The Jockey as a tail: How can a jockey influence horse performance?

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***Abstract*—Historical horse racing records show that a dramatic improvement in horse racing times (5-7%) was directly correlated with the adoption of the "Martini glass" Jockey posture, and this crouched posture is thought to decouple movements of the horse and rider, as demonstrated by kinematic observations [6]. That is, the jockey uses their legs to move relative to the horse in such as manner as to cancel the horse's motion, such that the jockey's mass moves little in the inertial (world) frame, such that the horse must supply a constant force equal to jockey weight, but not additional forces to overcome jockey inertia. This paper proposes three topics for workshop discussion, that stem from this work. The first is: what modeling and analytical approaches, mathematical or robotic in the former case, could best give insight into this phenomenon and make new, testable predictions? Recent such work considering elastically coupled loads [1] has given insight into optimal coupling mechanics and the benefits of elastic coupling. The second relates to the open question of whether the jockey can employ another, different movement relative to the horse that improves maximum speed. We provide a simple conceptual outline of a phasing of jockey fore-aft oscillation relative to the horse that could improve stride length, and potentially reduce required horse leg work, relative to a jockey that is fixed with respect to the horse.**

I. Introduction

An dynamic thread of current research in movement science concerns how relative movement of some set of sub-components of a moving system affects the performance of the overall moving system [5, 4, 3, 7, 6, 1]. Sub-components here are appendages moved during jumping [5, 4] or legged locomotion [7], or viscera [2] moving internally, or a jockey moving relative to the horse [6]. In the aerial cases, inertial reconfiguration may be simpler to analyze because of the known overall ballistic movement of the system. In the terrestrial case, and especially the jockey case, the stance phase in which two-dimensional movement of two bodies, for which one bodies' legs are transmitting forces to the ground, complicates analysis.

II. Modeling and analysis approach

Future directions for experimental work in this system are readily apparent, though technically challenging. Theoretically, however, an interaction between robotics and this research could give important insight.

One approach to computing the energetic cost to the horse for a given jockey motion is to assume horse and jockey are point masses (Figure 1), and use the equation

$$dW_{legs} = \left[m_h \left(\vec{a}_h + g\hat{k}\right) + m_j \left(\vec{a}_h + g\vec{k}\right)\right] \cdot d\vec{r}_{horse}.$$

to compute horse leg work. However, this equation relies on assumptions about the effect on horse kinematics that are difficult to measure. Abstract models as in [1] may provide more insight, which we propose as a topic for workshop discussion. What model or analysis could best explain the benefit to the horse for the jockey's motion versus rigid attachment of mass?

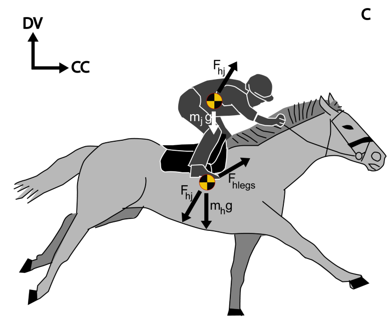

Fig. 1. Couple two point mass model of horse and jockey.

III. Jockey phasing for maximum speed

Jockeys frequently switch from the "Martini glass" posture described in [6], which appears to have the objective of mechanical isolation of jockey from horse movements, to one in which they move significantly forward and backward in the saddle with each stride, as horse races conclude, which is described by jockies as "finishing."

We propose the following thought experiment for workshop discussion. In the aerial phase, the jockey can throw themselves backwards: this pushes the horse forwards, resulting in the horses' hooves landing further forward, potentially increasing stride length, relative to a horse-jockey system that does not do so. The jockey is then situated at the back of the horse on contact. Were the jockey to shift forwards during stance, the horse's legs must transmit any increased forces due to this to the ground, or else the horse-jockey system would remain equal to a non-moving jockey system. However, were the jockey to move forward relative to the horse during stance at a phase where the posture of the horses legs is such that they can transmit additional forces to the substrate without substantial additional muscle force or work development, it may be that the horses' legs can "handle" the additional load, benefiting the horse-jockey system.

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