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Embodied attention for gaze analysis in daily life activities

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Significant progress has been made towards understanding the role of vision in the control of action, particularly in the last 25 years with the emergence of mobile eye-tracking solutions which measure gaze in relation to the subject's scene view (2D video feed) (Eileen, 2011). In addition, increasing emphasis has been placed on the ecological validity of gaze studies, taking them out of the lab and into the "wild" (Hayhoe & Ballard, 2005; Kingstone et al., 2003; Land & Tatler, 2009). These steps have challenged many of the fundamental results of static eye-tracking experiments and are changing the way we look at eye-movement ethology. However unlike static experiments they require painstaking annotation of gaze position in relation to the scene, objects and the body. Recent developments have been made to automate elements of this process by estimating gaze with respect to the 3D world (Paletta, Santner, & Fritz, 2013) and physical objects in the world (Essig et al., 2012). However, we are also interested in the relationship between eye-movements and full body kinematics in unconstrained natural tasks.

In this work we present a new paradigm for probing this relationship: annotating eye-movements with 3D full-body kinematics in every-day natural tasks. We use a portable eye-tracker (SMI Eye Tracking Glasses, Sensomotoric Instruments, Teltow Germany) in combination with a portable full body motion capture suit, measuring 51 degrees of freedom (DOF) from the body with 16 inertial measurement units (IGS-180 Animazoo, Brighton UK) and 22 DOF from the right hand (Cyberglove 1) and 18 from the left (Cyberglove 3, Cyberglove Systems, San Diego California USA). All tracking equipment is marker less and thus allows extensive behavioral monitoring "in the wild". The eye-tracker data is processed post-hoc to give 3D gaze position relative to the subjects head using our own software (Abbott & Faisal, 2011; Abbott & Faisal, 2012) and the motion capture data. The experiment had 3 natural scenarios: breakfast time, evening chores and navigation. During each scenario, task level instructions were given and subjects conducted activities such as laying the table for breakfast, sweeping the floor and walking to a specified location in the building. During the experiment we had a manual online annotator to separate tasks and sub tasks, and an usher to guide the subject from task to task.

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This data intensive approach, in ecologically valid environments gives detailed information of the simultaneous output from the motor plant and thus allows us to extract meaningful statistics from the data without the need of hand coding eye-movement data frame by frame. This level of data richness (98 DOF), coupled with the extensive recordings of natural behavior (total>30 hrs) will allow us to answer general questions about the natural statistics of movement, highlighting variation and consistencies, both inter and intra subject, to be understood and verified quantitatively in natural tasks.

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