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Applying Image Processing Algorithm to Dynamic Face Detection

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Abstract. *An image processing algorithm is applied to detect dynamic human face. In this study, a Kalman filter algorithm is applied, which can track the dynamic human face. After the target image is captured, the pre-image processing is applied to enhance the saturation of image and the noise will be filtered out also. And then, one algorithm is applied to segment the image and extract the complexion by using color space transformation. The system can estimate the features in the detected image and choose the connected components in human face. Furthermore, the Kalman filter algorithm is applied to predict the dynamic coordinates of human face. Based on the experimental results, the proposed algorithm in this paper can detect the motion face efficiently.*

Keywords: Kalman filter algorithm, dynamic human face, color space transformation

1. **Introduction.** The applications of face detection algorithm [1-4] are very popular and play an important role in many situations. For example, it is usually applied in a security system, entrance checking system, checking safe condition of car driver, and etc. An image processing algorithm for face detection under dynamic or static status is presented in his paper. In this study, the background subtraction algorithm [5-6] is applied to enhance the processing efficiency. This method can improve the complexion enhancement which will let the contrast more sharply. The proposed method in this paper can detect the human face even though in different situations, such as in a complex background image, face with different complexions, and illumination variation. This algorithm can find the place which includes the human face effectively. In order to detect human face in the dynamic vision, the Kalman filter algorithm [5-6] is applied in this study.

In this paper, the YCrCb color space is applied, which does not need complicated spatial conversion, and only needs to calculate two edges that may exist in the skin color. Therefore, the operation efficiency of skin color enhancement is greatly improved. In order to enhance the detection accuracy, the multiple feature values are applied to find the face also. Each feature value can be obtained by simple calculation, and can assist the program to find the position of the face in a complex image. There are two detection algorithms in this study, which include the human face detection in a static image and the other one can detect human face in the dynamic vision. There are four steps for detecting human face in the static image. The first step is the pre-processing of image. The second step is the image segmentation and image extracting. The third step is to estimate the features of face in captured image. The last step is to choose the connected component which includes human face. In this study, both the Kalman filter algorithm [4-5] and the background subtraction are applied to enhance the processing efficiency. The background subtraction method can filter out the background image effectively and the Kalman filter algorithm can predict the dynamic coordinates of human face.

The rest of this paper is arranged as follows. The image processing algorithm is described in the second section. The detail algorithm proposed in this paper is described in the third section. The fourth section is the experimental test. In this section, the experimental results by using the proposed algorithm are presented. The conclusion is presented in the last section.

2. **Image processing Algorithm.** In the detection process, the saturation of complexion research is enhanced first and then the Windyga method is used to filter out the noise [4-6]. For image segmentation, the algorithm uses the Marr-Hildreth filter and Sobel filter to segment the image. Then the HSV and YIQ color space is applied to extract the complexion. Finally, the morphological process is applied to filter out the small pieces in the processed. In the third step, the algorithm calculates the size of each connected component that use thinning method to obtain the perimeter of each connected component. Thus, this algorithm estimates the roundness of each connected component by the acquired size and perimeter. In the last step, the algorithm calculates the weights of each connected component by the features estimated in the third step, such as size, perimeter, roundness, and it can determine which connected components have the human faces.

The detail steps of image processing are shown as follows. After a series of images captured by the camera, and then the algorithm applies the image processing technology to acquire the information for the further process [7-9]. At first, the pre-image processing is applied to capture the target image, enhance the saturation of complexion, and filter out the noise also. In order to obtain better effect, the image enhancement algorithm is applied also. In the process, the region of interest (ROI) is set to remove the unnecessary area of pattern in the image. In general, the image is in RGB color space, but this kind of image sometimes will be affected by shadows. In order to avoid the influence effect, the HSV color space is proposed. In order to reduce the computation burden, the system usually converts the color image to grayscale image. The

converted image may contain some noise. The noise needs to be filtered out before applying the edge detection processing. In this paper, the Canny edge detection method is proposed to detect the edge of the object. Because the Canny edge detection method has done the filter out noise in pre-processing. The Canny edge detection method applies dual hysteresis thresholds, which let Canny edge detection have some advantages which can filter out noise and enhance edges.

