A real time mobile-based face recognition with fisherface methods

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Abstract. Face Recognition is a field research in Computer Vision that study about learning face and determine the identity of the face from a picture sent to the system. By utilizing this face recognition technology, learning process about people's identity between students in a university will become simpler. With this technology, student won't need to browse student directory in university’s server site and look for the person with certain face trait. To obtain this goal, face recognition application use image processing methods consist of two phase, pre-processing phase and recognition phase. In pre-processing phase, system will process input image into the best image for recognition phase. Purpose of this pre-processing phase is to reduce noise and increase signal in image. Next, to recognize face phase, we use Fisherface Methods. This methods is chosen because of its advantage that would help system of its limited data. Therefore from experiment the accuracy of face recognition using fisherface is 90%.

1. Introduction
At recent time, it cannot be denied that society benefits from ease of facility in cyberspace. Technology cannot be separated by society; that society could affects the progress of technology; and a thesis from determinist group could be dropped is one of many examples where technology deviates from its purpose originally, or its whole different effect comes from same technology [1], so technology can be utilized for a lot of things to obtain necessary information.

Face Perception or Face Recognition is a computational process in learning feature of face on image. As technology develops, face recognition is no longer able to utilized only in a desktop, but also in a smartphone, so it is more practical and able to be utilized anywhere in real time.

However, a problem arises when applying face recognition with data from university. Websites for student directories only have one image per every students in the university. This could give a significant effect due to lack of training data which will give impacts on accuracy of face recognition. By utilizing Fisherface Methods, this problem is expected to be solved.

2. Identification of Problems
Problem in this research is student identification process in a university using data from its public university websites. However, data from that website directory only have one image per person.
Therefore author will explain a methods where face recognition system could identify from data in directory from students directory and display the result to an application in Android operating system.

3. Previous research
Eigenfaces vs fisherfaces recognition using class specific linear projection [2] discuss the accuracy result in face recognition between Fisherface Methods and Eigenface Methods with specific linear projection on image objects in varying lighting and facial expressions. In this research, author concludes that Fisherface Methods is better at identifying face with varying facial expressions and lighting.

Pseudo-Fisherface Method for Single Image Per Person Face Recognition [3] discuss a modified method of Fisherface by researchers where the sample image for every identity is one. With this methods called Pseudo-Fisherface, every person could have several sample but only one dataset is saved and used in the system.

XFace: A Face Recognition System for Android Mobile Phones [4] discuss a face recognition with XFace Methods that developed by the researcher in mobile operating system, Android. XFace Methods is a face recognition with several pre-processing such as ROI (Region of Interest), LBP (Local Binary Pattern) feature extraction, reduction of feature extraction dimension with PCA (Principal Component Analysis) and LDA (Linear Discriminant Analysis) and classification of minimum distance.

4. Research methods
The general architecture which describes these methods which will be executed by the system can be seen in Figure 1.
4.1. Grayscaling
In this section, system will execute grayscaling on image. Grayscaling is a process to transform color image into grayscale image. Pixels image which originally consist value of RGB (Red Green Blue) and changed into Gray value in Grayscaling process[8]. The purpose of this grayscaling process is to reduce parameters which will be processed in next stage so the process would be faster.

4.2. Face Detection
In this section, the gray image will be processed to detect largest object in the image which probably is a face. This face detection process utilizes LBP (Local Binary Pattern) Methods Frontal Face. The reason for this is because LBP Methods uses minimum resource while reducing the accuracy about 10% to 20% when compared to Haar Classification [5].

4.3. Eye Detection
In this section, system will detect if there are eyes in the image. Once the system detect both eyes, the image will be rotated, resized, and translated so the result image will be an image with two eyes arranged to be horizontal from one with another.

In this system, two cascade classifier file will be used, one is Haar Cascade Eye and Haar Cascade Eye Tree Eyeglasses. Haar Cascade Eye is a cascade classifier which contains trained data for basic
eye in image, while Haar Cascade Eye Tree Eyeglasses is a cascade classifier which contains trained data for eye obstructed by eyeglasses in image

4.4. Histogram Equalization
In this section, system will execute a leveling on a histogram to leveling its lighting on an image. Usually, an image of face have a brighter side in one side when compared with its other side. Histogram equalization usually increases global contrast of many images, especially when the usable data of the image is represented by close contrast values [6]. Therefore, to reduce noise in that lighting, system will execute both side separately and entirely. The result of those process will be combined to make a whole new image consist of processed value from those images.

4.5. Bilateral Filtering
In this section, system will execute a process called Filtering. In image processing, this is one of most crucial process. The reason why it is crucial is because it reduce noises in image which affects greatly on processing. In this system, Filtering process which will be executed is called Bilateral Filtering. Bilateral Filtering is a filtering called blurring the image while keeping the edge of image [7].

4.6. Elliptical Mask
In this section, another filtering will be applied to processed image with elliptical shape to crop background and unnecessary image. This process is called Elliptical Mask since a layer with elliptical shape is used to mask the image. The purpose of this process is to minimalize noise in background and hair.

4.7. Fisherface Recognition
Fisherface Recognition used a feature extraction method to look for class-specific linear equations, Linear Discriminant Analysis (LDA) or also called as Fisher’s Linear Discriminant Analysis (FLDA) which is improved for Fisherface Recognition.

Fisherface Methods in OpenCV library require data training and data testing are in grayscale image. This Fisherface Methods also assumes that training data has same size with testing data. The disadvantage of Fisherface Method in OpenCV library is it doesn’t support update.

