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An Immersive Environment to Analyze Biomechanical Data from Small Female PMHS Sled Tests in Oblique Frontal Impacts

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To protect small females in motor vehicle crashes, the National Highway Traffic Safety Administration (NHTSA) is developing an advanced Anthropomorphic Test Device (ATD) using biomechanical data conducted on Post Mortem Human Surrogates (PMHS). As part of this NHTSA-funded program, sled tests were conducted on small female PMHS using a standard frontal buck aligned such that the acceleration vector was either a 30-degree driver far-side or near-side oblique frontal impact. Six degree-of-freedom transducers were placed at the head, spine, and pelvis along with retroreflective targets to measure three-dimensional occupant kinematics. Several off-board and on-board high-speed video cameras were used to document gross occupant motion. The complex three-dimensional PMHS motion and large amount of data generated from these tests are challenging to analyze using standard plots and planar images. A more efficient way to analyze these data are to utilize an immersive 3-d environment. A Virtual Workspace (VW) was created inside a Cave Automatic Virtual Environment (CAVE) using a combination of software. Rigid body motion of the head, spine (T1, T8, and L2), and pelvis anatomic motion were calculated relative to the sled from Computed Tomography (CT) images coupled with the marker trajectory data using a 3-d kinematic model developed in Matlab. The translation and rotation of each anatomic segment relative to the seat were calculated and output into time-history comma separated value (CSV) files. Additionally, rib defections were calculated and output to an avi movie file. Stereolithography files of the head, spine, pelvis and sled were generated and imported into Blender where the files were converted to and OBJ file. An avi movie was generated from onboard high-speed video of the event. These elements were combined in VW to review the data using Unity and Middle VR. A 3-d model of the buck and occupant and their motion were displayed in the center of the VW and could be viewed from different perspectives. Simultaneously, rib deflection and high speed video were displayed and synched to the occupant motion. The CAVE environment and VW provide an effective method for an engineering team to analyze the complex occupant motion and delineate the biomechanics of injury.