Recognition of Deictic Gestures for Wearable Computing

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1 Introduction

In modern society there is an increasing demand to access, record and manipulate large amounts of information involved in many aspects of professional and private daily life. This has inspired a new approach to thinking about and designing personal computers, where the ultimate goal is to produce a truly wearable computer. Wearable in the sense of being a natural extension of the body like clothes, shoes or glasses.

A number of different devices have been developed or adopted to the special user interface requirements in wearable computing [4]. Depending on the context the requirements differ. However, one common issue in most wearable computing interfaces is the need for a pointing device, similar to the computer mouse used in standard WIMP interfaces. Without it, precise deictic interaction is either not possible or very cumbersome.

The most common way of achieving this is by the use of a data glove, [5], bend sensors [6], ultrasonic devices [2], and accelerometers [6]. Less intrusive methods are based on head-mounted cameras segmenting the hand(s) in the image. For further information on state-of-the-art see [3].

The aim of this paper is to develop a head mounted camera-based gesture interface for wearable computing that neither requires special lighting (infrared) nor markers attached to the hands/fingers. Our approach is to adopt an advanced tracking framework: the Sequential Monte Carlo (SMC) method [1], which is often used in the computer vision research field and tailor it to the needs originating when the camera is head mounted.

2 Tracking Framework

We require two gestures to be recognizable, pointing and clicking. The former is defined as an outstretched index finger and thumb with all other fingers bend. The latter is defined in the same way except that the thumb is now held against the index finger.

We represent the appearance of the two gestures by the contour of the hand which is manually created using B-splines defined by a set of control points. Applying a linear transformation to these points is the same as applying the transformation to the B-splines.

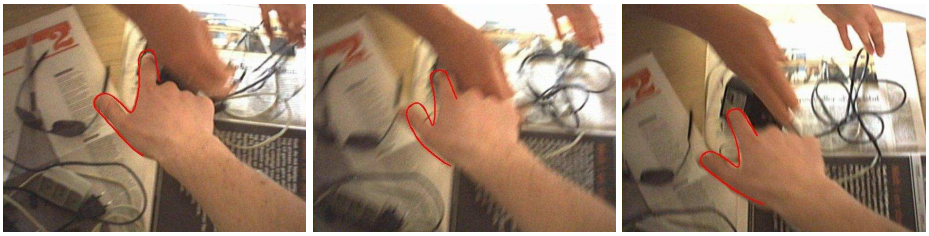
Due to the low signal-to-noise ratio in images the hand can not always be segmented perfectly from the background. Hence, the recognition in a particular frame will not always be unique, or in statically terms, the conditional probability of a gesture given the image measurements will in general be multi modal. This calls for a Sequential Monte Carlo (SMC) method which can handle such situations [1].

In order to apply the SMC method we need a motion model to be able to predict a state vector over time. We assume the individual dimensions in the state space are independent, and can be modeled by first order auto-regressive (AR) processes.

When the contour description of the tracked object has been created and the changes in state from frame to frame can be predicted, comparing the predicted contours with the actual images is the next step. In the SMC tracker this is represented by the observation PDF. In this work this is implemented by finding all edges along a normal centered in each point on the contour. We use a generative model where the statistics of the position and color of the estimated edges and the expected edges (along each normal) are compared using an interior-exterior order statistic likelihood function.

3 Results

In general the tracking of the hand and the recognition of the current gesture works well and especially the index finger is tracked reliably. In figure 3 successful tracking is illustrated for a challenging sequence with very cluttered background, fast hand movements, and additional hands entering the scene.



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