Morphology process is often used in target detection, noise removal, block segmentation and skeleton boundary capture. The operation is used to mask in the image of the pixels as a shift operation. The different Morphological algorithms can do different treatments to achieve image segmentation and recognition purposes. Many of the applications of morphology can be deduced based on these basic operations to perform advanced image processing. In addition, applying morphology to image processing simplifies image data and maintains the basic outline of the graph.

In order to capture the area of skin color in the image, it needs to find out the color distribution of skin image, which is the most concentrated to facilitate subsequent image segmentation. The data set used in this paper is more than 3,000 facial photos. The database covers different races such as yellow, white, and black. The values of gray-scaled skin color are scattered between 46 and 239 (gray-scale values are 0-255), which is a very wide range. In this study, the distribution of skin color is analyzed by using more than 3,000 images, and then determines the color space which needed for subsequent image processing. At first, this research converts the image into the color space described as above, and then makes a line graph based on the numerical value and the number of pixels. The statistical standard deviation can observe the concentration of skin color and each color space. According to the statistical data, we can find where color information and brightness are separated, and where the distribution of skin color is more concentrated. Then we will count the distribution of the color information of the skin color in different color spaces under different brightness and grayscale values.

3. **The process of face detection Algorithm.** The main process of static human face detection algorithm is shown in Figure 1. The process has four steps which are image pre-processing, image segmentation and extraction, feature value calculation, and image block selection. The major work of image pre-processing is to enhance skin color compensate for dark areas and filter out image noise. The part of image segmentation and extraction is to extract skin color blocks. In order to identify the block of human face, the feature value need to be calculated.

The color compensation process is shown in Figure 2. In this process, it will adjust the brightness of some slightly darker pixels to reduce the contrast between light and dark in the image. After the brightness is adjusted, the part which is too bright or too dark will be filtered out. The color enhancement parts include that are the most saturated color of the skin color and the color desaturation. After the skin color is strengthened the brightness value will be

adjusted again.

