

Passive Kneed Human Dynamics Model with Arms for Vision-Based Robotics

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1 Motivation

Estimating the physical parameters of articulated-multi-body-systems using an uncalibrated monocular camera poses significant challenges for vision-based robotics. The goal of this work is to develop a planar passive kneed human dynamics model with arms that is capable of generating diverse activities (e.g. walking, running, sitting, jumping etc.). We believe that such a model could act as a general dynamics model which can be calibrated for specific activity using the pose estimates obtained from its uncalibrated monocular video and thereby, help in creating low-order surrogate computational models for analysis and control.

2 State of the Art

Prior work incorporating the use of a simple human dynamics model for walking has shown encouraging results for estimating kinematic and inertial parameters (developing a dynamically equivalent model) using uncalibrated monocular videos [1, 2]. However, the framework is not generalizable to different activities due to the absence of a general human dynamics model having both knees and arms, which we seek to develop in this work.

3 Own Approach

In our pursuit to develop a robust framework for estimating human parameters using uncalibrated monocular videos of different activities, we develop a model incorporating the following: (1) *Passive Kneed Human Dynamics Model with Arms*: We develop a passive human dynamics model incorporating the dynamics of both the knees and upper limbs (Fig. 1(a)). Human body is actuated with antagonistic redundant musculotendon system which can tighten and relax to exert forces on the body. To this end, we define parametric model of joint torques in terms of torsional springs. The knee joints and torso are assumed to have a damped spring, and hip and arm (assumed to be a single rigid body) joints are assumed to have undamped springs. (2) *Ground Collision Constraint*: We model the collision of foot with the

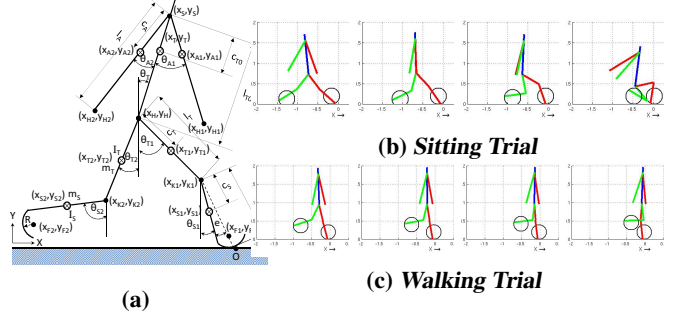


Figure 1: (a) Passive kneed human dynamics model kinematic nomenclature, (b) and (c) simulation results for different activities.

ground as impulsive. (3) *Joint Limit Constraints*: We handle the joint limit constraints by monitoring active constraints and applying virtual torques when violation is detected. To estimate the physical parameters of the human model, we plan to optimize the model pose to the pose estimates obtained using uncalibrated monocular videos as presented in [1, 2].

4 Current Results

Initial results for two different activities illustrate that the proposed dynamics model could be tuned to simulate a diverse set of activities (Figs. 1(b),(c)).

5 Best Possible Outcome

We believe that the proposed dynamics model could act as a versatile model which can be used to simulate different activities and hence, help in estimating physical parameters of humans performing different activities solely using their uncalibrated monocular videos.

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References

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