Face Movement Detection Using Template Matching

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Abstract— ***Face recognition process can be used for individual verification and identification. Generating an image that can be used for identification, manipulation, modeling, pattern recognition, and object search is the main thing on face area determination. The template matching method used the intercourse between the input image pattern and the referral face pattern along with its features. In this paper will be purposed about face detection use template matching method on movement face. The technique used is to determine the face region by separating the skin region to non-skin region. Detected face area is dynamic. Faces can move horizontal or vertical. Then the results of the process is a face image model. The face image model will show whether the skin is a face region, which will also produce coordinates of the face region***

Keywords— Face recognition, template matching, movement face detection.

I. INTRODUCTION

Humans often use face detection to recognize other individuals. Initially, face recognition algorithm used simple geometric model, then this model continues to better evolve so that it becomes the representation of advanced mathematics and matching processes. The last ten to fifteen years, great advances and initiatives have encouraged face recognition technology into an alternative method. Face recognition process can be used for individual verification and identification. In another case, partial face recognition development has generated a lot of literature, but only part of the study has tried to analyze whether and how the partial face biometry actually appears to have the negative effect on the level of accuracy and error [1].

Detecting an object is part of computer technology, especially in computer vision. This field will image processing of an object and the computer vision can interact to recognize the specified part of an object. For example human faces, fruits, leaves, buildings, trees, cars and others. The object that will be processed can be obtained from the digital image or video frame. Face detection algorithm is based on how to determine whether there is a face in the picture or not [2]. In other words, face detection is a process of searching automatically for a face object displayed on a picture or video [3].

Identify the target face on an observation, where the face is placed regardless of position, scale, orientation, lighting conditions, expression, etc. Faced with these challenges, previous face detection research had focused on computer vision [4]. Generating an image that can be used for identification, manipulation, modeling, pattern recognition, and object search is the main thing on face area determination.

In this paper will be discussed the face detection use template matching method on moving face. The technique used is to determine the face region by separating the skin region to non-skin region. Detected face area is dynamic. Faces can move horizontal or vertical. Then the results of the process is a face image model. The face image model will show whether the skin is a face region, which will also produce coordinates of the face region.

II. DIGITAL IMAGE DETECTION

A. Digital Image

The reference image is the original image captured by a camera, that can also be called a digital image or RGB. The next reference image will be processed by the specified method. A digital image display system or so-called a reference image can be seen in Figure 1. A Digital image can be obtained automatically by sampling process of a three-dimensional object that will form a matrix. The value of light intensity is the elements of the matrix.

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Fig. 1. Image reference

A Digital image is an image in a two-dimensional field. Images are also values with certain functions. An Image is a collection of colors in RGB, which can look beautiful, have patterns, abstracts, etc. By type, the image is divided into two types: the still image and the moving image. Still, an image is a single stationary object that does not move. While moving image is a collection of still objects that displayed sequentially within a certain time range, making it visible as a moving image. Each image in the sequence is called a frame [2] [5].

B. *Image Detection*

The face image is an important analysis in the interaction between human-computer (Human-Computer Interaction / HCI) based on computer vision study. Face detection is a series of process to find solutions where the position of the image should be determined. The goal is to identify all areas of the image containing a face. In the case, the process must not ignore the positioning factor of three-dimensional, direction, and lighting conditions.

Display images such as pose, scale, rotation and image orientation, face expressions, are difficulties related to face detection systems due to variations in images. Face detection is when fluctuating image is given, face detection will determine whether there is a face or not in the image, and if there is a face, the location and extent of the image will be determined. The things that effect in face detection are; position, the presence of structural components, face expression, occlusion, image direction, and image condition. Skin color has been used and proven to be an effective feature used in face detection. Although each human being has different skin color, the main difference is in the intensity of the color.

