



FACE RECOGNITION WITH OR WITHOUT MAKEUP USING HAAR CASCADE CLASSIFIER ALGORITHM AND LOCAL BINARY PATTERN HISTOGRAM ALGORITHM

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Abstract-Face makeup is applied to cover unwanted marked on the face in order to improve a person's appearance. However, this is used in criminal activities since makeup can disguise the true identity of the person. This concern serves as the basis by several studies to discover the technique and applied different methods to optimize the detection and improve accuracy. This study aims to conduct an experiment by applying new methods and techniques in order to provide new results which will increase the scope to consider. Furthermore, this study utilized best performing algorithms: the Haar-Cascade classifier for face detection, Color Feature Extraction for detection of face makeup and Local Binary Pattern Histogram algorithm for extraction and recognition of the features which applied in the experiments considering condition from fluorescent light and sunlight, angle variation of 0 degree, 45% upward and downward and distance of 0.5 meter and 1 meter. The study collected an over-all of 3000 images which will serve as the training datasets. In result, the experiment marked an average accuracy of 88.75% comprises all the methods applied. Specifically, the result showed an average result of both sunlight and fluorescent result with no makeup marked an average score of 90% while the result with makeup marked a score of 87.5%. Moreover, the results showed a higher recognition in near distance of 0.5 meters, the fluorescent light recorded an accuracy result of 90% and 0% degree marked a score of 100%.

Keywords— Image processing, face recognition; makeup detection; feature extraction; color model;

I. INTRODUCTION

Image processing is widely used in object detection, visualization, sharpening, restoring of image, and in pattern measurement that translates between the digital imaging devices and the human visual systems [1] that provides useful information. On the other hand, different applications are being developed to recognize the face image of a person [2]- converting the image sensor into digital images that suggests enhancement of image like extracting the objects, changing the size, scaling, and interpreting communications across a network through compression of an image [3].

Among the applications, facial recognition is one of the emerging areas in the research field and widely used to recognize the identify of a person [4], serve as access control to protect their devices [5], aid in security purposes [6], check criminal records, recognize patterns, find lost children by using the camera set up in public places [7], track attendance [8], and detect faces with makeup which is used in criminal activities.

A. Background of the Study

Several studies were conducted focusing on face makeup detection. The used of YouTube Make up database which serves as the training datasets however the study finds to determine the degree of makeup applied to the face [14]. The used of locality constrained dictionary learning to detect, analyze and remove makeup performs 87.73%. Issues on pose, expression and illumination and occlusion on makeup region which resulted an error in eliminating the sparse noise [15]. A makeup detector was also proposed to reduce the impact of makeup in the face when it comes to lighting issues which marked an over-all classification result of 99.35% [16]. A makeup detection with the used of Local Gabor Binary Pattern and Histogram of Gradient, Local Binary Pattern and Support Vector Machines marked a classification rate of 91.67% only due to texture , color and shape of face images [17]. An approach also was conducted to address the thirty degree angle variations, unintentional changes like tonsuring head and using scarf using Adaboost Face Detector and classifier in OpenCV and Haar-like filter. On the other hand, the study also looks into the algorithm to be applied to make the study successful. Based on reviews of literatures. Haar Cascade is a machine learning object detection algorithm. Moreover, it is tested on real and complex sequences like occlusions and poses variation [9]. Notably these algorithms provide the highest accuracy even images is profoundly affected by the illumination (Vandna Singh 2013) recorded 93.24%. In fact the AdaBoost Classifier Cascade is based on the Haar-Features for the object detected in various sizes [10] and notably provides a best result about 40-60% rate [11]. Also, the algorithm is used through Raspberry PI to track head poses position in high definition videos which obtained 30fps under 1080p resolution for higher accuracy and speediness (Rajashree Tripathy). Moreover, this algorithm has parallel processing multiple classifiers to accelerate the processing speed of the face detection. [12]. In addition, the Local Binary Pattern Histogram is used to analyze the face images in terms of shape and texture which is remarkably very efficient texture operators. In fact, it provides positive results and it is the easiest face recognition algorithms. These inputs provide opportunities for the researcher to conduct an experiment with a new approach and techniques which will serve new information. And since, there were limited studies on these, the study will apply different angles variations and lighting conditions with different types of lighting effects manipulated in Photoshop to check the performance of the algorithm used in this study.

