The Tail of KlingOn

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I. Introduction

The value of a tail for vertical climbing has been apparent since the first efforts to develop scansorial robots [1,2]. The tail provides a low-friction, positive normal force against the wall so that the robot's forelimbs don't have to pull as hard into the wall to prevent pitching backward. If the front limbs should lose their grip, the tail creates a tripod letting the rear limbs, which normally push gently against the wall, pull inward, thereby preventing catastrophic failure. The same phenomenon has been observed in geckos, which normally don't press their tails against the wall, but do so reflexively if their front limbs lose adhesion [3].

Tails can also ameliorate the dynamics of landing. Gliding geckos and other gliding animals use their tails to steer while airborne, actively controlling orientation to pitch up immediately prior to contact, reducing the severity of impact [4]. Recent investigations of the dynamics of tails have also illuminated their role in self-righting, and orientation correction in ballistic trajectories [5,6]

II. Tails for Multimodal Perching and Climbing

These observations suggest that an active tail could be especially useful for a multi-modal perching/climbing robot such as KlingOn [7]. For climbing with discrete steps, the tail should be sized appropriately to the stride length. However, if the tail becomes too long, we see rapidly diminishing returns in stabilizing climbing, and the tail becomes heavy and unwieldy for the airborne trajectory.

This talk will cover recent results with KlingOn II, a multimodal robot with an active tail. Collaboration with the PolyPedal Lab at UC Berkeley has begun to investigate how the tail should be controlled immediately prior to and during first contact to reduce the peak tensile force required at the adhesive pads. The goal of this investigation is to expand the "envelope" of initial states for which attachment is possible. Enlarging this envelope of velocities and orientations immediately prior to contact enables a wider range of perching trajectories and speeds.

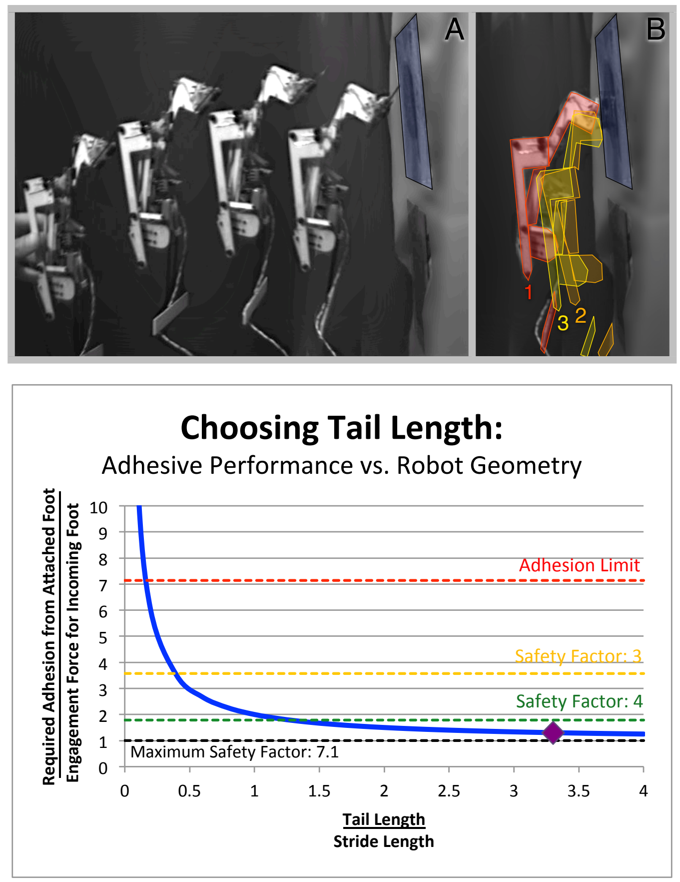

Figure 1. (Top) KlingOn approaches wall and attaches (Bottom) Considerations for tail length in vertical climbing

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