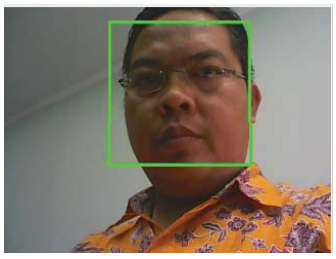

Fig. 2. Image detection

In the process of face detection, if given an image whose variations in the position change, this would make the detection process becomes a little complex. The detection process would check periodically whether or not there was a face in the image. If the face image was found, it will be determined the location and area of the image. Human Skin Color was an effective character in the face detection process. Although every human being has a different skin color. but which are seen in the process was the color skin intensity.

III. Material and Method

A. *Template Matching*

The Template Matching Method was generally used for getting the face areas, with the greatest possibility to be a human face. A Template was the examples from the object or the facial features that are the main target. The template matching method used the intercourse between the input image pattern and the referral face pattern along with its features. In other words, matching the two face image features to find the closeness of the data. This approach also used some predefined templates, whose the purpose was for detecting faces. This method will compare the sub-regions and the predetermined template in a way of executing the pixel intensity data which is obtained before [1].

The used template matching algorithm can be seen on Fig.3. in that picture there was a Data. Data was a representation of the whole entire face detection process. The data has stages of the process that must be done. The final result of the process was face detection. The results could be viewed as in Fig.2. The steps are as follows: 1) assign a face image as the original image data. This image is obtained from the camera; 2) Resized the obtained image. the objective of image resize was to get an ideal resolution of the image so that could used in the image processing process; 3) Processing the skin color model with the lore of the color space. Then calculate the similarity of color, color conversion to grayscale, segment the image (skin segmentation) to get skin color or not skin color; 4) Displays the results of the process that has been done, if the possibility of the face area is detected it will be displayed as a skin region.

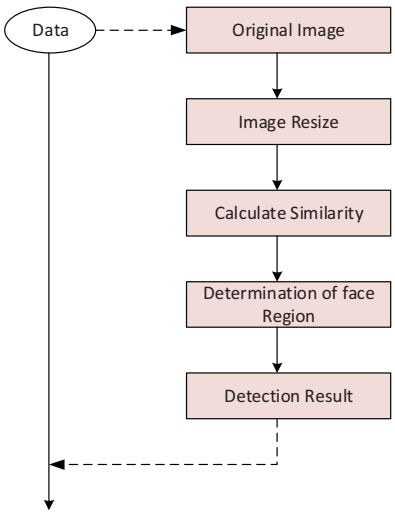

Fig. 3 Method Flowchart

B. *Skin Segmentation*

In face detection algorithm, the first step is skin segmentation. Skin segmentation aims for disposing of as

many imageries as indicated as skin areas. By applying Gaussian distribution on the skin color model, will obtain the possibility of skin for any pixels from images, as seen on fig.4. There are two ways that can be used in segmentation based on skin color, there is convert RGB image to YCbCr space or using the RGB to HSV method. But in this paper will use the RGB method into the YCbCr space. This is because this method has the advantage of eliminating the effects of luminance when converting an image to YCbCr space. To get the value of skin color spread can be searched with this allowing Gaussian model equation, N(mC)

Rerata : $m = E(x)$, dengan $x = (r \quad b)^T$

Kovarians : $C = E\{(x-m)(x-m)^T\}$

The color histogram on Fig 5 showing the spread of skin tones for the various people who are clumped in chromatic color space. In the RGB space, each component image (red, green, and blue) has different brightness levels. Therefore in the YCbCr space, all information about the brightness level is given by component Y, because the components of Cb (blue) and Cr (red) are independent of luminance. For the equation is as follows.

$$P(CrCb*|skin) = \frac{[CrCb*]_{skin}}{Total_{skin}} \quad (1)$$

And the conditional probability of a pixel color in the YCrCb space, considering it is a pixel with non-skin color:

$$P(CrCb*|nSkin) = \frac{[CrCb*]_{nSkin}}{Total_{nSkin}} \quad (2)$$

We can use the Bayesian classifier, with the minimum cost decision rule [10]:

$$\frac{P(CrCb*|nSkin)}{P(CrCb*|skin)} \leq \alpha \quad (3)$$

Where:

