Nouse 'Use Your *N*ose as a *Mouse*' – a New Technology for Hands-free Games and Interfaces

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Abstract

With the invention of fast USB interfaces and recent increase of computer power and decrease of camera cost, it has become very common to see a camera on top of a computer monitor. Vision-based games and interfaces however are still not common, even despite the realization of the benefits vision could bring: hand-free control, multiple-user interaction etc. The reason for this lies in the inability to track human faces in video both precisely and robustly. This paper describes a face tracking technique based on tracking a convex-shape nose feature which resolves this problem. The technique has been successfully applied to interactive computer games and perceptual user interfaces. These results are presented.

Keywords: HCI, perceptual user interfaces, face tracking, feature detection, shape from shading, evidence theory.

1 Introduction

1.1 Perceptual user interfaces

We consider the problem of tracking faces using a video camera and focus our attention on the design of vision-based perceptual user interfaces. These are the systems which use a videocamera to track user's face position in 3D in order to convert it to a position of a cursor or another virtual object in 2D screen. They are aimed at providing a hands-free alternative to mouse, joystick, track pad or track ball. Let us list a few applications of such systems.

First, face-tracking-based program control can be seen as a replacement for an inconvenient track stick or track ball currently used in many laptops. It can also be seen as an additional way of interfacing with a computer, which can be used, for example, to switch a focus of attention in windows environment. Our presentiment is that soon most laptops will be equipped with build-in 'eye' (camera) above the screen. This application therefore will be very useful.

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Second, as mentioned in [3], vision-based perceptual user interfaces can be used to control commercial computer games and immersive 3D worlds. In addition to being hands-free, these interfaces provide a way for multiple-user interaction – several users can be tracked at the same time with several cameras.

Third, as described by [19], this technology has applications in the industry for disabled. Users who have difficulty using a standard mouse could manipulate an on-screen cursor by moving their head.

Finally, face tracking has applications in video-coding, video-conferencing, content-based image retrieval and security industry.

1.2 Previous work

The mentioned applications require face tracking to be fast, affordable and, most importantly, precise and robust. In particular, the precision should be sufficient to control a cursor, while the robustness should be high enough to allow a user the convenience and the flexibility of head motion.

A few hardware companies have developed hands-free mouse replacements. In particular, in accessibility community, several companies developed products which can track a head both accurately and reliably. These products however either use dedicated software or use structured environment (e.g. markings on the user's face) to simplify the tracking process.

At the same time, recent advances in hardware, invention of fast USB and USB2 interfaces, falling camera prices, and increase of computer power brought a lot of attention to the real-time face tracking problem from the computer vision community. The obtained vision-based solutions though still do not exhibit required precision and robustness. Let us review these solutions.

The approaches to vision-based face tracking can be divided into two classes: image-based and feature-based approaches [4, 13, 11, 23]. Image-based approaches use global facial cues such as skin colour, head geometry and motion. They are robust to head rotation and scale and do not re-