B. Research Objectives

1. To build datasets which contain images with and without makeup in different angles and lighting condition.
2. To utilize the the Haar-Cascade Classifier to detect the face, Local Binary Pattern Histogram for feature extraction and face recognition, and Color Feature Extraction algorithm for makeup detection.
3. To build a prototype model to recognize the face and detect if the face is wearing or not wearing makeup.
4. To test the accuracy of the algorithm in this study.

C. Model of the Study

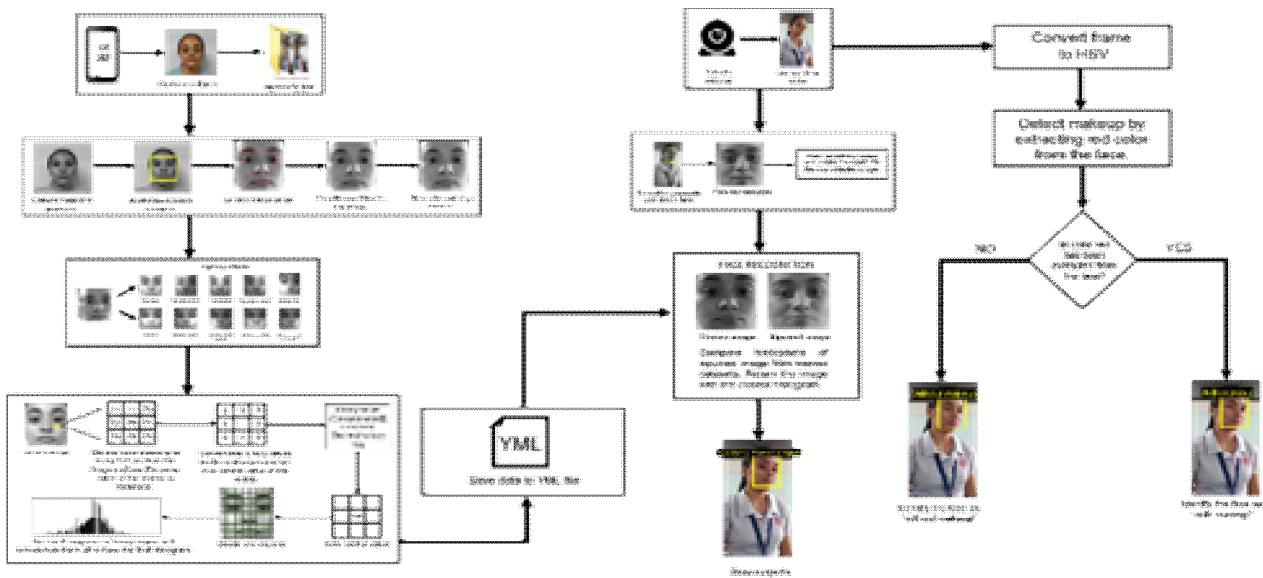


Fig. 1 Model of the Study

Fig. 1 shows the image is captured using mobile device in different angles and lighting condition which will serve as the training datasets of the model. In the testing part, the prototype model is used with the implementation of Haar Cascade Classification through analyzing the facial landmarks consist of eyebrows, eyes, nose and the mouth. Then the model extract the face features using OpenCV Local Binary Histogram Algorithm. And for detection, the model applied the closest matched based on histogram value of an image from the trained images. And, lastly for the makeup detection, the study utilized the capabilities of the Color Features extraction techniques to detect if the face image contains makeup or not.

