Abstract:

The representing upper extremity posture has posed a great challenge in the field of analytical biomechanics. The upper extremities have great freedom of motion which allow for large rotations in multiple directions. The Euler and quaternion methods, which are two commonly used methods for describing joint angles and body segment postures and movement, have great limitations when dealing with this. The planar projection method is commonly used to represent joint angles and body segment postures and movement. The advantages of this method over other common methods are that it yields rotations with anatomical meaning that make it easy to understand from a clinical standpoint, it is not affected by Gimbal lock issues, is more accurate at multiple great rotations and has a known error calculation method. The disadvantages of this method are that it does have accuracy limitations and the potential for high angle error if used improperly. The planar projection method’s superior accuracy for multiple large rotations makes it a good candidate for representing upper extremity orientation. This thesis investigates a modified planar projection approach using a simplified opto-electronic marker configuration to improve the accuracy and reduce the calculated error when calculating upper extremity orientations. One modification is the method by which the anatomical planes are defined. The anatomical planes are calculated by first defining orthogonal axes at the chest and then rotating the axes to account for the slope of the chest. By defining the anatomical axes using anatomical landmarks of the upper torso, the body can move freely without disturbing the virtual anatomical plane calculations. The other modification is to calculate the joint angles using two different vector projections and using the projection that has the least amount of calculated error associated with it. This modified method is tested using human and mechanical tests and is applied to data pertaining to laparoscopic surgical tasks. The ergonomic risk exposure of the tasks is quantified from the postural results using a threshold technique.