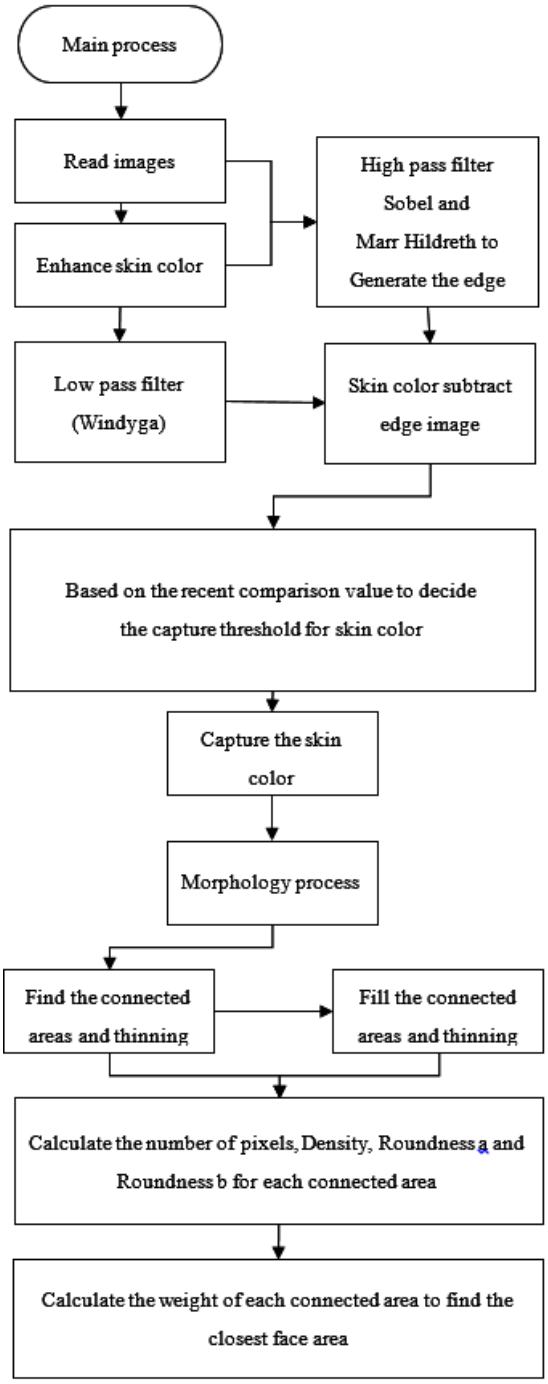

FIGURE 1. The static human face detection algorithm

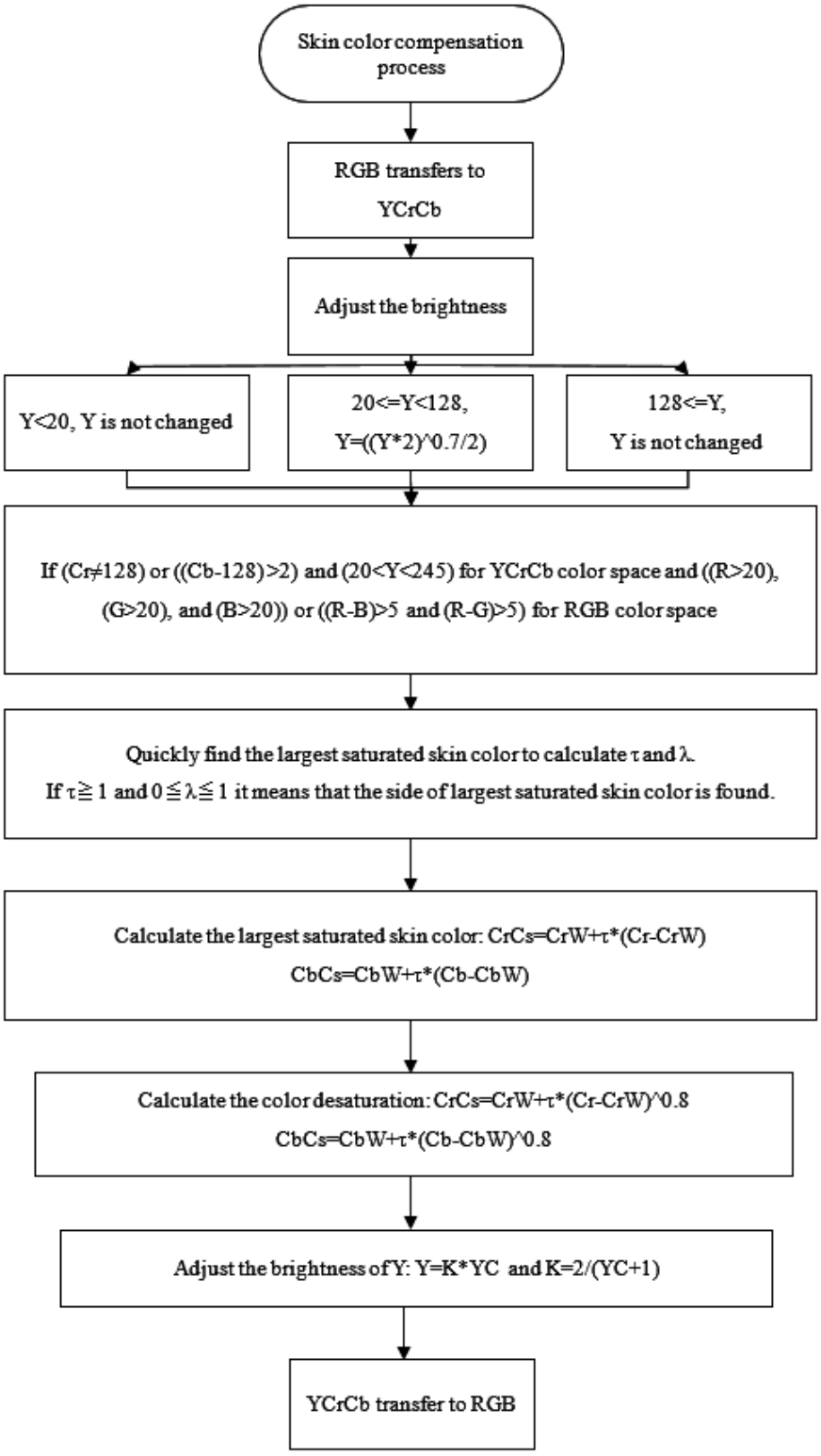

FIGURE 2. The color compensation process

The image subtraction process is to subtract the edge image from the pre-processed image. The purpose is to cut the image through the edge of the image. In this study, the Sobel and Marr Hildreth filters are selected. The Sobel filter can get thicker and more obvious edges, and the Marr Hildreth filter can get more detail edges. The skin color is found through HSV color space and YIQ color space. The threshold value is selected by using the latest paired threshold value determination method. When the six sets of threshold values are met, the pixel is retained. The calculation process of feature parameters and weights is shown in Figure 3. The main purpose is to find the feature parameters of each connected region, and then use the feature parameters to calculate the weight of each connected region.

