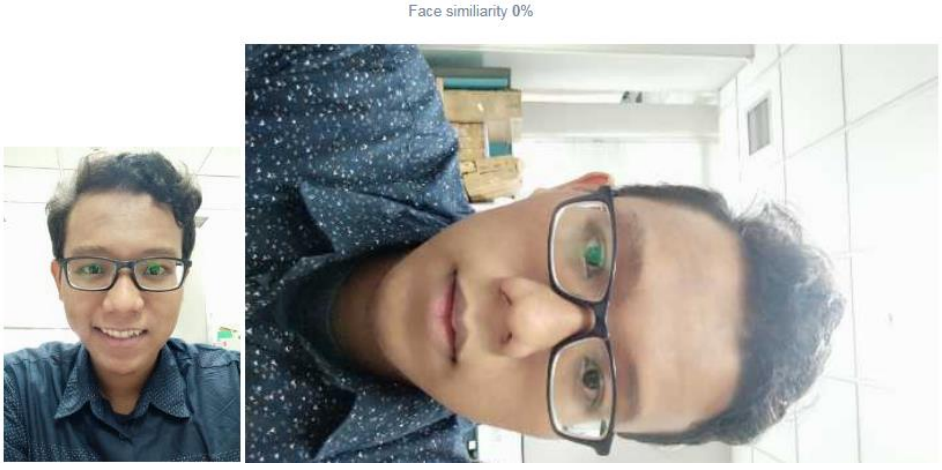

Figure 5. False orientation.

- The attendance photo that does not focus on the face, as in figure 6.

Figure 6. Face not focus.

- Too high threshold; the similarity level of 51% is a minimum benchmark for attendance to be considered valid but some photos of faces of valid employees have level of similarities below 50% within the range of 46% - 49%.
  But if the threshold is lowered to 46%, some employees' photos of faces that are not similar will be considered valid owing to the fact that the level of similarity is 48%, as in figure 7. This is a special condition for future studies because the similarity range of 45% -50% has a "warning" label so that further checks can be carried out.

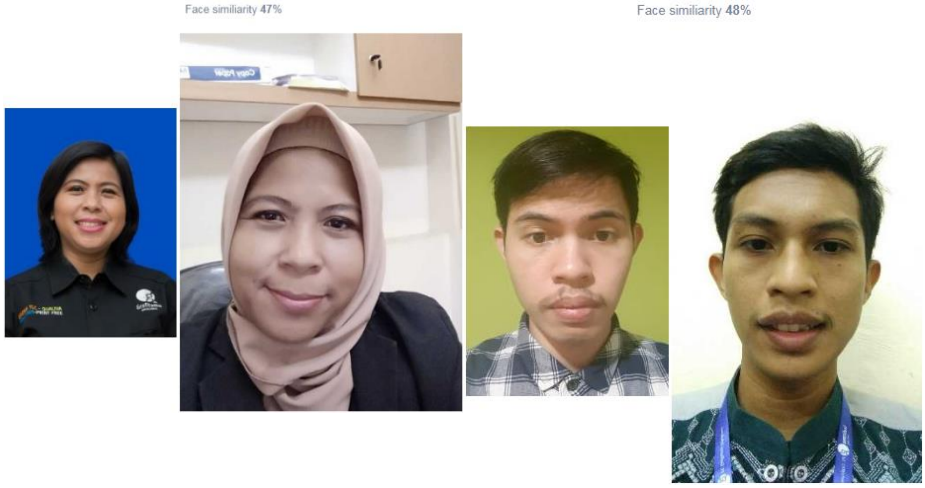

Figure 7. Similarity threshold.

From the results of research and testing, this research can be continued to improve the accuracy of face checking by using a face orientation checking system on the photo; if the photo orientation is wrong, the photo is rotated 90° clockwise or counterclockwise, so the orientation is correct.

Further research can also be done by implementing this algorithm on a smartphone, so in case the attendance photo is neither unfocused nor detected, the photos can be retaken.

6.0 CONCLUSION

Checking the face similarity using tiny face detector has an accuracy of 83% in a shorter period of time compared to manual checking by HR department staff. Using a threshold of 51% increases the precision level to 100% so checking the level of face similarity using tiny face detector on cloud-based HR applications can be implemented to check the validity of employees' attendance. Therefore, further research and testing are needed to improve accuracy and ease of use.

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