Center Position Tracking Enhancement of Eyes and Iris on the Facial Image

Duck-hyun Chai and Kwang-ryol Ryu, *Member, KIMICS*

Abstract – An enhancement of tracking capacity for the centering position of eye and iris on the facial image is presented. A facial image is acquisitioned with a CCD camera to be converted into a binary image. The eye region to be a specified brightness and shapes is used the FRM method using the neighboring five mask areas, and the iris on the eye is tracked with FPDP method. The experimental result shows that the proposed methods lead the centering position tracking capability to be enhanced than the pixel average coordinate values method.

I. INTRODUCTION

The various human interface realization has been studying for speech, letter, face and motion recognition with computer and automation system actively.[1-9] Recently a mouse and keyboard are tried to be remove from main frame for the handicapped and complicate controlling system. This cutting edge technique is that a cursor on screen is tracked and moved with the pupil or iris to click a icon or letter with blink, and is applied widely. So far the method is used the expensive infrared camera and applied the varying template or the pixel average coordinate value for finding a center of iris. The FRM(Five Region Mask) and FPDP(Four Points Diagonal Positioning) methods with general purpose CCD camera is proposed for tracking eye and iris on the face image.

II. EYES AND IRIS TRACKING METHODS

An Improved Method for Tracking Eyes and Iris on the Facial Image is described below in detail. To track the eyes on the facial image, input image is translated by binary image and FRM is found eye on face and remove the eyelid from the eye. FPDP is tracked center position of iris. Tracking process is depicted as shown in figure 1.

A facial image is obtained by a CCD camera. When CCD camera has a facial image, the surrounding edges must be bright. The reason is that eye edge is concerned with brightness. A facial image is translated by binary image. Binary image is easy to calculate more than gray image. Translated image must be removed hair, ear, nose and mouth except eyes. Five region mask in figure 2(a) is applied for them to remove. In figure 2(b), between the

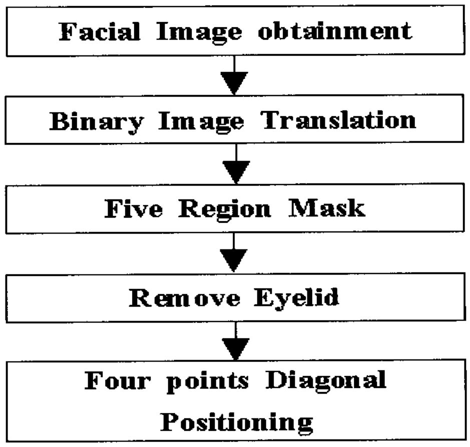
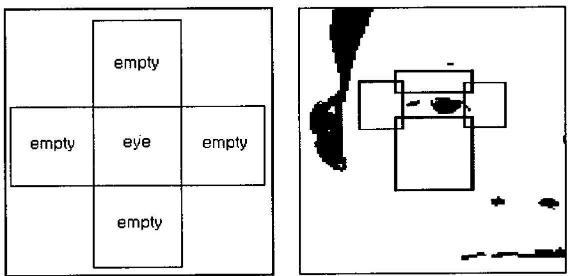


Fig. 1 Tracking the iris position process

eyebrow and the eye, the eye and the ridge of the nose, the eye and the ear and the lower part of the eye are shown blank space. The required masks recognize the eye with four blank spaces and eye space in center space



(a) Five Region Mask (b) Tracking Eye Using FRM

Fig. 2 Mask processing

as shown in figure 2(b). Four spaces must have pixels. Some pixels in size of eye must exist space of center in five region mask. If these spaces are satisfied, space of center in five region mask is presented the eye. We have a proposed FRM algorithm as described above. To remove upper and lower eyelid, FPDP is used method as shown in figure 3(a). The horizontal line is made contact with iris. The arrow is indicated that the point is an iris. If face is tilt, it occurs error like figure 3(b). Because FPDP is used to track the centering position of iris in fixed face. To resolve the problem thickness of iris is measured like figure 3(c). The arrow is direction of scanning. The thick of the eye is the iris. If Y-coordinate of lower boundary of the iris has changed up to down or down to up, it is end of boundary of the iris. The iris is separated from the eyelid like figure 3(d) by end of the iris of boundary. To track the center of the iris, FPDP is used. The iris of boundary is distorted with eyelid. To remove

