A simplistic model for quadrupedal walking and trotting

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1 Motivation

Recent research [1] has shown that a spring mass model can explain ground reaction forces of human walking and running with a single set of parameters. Extending on our previous work on passive dynamic locomotion with quadrupeds [2, 3] we examine whether an extended spring-mass model is able to explain experimentally obtained ground reaction forces for walking and trotting crossbred horses.

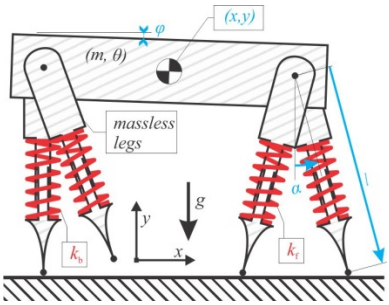

Fig. 1. The passive dynamic model used in this study has a main body with distributed mass and four massless legs.

2 State of the Art

Traditionally, two different simplistic models have been used to describe the dynamics of human locomotion. A spring-mass model for running and an inverted pendulum model for walking. While the latter failed to explain the characteristic double hump in the vertical ground reaction forces of a walking motion found in nature, the spring-model can do so in a different oscillation mode [1].

3 Own Approach

We developed a passive dynamic quadrupedal model that is able to produce walking and trotting with a single set of parameters. The model has an extended main body and four massless legs that, during swing, instantaneously go to a predefined angle of attack; similar to a bipedal SLIP model. Periodic motions of this model were identified in a MATLAB simulation framework for gait creation [4].

An automated method to identify model parameters to optimally match the ground reaction forces of the model with experimental data has been developed.

4 Current Results

Our model is able to produce periodic walking and trotting gaits, that *qualitatively* exhibit the same ground reaction forces as seen in the data of a representative crossbred horse (as provided to us by the Veterinary Teaching Hospital Zurich). Through means of automated parameter adjustment, we are very closely matching trotting data in a *quantitative* fashion and currently investigating how to do so for a walking gait.

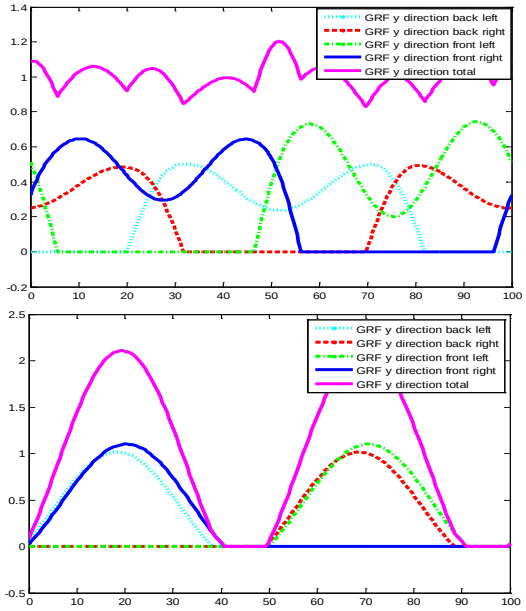

Fig. 2. Vertical ground reaction forces for simulated walking (top) and trotting (bottom).

5 Best Possible Outcome

Ideally we succeed in *quantitatively* matching ground reaction forces for both, trotting and walking gaits, thus creating a single model that explains the different dynamic behaviors of quadrupedal locomotion.

Acknowledgement

Thanks to the Veterinary Clinic of the University of Zurich we had access to ground reaction data of a representative crossbred horse.

References

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[4] Remy, C.D., Buffinton, K.W., and Siegwart, R.Y., 2011, "A MATLAB Framework for Efficient Gait Creation”, IROS 2011