Technical Report

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THE ROLE OF FIXATION IN VISUAL MOTION ANALYSIS

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Abstract

The human eye is different from existing electronic cameras because it is not equipped with a uniform resolution over the whole visual field. Near the optical axis it has the fovea where the resolution (over a one degree range) is higher by an order of magnitude than that in the periphery. With a small fovea in a large visual field it is not surprising that the human visual system has developed mechanisms, usually called saccades or pursuits, for moving the fovea rapidly. It is important to understand both the structure and function of eye movements in the process of solving visual tasks. In other words, how does this particular ability of humans and primates to fixate on environmental points in the presence of relative motion help their visual systems in performing various tasks? To state the question in a more formal setting, we investigate in this paper the following problem: Suppose that we have an anthropomorphic active vision system, that is, a pair of cameras resting on a platform and controlled through motors by a computer that has access to the images sensed by the cameras in real time. The platform can move freely in the environment. If this machine can fixate on targets that are in motion relative to it, can it perform visual tasks in an efficient and robust manner? By restricting our attention to a set of navigational tasks, we find that such an active observer can solve the problems of 3-D motion estimation, egomotion recovery and estimation of time to contact in a very efficient manner. The algorithms for solving these problems are robust and of a qualitative nature and employ as input only the spatiotemporal derivatives of the image intensity function (i.e. they make no use of correspondence or optical flow). Fixation is achieved through camera rotation. This amounts to a change of the input (motion field) in a controlled way. ¿From this change additional information is derived making the previously mentioned navigational problems easier to solve. The possibility that a machine possessing gaze control capabilities can successfully address other problems, such as figure-ground segmentation, stereo-fusion, visual servoing for manipulatory tasks and relative depth.

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