II. METHODOLOGY

A. Building the images

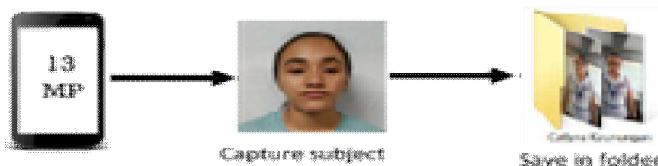


Fig. 2 The training datasets of the study

Fig. 2 shows how to build the images into classifications. The images were captured using a Smartphone with 13 megapixels camera. The study selected 10 subjects composed of five (5) females and five (5) males and capture each faces according to the following features – (a) without makeup and neutral (5 images per subject); (b) without makeup and smiling without showing teeth (5 images per subject); (c) without makeup and smiling while showing teeth (5 images per subject); (d) with makeup and neutral (5 images per subject); (e) with makeup and smiling without showing teeth (5 images per subject); (f) with makeup and smiling while showing teeth (5 images per subject) using various lighting model and capture in 0.5 meters and 1 meter in distance with an over-all total of 300 images. Makeup on the face includes eyebrow makeup, blush on, and lipstick/lip tint. The images will be saved on different folders with their names as the names of the repository

B. Image Processing

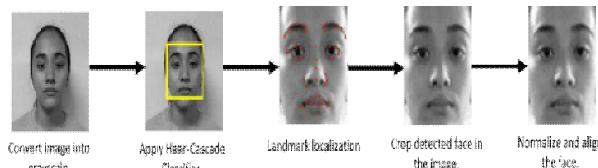


Fig. 3 Image Conversion

Fig. 3 shows the pre-processing of the image from its raw file then cropped to 500 x 500 in dimension then converts the image into greyscale.

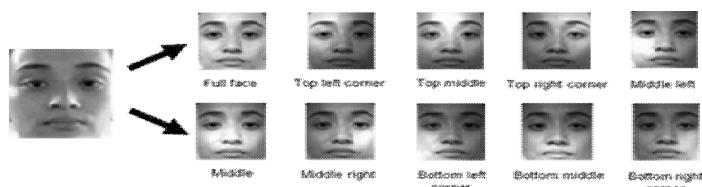


Fig. 4 Ten lightning Effects

Fig. 4 shows that the model applied the lighting effects modified in Adobe Photoshop. The images applied the lighting effect in a full face, top left corner, top middle top right corner, middle left, middle, middle right, bottom left corner, bottom middle, and bottom right corner in order to produce variety of features which will serve as the training datasets thus also increase recognition accuracy. Thus, the total images resulted to 3,000.

C. Face Detection

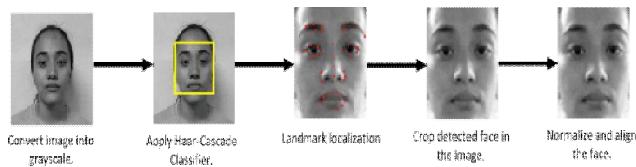


Fig. 5: Application of Haar Cascade Classifier Algorithm

The study used OpenCV, Haar Cascade Classifier Algorithm to detect the face on the image and convert the image into grayscale and calculate the x and y coordinates of the face using frontal face classifier which consists of eyebrows, eyes, nose, and mouth. Landmarks (using DLib) is used to normalize the images.

D. Feature Extraction

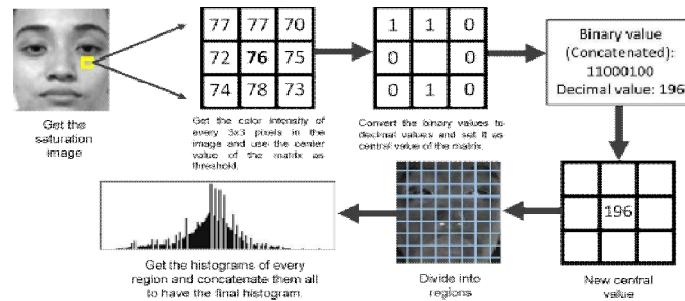


Fig. 6: Feature extraction using Local Binary Pattern Histogram

The features were extracted using API local binary patterning with 3x3 pixels with the intensity values of each pixel. The central value of the matrix will be used as the threshold. Secondly, it would set a new binary value for each neighbor of the central value (threshold). Then, convert the binary values to decimal and set it as a central matrix value. LBP on the other hand, process would be repeated to each region of pixels of the image until all regions have values.) After getting all the LBP values, the image would be divided into multiple grids using Grid X and Grid Y then extract histogram in each region/grid. Lastly, it would concatenate each histogram to create the final histogram of the image. These histograms would be then saved in YML file. The extracted histograms would also serve as the trained datasets.

