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Identification of Energy Dissipation Models in the Drivetrain of an Energy-Efficient Bipedal Robot

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Abstract

For the development of a bipedal walking robot controlled via hybrid zero dynamics, a parameter identification procedure is presented. The biped robot has five rigid body segments and is driven by electric drivetrains in the joints [1]. The presented study attempts to identify the energy dissipation terms in the drivetrain, which are critical for model-based controller design. To simplify the identification, experiments use a single leg of the prototype, consisting of thigh and shank segments, emulating either a single or a double pendulum. Encoders in the joints are used to capture the joint angle and angular velocity. Transient dynamics of the prototype are captured by varying actuation amplitudes, particularly across angular velocities. Different energy dissipation models, both linear and nonlinear with respect to angular velocity, are used to characterize the dissipation terms. A non-linear least squares optimization [2], which minimizes the residual between the simulated and measured trajectory while optimizing the model parameters in simulation, is used to locate optimal parameter estimations. Finally, the transient performance of the dissipation models is compared: sequential local optimizations—separately identifying parameters for each combination of measurement set and dissipation model—are contrasted with a global optimization approach that fits an assumed dissipation model to a combined dataset from all measurements, yielding a single parameter set.

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References

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Categories

TND: Transient and Non-stationary Dynamics