Abstract

Deciphering and predicting the dynamics of locomotion over compliant terrain is garnering increasing interest because of its applicability in search and rescue missions, planetary explorations, as well as robot navigation on diverse surfaces. In the realm of assistive devices for individuals with limited ankle mobility, it is valuable for an assistive device to be of use in both indoor and outdoor environments. In this thesis research, the Dynamic Data-Driven Application Systems framework is employed and this framework is used to determine lower extremity trajectories for supporting the operation of a robotic device operating on uneven terrain. With this framework, data obtained from simulations is combined along with noisy sensor measurements to predict the contact forces of a leg interacting with granular media.

For the simulation of the dynamical responses of legged locomotion on granular media, two models are used. They are, namely, a reduced-order model based on the Resistive Forces Theory (RFT) and a high-fidelity model based on the Smoothed Particle Hydrodynamics (SPH) method. The results of the two models are compared for various leg morphologies to assess how well these models can be used to capture complex contact interactions between a robot appendage and a granular media. After data collection from simulations, the efficiency of the proposed data-driven framework is illustrated and discussed by examining test cases that involve the gait responses of robotic appendages interacting with granular material. Preliminary experiments of foot interactions with a granular media have also been conducted and this data has also been considered in the DDDAS framework.

The present work can serve as a basis for further developing the utility of the DDDAS framework for robot device operations, with a particular emphasis on assistive robots. The utility

of data generated from off-line simulations and real time data generated from sensors on these asssistive robots can help the robots adapt better to different terrains.