Recognition result from Fisherface is the label data in traindata.yml file for its feature has the less difference in data testing. This result will be generated by the system if the current data has similarity in training data which is called confidence in this system. The less confidence between the data, system will assume that the data is similar. For this research, threshold value for confidence used in the system is 0.7.

4.8. Database
Database in server has 2 tables, Face_Trait and sqlite_sequence. Face_Trait table is table where student data from directory is saved. This table has 4 fields which are id, image_name, nim, and name. Field id is an integer data with autoincrement, while image_name, nim, and name is a text-type of data. Sqlite_sequence table is a table generated by sqlite to save data for autoincrement for id in Face_Trait table.

4.9. Recognition Result
After recognition result is matched in the database, server will send information about student based on recognition in JSON form to Client. In user’s smartphone, system will shows data about student’s name which is recognized by system.

5. Result and Discussion
Before testing the application, system will be trained with 40 training data. Then testing is executed with 20 testing data. There’s two phase in testing data, Detection Testing and Recognition Testing.
5.1. Detection Testing
Data is given value “True” if face detection result from system is the same as expected from author, and is given value “False” if the result isn’t the same as what to be expected. Each left or right eye is given value “Detected” if the eye could be detected with more than 50% of the time, and is given value “Hard to Detect” if the eye is detected for less or 50% of the time. Eye detection for each side is important because with detected eyes, then the system will assume that the face faces front and will execute recognition process. For face and eye detection result can be viewed in Table 1.

| No | Image          | Face Detected | Left Eye Detected | Right Eye Detected |
|----|----------------|---------------|-------------------|--------------------|
| 1  | 151402001.jpg  | True          | Detected          | Detected           |
| 2  | 151402002.jpg  | True          | Detected          | Detected           |
| 3  | 151402003.jpg  | True          | Detected          | Detected           |
| 4  | 151402006.jpg  | True          | Detected          | Detected           |
| 5  | 151402007.jpg  | True          | Detected          | Detected           |
| 6  | 151402009.jpg  | True          | Detected          | Detected           |
| 7  | 151402010.jpg  | True          | Detected          | Detected           |
| 8  | 151402013.jpg  | True          | Detected          | Detected           |
| 9  | 151402014.jpg  | True          | Detected          | Detected           |
| 10 | 151402015.jpg  | True          | Detected          | Detected           |

Based on testing result, face detection in system is calculated as follows:

\[
Accuracy = \frac{\text{sum of data detected correctly}}{\text{sum of testing data}} \times 100% \\
Accuracy = \frac{20}{20} \times 100% \\
Accuracy = 100%
\]
5.2. Recognition Testing

For recognition testing, system is tested by the person directly as seen in Figure 2.

![Figure 2. Direct testing to students](image)

For result of this testing can be viewed in Table 2 as follows:

| No. | Expected Result        | Generated Result        | Result |
|-----|------------------------|-------------------------|--------|
| 1   | Surya Permama Putra    | Surya Permama Putra     | True   |
| 2   | Shifani Adriani Ch.    | Shifani Adriani Ch.     | True   |
| 3   | Sandy Pradana          | Sandy Pradana           | True   |
| 4   | Ayu Dwi Rizky          | Ayu Dwi Rizky           | True   |
| 5   | Muhammad Ravie         | Muhammad Ravie          | True   |
| 6   | Grace Lusiana Siregar  | Grace Lusiana Siregar   | True   |
| 7   | Riska Amaliyah         | Riska Amaliyah          | True   |
| 8   | Zuhroh Nilakandi Maulida | Zuhroh Nilakandi Maulida | True |
| 9   | Muhammad Ilham Rizky   | Muhammad Ilham Rizky    | True   |
| 10  | Hizkia Tarigan         | Hizkia Tarigan          | True   |
| 11  | Riyandi Syahputra      | Riyandi Syahputra       | True   |
| 12  | Muhammad Ari Winata    | Muhammad Ari Winata     | True   |
| 13  | Putri Ramadannia       | Putri Ramadannia        | True   |
| 14  | Rizki Sari Dewi        | Rizki Sari Dewi         | True   |
| 15  | Winda Indriani Tanjung | Winda Indriani Tanjung  | True   |
| 16  | Reno Maulina           | No Result               | False  |
| 17  | Faris Zharfan Alif     | Faris Zharfan Alif      | True   |
| 18  | Tata Feraro Mukarram   | Tata Feraro Mukarram    | True   |
| 19  | Rhama Perdani Ahmad    | Putri Adina             | False  |
| 20  | Rany Ervina Gultom     | Rany Ervina Gultom      | True   |

From 20 data testing which is tested, on 18 data result is not what expected because confidence which is generated by system between data testing and other system data is lower than supposed system data. This would cause system to give wrong identification to Client. Based on testing result, recognition testing from data testing is calculated as follows:

\[
Accuracy = \frac{\text{sum of data recognized correctly}}{\text{sum of testing data}} \times 100\%
\]

\[
Accuracy = \frac{18}{20} \times 100\%
\]
Accuracy = 90%

Based on calculated result, the accuracy with Fisherface methods reached 90%. Overall testing result can be viewed in Table 3:

| Testing               | Sum of Correct Data | Sum of Total Data | Accuracy |
|-----------------------|---------------------|-------------------|----------|
| Face Detection        | 20                  | 20                | 100%     |
| Eye Detection         | (20+20)/2           | 20                | 100%     |
| Fisherface Recognition| 18                  | 20                | 90%      |

6. Conclusions
Based on testing and research on collected data, several conclusions can be drawn: Student directory data from Universitas Sumatera utara can be used as data training. While Face recognition with data directory is successful with 90% accuracy. Preprocessing in system raise accuracy in face recognition.

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