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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (15): 3229-3232, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.3229.3232

Hand Gestures Recognition in Ar Based Interaction System

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Abstract: This article briefly introduced the importance of natural interaction, especially hand gestures recognition, in augmented reality (AR) and proposed a simple AR based interaction system. And then, the main technologies used in the system were discussed, such as hand gesture image subtraction, image segmentations, finger gesture model, etc. Finally, these methods were verified with a virtual implementation of the control panel in a simulation system.

Key words: Hand gestures recognition, natural interaction, virtual interface, augmented reality

INTRODUCTION

With the development of ubiquitous computing, augmented reality has become an important research direction. But in this area, current user interaction approaches with keyboard, mouse and pen are not natural enough for providing more immersive virtual environment. Gesture interaction, due to its nature of being frequently used in people's daily life, will become the preferred means of interaction in augmented reality environment. Although there are a large number of studies in gesture recognition(Hopmann et al., 2011; Zhang and Zhang, 2008), there are not large-scale applications for this technique. So the research of this technique is far from being saturated, and it is still hotspot in the field of human-computer interaction. At present, the research in the field of gesture interaction are mainly about hand tracking, position classification and finger movement recognition. The premise for such various kinds of gesture interaction is the algorithm of gesture recognition. Usually, people used skin color detection algorithms (Kakumanu et al., 2007) and image subtraction (Kim et al., 2004; Lee et al., 2003) to extract hand image from motion pictures. Skin color detection algorithms can recognize human gestures by seeking in a feature table to locating the corresponding area of characteristics. The advantage of this kind of algorithms is its high speed, which is suitable for dynamic environment, yet the disadvantage is that the identification of hand-held tool is difficult; And the image subtraction algorithm is not restricted by the color, so it can extract from the background any specified foreground objects (including manpower and handheld tools, etc.). But it also has some disadvantages like slow recognition speed since it need larger amount of calculation than skin color identification. This research mainly combined the two methods to build a gesture recognition system. And the gesture interaction will be implemented in the virtual control panel in markers based augmented reality system.

OVERVIEW OF THE GESTURE INTERACTION SYSTEM

This article provide two-dimensional interaction system with simple gesture recognition. The system applied hand-gesture model to accomplish the interactions in an AR envieronment. System flow chart is shown in Fig. 1. First, analysing the captured video frames

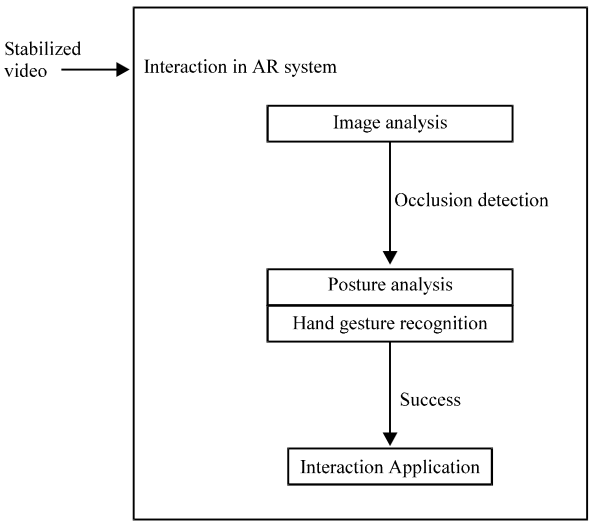

Fig. 1: Overview of the Gesture Interaction System

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by using computer vision technology; sencond, performing posture analysis process to extract the posture parameters so as to classify gestures; third, translating recongized gestures into understandable event-driven command by interactive program if classification is correct.

If all of the virtual objects are defined relatively to the markers plane, the interaction between the virtual objects and the real ones could proceed in a common coordinate system.

In a virtual window, hand gestures are needed to accomplish operations similar to the mouse-down and mouse-up. To achieve this goal, we need to use the complex finger tracking to complete the gestures operation in the movement.

HAND GESTURE IMAGE SEGMENTATIONS

Image subtraction: Image subtraction approach is mainly used to calculate the pixel-level intensity between two image frames. In the hand gesture recognition system, we need firstly to remove the movement of camera by using the image stabilization, and this will make the occlusion detection greatly simplified. If there is no occluder, the corrective marker and is very close to the initial mode. So occlusion on any marker in the subtraction image will produce significant pixel-level differences, this is the reaction of the occluder appears.

