Understand gait transition in Jerboas using a template model

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Motivation

Jerboas quickly switch among many gait patterns that are associated with distinct accelerations, rather than speeds [1]. It has been hypothesized that these bipedal gait transitions are likely to enhance their evasion ability. However, it is difficult to understand the underlying dynamics of these locomotion patterns due to the large number of degrees of freedom expressed by the animals.

Method

The parameter identification problem can be formulated as a nonlinear optimization problem where the cost function is defined as the summation of the residuals in a total of n trails and the value of this cost function is minimized as an unconstrained optimization problem with a single set of parameters p [2]:

\[ C_{opt} = \min \left\{ \sum_{i=1}^{n} c_i (X_i, p) \right\} \]

\[ c_i (X_i, p) = \int_0^{T_i} \left( \left\| X_{sim,i} (t, p) - \dot{X}_i (t) \right\|^2 + \left\| F_{sim,i} (t, p) - \dot{F}_i (t) \right\|^2 dt. \]

Experiments

- Video recordings were taken at 250 fps using high-speed cameras. Ground reaction forces were simultaneously recorded with an instrumented 2-axis force platform [1].
- Center of mass was estimated by the center between the eye and tail base.
- The pose of the jerboa as well as the foot locations were extracted from the recordings using a learned deep neural network framework using DeepLabCut [3].

Model

Fitting results showed our model closely matches the jerboa’s center of mass motion and leg angles during a single stride of the skipping gait.

Preliminary results

References