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Abstract

Compositional methods for developing, analyzing and synthesizing robot behaviors construed as controlled hybrid dynamical systems with regular properties [1] has proven an effective framework for achieving steady state gaits [2,3]. Exploiting their potential for programming transitional behaviors, requiring more complicated interactions with the environment [4,5] has been limited by our inability to find appropriate constituent models ("templates" [6]) from which to construct these complex behaviors.

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Composition of Templates for Transitional Legged Behaviors

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Summary

Compositional methods for developing, analyzing and synthesizing robot behaviors construed as controlled hybrid dynamical systems with regular properties [1] has proven an effective framework for achieving steady state gaits [2,3]. Exploiting their potential for programming transitional behaviors, requiring more complicated interactions with the environment [4,5] has been limited by our inability to find appropriate constituent models ("templates" [6]) from which to construct these complex behaviors.

This talk will review the development, analysis and deployment of promising new template models [7] that have spurred the creation of new transitional legged behaviors [8]. Empirical work in progress suggests that they will be useful in a variety of dexterous leaping behaviors of the kind explored in [4] and may offer a foundation for more general programming of quasi-statically mismatched robots [5].

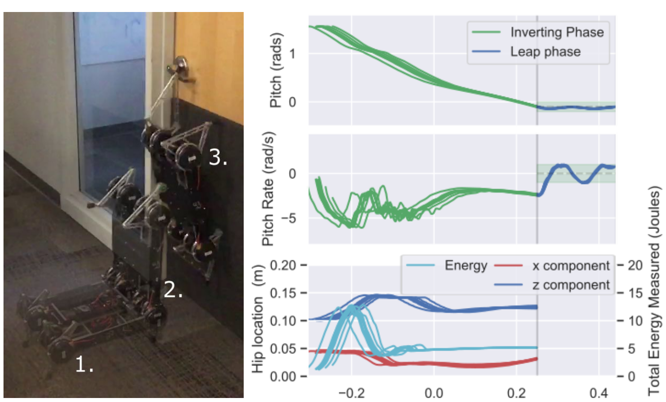

Figure 1 : **Left**: Composite image of the sequence of actions that comprise the door-opening behavior. The PH template [8] is used to inject energy between (1) and (2), after which the FT [7] leaping controller is engaged enabling manipulation of the handle at apex (3). **Right**: Depiction of 10 trials (9 of which were successful) illustrating the ability of the FT [7] controller to track pitch (top) and pitching velocity (middle) targets during the leap phase ($t > 0.25$). Additionally, the efficacy of the PH template to remain fixed in the world frame as well as a relatively constant measured total energy (bottom) is illustrated as well.

Experimental Results

Preliminary experimental data for a door opening behavior, composed from the aforementioned templates were taken. While the manipulation component is unmodeled, the leaping component is dictated by two template models and suggests that a hybrid dynamical systems program in the style of [8] using templates of this kind will inform the rest of the behavior. Fig. 2 illustrates the "pinned hip" (PH) [8] and "floating torso" (FT) [7] portions of the controller, the former maintaining a fixed lower hip position in the world frame, enabling an energy-based prediction of the configuration in which the latter will track a desired attitude.

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