Podium Presentations

Session II: Health Effects I

Chairs: Suzanne Smith and Oliver Wirth

RIDE MOTION EFFECTS ON THE ACCURACY OF RAPID POINTING TASKS

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Introduction

Reaching movements are planned and subsequently executed [1] using visual and somatosensory feedbacks [2], where absence of visual feedback is known to increase endpoint variability [3]. Visual occlusion decreases the ability to make rapid online compensatory movements, which results in initial radial deviations that are highly correlated with radial dispersion at the target. Perturbations of rapid, visually-guided reaches are compensated on-line and result in endpoint dispersions poorly correlated with initial deviations, emphasizing the strong effect of visual feedback in temporally-constrained reaching tasks. In control conditions (no vibration), these uncompensated, rapid reaches serve as estimates of the individual's intended trajectory. When ride motion is present, trajectories of rapid, visually-occluded reaches provide a measure of the natural biodynamic response of the cantilevered spine-arm-hand linkage. These intended movement trajectories and the biodynamic response (vibration feedthrough) are used to predict the effect of ride motion on the performance of rapid reaching tasks. Goals of this study are to investigate the influences of vehicle motion on human reaching and pointing, and to reveal movement strategies used in visually-occluded reaching tasks.

Methods

A six degree of freedom human-rated Ride Motion Simulator (RMS) was used to generate a dynamic vehicle environment. Participants performed discrete, rapid pointing tasks to targets presented on three touchpanel displays under stationary and random whole-body vibration. Reach instructions included ***successfully*** reaching identical circular targets (Ø = 0.25") with the right index fingertip ***as fast as possible***. Targets were presented on resistive-touch displays mounted approximately 60 cm from the participant's nasion. The touchpanel displays were located in the forward and lateral directions at eye level, and forward at 45° of elevation. These displays measured the spatial error of the reach destination. A ten-camera VICON motion capture system recorded the upper body kinematics of the participant. Reflective markers were placed on the participant's torso, head, and arms. Initial kinematics of the fingertip (i.e. time and magnitude peak tangential velocity) and tangential velocity at target were used to estimate the planned endpoint of the reach.

Results and Discussion

Ride motion resulted in increased endpoint variability compared to reaches performed in the stationary condition. Reaches to the elevated touchpanel consistently resulted in the largest variability across all motion conditions, suggesting that a vehicle occupant would not be capable of accurately activating a control in that location. Principal axes of endpoint ellipses were along and perpendicular to the direction of fingertip movements. Example graphs of endpoint variability with ellipses containing 95% of the data points are shown in Figure 1. These ellipses might be used to enhance vehicle cockpit designs, where controls and displays could be shaped and oriented within the vehicle with respect to the operator and the probable reach direction.

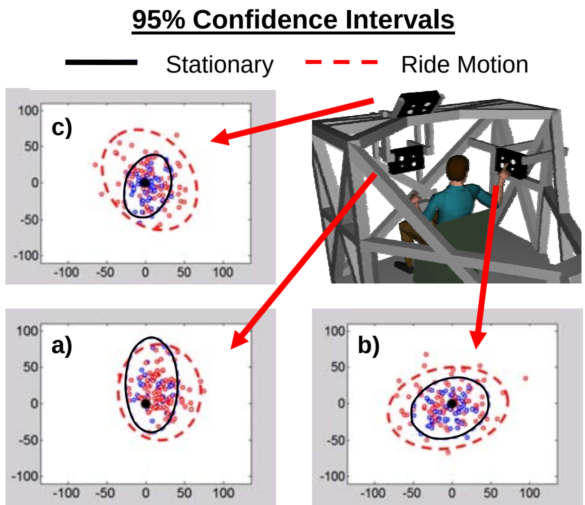

Figure 1. Comparison of 95% confidence ellipses of endpoint variability due to ride motion.

Analysis of the endpoint accuracy is illustrated using the circular representation in Figure 2a, where the deviations at peak velocity (PV, Figure 2b) are correlated with the deviations at the target (Figure 2c) with respect to the mean trajectory. If visual feedback mechanisms are not being utilized, than the dispersion of fingertip positions at PV (Figure 2b) should be replicated at the target. However, figure 2c shows that the actual endpoint dispersion at the target are poorly correlated ($R^2 = 0.07$) to values at PV for visually-occluded reaches, suggesting the interaction of proprioceptive feedback control.

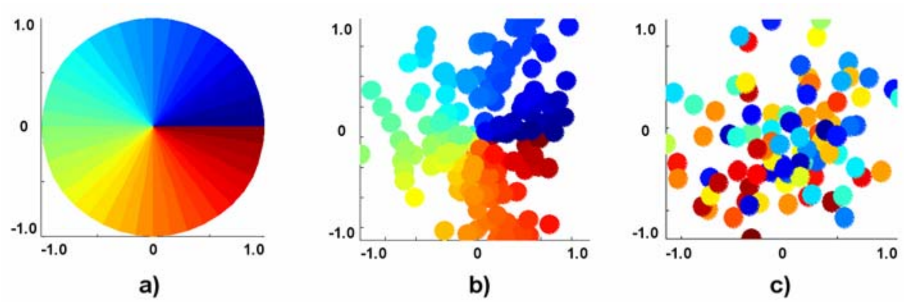

Figure 2. a) Illustration of the radial deviation of fingertip position at peak velocity (b, relative to the mean path) and reach endpoints (c, relative to the target center).

References

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