Moving User Segmentation for Sports Simulator Using Frame Difference and Edge Detection

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***Abstract*—This work presents a novel moving object segmentation approach using frame differencing method and edge detection to provide customized coaching service to users in advanced sports simulator like horse riding. To give this service in the simulator, exact user detection is very important. If the segmenting user from its background became better, we will get a better pose recognition results. In this paper, we will propose more exact user segmentation algorithm which gives better segmentation result than common temporal differencing method. To do this, edge image is applied in two ways. One is to eliminate noises on the temporal differencing image. Another is to make connected contour of user's body shape. At the end of this paper, the result of our method will be given.**

***Index Terms*—edge detection, object segmentation, temporal differencing, logical AND**

I. Introduction

The clear and fast segmentation of moving object is important and difficult problem in the field of computer vision. The segmentation result is the foundation of object recognition. Also, many applications, such as video surveillance, traffic Monitoring, people counting and etc, benefit from the reliable and robust object segmentation [1]. In the most real world environment, the vision sensors like camera are fixed. In this case many algorithms and techniques have been developed for the object segmentation in the past decade. The popular approaches for moving object detection are optical flow, temporal difference and background subtraction and so on. In Section 2, we will describe these methods and explain why they can't be applied in our system.

In our approach object segmentation method needs to work in special environment like sports simulator. Fig. 1 shows this environment. Depending on the needs of the health concerns and new culture of play, the sports simulator market has grown more and more. To fulfill these needs, sports simulator is rapidly getting developed. If the sports simulator was a machine which the user could only just ride on until now, then nowadays to make the user to interact with the simulator, realistic service is highly demanded [2].

Figure 1. The environment of sports simulator.

Moving user on the simulator is the unique object which we segment and detect to estimate the user's pose recognition automatically. To perform a user customized coaching system which mutually gives interaction between the human and the simulator, first of all, user segmentation method will be needed. To meet these needs, advanced user segmentation method is encouraged to be developed which recognizes the user's pose exactly in sports simulator environment.

Users on the sports simulator move up, down, left, or right. Due to this reason, user's pose is changed dynamically. So, we need to have more accurate user segmentation to give pose recognition and teach a high level professional coaching to users. To achieve them, moving object or user, segmentation is the most fundamental and important issue. So, our study wants to focus on here and solve this problem more efficiently.

This paper is structured as followed. First of all, existing famous object segmentation method with their

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approach, pros and cons will be investigated in the section 2. And then, novel method to be able to apply our system will be introduced in the section 3. Finally, the section 4 will give some future plan of our study and conclude a conclusion.

II. Object Detection Methods

Moving object detection is an important study field of computer vision. Its purpose is to extract moving object area in image sequence. Extracting moving object effectively and exactly is the foundation of tracking and sorting of moving targets [3]. Up to now, there are several proposals. Three typical; approaches are mostly used in motion detection: optical flow [4]-[6], temporal difference [7]-[9] and background subtraction [10]-[11]. Optical flow is an approximation of the local image motion and specifies how much each image pixel moves between adjacent images. It can achieve success of motion detection in the presence of camera motion or background changing. However, most of the flow computation methods are computationally complex and very sensitive to noise. The approach of temporal differencing makes use of pixel –wise difference between two or three consecutive frames in an image sequence to extract moving region. Temporal difference method can adapt to the dynamic changes of the environment to achieve real-time motion detection, but the segmented moving object is incomplete. Background subtraction is a particularly popular method for motion segmentation, especially under those situations with a relatively static background. It attempts to detect moving regions in an image by differencing between current image and a reference background image in a pixel-by -pixel fashion. However, it is sensitive to scene changes caused by light, weather etc.

In case of using these segmentation methods to our simulator system, some are less real time performance and some are lack of noise reduction. To apply our system, the object segmentation algorithm has an ability of low computational complex and an exact shape of user from its background. So, our proposed algorithm will focus on extracting exact moving object like human shape, while remove background and other noises.

III. Our Approach

In simulator environment our focus is on the moving part except the stationary part like background. The Moving object region is separated from other part of the scene by motion information [12]. Basic idea of our segmentation algorithm is change detection among two frames. And then, edge detection result is applied its result. The edge of user is a fundamental component. Edge detection is one of the most commonly used operations in computer vision [13]. The reason is that edges represent the outline of an object.

The proposed algorithm is divided into four major steps as shown in Fig. 2. The first step is to calculate the frame difference method by thresholding the difference between two consecutive input frames.

At that same time, edge detection of current image will be done. Before edge detection, Otsu's method also is applied because we are interested in the user's body contour only.

By the third step, logical AND operator between frame difference image and edge detection image is used to eliminate noise which occurs on the illumination and other stationary scene.

In the last step, edge connection algorithm will be applied. As a result, user's body contour on the simulator will be detection.

