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Strokes Separation from Hand Motion Trajectories

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Abstract. Motion detection and recognition have been adapted in home appliance such as a TVora game console. A remote controller of a TV can be replaced based on gesture analysis of your body. So you can control some functions of smart devices with just motion or gesture of your body. Motion capture technology is also necessary in a virtual touch screen. In this paper, we suggest a virtual touch screen system that can draw shape or write characters at a long distance from a whiteboard. We call this function as remote drawing. For remote drawing it is necessary to detect and track a hand that is means of drawing. Above all, it is most important to distinguish between stroke and movement when writing. In this paper, we develop a new method that draws only the stroke by analyzing the trajectories from hand tracking.

Keywords: We would like to encourage you to list your keywords in this section.

1 Introduction

Motion capture technology is an emerging and useful technologies used in various fields such as smart TV, game devices and etc. This technology has been around for decades but is being utilized rapidly in recent years with emergence of new devices. Up until just a few years ago, motion capture was a part of a system equipped with web camera. Thus, most of the functions for motion detection should be used with self-development. However, state-of-art devices such as Kinect, Leap Motion sensor and their application programming interface (API) make it very easy for motion capture and allow us to focus on the development of their applications.

Computer-based lectures have been progressed in most of educational institutes from K-12 schools to higher education. Also an interactive whiteboard plays a key role in computer-based education. The market of the whiteboard and touch screen is rapidly expanding and sales of the screen continue to increase 15~17% each year in worldwide market [1, 2]. Interactive whiteboards in size of 60-inch, 72-inch and 80-inch are mainly used in Korea. 72-inch sized whiteboards are the most common model and the use of 80-inch sized whiteboards will increase in the future. The price of interactive whiteboards is about two million to five million won. By the way, price of touchscreen mounted on the front of the whiteboard corresponds to more than half of the whiteboard price.

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Tempered glass and a metal frame must be attached to the whiteboard to mount a front touch screen on the whiteboard, and these components increase the weight and size of the product and make it difficult for the fabrication of larger-size products. Because of the components maintenance costs will be also increased. If a virtual touch screen replaces the physical screen, unit price and maintenance costs can be fetched down. By adapting OLED TV a product with very thin thickness can be manufactured in design aspect.

Motion detection and recognition have been adapted in home appliance such as TV. TV remote controller can be replaced with motion recognition. Just motion in the body or hand can control playing a game without any controller in recent game console such as Xbox 360. Motion capture technology is also necessary in a virtual touch screen. In this paper, we suggest a virtual touch screen system that can draw shape or write characters at a long distance from a whiteboard. We call this function as remote drawing. For remote drawing it is necessary to detect and track a hand that is means of drawing. Above all, it is most important to distinguish between stroke and movement when writing. In this paper, we develop a new method that draws only the stroke by analyzing the trajectories from hand tracking.

2 Remote Drawing

2.1 Hand Detection and Tracking

We develop a virtual touch screen based on Kinect sensor. Kinect sensor can physically detect the range of approximately 0.8~4m but has a practical ranging limit between 1.2 and 3.5m distance. The sensor has an angular field of view of 57.5° horizontally and 43.5° vertically [3]. Fig. 1 shows ranging limit and field of horizontal view.

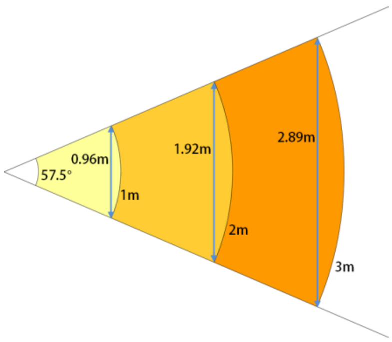

Fig.1. Ranging limit and field of horizontal view of Kinect sensor. Vertical ranges are calculated from distance from camera and field of view.

We utilize OpenNI software library for hand detection and tracking. Nite middleware based on OpenNI provides GrabDetector and handTracker classes for this purpose. GrabDetector class can be used to detect grab gestures and handTracker class provides all functionality related to hand tracking, including gesture detection. We detect the hand by shaking a hand and then track the hand's trajectories when a grab gesture and hand's movement are detected.

2.2 Stroke Separation

For successful remote drawing, it is most important to distinguish strokesfrom movements between the strokes when writing. All the strokes must be displayed on a screen but the movements should be not. To distinguish between strokes and movements, hand trajectories should be separated into line segments. This process is similar to the shape approximation [4] but differs in that using sequential data.

We find line segments from hand trajectories by detecting end points of the segments. End points are detected based on Eq. (1). P_1 is a starting point, P_C is a current point and MBR(P_1, P_C) is a minimum bounding box that contains all the points between a starting point P_1 and a current point P_C. A(P_1, P_C) is an area of a rectangle that has P_1 and P_C as two end points of its diagonal, and A(MBR(P_1, P_C)) is an area of the minimum bounding box.

$$R_C = \frac{\mathrm{A}(P_1, P_C)}{\mathrm{A}(\mathrm{MBR}(P_1, P_C))} \quad (1)$$

End points are detected as follow.

① Select a starting pointP_1

② Move a current point P_C on the trajectory and find a minimum bounding box MBR(P_1, P_C) and calculate R_C in Eq. (1)

③ Mark the current point P_C as the end point of a line segment if R_C is over a given threshold. Otherwise move a current position P_C to the next point on the trajectory

Using extracted line segments we classify the segments into strokes and movements between strokes. To classify the segments we use velocity of a line segment. Strokes usually have slow velocity against the movements, and so line segments less than a given threshold are classified into strokes. Line segments such as containing sequences moving bottom to up or right to left are hardly likely to be strokes. A pre-defined weight is added to the segments with such movements and the segments will be classified into the movement with high probability.

3 Experimental Results

We try to segment a trajectory into line segments and classify each segment into stroke and movement. Some examples are shown in Fig. 2. Although a man or woman writes a character, the character may be of a different look each time. Furthermore there are too many characters to be distinguished. The classification is so difficult problem but we can have some meaningful results.

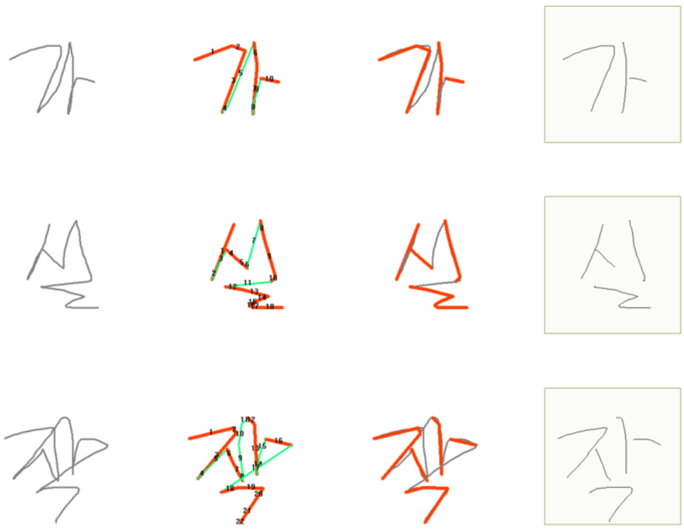

Fig. 2. Left most images show hand motion trajectories. Second columns are extracted line segments with numbering. Third and fourth columns show only the strokes.

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