Recognition of Fainting Motion from Fish-eye Lens Camera Images

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Abstract: This study is to present a fainting motion recognizing method by using fish-eye lens images to sense emergency situations. The camera with fish-eye lens located at the center of the ceiling of the living room sends images, and then the forground pixels are extracted by means of the adaptive background modeling method based on the Gaussian complex model, which is followed by tracing of outer points in the foreground pixel area and the elliptical mapping. During the elliptical tracing, the fish-eye lens images are converted to fluoroscope images, the size and location changes, and moving speed information are extracted to judge whether the movement, pause, and motion are similar to fainting motion. The results show that compared to using fish-eye lens image, extraction of the size and location changes, and moving speed by means of the conversed fluoroscope images has good recognition rates.

1. Introduction

Fainting is likely to happen among elderly people, and this may lead to injury or even to death. Therefore, fainting is regarded as a cause of high risks among solitary elderly men. The medical treatment results on fainting are greatly influenced by the time from recognizing fainting to call for help, and to emergency treatment. Thus, there have been fainting motion sensors which make use of acceleration sensors and inclination sensors to recognize motions automatically and call for help [1,2]. The problem is, though, users should always carry the sensors. To solve this problem, vision based fainting detection methods have been developed. As for vision based methods, wide range fish-eye lens cameras or omni-directional cameras were used to minimize the number of cameras required [3,4,5]. Such studies proposed the way to detect human body through the fish-eye lens image and recognize fainting motion based on the size change of human's moving shape.

This study is to propose the method to improve fainting motion detection performance by recognizing fainting motion from the perspective image which is extracted from fish-eye lens image. The difference of standing shape and lying down shape is well recognized in the perspective image than the fish-eye lens image as shown in Figure 1. The fainting motion recognition performance is improved by converting fish-eye lens image to perspective image based on this feature.

2. Motion Detection and Tracing

This study uses the method detecting a moving object based on the difference between the background and input image.

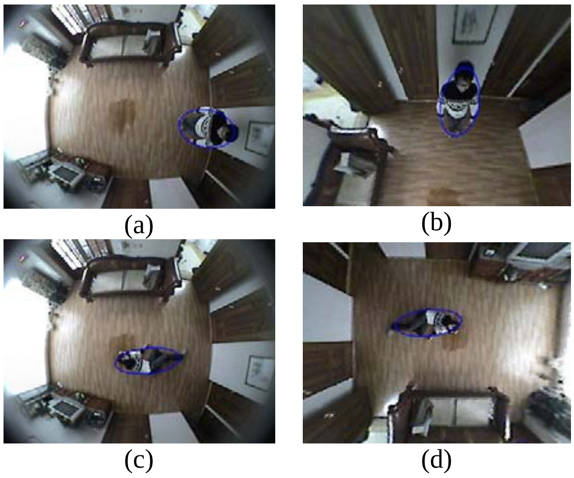

Figure 1. standing (a) fish-eye lens image (b) perspective image
lying (c) fish-eye lens image (d) perspective image

Since the background image keeps changing according to the light and object movement, the adaptive background modeling method based on the Gaussian mixture model was utilized to update the background images flexibly. To generate background model images, the initializing time is required to set the basic image where there is no moving object. At least 300 frames of image should be input.

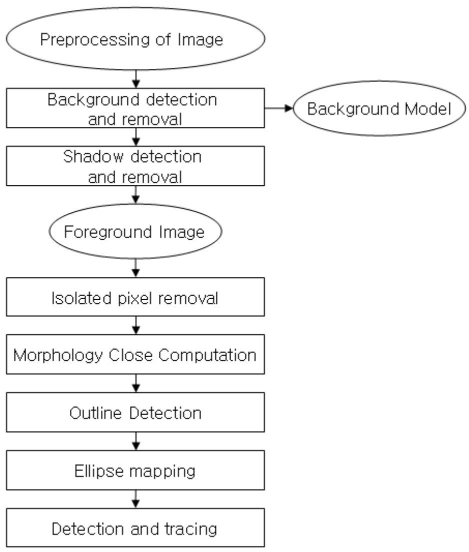

Figure 2. The process of man detection and tracing images treated in advance

2. 1 Pre-treatment of Image

The input image of the system presented in this study is RGB color model image. Since RGB color image is sensitive to the light change, the input image RGB color model is converted to YCbCr color model in this study. The color conversion is followed by the calculation of the average image brightness, and when the value changes beyond the critical value the image pixel values are compensated to prevent average brightness from drastically changing. In general, cameras automatically adjust image brightness by adjusting the exposure according to light changes, but since any drastic changes of the image brightness may be recognized as a moving object, the image brightness change is set to maintain gradual in the preprocessing stage.

