

Occupant Behavior Analysis in Seating Posture including Large Backrest Inclination

- Whole-Body Frequency Response Characteristics under Six-Axis Frequency Sweep Excitation -

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Automated driving is expected to increase the use of non-standard seating postures, including highly reclined postures. However, most human vibration studies have mainly focused on standard seating postures and limited excitation directions. Backrest inclination changes body-seat contact conditions, and whole-body dynamic responses are expected to depend on both seating posture and excitation direction. This preliminary study investigated posture-dependent whole-body frequency responses under six-axis excitation.

Two healthy adult male participants sat on a seat mounted on a six-degree-of-freedom motion system. As shown in Fig. 1, three seating conditions were evaluated: Conditions (a), (b), and (c), with standard, moderate, and large backrest inclinations, respectively. A logarithmic sinusoidal frequency sweep from 0.1 to 6 Hz was applied over 90 s along the fore-aft, lateral, vertical, roll, pitch, and yaw directions of the ground-fixed coordinate system, with a maximum acceleration amplitude of 1 m/s². Whole-body motion was measured using an OptiTrack motion capture system (NaturalPoint, Inc.) with 61 reflective markers. Accelerations and angular velocities of body segments were expressed in the body-fixed local coordinate system of each segment, and frequency responses relative to the input acceleration were estimated. Each condition was repeated three times.

Representative results are shown in Figs. 2 and 3. Under fore-aft excitation, the dominant resonance in the vertical response shifted from approximately 3.6 Hz in Condition (a) to 3.2 Hz in Condition (b) and 2.7 Hz in Condition (c). Whereas body segments moved relatively independently in Condition (a), they moved more coherently in Condition (c). Under lateral excitation, the head yaw response increased in Conditions (b) and (c) owing to head-headrest contact. The dominant resonance in the lateral response also shifted toward higher frequencies. Whereas the body rotated mainly about the pelvis and both feet in Condition (a), the whole body rotated in yaw on the seat surface in Conditions (b) and (c). The higher resonance frequency may have resulted from a shorter effective moment arm. These trends were consistent in both participants, while inter-participant differences became smaller in Conditions (b) and (c).

Backrest inclination substantially altered the dynamic characteristics of the human-seat system. The proposed method, combining six-axis excitation and whole-body motion capture, may provide a useful approach for evaluating vibration comfort in diverse seating postures and for designing seats for future mobility. Future work will include experiments with more participants and simultaneous measurements of seat contact loads.

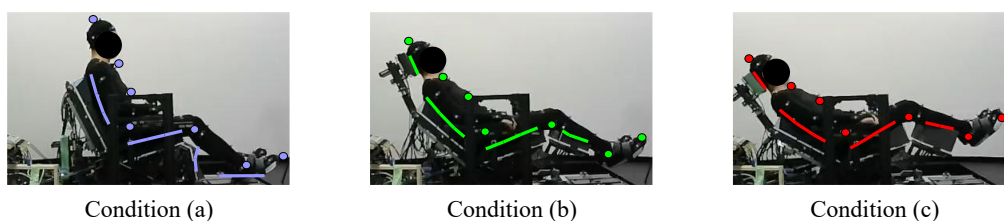


Fig.1 Seating Posture Conditions

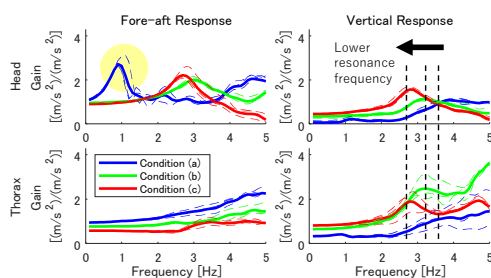


Fig.2 Frequency Response under Fore-aft Excitation

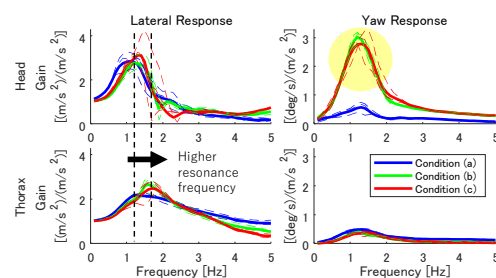


Fig.3 Frequency Response under Lateral Excitation