

6754 Th, 14:30-14:45 (P43)
Modeling of the human gait by means of dynamic software and inverse kinematics: An approach for design of prosthesis
 F. Vargas, A. Ramirez, D. Garzón, M. Roa. *Universidad Nacional de Colombia, Bogotá, Colombia*

We show the results that were obtained through modeling the human walking by using engineering software. It was done in a dynamic simulator joined to a 3D CAD software. The aim is the exploration of the likely uses of the programmes that are traditionally used by engineering design, in biomechanics and in the diagnosis of pathologies that affect the regular biped locomotion. The investigation was done with a three-dimensional model of the human body that was articulated by changing measurement based on a previous parameter. The Solid Edge V14 was used in this work and the model can be fitted to any physical body by using two parameters of simple inspection like height and body muscle. The model was provided with cinematic data about regular human gait that was obtained in a movement analysis laboratory which uses video graphic computers systems that were developed by the IBV (Instituto de Biomecánica de Valencia, Spain). This data relates the angular movement of three joints of the limbs involved in the locomotion process (hip, knee, ankle) with the time and percentage of the gait cycle. The dynamic results that were obtained in the simulator (MSC Dynamic Designer Motion Pro) were articular moments in three dimensions (sagittal, coronal, transverse) about the joints mentioned above in both left and right legs. These results were put against with the ones obtained by the video graphic system (IBV) in order to support our model and the correlation was closed and consistent. So, the research demonstrates the possibility to make a model of the human body by using engineering software. Furthermore, it becomes a useful diagnosis tool that is trustful and could be used as a source of information to redesign personal prosthesis or orthosis.

7507 Th, 14:45-15:00 (P43)
Leg design for stable walking and running

A. Seyfarth¹, F. Iida^{1,2}, Jürgen Rummel¹, H. Geyer^{1,3}. ¹*Locomotion Lab, Friedrich-Schiller-University Jena, Jena, Germany*, ²*Artificial Intelligence Laboratory, University of Zurich, Zurich, Switzerland*, ³*Biomechanics Group, MIT Media Lab, Massachusetts Institute of Technology, Cambridge, MA, USA*

During the last two years various simple legged robots were developed at the Locomotion Laboratory at Jena. The common design principle of all these robot testbeds was an oscillating hip driven by an electric motor and passive legs made of rigid segments, joints and elastic structures. In order to investigate the mechanisms of mechanical selfstability no sensory information was used to stabilize the movement.

We found that stable forward hopping was reproduced in different single legged robots (e.g. using an elastic pogo stick or a segmented leg) for varying oscillation frequencies and angular adjustments of the hip oscillator. Walking was observed in a biped robot with human-like leg geometry and out-of-phase harmonic oscillations of the left and right leg.

Based on a newly designed bipedal robot we aim to investigate, whether simple leg control policies can be used to alternatively achieve stable walking and running. Therefore, we introduced additional motors adjusting elastic structures spanning knee and ankle joint. The simulation of the robot dynamics revealed that transitions from walking to running can be achieved for fixed leg configurations and without sensory feedback only by increasing the hip frequency (as observed in human locomotion). As a next step we now enforce minimizing energetic costs as an additional optimization goal.

In future we will add sensory feedbacks to further stabilize walking and running movements, e.g. in face of unexpected obstacles, or in order to support the stabilization of the upper body.

7389 Th, 15:00-15:15 (P43)
Mechanical design and testing of a biped robot to reproduce normal and pathological gait patterns from motion capture systems

R.E. Silva Santana¹, A. de Toledo Fleury^{1,2}, L. Luporini Menegaldo³. ¹*Polytechnic School, Mechanical Engineering Department, University of São Paulo, São Paulo, Brazil*, ²*FEI University Center, Mechanical Engineering Department, São Bernardo do Campo, Brazil*, ³*Military Institute of Engineering, Mechanical and Materials Engineering Department, Rio de Janeiro, Brazil*