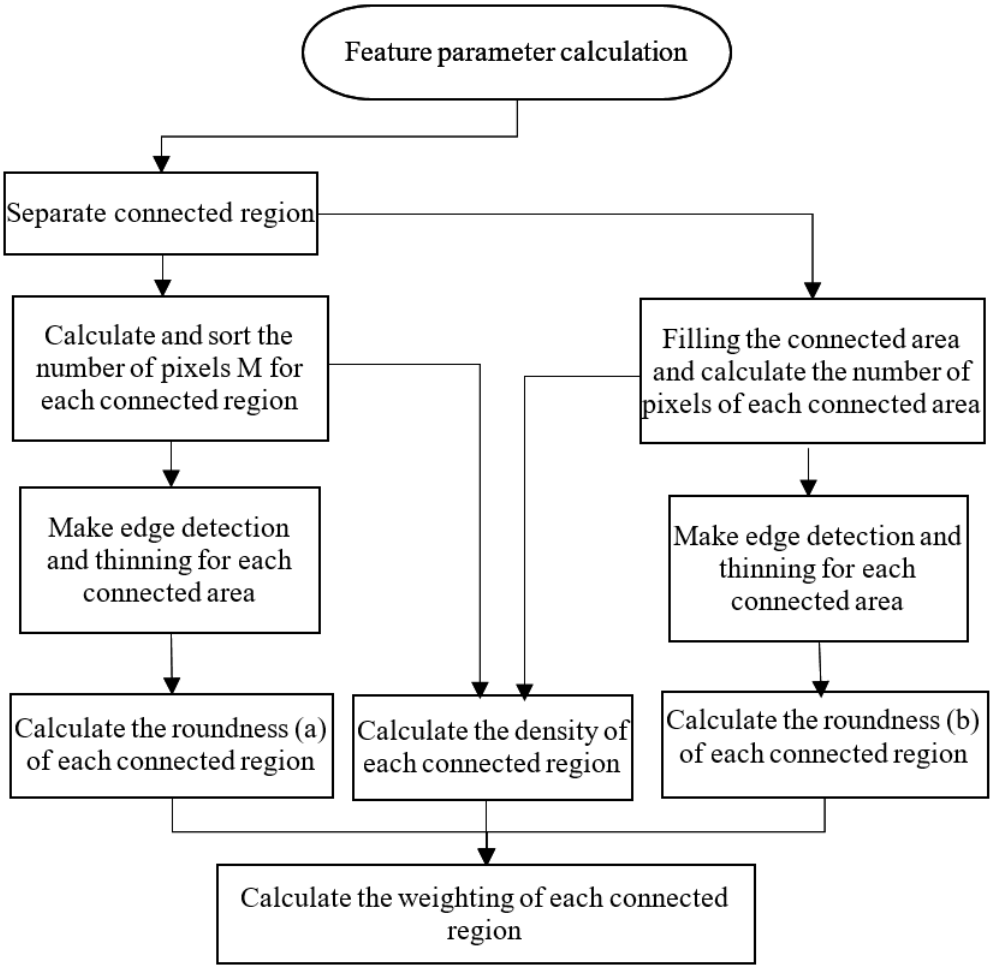

FIGURE 3. The calculation process of feature parameters and weighting

Dynamic face detection of moving images needs much more samples than that of a single static image. We may use the video image, because the amount of data in a video is much more so it can achieve the same goal with a simpler algorithm. The flow diagram for dynamic image detection is shown in Figure 4.

