

FROM HIGH SPEED PLANTAIR PRESSURE MEASUREMENT TO LOWER LIMB SKELETAL MOTION

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INTRODUCTION

At present, more and more gait labs are equipped with a motion analysis system, force plate, EMG and a pressure plate system which helps them in their efforts to understand and change the gait patterns of their patients.

In clinical surroundings, it might not be necessary to have such a complete analysis set-up. Time and costs restrictions on clinical analysis could limit the use of motion analysis and EMG systems. Predominantly, the need for a highly technical operator, set-up time, processing time, and the need for a designated working area are the restrictions for applying these methods. However, information of lower limb motion has been related to sustained injuries (in MacClay, 2000). Therefore, motion analysis cannot be discarded that easily when studying an individual's gait.

In the present preliminary study, a midway is suggested between a full gait analysis and the sole use of a pressure plate system. By simulating lower limb motion from high speed plantar pressure measurements, the restrictions mentioned above are circumvented. In previous research by Hagman (2002, 2005), Lake et al (2005), and Dixon (2004), mechanical and statistical modelling were used to simulate or predict lower limb motion from pressure measurements.

Using the results from these studies and adding a number of pressure variables, it was the goal of this study to develop and run a forward dynamic lower limb model.

METHODS

Simultaneously measured plantar pressure and motion data of human gait were kindly made available by Dr. Mark Lake. The motion data was registered by a Qualisys system running at 1000Hz, and the pressure from a footscan® pressure system running at 500Hz (details in Lake et al. (2005)), see Figure 1.

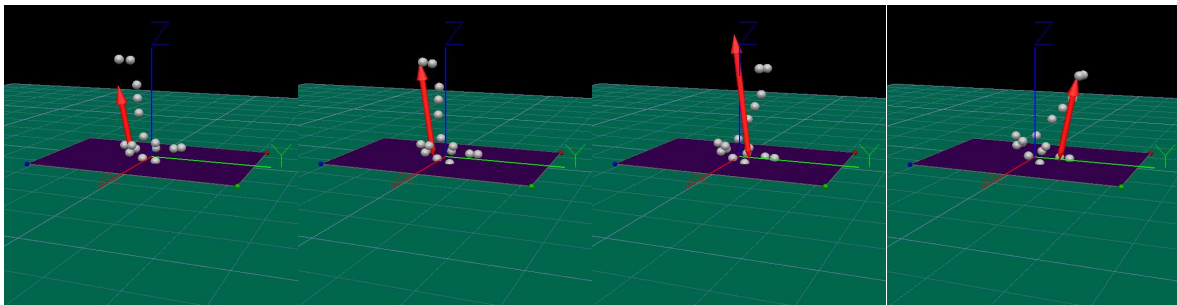


Figure 1: An example motion data used for the dynamical lower limb model.

Subsequently, a forward dynamical lower limb model was developed within the AnyBody environment (<http://www.anybodytech.com/>). The model consisted out of all

26 common foot bones and the tibia. Some joints structures were taken to be fixed, such as the joints between the navicular bone and the cuneiform bones.

Other joints were controlled rotationally and are dependant on pressure variables obtained from the pressure plate system: center of pressure path, foot balance, inversion/eversion, and local pressures.

Furthermore, the controls were not the same during heel impact, midstance, and propulsion. In Figure 2, an example of the lower limb model is depicted.

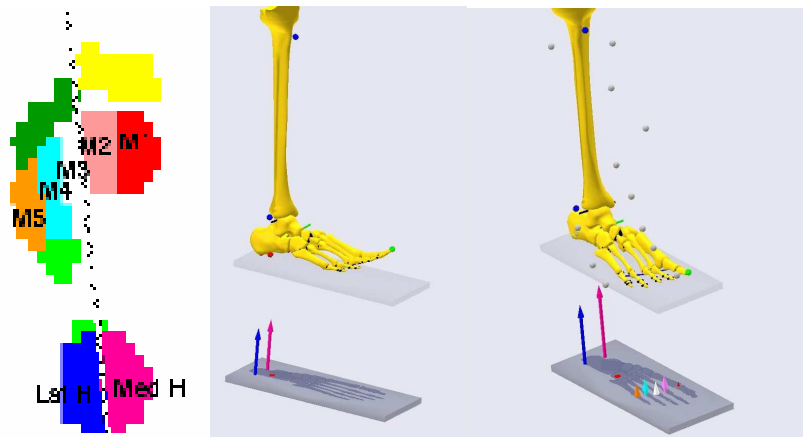


Figure 2: The way the lower limb model is driven. On the left the pressure image indicating the pressure variables. In the middle the model driven by the pressure variables. On the right the model in comparison with motion data.

RESULTS

At present, a comparison between simulated and actual kinematics has not yet been performed using a mathematical criterion. In the construction phase of the lower limb model, the combined kinematic and pressure data were used to develop these controls. The gross motion of the model is therefore within the boundaries of “normal” gait.

DISCUSSION

Still the necessary research has to be devoted in developing the “right” controls that drive the model. We expect that most of the present controls need fine tuning, meaning more sophisticated relationships between pressure and motion.

We believe that the applicability of this technique in clinical settings will be one everybody looks forward to. Therefore, it is our commitment to further extend the possibilities of this model and to validate it with real kinematic data.

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