- $[CrCb*]_{skin}$ is the number of pixels with the CrCb* color in the skin histogram;
- $[CrCb*]_{nSkin}$ is the number of pixels with the CrCb* color in the non-skin histogram;
- $Total_{skin}$ is the total number of pixels counted in the skin histogram;

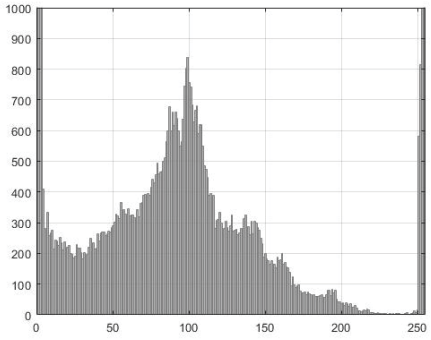

Fig.4 Skin histogram for Thresholding

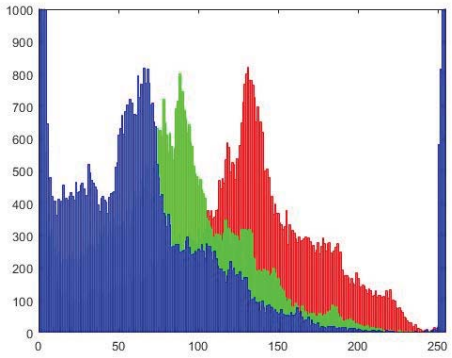

Fig.5 Skin histogram for RBG

C. Skin Region

The skin area was defined as a closed region in an image, which can have 0, 1 or more holes in it. The color restrictions ware represented by pixels with number 1 for binary imagery. All holes in a binary image had a pixel value 0 (black area). Number of holes in a skin area The number of holes in a region could be searched by counting Euler's number from the region, which is defined as follows: H CE − = with E = Euler's number C = number of connected components H = number of holes in an area Center of mass To learn the skin area, it was necessary to determine the area and center from the skin area. One of the ways was by calculating the centroid from the skin area. Center area in the binary image was the same as the mass center and could be calculated as follows.

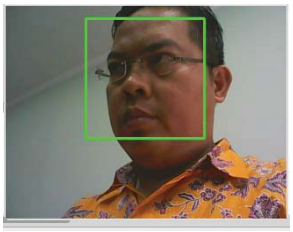

Fig. 5 Skin Region at a certain angle

Most faces were used in a vertically oriented face detection. Nonetheless, there were images with a bit of tilt angle. for getting a high compatibility in rotating a corresponding face of the model with the angle that fit the original image needed a proper way. θ slope angle given by the following formula.

$$\theta = \frac{1}{2}\tan^{-1}\frac{b}{a-c}$$

with

$$a = \sum_{i=1}^{n}\sum_{j=1}^{m}(x'_{ij})^2 B[i,j]$$

$$b = 2\sum_{i=1}^{n}\sum_{j=1}^{m}x'_{ij}x'_{ij}B[i,j]$$

$$c = \sum_{i=1}^{n}\sum_{j=1}^{m}(y'_{ij})^2 B[i,j]$$

and $x' = x - \bar{x} \;;\; y' = y - \bar{y}$

D. Framework

In this paper proposes a template data processing technique that minimizes the detection area so that it matches the ROI. The detection area includes the front face area and right and left side faces. Face data retrieval for right and left side, done by rotating face periodically. This rotation is done up to an angle of 90^0. Method to be described in this paper has the following goal

- Find the template based position of faces in an image,
- Find the template rotate the position of faces in a mage.

We assume that:

- The environment lighting is controlled and stable,
- The camera where the system will work is dynamic (moving),

The system will detect for some angles face positions. In this section, the research is focused on the design of face detection system and using the cheap device but has good performance. In outline, steps will be done as in Fig 6.