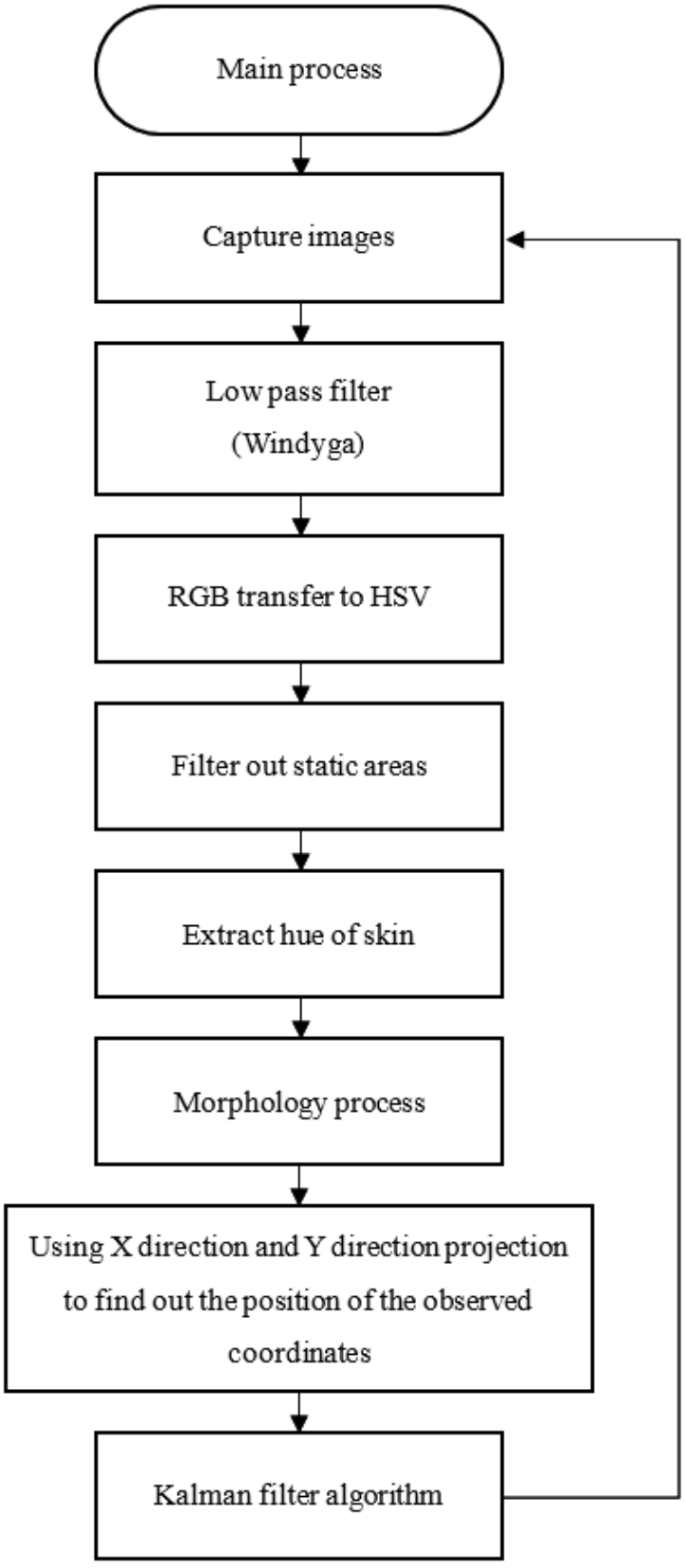

FIGURE 4. The flow diagram of dynamic face detection

The process of filtering out static areas in dynamic detection algorithm is conducted. The purpose of this process is to remove the static background in

the dynamic image, which can be regarded as an improvement of the background image subtraction method. Under the operation of this process, the background image will be continuously updated to reduce the situation that some backgrounds cannot be filtered out due to changes in light and shadow.

4. **Experimental results.** The experimental results are shown in this section. There are two kinds of experimental results which are static and dynamic detection results. The advantage of static detection is that it does not need to process a huge amount of data. But the disadvantage is that if the amount of data is too small, it requires more complex algorithms to improve the success rate. It is easily affected by background, skin color, light, shadow, and clothes also. The experimental result of a complex background is shown in Figure 5. The pre-processing for a black person is not enough to highlight the facial area in front of the bookcase with similar skin color. However, according to the various feature values mentioned above, the facial area can still be effectively captured and extracted it out. The experimental result of motion detection is shown in Figure 6.