2. 2 Foreground Image Generation

When any moving object appears in the input image, the pixel is recognized as different from the background, and classified as foreground pixels. Since the shadow of a moving object may be recognized as a part of the moving object, the shadow detection and removal process is included. Since the shadow area is darkened while the original color remains, the shadow area is recognized by using the amount of the brightness change and color change. Figure 3. shows the examples of a background image, an input image and a foreground image.

Figure 3. (a) background image (b) input image
(c) foreground image

2. 3 Noise Removal

Even in the area outside of the moving object, noise may cause the pixel to be classified as part of the foreground pixel. To remove noise in the foreground pixel area, any parts that consist of 4 or less pixels were removed. Then the separated areas are merged by applying the morphology close computation. When a part of the moving object has similar color with the background, it might be separated as a part of the background. By adopting this computation method, the separated parts are merged again. Figure 4(a) shows the image from which noise was removed.

Figure 4. (a) After removing noise from the image in Figure 3(b); (b) The result of elliptical mapping

2. 4 Ellipse Mapping

After removing noise, the contour detection method is adopted to trace the connected contour points in the foreground pixel area. Then the contour points are mapped with an embracing ellipse to simplify the shape of the moving object area. By tracking the ellipse detected from the images continually as time passes, the information in ellipse shape change, location change, and moving speed is extracted.

There might be more than one foreground pixel area due to noise, but the man area is limited in a certain range. The system adopted in this study recognizes fainting motion of a solitary man, and thus the biggest ones among the foreground pixel areas are selected as the man area.

3. Fainting Motion Detection

3. 1 Fluoroscope Image Change

Upon fainting, a fast body motion is followed by a lying motion, and then no movement. Thus, this study presents the fainting motion recognition method based on the changes of the ellipse shape and movement speed. As in Figure 1, however, the changes of the body form are more clearly displayed in perspective image than in fish-eye lens image, and thus this study method recognizes fainting motion by converting fish-eye lens image to perspective image.

To convert fish-eye lens image to perspective image, the method induced by Zimmermann was adopted [6]. Figure 5 shows the coordinate reference frame of fish-eye lens image and perspective image.

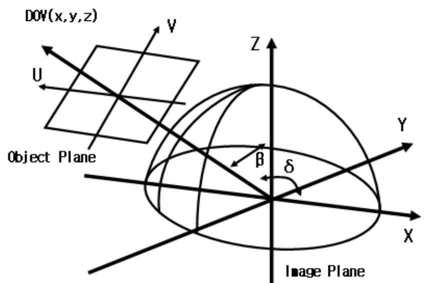

Figure 5. Coordinate reference frame

The mapping function from the coordinates of perspective image(u,v) to that of fish-eye lens image(x,y) is as in the expression (1) below.

$$
\begin{aligned}
x &= \frac{R[uA - vB + mR\sin\beta\sin\delta]}{\sqrt{u^2+v^2+m^2R^2}} \\
y &= \frac{R[uC - vD - mR\sin\beta\cos\delta]}{\sqrt{u^2+v^2+m^2R^2}} \\
A &= (\cos\Phi\cos\delta - \sin\Phi\sin\delta\cos\beta) \\
B &= (\sin\Phi\cos\delta + \cos\Phi\sin\delta\cos\beta) \\
C &= (\cos\Phi\sin\delta + \sin\Phi\cos\delta\cos\beta) \\
D &= (\sin\Phi\sin\delta - \cos\Phi\cos\delta\cos\beta)
\end{aligned}
\qquad (1)
$$

In Expression (1), R indicates the radius of the fish-eye lens image circle, ***m*** indicates the magnification rates, Φ indicates the rotation angle of perspective image, indicates the latitudinal angle between ***Z*** axis and the gazing direction, and δ indicates the longitudinal angle between X axis and the gazing direction. In this study, R, m, Φ and are used as constants, and $R=160$, m=1 , Φ=0 respectively.