E. Makeup Color References

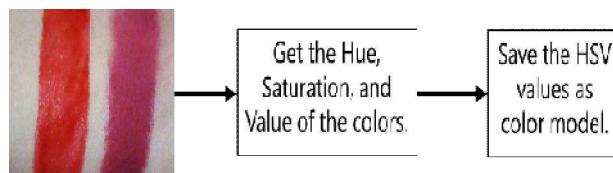


Fig. 7: Getting the Color References

Fig. 7 explains how the color references are obtained. The study used two different lip makeup colors (from lipstick and liptint) to be used as the color references. These colors will be extracted and the HSV values will be get then save them as the color models.

F. Face Recognition and Makeup Detection

Face recognition is used for identifying the person being captured from the camera, while makeup detection would identify if the person is wearing makeup or not. The study used Euclidean distance for comparing histograms.

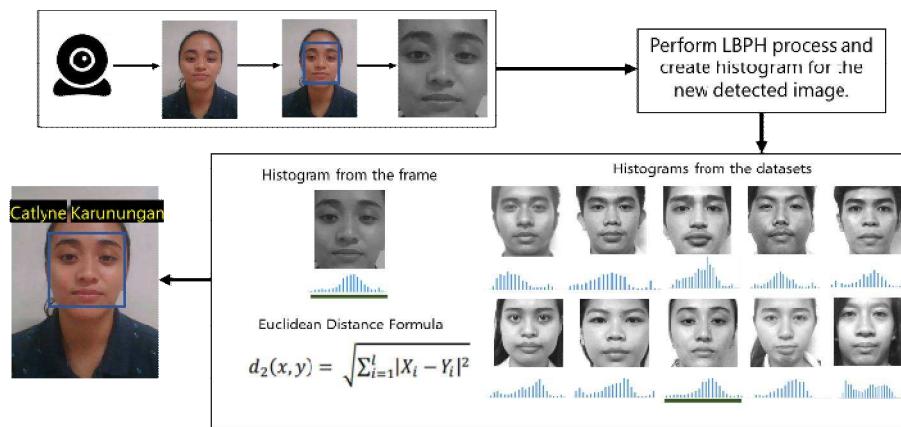


Fig. 8: Face Recognition Steps

Fig. 8 shows the flow of facial recognition. Using a web camera, a real-time video would be set up. Once the face had been detected on the video using Haar Cascade Classifier, the face would also undergo LBPH process. Using Euclidean distance, the system would find the images on the dataset with the nearest histogram from the detected face. Once the images matched, the system would show the name of the subject on the screen.

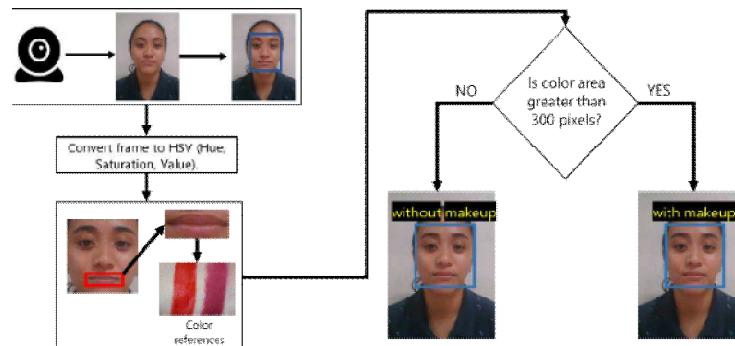


Fig. 9: Makeup Detection Steps

Fig. 9 shows the flow of makeup detection. Using a web camera, a real-time video would be set up and its frames were converted from RGB to HSV (Hue, Saturation, Value) values because HSV color space is more robust to lighting changes [13] and the face would be detected using Haar Cascade Classifier. Then, color feature extraction technique was used to detect the color from the face specifically on lips. If the color from the testing subject matched from the ranges of color models/references in the system and is extracted and detected from the face, the system would identify the face as "with makeup"; otherwise, it would identify the face as "without makeup".

