An Improvement Design of a Smartphone Interface and Image Processing Methods to Reduce Uncomfortable Light from a Digital Projector

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***Abstract*—In this paper we propose an improvement design to integrate a combination of both a smartphone and a projector to reduce uncomfortable light emitting from a digital projector. The smartphone executes the face detection module, and superimposes the black mask in the position of the face to reduce all uncomfortable light shining in the speaker's eye. This design uses the skin color detection and background subtraction methods to increase the face recognition rate of the previous design. In addition, this design also provides the face detection method for multiple users, so that the projector simultaneously places multiple black masks, and each mask is superimposed for each user's face.**

I. INTRODUCTION

Our previous design uses the face detection and frames per second and image resolution reduction to reduce the amount of computation, but by reducing the image resolution, the accuracy rate of the face recognition rate is only 84% of the mask. To enhance the accuracy rate of the face detection, this design includes the skin color detection [1], the background subtraction [2], the image brightness adjustment, and the image processing methods for multiple users.

Fig. 1 shows the overall architecture of this design. The smartphone, which is placed above the projector, communicates with a link to the projector. This design uses the built-in camera of the smartphone to capture images, and by using both skin color detection and background subtraction to give the impression of the user moving, superimposes the black mask on the user's face in order to reduce the projector light shining is the user's eyes [3].

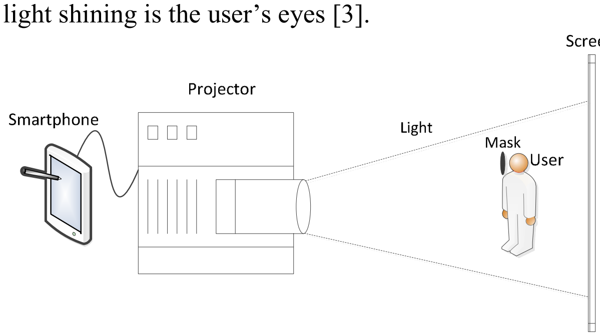

Fig. 1. The overall architecture of this design.

II. SOFTWARE ARCHITECTURE

Fig. 2 shows the whole software flowchart which shows both the process by which the background of the captured images is obtained, and how the background subtraction method is used to detect non-human skin color background. Then this design begins to both analyze and determine whether the brightness will cause the face detection to fail. When this design executes the skin color detection, it will decrease the average brightness of the image. Next, it increases the face detection rate. Then this design uses both the background subtraction and the skin color detection methods to obtain the captured images. In conclusion, this design then finds the position of the user's face in order to determine the coordinates where it will place the masks.

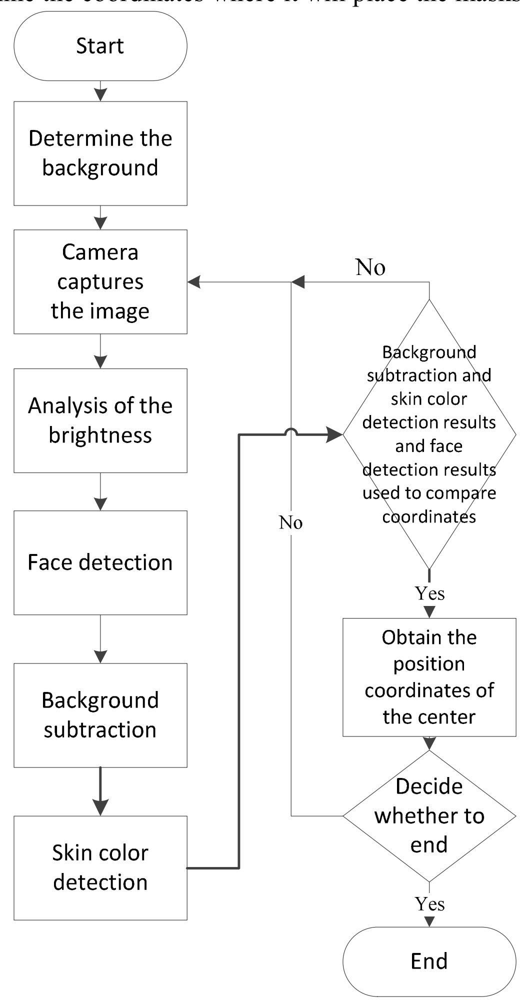

Fig. 2. The whole software flowchart.

A. Background subtraction

This design uses the skin color detection at a local non-human face location. Because the background color of non-human objects is close to the skin color, this design will separate the user and the background by means of the skin color detection. First, this design will find the background; then it uses the background subtraction method to enhance the location of the user's face.

