Evaluation of 3D Pointing Accuracy in the Fovea and Periphery in Immersive Head-Mounted Display Environments

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Abstract—The coupling between perception and action has seldom been explored in sophisticated motor behaviour such as 3D pointing. In this study, we investigated how 3D pointing accuracy, measured by a depth estimation task, could be affected by the target appearing in different visual eccentricities. Specifically, we manipulated the visual eccentricity of the target and its depth in virtual reality. Participants wore a head-mounted-display with an integrated eye-tracker and docked a cursor into a target. We adopted a within-participants factorial design with three variables. The first variable is *Eccentricity*: the location of the target on one of five horizontal eccentricities (left far periphery, left near periphery, foveal, right near periphery and right far periphery). The second variable is *Depth* at three levels and the third variable is Feedback Loop with two levels: open/closed. *Eccentricity* is refactored into *Motion Correspondence* between the starting location of the cursor and the target location with four levels: periphery to fovea, fovea to periphery, periphery to periphery, fovea to fovea. The results showed that the pointing accuracy is modulated mainly by the target locations rather than the initial locations of the effector (hand). Visible feedback during pointing improved performance.

Index Terms—Virtual Reality, Vision, Periphery, 3D, Pointing, Visual Feedback.

1 Introduction

Daily actions such as reaching and grasping require coordinated control of both hand and eye movements. In this context, humans need to process the dynamically changing visual inputs, and often integrate information from other sensory modalities such as audition, somatosensation (proprioception, touch) etc. Previous studies have extensively explored reaching behavior in both real and virtual worlds, in which human observers usually fixate their gaze on the target. However, it is often the case that the targets for pointing and reaching are located in the periphery and not in the focus of gaze. To name a few, typing characters