Manuscript received June 20,2005.
Duck-hyun Chai is with Mokwon Univ., Korea (e-mail: m9739090@mokwon.ac.kr)
Kwang-ryol Ryu is with Mokwon Univ., Korea (e-mail : ryol@mokwon.ac.kr)

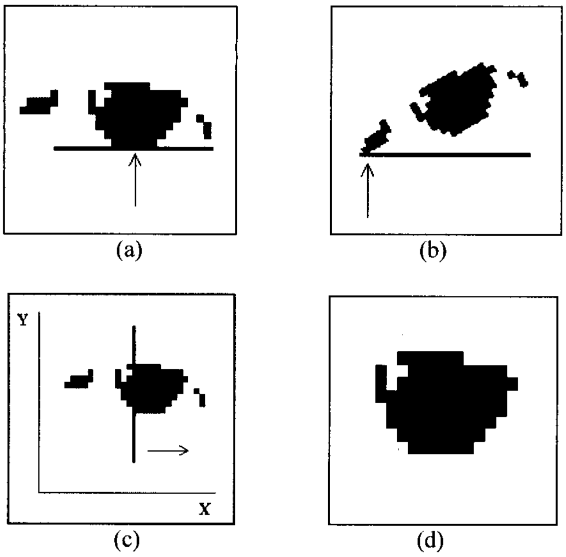


Fig. 3 Separate the iris from the eyelid

an irregular point of edge of the iris by eyelid, the iris is designated edge of the eyelid with i and j as shown in figure 4. An upper part of i and lower part of j is not used. Arbitrary 4 points are a, b, c and d. They designated between i and j. The half point of a and b is f and the half point of c and d is g. The point of h means cross point that the vertical of segment of line f-h and g-h. The point of h is center position of the iris.

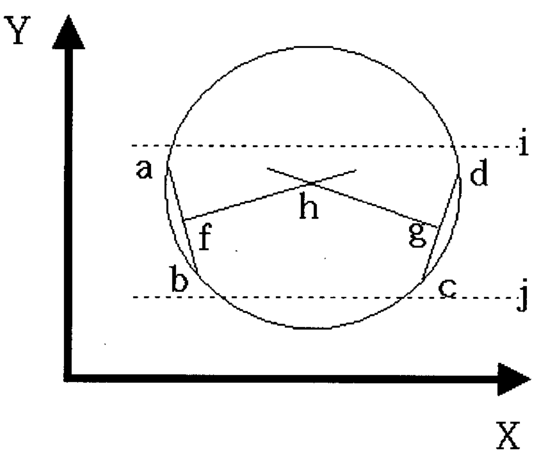


Fig. 4 FPDP processing

III. EXPERIMENTAL RESULTS

A. Tracking Process of Position of eye using FRM

To realize exact experimental setup, the camera is established eye upper. Because the shadow of lower part of eye is removed. CCD camera is distanced from face about 50cm and is obtained input image by 256x256 pixels like figure 5(a). Input image is divided gray level into 256 and translated by a binary image by critical point