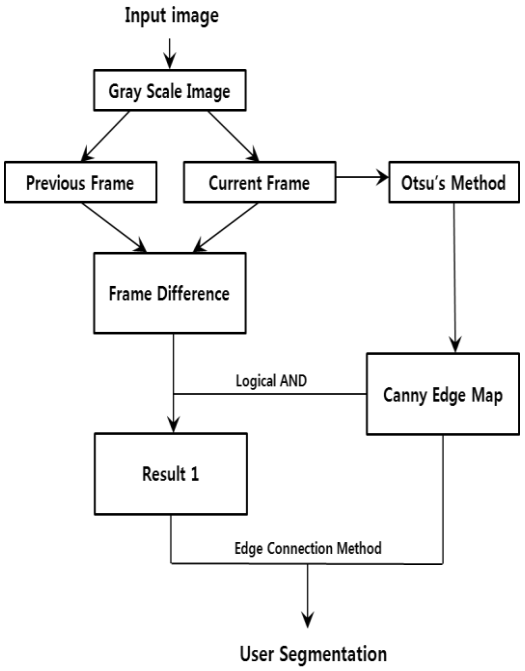

Figure 2. Flow of proposed method.

A. Frame Difference

To get the moving object in the background, frame difference should be calculated. In our approach, the gray scale images of previous and current image are used to get the result. The frame difference image is generated simply by thresholding the frame difference. The more optimal threshold value is given, the more exact moving silhouette will be taken except some noises.

Figure 3. The result of frame difference (a) previous image (b) current image (c) frame difference image.

Fig. 3 shows the process of frame differencing method. Fig. 3 (a) is the previous image about gray scale level. Fig. 3 (b) is the current image. The last image of Fig. 3 represents the result among these two consecutive images. As you can see, there are some problems in this image. While calculating the difference, some unnecessary parts are included. These are a pattern of user's clothes, user's helmet and other noises. To eliminate them, we will combine edge detection map later.

B. Edge Detection

To get a more simple edge image, our system uses binary image of gray scale image. For Available images in the sports simulator, because of the existence of noise, normally the image filtering is needed. However, the filter will generate fuzzy edge [14]. Traditional edge detectors such as Sobel, Prewitt, and Roberts do not give the accurate edges, but the edges which have a certain width. To be precise width of a single pixel edge, we can use Canny edge detector. Canny edge detector is one of the best edge detectors, which in many areas has been widely used in image processing [15]. The Fig. 4 (a) shows Canny edge image.

The basic steps of detection by using Canny edge detector are as follows

1) Filter the image by using Gaussian filter to remove the noise.
2) Calculate the ample and direction of the gradient of each pixel of the image after filtering.
3) Make the "non-maximal inhibition" to the gradient in order to make the edge down to one pixel width.
4) Do double threshold processing and edge linking.

C. Logical AND

Moving edge of user is the edge of moving user on the sports simulator. Frame difference image can be regarded as time gradient, while edge image is space gradient. Moving edge can be defined by the logic AND operation of difference image and the edge image. Fig. 4. shows the result of moving edge detection. Logical AND makes moving edge-only images. However, there has been terrible problem in our sports simulator environment. These unclear edges of user will not give an exact pose recognition result. So, next step of our approach will present a novel edge connection method.

Figure 4. The result of Logical AND (a) Edge image (b) Differencing image (c) Moving edge image.

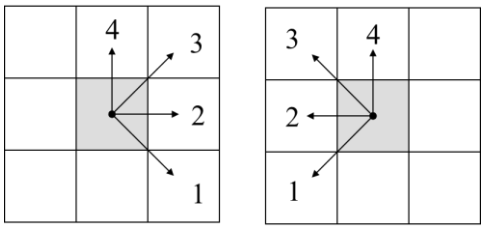

Figure 5. The direction map (a) left direction (b) right direction

D. Edge Connection Algorithm

The result of logical AND produce unclear edge and some noises from illumination and false detection. To extract more clear edge, edge connection algorithm is proposed.

The basic steps of this algorithm are as follows

1) Current edge image Ei and its moving object image Mi are prepared first.
2) Find the first white pixel s of Mi (from left to right and from top to bottom order)
3) Split Mi in two part, first one is the left side of s and second one is the right side of pixel s.
4) In the left side of pixel s, find the start pixel (bottom-top and left-right order) and using Fig. 5 (a) left direction map. The order of priority of edge search direction from 1 to 4 If there are white intensity value in same pixel position of Ei, give a white pixel value in the same position of Mi The next center point will be the latest direction point.
5) In the right side of pixel s, find the start pixel (bottom-top and right-left order) and using Fig. 5 (b) direction map. The details same as step 4.
6) In each case, step 4 and 5, if they meet the pixel s, the algorithm will be finished.

Figure 6. The result of Edge Connection Algorithm (a) result of moving edge detection (b) proposal result.

Fig. 6. (b) shows the results of edge connection algorithm. As you can see, our final results give more exact and useful user's body contour than normal moving edge detection.

IV. Conclusion

This paper presents an improved moving object detection algorithm based on frame difference and edge detection applicable for sports simulator. This method not only retains the small calculation from frame difference method and the impregnability of light from edge detection method, but also improves in noise restraining. And then, our edge connection algorithm helps to give more clear edge of user. Through the clear body shape, the moving edge detection will help to give more reliable pose recognition result. Future work will focus on how to develop the method efficiently and get more exact user's body shape.

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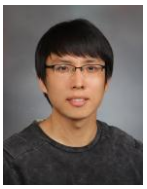

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