Interactions Between Trunk Posture and Changes In The Lower Limb Kinematic and Kinetics

Sarra Abbasher Mahmoud Gismelseed

Abstract

The human body and its various and unlimited abilities were an inspiring field to be studied and discovered since the beginning of humanity. Although human motion was widely studied experimentally using sophisticated gait laboratories, such experiments don't have the ability to predict new motion or feature of human motion. Bipedal walking research has taken many forms with different goals. From biomechanical point of view, research focused on trying to develop realistic models that help in representing, clarifying, and analyzing normal and abnormal human movement.

The aim of this study is to use simple models that are able to mimic and capture some essential features of normal and abnormal human motion. The complexity of the models varies, ranging from very simple to moderate complexity, depending on the type of movement being studied. In this work, we studied the interaction between torso (trunk) posture and the lower limb kinematics and kinetics in normal and abnormal motion using the proposed biped models. The models incorporate the effects of both physical and kinematics constraints of human locomotion by formulating an optimization problem that aimed at minimizing a cost function. The selection of the cost function also depends on the studied motion as well as the constraints necessary to produce motion similar to human motion.

First, a two links biped model that consists of a torso and a massless leg was used to study two basics patterns of human locomotion: walking and running. The findings demonstrated the model's capability to exhibit kinematics characteristics of lower limbs and torso and to explain the behavior of torso motion at running and walking as well. We have also shown the effect of step size and walking speed on torso movement using this model.

Then, to recognize the significance of investigating gait aspects, particularly the influence of gait speed and torso range of motion, a five links biped model is involved. The model consists of a torso segment and two legs with knee joints, enabling the study of the effect of speed on biomechanical variables for both lower limbs and upper body when the torso is unrestricted and when it is restricted. The results indicated that increasing the walking speed affects gait variables and restricting torso movement at different walking speeds also altered the motion of lower limbs and upper body.

Finally, the work involved a three links model to study the impact of different factors on sit-to-stand motion since sit-to-stand is one of the basic motions in everyday life, and the way it is being performed affects the quality of life. The model included a torso segment and a leg with a knee joint. The results showed the ability of the model to predict the changes in kinetic and kinematics parameters by changing the speed of motion, reducing joint strength, and reducing seat height. The results also showed that changing speed of motion, joint strength, or seat height will affect joint angular displacement, joint torques, joint angular velocities, center of mass position, and ground reaction force.