Recognition Using the Multi-PDM Method and Hidden Markov Models

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ABSTRACT

This paper intoruduces a gesture interpretation based on a multi-Principal-Distribution-Model (PDM) and Hidden Markov Models (HMMs). To track the hand-shape, it uses the PDM model which is built by learning patterns of variability from a training set of correctly annotated images. For gesture recognition, we need to deal with a large variety of hand-shape. Therefore, we divide all the training hand shapes into a number of similar groups, with each group trained for an individual PDM shape model. Finally, we use the HMM to determine model transition among these PDM shape models. From the model transition sequence, it can identify the continuous gestures denoting one-digit or two-digit numbers.

1. Introduction

Gestures have been widely used by human being. Gesture input aims to exploit this natural expertise for human-computer interface. If the machine can understand the human gesture either static or dynamic effectively, then it will greatly benefit us human being. In the last several years, there has been an increased interest in trying to introduce human-machine interaction through human body motion that coincides with a growing interest in a closely related field - virtual reality. Pavlovic *et al.* [1] presented a review of the most recent works related to hand gesture interface techniques: glove-based technique[2] and vision-based technique[3-9]. The vision-based technique is the most natural way of constructing a human-computer interface which has many applications. However, it has difficulties in (1) segmentation of the moving hands; (2) tracking and analyzing the hand motion; and (3) recognition.

This paper presents a multi-PDM-based method for hand tracking and handshape extraction, and then generates an ordered sequence of model transitions by using the hidden Markov Model(HMM). The PDM-based hand shape extraction is resistant to complex background influence, and the model transition is invariant to the non-uniform changes in speed and viewing direction. Our method has the advantage that the gesture recognition depends on how the system makes the PDM model transition instead of how exactly it reaches a certain position in 3-D space. Our goal is to convert the variances of the gesture in the spatio-temporal space into a sequence of PDM model transitions as a gesture symbolical representation.

The gesture recognition technique includes tracking the object of interest and identifying the non-rigid hand-shape. The major assumption for a successful tracking algorithm is that the 2-D shape of the moving hand-shape changes smoothly between two consecutive frames. The system has two stages: (1) multi-PDM-based hand-shape tracking and measurement, (2) HMM-based PDM model transition determination. First, we find that the PDM method can only fit new hand examples similar to shapes of the corresponding training set. Since there are so many different hand shapes with lots of varieties, we need to divide all the hand shapes into a number of similar groups, with each group trained for an individual PDM model. Second, for each frame, with the observation of the fitness function, we apply HMM to determine the PDM model transition. The model transition is required when the current flexible model is no longer suitable for a large variation of the hand-shape in the following frames.

2. Shape Model and Feature Points Interaction

Here, we modify the Active Shape Model[10](or Point Distribution Model(PDM)) method to extract the hand shapes. For PDM, the average example is calculated and the deviation of each example from the mean is established. A principal component analysis of the covariance matrix of deviations reveals the main mode of variation. Usually only a small number of model parameters is required to