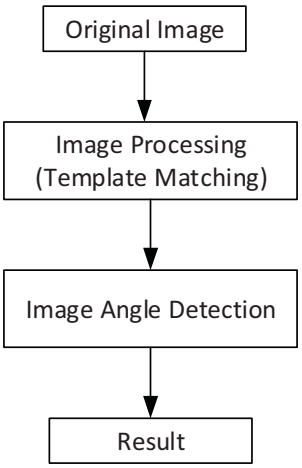

Fig. 6 Framework

The system will detect for some angles face positions. In this section, the research is focused on the design of face detection system and using the cheap device but has good performance. In outline, steps will be done as in Fig 6. Described in the preceding section. After that, shooting is continued by turning the face. The rotation on the face is done clockwise and counterclockwise. The maximum rotation angle is 90^0. The next process is to display face results in a quadrilateral ROI like Fig.5

IV. Result and Analysis

The results of the experiments performed will be discussed in this section. The obtained results are divided into two parts, the first is the result data for the neutral position and the second is the position in some corner of the catch image of the face (rotating position). The data retrieval process consists of 4 processes namely 1) Displaying the reference of image data; 2) displays the grayscale conversion image; 3) displaying skin segmentation result image; 4) displays the image of thresholding; 5) displays the image of face detection in ROI. All the views can be seen in figure 9.

Captured face image data from the camera will be displayed in the original. This process does not require any specific algorithms or techniques. See figure 8 (a). Any results obtained from the camera will be displayed in intact. Both from the side of the face as well all the color attributes of the features that come with it. The resolution used in capturing the image is 320 x 240 pixels. This is the standard resolution used in the retrieval of an image. Afterward, an image that has been obtained in RGB format, will be converted first into the grayscale format. It is aimed to know the value of color intensity level. The colors are black, gray, and white. Gray levels here are the color of gray with various levels from the black to the closest to white.

The next step is to process the original face image data into the skin segmentation. This process aims to ensure that the obtained image data is skin or not a facial skin. The results can be seen in figure 8 (b). In that picture, all image features other than the facial skin image will be removed. The point is that only skin color is displayed, besides the skin color will be blackened. The next process is thresholding. This process aims at the grayscale image process into binary or black and white images so that it can be known which region includes the object and background of the image clearly. The results of this process can be seen in figure 8 (c). Everyone has a different face skin color, therefore needed adaptive thresholding process in order to obtain the optimal value.

The final step of this process is to show the results of face detection in the frame of the region of interest (ROI). The results can be seen in figure 8 (d). The template matching process is a process for obtaining cross-correlation values between the skin areas indicated as the face area with the model facial image. Once the system decides that the processed skin area corresponds to the human face, it will be determined a new image (gray level imagery) with the area declared as facial skin replaced with the face of the model. Then the face is marked as an inspection box on the reference image. This indicates that the face area is detected.

A. Neutral Position

An object image is placed right in front of the camera. So the image of the face that is captured is the face of the front. The illustrations can be seen in figure 7. In the picture, there are two images that are oriented head looks up. An empty circle image indicates a head with an unknown face position. Then the circle image is pocked down and leveled, is ahead illustration with a face facing the arrow. This indicates that the face is in the front position. Furthermore, this position is called neutral position. This position is the first data position in the face detection process. The result will show full face detection, as shown in figure 8.