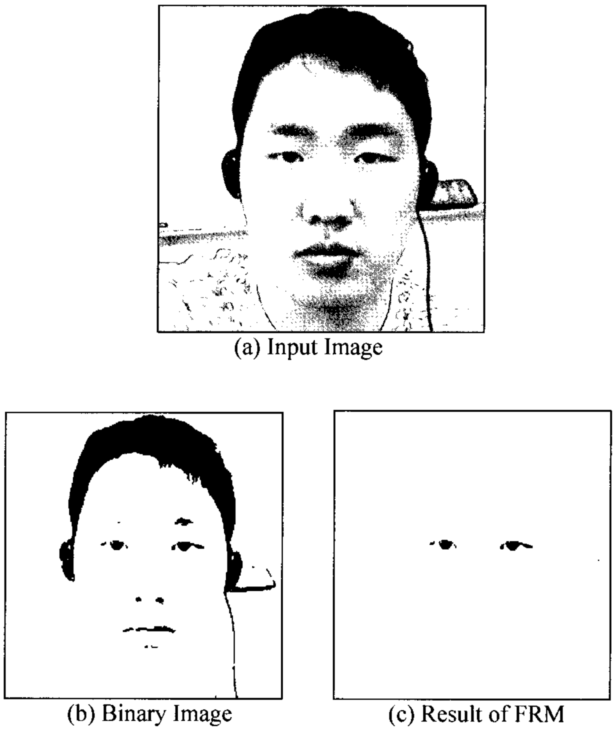


Fig. 5 FRM processing

as shown in figure 5(b). Critical point is 70. If pixel value of input image is lager than critical value, pixel valuis translated by 255. Or pixel value of input image is small than critical value, pixel value is translated by 0. Critical point can be changed by brightness of surroundings.

Table 1 The critical point of each process

Space of FRM	Satisfied number of pixels (pixel value : 0)
Left Blank : 20 * 20 Pixels	360 pixel
Right Blank : 20 * 20 Pixels	360 pixel
Upper Blank : 20 * 20 Pixels	70 pixel
Lower Blank 30 * 40 Pixels	1100 pixel
Center Blank 20 * 20 Pixels	200 pixel

FRM is used five spaces. Left, right and center spaces are constructed by 20 by 20 pixels. Upper space is constructed by 4 by 20 pixels. Lower space is constructed by 40 by 30 pixels. Each space has the satisfied number of pixels as shown in table 1. Using FRM, eyes are remained as shown figure 5(c). Tracking the Center Position of iris using the FPDP is as shown in figure 6. White X is indicated center position of iris.

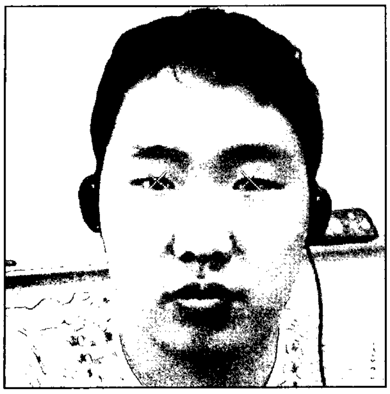


Fig. 6 Result of FPDP

B. Measurement of exactness

To exact the position, distance to meet middle coordinate value is measured by using the FRM and FPDP. Errors are occurred by distance of middle coordinate. Table 2 shows error of degree of face to degree of face. O is recognition of eye and X is that FRM cannot find eye. Upper and lower direction of face is recognized between -30° and +60°. Other section can not be recognized, because shadow of the eyelid covers the iris. Left and right direction of face can be recognized between -45° and +45°. Turning direction of face can be recognized between -45° and +45°. In case of face moving over 45°, pixels of the eyebrows and nose are changed. Then, critical value of blank space of FRM is not recognized the eye. Table 3 shows Error of vertical

Table 2 Error of moving of face to degree of face

	-60°	-45°	-30°	0°	+30°	+45°	+60°
Top - down	X	X	O	O	O	O	O
Left - right	X	O	O	O	O	O	X
Rotate	X	O	O	O	O	O	X

degree of iris to moving of iris. Table 4 shows error of horizontal degree of iris to moving of iris. The small iris with 0.3cm is shown and error is larger. In this case the iris is covered with the eyebrows and shadow of eyelid. Over degree of 60° is marked in X at table 3 and 4. X is over than 6 pixels. In this case the iris is covered with most of eye part.