G. Prototype Model



Fig. 9 Recognizing Face using the Prototyped Model

Fig. 9 illustrates the prototype that was written in Python and used OpenCV as the library for image processing; Haar Cascade Classifier for face detection, and Local Binary Pattern Histogram.

III. RESULTS AND DISCUSSION

The study assessed the accuracy based on the number of the subjects being detected together with accurate information like the name and the label of a person if it wearing making up or not. Given the formula below

$$\text{Accuracy} = \frac{\text{Number of face detected}}{\text{Number of testing face image}} \times 100$$

Furthermore, the study used the same ten subjects (5 males and 5 females) that were used to gather the datasets to test the accuracy of the prototype model. Listed below are the accuracy results on different angle variations, distances, and lighting conditions.

Table 1. Result of Recognition with Makeup using Fluorescent Light

| Angle Variation | Distance | |
|-----------------------------|-----------|---------|
| Face Angle | 0.5 meter | 1 meter |
| Frontal Angle 0 degree | 100% | 100% |
| Upward Angle in 45 degree | 90% | 80% |
| Downward Angle in 45 degree | 80% | 80% |
| Average Result | 90% | 86.66% |

Table 1 used fluorescent as light and faces with makeup with an average result of 90% in the first distance and 86.66% on the second distance. In line with this, the reason why upward angle in 45 degree on 0.5 meter is only 90% is that fluorescent light affects the dominant face features; hence, the system cannot recognize the face properly. On the other hand, the upward angle in 45 degree on 1 meter results with 80% because of the range of the subject from the camera, making also less features on the face to be detected and recognized.

Table 2. Result of Recognition without Makeup using Fluorescent Light

| Angle Variation | Distance | |
|-----------------------------|-----------|---------|
| Face Angle | 0.5 meter | 1 meter |
| Frontal Angle 0 degree | 100% | 100% |
| Upward Angle in 45 degree | 100% | 90% |
| Downward Angle in 45 degree | 80% | 80% |
| Average Result | 93.33% | 90% |

Table 2 used fluorescent as light and faces without makeup with an average result of 93.33% in the first distance and 90% in the second distance. In accordance with this, the upward angle in 45 degree on 1 meter got 90% because the size of the eye changes as the head moves upward therefore not having the same shape as on the datasets. For the downward angle in 45 degree with a distance of 0.5 meter, the percentage is 80% because the datasets are only in frontal angle with zero degree, which do not satisfy the tested angle; same reason with the distance of 1 meter, which is also 80%.

Table 3. Result of Recognition with Makeup using Sunlight

| Angle Variation | Distance | |
|-----------------------------|-----------|---------|
| Face Angle | 0.5 meter | 1 meter |
| Frontal Angle 0 degree | 100% | 100% |
| Upward Angle in 45 degree | 70% | 70% |
| Downward Angle in 45 degree | 90% | 80% |
| Average Result | 86.66% | 83.33% |

Table 3 used sunlight and faces with makeup with an average result of 86.66% on the first distance and 83.33% on the second distance. The result in upward angle in 45 degree on 0.5 meter, which is 70%, is due to the sunlight that makes the eye makeup (eyeliner) more defined, making the subject looks different from the saved datasets. In addition, the upward angle in 45 degree on 1 meter is also 70% because of the distance between the subject and the camera, making the system detect the face with makeup that covers the bare face and is hard to recognize. The outcome on the downward angle in 45 degree on 0.5 meter is 90% since the sunlight does not affect much of the entire face of the subject. Moreover, the downward angle in 45 degree on 1 meter is 80% due to sunlight conditions and occlusions, which make the eyebrow line of the subjects change in downward angle on far distance.