Subtraction need to calculate absolute difference between the stabilized image frame and the initial mode. And the intensity of each pixel $I(p_D)$ in different image may be calculated using the following formula:

$$I(p_D) = |I(p_I) - I(p_P)|$$

Where $I(p_I)$ and $I(p_P)$ are corresponding pixel gray in the stabilized image frame and mode frame. Fig. 2 shows the stabilized image (a), the initial mode (b), and the difference images (c). At this point, there is no occluder, any kind of difference just from a small error in graphic matrix calculation.

Image segmentation: Image segmentation is a process to separate different intensity regions in one image. In this system, we use the image segmentation techniques to find occluder in the subtraction image. The binarization is one of the particular segmentation algorithms. In this system, we chose a simple fixed threshold algorithm to process the subtraction image. That is, for each pixel location p_D, a constant threshold value $I(p_B)$ is used to calculated the binarization values with the following formula:

$$I(p_B) = \begin{cases} 0, I(p_D) < T \\ 1, \text{otherwise} \end{cases}$$

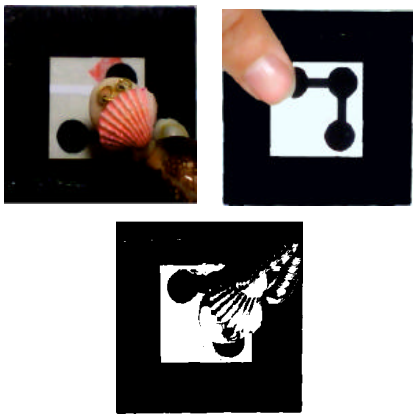
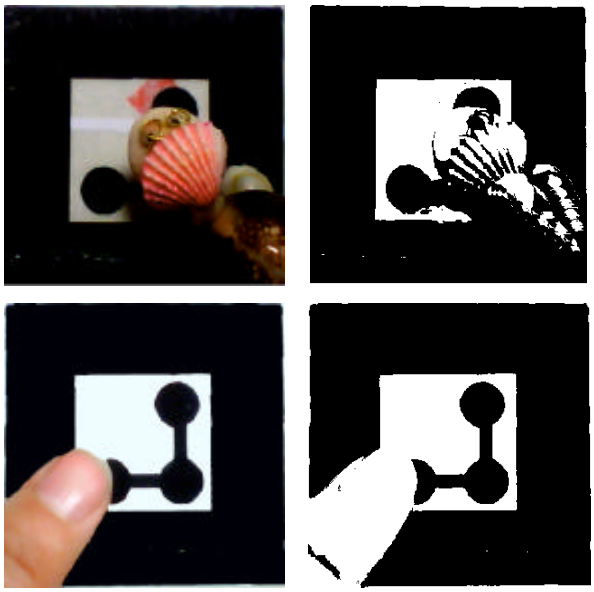


Fig. 2: Stabilized image subtraction



(a) (b)

Fig. 3: Shows the occlusion detection as well as in the binarized image corresponding to the extraction

FINGER GESTURE MODEL

This interactive system is designed to provide users a virtual interface to control a virtual object. And the human interface is defined as a virtual control panel shown on a marker in a plane. Meanwhile, the system is intended to replace the mouse operation by finger gestures. To simplify the problem, we divide the gesture recognition into the following two categories: indication gestures and selection gestures. In the application, indication gesture corresponds to the mouse-move operation and the choosing gesture corresponds to the

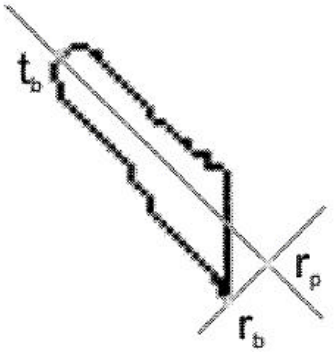


Fig. 4: Fingertip locating

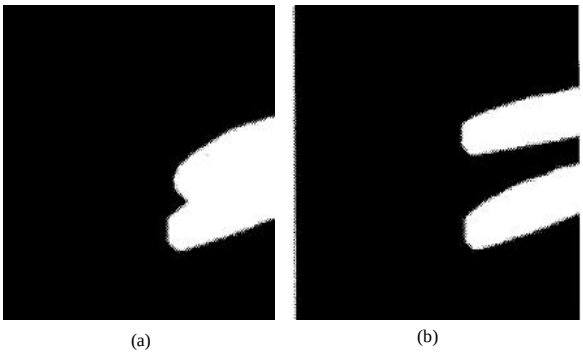


Fig. 5: Determining the number of fingers from detected particles (a)singer particle (b)two separate paritcles

