Calibration Free, User Independent Gaze Estimation with Tensor Analysis

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Abstract

Human gaze directly signals visual attention, therefore, estimation of gaze has been an important research topic in fields such as human attention modeling and human-computer interaction. Accurate gaze estimation requires user, system and even session dependent parameters, which can be obtained by calibration process. However, this process has to be repeated whenever the parameter changes (head movement, camera movement, monitor movement). This study aims to eliminate the calibration process of gaze estimation by building a user-independent, appearance-based gaze estimation model. The system is ideal for multimodal interfaces, where the gaze is tracked without the cooperation from the users. The main goal is to capture the essential representation of the gaze appearance of the target user. We investigate the tensor analysis framework that decomposes the high dimension gaze data into different factors including individual differences, gaze differences, user-screen distances and session differences. The axis that is representative for a particular subject is automatically chosen in the tensor analysis framework using LASSO regression. The proposed approaches show promising results on capturing the test subject gaze changes. To address the estimation shift caused by the variations in individual heights, or relative position to the monitor, we apply domain adaptation to adjust the gaze estimation, observing further improvements. These promising results suggest that the proposed gaze estimation approach is a feasible and flexible scheme to facilitate gaze-based multimodal interfaces.