This work shows the development and testing of a low-cost PC-controlled biped robot able to reproduce the main features of gait patterns acquired from clinical gait labs. The robot is actuated by servo-controlled electrical motors, and has 10 degrees of freedom: foot-ankle plantar flexion/dorsiflexion and inversion/eversion, knee flexion/extension, hip flexion/extension and adduction/abduction, for both legs. Robot link lengths were chosen proportional to anthropometrical mean dimensions taken from Winter (1991). Movement

are transmitted from motors to limbs through an optimized spatial parallel linkage (Menegaldo et al., 2005), and the joint angles controlled and measured by using an inverse linkage kinematical model. The feet and ankle attitudes are measured by low cost MEMS (Micro Electrical Mechanical Systems) accelerometers. Despite the fact that some degrees of freedom were not included in this first version, especially hip and knee rotations, the robot has been able to reproduce acceptable patterns of gait obtained from VICON clinical gait lab, both for normal and cerebral palsy, with a small aid of an operator to augment robot's stability. Gait phase times identified through footswitches and joint angular displacements performed by the robot have shown good agreement with the motion capture data used as open-loop input. Acknowledgements: CNPq, CAPES, AACD.

References

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 Winter D.A. (1990). *Biomechanics and Motor Control of Human Movement*, 2nd Ed. John Wiley & Sons.

6075 Th, 15:15-15:30 (P43)
The effects of walking speed on orbital stability of human walking

J.B. Dingwell¹, H.G. Kang¹, L.C. Marin². ¹*Department of Kinesiology, University of Texas, Austin, Texas, USA*, ²*Amputee Care Center, Brook Army Medical Center, Fort Sam Houston, Texas, USA*

Older adults and those with gait pathologies consistently exhibit slowed walking speeds. They experience challenges in walking stability, and are at increased risk of falls, a significant and costly health care problem. Local stability describes how systems respond to small perturbations *in real time*, and was found to improve with slower walking speeds, suggesting slowing down may be a strategy adopted by older adults and those with motor pathologies to improve walking stability. Orbital stability, defined using Floquet multipliers that quantify how *periodic* systems respond to very small perturbations *from cycle to cycle* (stride to stride), may be more suited to study dominantly periodic systems like walking. While some studies have shown that human walking is orbitally stable, others have demonstrated local *instability*. Does slowing down also improve orbital stability? We set out to determine how walking speed affects the orbital stability of human walking.

Trunk kinematic data were examined from 11 young healthy subjects walking across a wide range of speeds on a treadmill. Maximum Floquet multipliers (Max FM) were computed to quantify the orbital stability at different speeds. Repeated-measures ANOVA and regression analyses were used to compare Max FM values between speeds.

All subjects exhibited orbitally stable walking kinematics, although these same kinematics were previously shown to be locally *unstable*. Orbital stability changed very little with speed, compared to previous finding that local stability improves with slower walking speed. While orbital stability improved slightly with slower walking speeds, only the correlations between walking speed and orbital stability in the anterior-posterior motion was statistically significant ($p < 0.01$), and were generally weak ($r^2 < 17\%$). This is unlike previous findings, where local stability increases within the first stride after the perturbation. Unlike local stability, orbital stability may not be very sensitive to speed. Slower walking may absorb small perturbations immediately, but not after a full gait cycle.

3.6. Gait Variability

6455 We, 14:00-14:15 (P33)
Gait dynamics in older adults with a high level gait disorder: a prospective study

J.M. Hausdorff^{1,2,3}, V. Huber-Mahlin^{1,3}, T. Herman¹, C. Peretz^{1,2}, L. Gruendlinger¹, N. Giladi^{1,2}. ¹*Movement Disorders Unit, Dept of Neurology, Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel*, ²*Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel*, ³*Division on Aging, Harvard Medical School, Boston, MA, USA*

Introduction: Many older adults walk with a disturbed gait and exacerbated fear of falling whose origin cannot be readily attributed to known disease. These patients are considered to have a "higher-level gait disorder" (HLGD). A 3-year prospective study was performed to better understand the nature of this gait disturbance and its effects on gait dynamics and variability and to test the hypothesis that the decline in gait and function is greater in patients with a HLGD than it is in healthy controls (CO).

Methods: Twenty-two older adults with a diagnosis of HLGD and 25 age-matched "healthy" controls (mean age: 81 yrs) were examined at baseline and re-evaluated 3 years later. Tests included: neurological exam, the Mini Mental State Exam (MMSE), the Dementia Rating Scale (DRS) – a measure sensitive to frontal and fronto-subcortical dysfunction, the Timed Up and Go test (TUG), as well as measures of gait variability and dynamics.