Experimental Validation and Reliability Testing for Center of Mass Body Tracking

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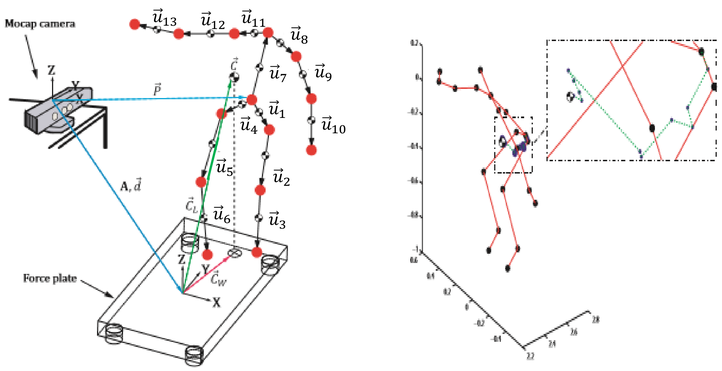
Objective: To improve upon current center of mass testing protocols, reduce sensor error through improved calibration, and refine employed center of mass estimation algorithms to produce more meaningful parameters.

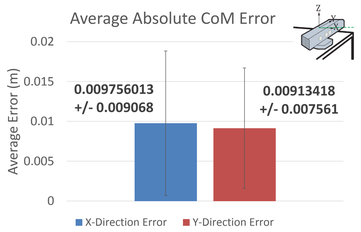
SESC (Statically Equivalent Serial Chain) Basics

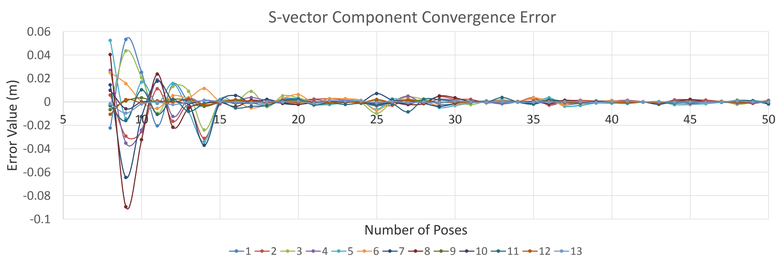
- What it is: a modeling technique in which the center of mass (CoM) of a system of rigid segments (human, humanoid, etc.) is calculated without the requirement of body parameters such as individual link masses
- CoM tracking in humans is valuable as a parameter for postural control (e.g. balance and gait definition for rehabilitation)
- Techniques utilize inexpensive methods for motion capture, namely a Wii Balance Board (WBB) and an Xbox Kinect



Center of Mass Prediction

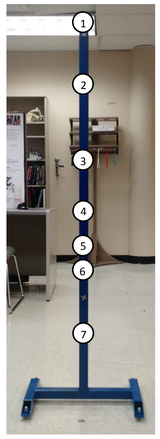
- CoM predicted with errors of less than 1 cm
- Number of poses required for good data collection: 35-50

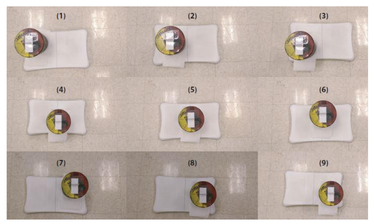


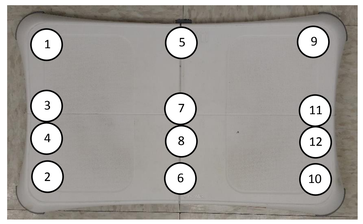


Calibration Protocol and Sensor Accuracy

- Calibration requirements:
  - 9 weight placements on WBB
  - Level (0° tilt) Kinect
- Accuracy reporting: Measured/actual value compared to sensor-reported values for center of pressure and spatial location
  - WBB – 96% accuracy
  - Kinect – 93% accuracy
  - Optimal depth for measurements – 100 inches from Kinect (99% accuracy)

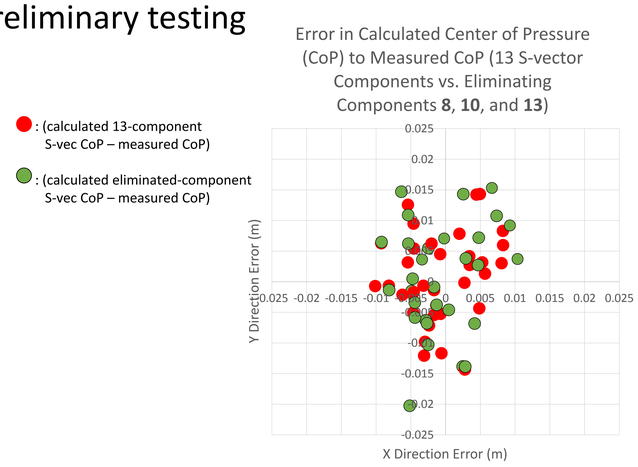






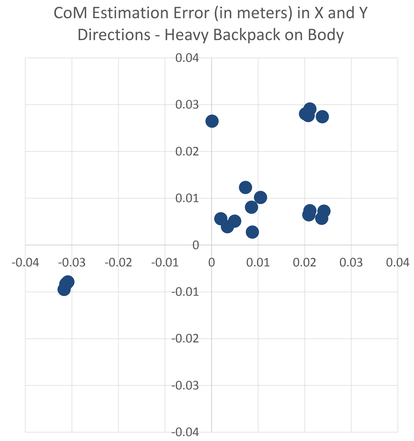
Elimination of S-Vector Components

- S-vector: Unique to all people; contains information about CoM locations of individual segments
- Elimination of components simplifies model
- S-vector components 8, 10, and 13 can be estimated to be removed from the model based on preliminary testing



Center of Mass Accuracy Validation

- Subject wore a heavy backpack to displace CoM
  - CoM is forced to lie outside two nodes
- CoM estimation is similar to trials without backpack



Optimal Testing Time Frame and Constraints

- Determined the fastest and most accurate method for static pose capturing
  - Number of frames per pose capture – 15 frames
  - Allowable CoP standard deviation (SD) – 4 mm
  - Allowable node location SD – 1 cm
- Total time to capture 50 poses – 3 minutes for an experienced subject; 7 minutes for unexperienced

Future Work

- Further testing to validate which S-vector components can be eliminated to decrease number of poses needed
- Experimentation needed to validate the inclusion of a stabilizing body (such as a cane)
- Donor Model experimentation to determine if people who cannot demonstrate enough poses can supplement with pre-set ones
- Compare SESC modeling to Plug-in Gait studies (e.g. Vicon motion capture)