Figure 6. shows the result of converting 4(b) image to perspective image.

Figure 6. The result of perspective image from Figure 4(b)

3.2 Fainting Motion Identification

The fainting motion recognition method involves the extraction of the ellipse shape change, location change, moving speed information from the converted perspective image and judging whether the movement, pause and motion are similar to fainting motion. As in the result, the ellipse shape and location change according to the behavior of the man, and when the user stands up, walk or lie, then the values of width and height of the ellipse change.

Figure 7. and table 1. show the changes of the frame, width, and height upon fainting. As in the result, when the user stands(652 frame), the value of height of the ellipse is higher than that of width while that of width is higher than that of height when the user lies(704 frame).

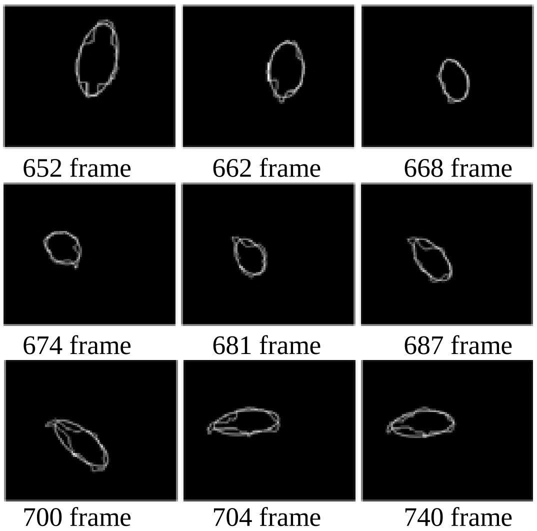

Figure 7. Fainting motion detection using perspective image

This change reflects the change in speed(frame) of the user's motion. The distinction between lying and fainting is based on the speed values according to each motion.

Table 1. Changes in the ellipse shape to detect fainting motion

frame	width	height
652	51	96
662	46	77
668	38	54
674	44	45
681	43	49
687	53	54
700	74	65
704	89	37
740	84	37

4. Experimental Result

This study includes the photographing of the 7 fainting motions according to the location and direction as in Figure 8. and the detection experiment of fainting motion and abnormal situation. Table 2. shows the comparison between the fainting motion detection using fish-eye lens image and the detection using the converted perspective image. As in the table, the converted perspective image indicates the more accurate size change according to motions, and proves to have more excellent fainting motion detection performance.

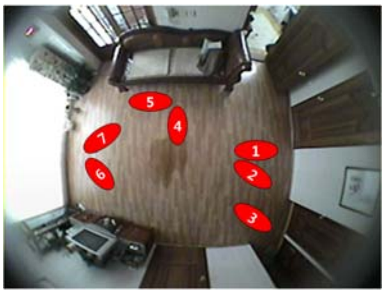

Figure 8. Fainting motion experiment location

Table 2. The comparison of fainting motion recognition between fish-eye image and perspective image

No	Actual Motion	Recognition Result	
		Fish-eye Image	Perspective Image
1	Faint	Faint	Faint
2	Faint	Faint	Faint
3	Faint	Sit	Faint
4	Faint	Sit	Faint
5	Faint	Faint	Faint
6	Faint	Faint	Faint
7	Faint	Sit	Faint

5. Conclusion

This study is to propose the method to detect and track a man form the fish-eye lens image to automatically recognize fainting motion. The ellipse mapping method was adopted in this study for realtime recognition, and fish-eye lens image was converted to perspective image to improve the recognition correctness of fainting motion. Besides, the use of the adaptive background model makes the proposed method flexible to light change, and the use of the color model converting and average brightness correction increase accuracy of the proposed method.

Acknowledgment

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