Table 4. Result of Recognition without Makeup using Sunlight

| Angle Variation | Distance | |
|-----------------------------|-----------|---------|
| Face Angle | 0.5 meter | 1 meter |
| Frontal Angle 0 degree | 100% | 100% |
| Upward Angle in 45 degree | 80% | 80% |
| Downward Angle in 45 degree | 90% | 80% |
| Average Result | 90% | 86.66% |

Table 4 used sunlight and faces without makeup with an average result of 90% in the first distance and 86.66% on the second distance. For the upward angle in 45 degree with a distance of 0.5 meter, the result is 80% since the sunlight makes the shadow on face decrease especially on the upper part from eyebrows to nose. Similarly, the sunlight and distance also affect the face features of the subjects that are on upward angle in 45 degree on 1 meter. On the other hand, the downward angle in 45 degree on 0.5 meter results to 90% because the angle variation is different from the trained datasets, and the downward angle in 45 degree is 80% because of the long distance between the subject and the camera making the face look smaller and does not have a clear face features.

Table 5. Summary Result of Recognition with Makeup using Fluorescent Light & Sunlight

| Angle Variation | Distance | |
|-----------------------------|-----------|---------|
| Face Angle | 0.5 meter | 1 meter |
| Frontal Angle 0 degree | 100% | 100% |
| Upward Angle in 45 degree | 80% | 75% |
| Downward Angle in 45 degree | 85% | 80% |
| Average Result | 88.33% | 85% |

Table 5 used fluorescent light as well as sunlight and faces with makeup with an average result of 88.33% in the first distance and 85% on the second distance. The upward angle in 45 degree on 0.5 meter is 80% because the lighting condition affects the color of the lip makeup, and the upward angle in 45 degree on 1 meter is 75% because the face is far from the camera, hence the detection of the color of the lips is not accurate. Additionally, the downward angle in 45 degree on 0.5 meter is 85% due to the angle variation that made the color of the lips darker because of the shadow. Likewise, the downward angle in 45 degree on 1 meter is 80% because of the same reason with upward angle where the distance of the subject is far from the camera, making the detection of the color of the lips inaccurate.

Table 6. Summary of Result of Detection without Makeup using Fluorescent Light & Sunlight

| Angle Variation | Distance | |
|-----------------------------|-----------|---------|
| Face Angle | 0.5 meter | 1 meter |
| Frontal Angle 0 degree | 100% | 100% |
| Upward Angle in 45 degree | 90% | 85% |
| Downward Angle in 45 degree | 85% | 85% |
| Average Result | 91.67% | 90% |

Table 6 used fluorescent light as well as sunlight and faces without makeup with an average result of 91.67% in the first distance and 90% on the second distance. The upward angle in 45 degree with a distance of 0.5 meter is 90% because some of the subjects' lip color are closely similar to the range of colors on the system; therefore, some of the faces are identified as "with makeup". The reason is same with the upward angle in 45 degree on 1 meter with a result of 85%. For the downward angle in 45 degree with a distance of 0.5 meter, the result is 90% due to the lighting condition that made the lip color different. Lastly, the downward angle in 45 degree on 1 meter is also 85% because of the similar reason with the previous one where the lighting condition does not reached the bottom part of face, making the color of the lips darker.

IV. CONCLUSIONS

Based on results, the prototype model works efficiently when the subject is near the camera, without makeup of 90.83% while the 0 degree of 100% angle and the used of fluorescent of 90% however, it may create adverse result due to face occlusion, resolution, noise and distance issues. For further enhancement of this manuscript, the researchers recommend the following:

- Consider to add algorithm to detect the degree of makeup to make it more effective and efficient.
- Use a high-resolution web camera.
- Add building images while considering other makeup accessories.

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