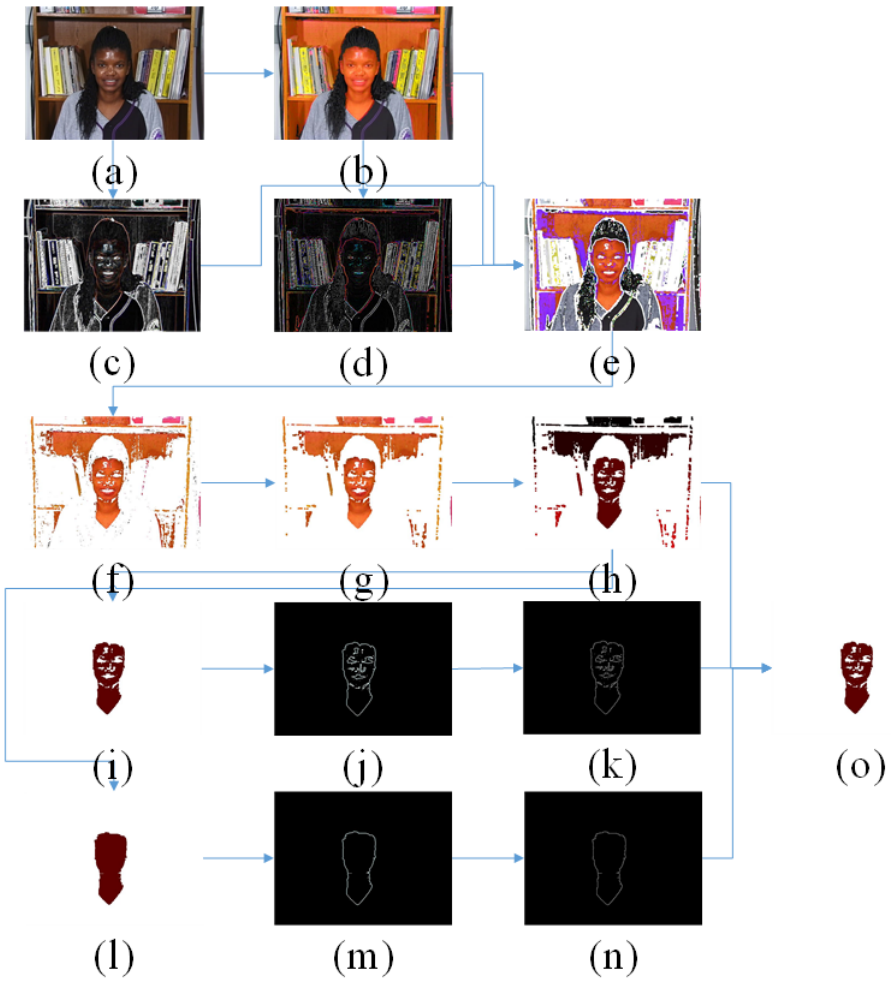

FIGURE 5. The experimental results in a complex background

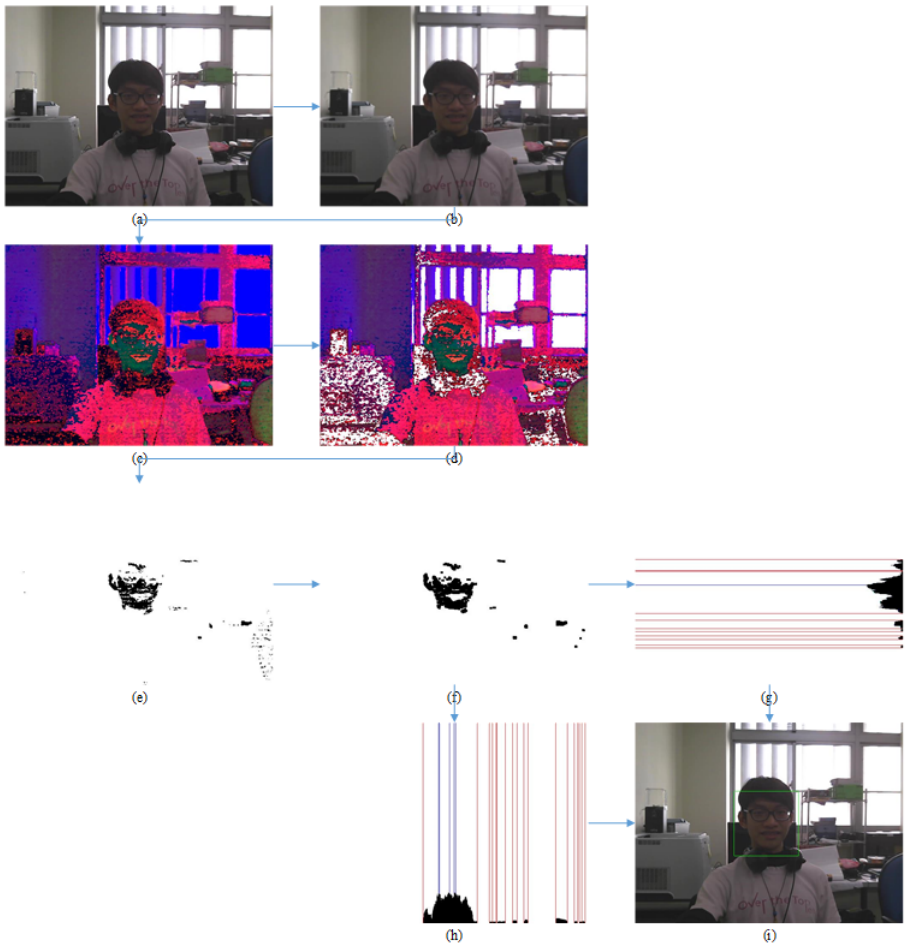

FIGURE 6. The experimental results of dynamic face detection

5. **Conclusion.** A dynamic face image detection method is proposed in this paper. In this paper, we directly search for saturated colors in color space. It does not need for complicated space conversion in the process, and only two possible edges of skin color are calculated, so the calculation speed of skin color enhancement is greatly improved. This study also uses multiple eigenvalues to find the face. Each eigenvalue can be obtained through simple calculations, and it can also help to find the position of the face in a complex image. In the motion detection part, the Kalman filter is combined to make face detection more efficient.

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