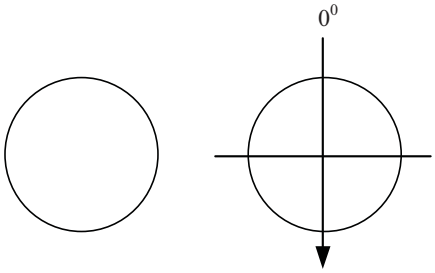

Fig 7. Top view of the Neutral position

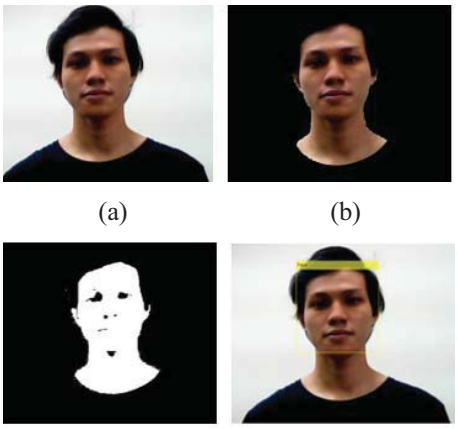

Fig 8. Face detection for neutral position

B. *Rotating Position*

Rotating position is the process of taking face image in several positions. This is illustrated in figure 8. In the picture, the face image rotates in two directions, That is clockwise and counterclockwise. The number of image positions in opposite directions is two positions. These positions are located at the 45^0 and -90^0 angles. This position is illustrated by two arrows that rotate in the opposite direction of the clock. See figure 8 (a). The range of the two arrows indicates the reference angle of 0^0. This also applies to the clockwise position. See figure 8 (b). But that distinguishes only the direction of rotation. The image positions are located at 45^0 and -90^0 angles from the angle range 0^0. The overall result view of this process can be seen in figure 9.

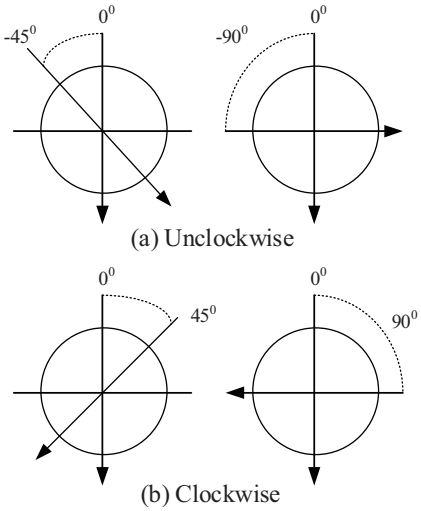

Fig 9. Top view of rotating position

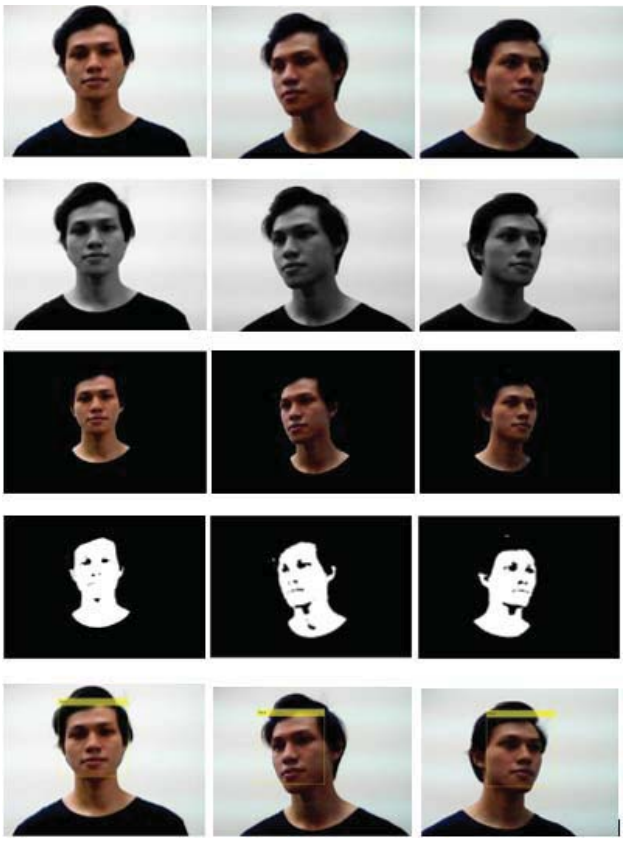

Fig 10. Face detection for rotating the position

CONCLUSION

Any results obtained from the camera will be displayed in intact. Both from the side of the face as well all the color attributes of the features that come with it. The resolution used in capturing the image is 320 x 240 pixels. Rotating position is the process of taking face image in several positions, which is illustrated in figure 9. In the picture, the face image rotates in two directions, That is clockwise and counter clockwise.

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