Real-Time Hand Detection and Tracking Using LBP Features

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Abstract. In this paper a robust and real-time method for hand detection and tracking is proposed. The method is based on AdaBoost learning algorithm and local binary pattern (LBP) features. The hand is detected by the cascade of classifiers with LBP features. A detailed study was developed to select the parameters for the hand detection classifiers. When tracking the hand, a region of interest (ROI) is defined based on the hand region detected in the last frame, and in order to improve robustness on rotation affine transformation is applied to the ROI. The experimental result demonstrates that this method can successfully detect the hand and track it in real-time.

Keywords: hand detection, hand tracking, boosting, LBP, HCI.

1 Introduction

Hand detection and hand tracking play important roles in Human-Computer Interfaces (HCI). To achieve natural HCI for virtual environment applications, human hand could be considered as an input device. Gesture is a powerful human-to-machine communication method. Two primary problems of gesture recognition are hand detection and hand tracking. The tasks of hand detection and tracking are challenging because the hand is a non-rigid object. Considering the global hand pose and each finger joint, the human hand motion has roughly with 27 degrees of freedom (DOFs) [1].

Several hand detection and tracking systems had been proposed. The first generation approaches require glove-based devices to help recognize the hand. However, the gloves and their attached wires are still quite cumbersome and awkward for users. Moreover, the cost of the glove is often too expensive for regular users. The second generation approaches use skin color or shape feature [3][4][5]. However, those methods are lack of robustness when dealing with dynamic environments and various kinds of lighting. The third generation approaches are based on a cascade architecture using boosting algorithm, which was first introduced by Viola and Jones [2] to for face detection and tracking problems. That approach allows robust and fast detection of hands [6][7].
In this paper, we introduce a robust and real-time method for hand detection and tracking, which is based on the boosting architecture combining with local binary pattern (LBP) features.

The rest of the paper is organized as follows. In Section 2 and Section 3, we present the AdaBoost algorithm with LBP features that we use for hand detection and tracking. Experimental results are discussed in Section 4. Finally, we draw the conclusions about our hand detection and tracking application.

2 AdaBoost Algorithm with LBP Features for Hand Detection

Hand detection is one of the obstacles of gesture recognition. Skin-color-based method, one of the solutions for hand detection has to face the difficult task of distinguishing the hands from other objects having skin color, such as arms and face. And it is very sensitive to the changing of light. Thus, if the background or lighting condition does not meet the needs, it would be difficult to detect the hand with skin color-based method.

In this paper, we use AdaBoost algorithm with local binary pattern (LBP) features to detect the hand. It can avoid affections of other objects with skin color, and it is also robust to lighting changes. LBP is a texture descriptor which codifies local primitives into a feature histogram. The cascade of AdaBoost architecture for objects detection is first proposed by Viola and Jones [2] to solve the problem of face detection. Their method uses four basic Haar-like features. They also use AdaBoost algorithm to select and train the classifier. AdaBoost is one of Boosting algorithms combining weak classifiers to form a strong classifier with better accuracy.

2.1 LBP Features

Fig. 1. The basic LBP operator

In our method, we use the LBP features rather than the Haar-like features used by Viola and Jones [2]. The LBP operator is first introduced by Ojala et al. [8] as a powerful means of texture description. The operator labels every pixel of an image by thresholding its 3x3-neighbourhood with the center value and considering the result as a binary number. Then the histogram of the labels can be used as a texture descriptor. Fig. 1 shows the LBP descriptor. When training the classifier, the hand is divided into small regions from which LBP histograms are computed as a feature.

When detecting the hand in an image, the image is scanned by a sub-window containing the LBP features. In order to detect the different size of hand, the image is sampled in different scales. In each scale, the image is smaller than the last one with a