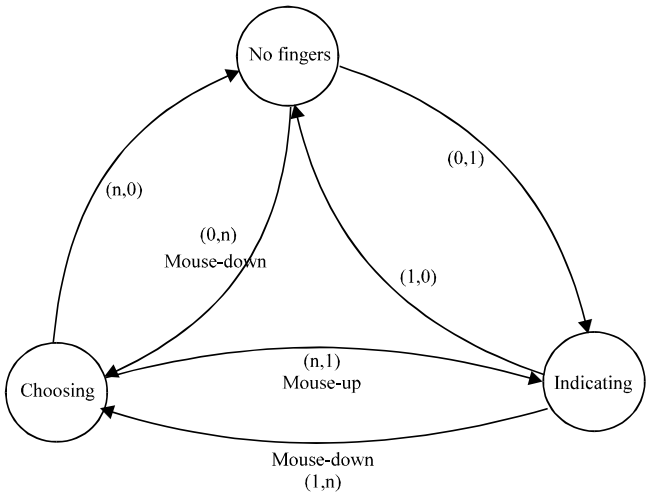


Fig. 6: Status machine

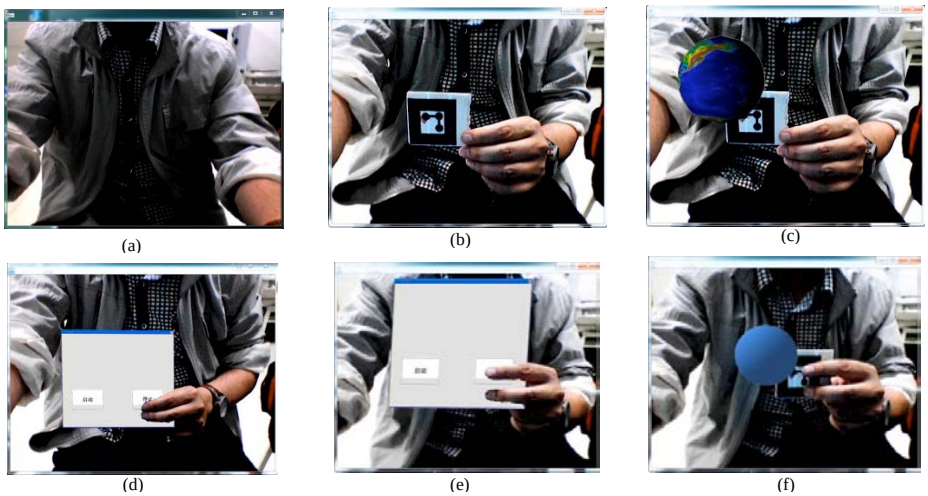


Fig.7 Gesture Interaction System

mouse-down operation. According gesture models, parameters for each finger gesture include: position of the fingertip and the number of fingers.

Fingertip location: Gesture analysis process selects the detected largest particles of finger and then use of shape descriptors of set of particle pixels (the moment descriptor) to extract the particle features. Moment descriptors are widely used for describing the shape of the basic theory. In the binary image, it can also be used to describe many properties of binary particle. For example, the center of gravity, the direction, etc. Fig 4. Shows the result of fingertip locating by using particle orientation method(Pitas, 2000), in which, edge pixels can be chosen from particles, its point closest to the coordinate axis r_p was chosen as a starting point. From the starting point, the farthest particles t_b was chosen as finger position.

Number of fingers and gesture recognition: The number of fingers can be quickly determined by the detected number of particles, as shown in Fig. 5. These two posture characteristics are used for classifying two types of simple gesture: the indicating and choosing operation in a target plane.

SYSTEM IMPLEMENTATION

The mechanism of interaction based on gesture model is similar to mouse operations in the system based on windows. For this purpose, we define a set of status, which can be implement the transition of three different status: indicating, choosing, and no finger detecting. Transitions between status are conducted according to the number of fingers, which can be represented through a pair of values (c_p, c_c) , where c_p is the previous state and c_c is the current state of the number of fingers. The working principle of status machine is shown in Fig. 6.

The final results of the AR interaction system are as shown in Fig. 7. (a) A scene with no markers; (b) A marker is added to the scene; (c) virtual objects (a model of earth) is add to the marker; (d) The occluder (finger) is detected in the scene, and so the virtual control panel appears; (e) two separate finger particles are detected, the status will be transferred to the next one; (f)the two finger status means choosing, this is similar to pressing down the mouse, the button "stop" is push down in the virtual control panel, so the virtual object is replaced by an ordinary geometric model.

ACKNOWLEDGEMENTS

This article is supported by the Natural Science Foundation of Inner Mongolia. (No: 2012ms0916)

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