Table 3 Error of vertical degree of iris to magnitude of iris

	0.3cm	0.7cm	1.0cm	1.2cm	1.5cm
Lower 60°	X	X	X	X	X
-45°	X	X	3	3	3
-30°	X	2	1	1	1
-15°	X	2	1	1	1
0°	X	3	2	1	1
+15°	X	1	1	0	0
+30°	X	1	1	1	0
+45°	X	1	1	1	1
Upper 60°	X	4	1	1	1

Table 4 Error of horizontal degree of iris to moving of iris

	0.3cm	0.7cm	1.0cm	1.2cm	1.5cm
60°	X	X	X	X	X
45°	X	X	X	X	5
30°	X	3	2	1	1
15°	X	1	1	1	0
0°	X	1	1	1	0

IV. CONCLUSION

An Enhancement of Capability for the Center Position of Eye and Iris on the Facial Image is presented in this paper. FRM method is suitable to find the eye on facial image exactly. FPDP method tracks the center position of iris. A result is that the moving face of extent of allowance is between lower 30° and upper 60° and between left 45° and right 45°. The allowable extent for moving iris is between lower 45° and upper 60° and between left 30° and right 30°. Moving average error of upper and lower is 1.34 pixels and moving average error of left and right is 1.23 pixels. Therefore, this method can track eye and iris position on face. This technique is applicable to industrial and assistance of the handicapped. The proposed algorithm needs to improve the exactness in dark and small iris in eyelid.

REFERENCES

[1] Hideo Kawai, Shinichi Tamura, "Eye Movement Analysis System Using Fondues Images," pattern Recognition. Vol. 19, No.1, pp. 77-84, 1986.

[2] A. TOMONO et al., "Eye Tracking Method Using an Image Pickup Apparatus," European Patent Specification- 94101635, 1994.

[3] Varchmin-AC et al., "Image Based Recognition of Gaze Direction Using Adaptive Methods. Gesture and Sign Language in Human-Computer Interaction," in Proc. of Int. Gesture Workshop. pp. 245-57, Berlin, Germany, 1998.

[4] Seika-TenKai-Tokushuu-Go, ATR Journal, 1996.

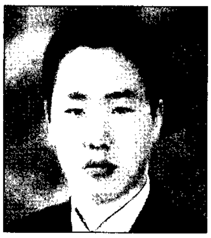
[5] A. Ali-A-L et al., "Man-Machine Interface through Eyeball direction of Gaze," in Proc. of the Southeastern Symposium on System Theory, pp. 478-82, 1997.

[6] Eye mark Recorder Model EMR-NC, NAC Image Technology Cooperation.

[7] K. N. Kim, R. S. Ramakrishna "Vision-Based Eye-Gaze Tracking," International Conference on Computer Vision(ICCV), September, 1999.

[8] Betke-M et al., "Gaze Detection via Self-Organizing Gray-Scale Units," in Proc. of int. Workshop on Recognition, Analysis, and Tracking of Faces and Gestures in Real-Time System, pp. 70-76, 1999.

[9] Duck-hyun Chai and Kwang-ryol Ryu, "The Four Points Diagonal Positioning Algorithm for Iris position Tracking Improvement," J. of KIMICS, Vol. 2, No. 3, pp. 202-204, 2004.



Duck-Hyun Chai
Received his B.S. degree in Electronics Engineering from Mokwon University in 2002 and he is doing M.S. course in Mokwon University. His research interest is in the area of image processing.

Kwang-Ryol Ryu
Received his B. S. degree in Wireless Communication Engineering from Kwangwoon University and his M. S. and Ph. D. degrees in Electronic Engineering from Kyunghee University in 1980 and 1988, respectively. From 1984 to 1985, he worked at the Samsung Electronics Research Center. From 1996 to 1997, he was in University of Pittsburgh in Visiting Professor. Since 1985, he has been a professor of the department of IT Engineering of Mokwon University. His research interest is in the area of Digital Signal Processing(image and vision)