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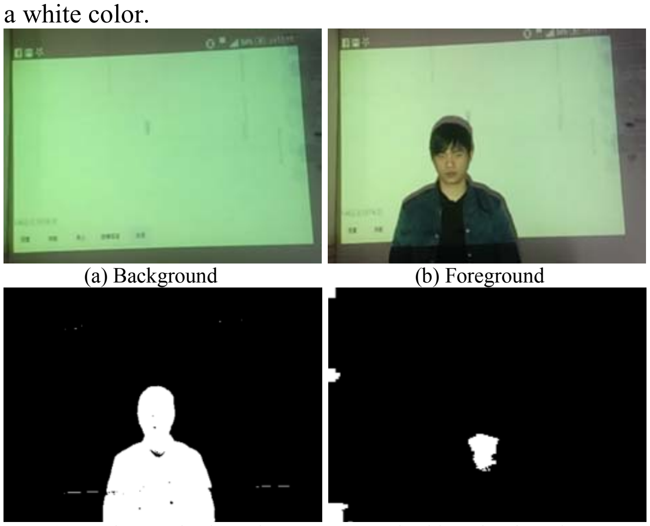
B. *Skin color detection*

For example, this design uses "yellow" as the reference color for the color detection module. One can also use different colors as the reference color. If the captured image has some parts close to the reference color of the first block, these parts are merged into a face. Then, by using the background subtraction the user's face can be determined by repeating the comparison.

Fig. 3(a) shows the captured image background, Fig. 3(b) shows when a user enters, Fig. 3(c) shows the results of the background subtraction, with both a different foreground and background, and Fig. 3(d) shows the results of the skin color detection method which represents the skin color by means of a white color.



(a) Background (b) Foreground

(c) Background subtraction (d) Skin color detection

Fig. 3. Results of the background subtraction and skin color detection methods.

Fig. 4 shows the synthesis of results obtained by means of the background subtraction and the skin color detection methods. This design uses the center coordinates of the white continuous area as the center used during a presentation to place the black mask on the strong light shining in a user's eyes.

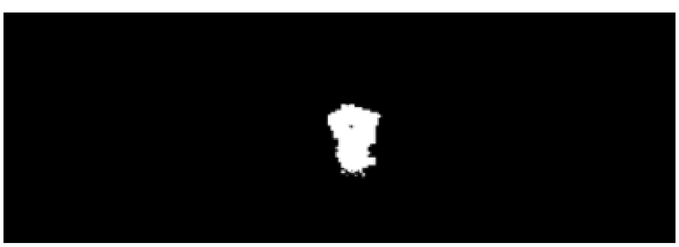


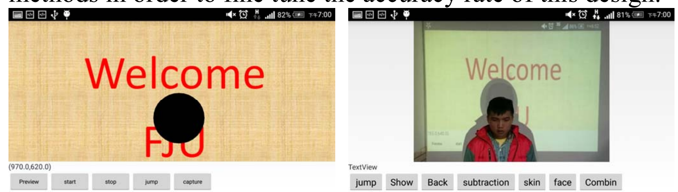
Fig. 4. Synthesis results of the background subtraction and the skin color detection methods.

C. *Brightness reduction*

If the image brightness is too strong, then the use of the skin color detection module will result in an error. When the skin brightness is too bright, the skin color detection module may misjudge the skin color to be a non-skin color. Hence this design adjusts the skin color detection module to first decrease the average brightness of the captured image in order to enhance the accuracy rate of the skin color detection.

D. *Smartphone interface*

Fig. 5 shows the smartphone interface of this design. Fig. 5(a) shows the preview screen and the moving mask. Fig.5 (b) shows the captured image of this design. It can provide users with a method to select the usage of the image processing methods in order to fine tune the accuracy rate of this design.



(a) Preview screen and moving mask (b) Captured image

Fig. 5 Smartphone interface of this design

III. EXPERIMENT RESULTS

TABLE I shows a comparison of this design with previous designs. Because the previous design has a single face detection, if a first user and a second user are either standing or sitting side by side, the design will fail to detect two faces. This design adds both the color detection and the background subtraction methods in order to detect the users' faces. However, if the user turns around and the design cannot detect the face color, as this design cannot synthesize the background subtraction of the captured image, the result will be an error.

TABLE I

COMPARISON THIS DESIGN WITH OTHER DESIGNS

	This design	Design A [3]	Previous design
Face detection	Yes	None	Yes
Skin color detection	Yes	None	Yes
User face detection	Yes	None	None
Accuracy rate	93%	-	84%

IV. CONCLUSION

This design enhances the face detection accuracy rate by adding the skin color detection, the background subtraction, and the brightness reduction methods. The superimposed mask covers the user face by increasing the accuracy rate to 93%. In addition, when a small group conducts a discussion in front of the projector, this design, by using multiple face detection, will locate the specific multiple users and will superimpose a black mask on each user's face.

References

[1] A Tofighi and SA Monadjemi, "Face Detection and Recognition Using Skin Color and AdaBoost Algorithm Combined with Gabor Features and SVM Classifier," 2011 International Conference on Multimedia and Signal Processing (CMSP), pp. 141-145, May 2011.

[2] T. Archana, T. Venugopal, Kumar, and M. Praneeth, "Multiple face detection in color images," 2015 International Conference on Signal Processing and Communication Engineering Systems (SPACES), pp.82-85, Jan. 2015.

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