RoboBird: A passive exo-tendon for guinea fowl

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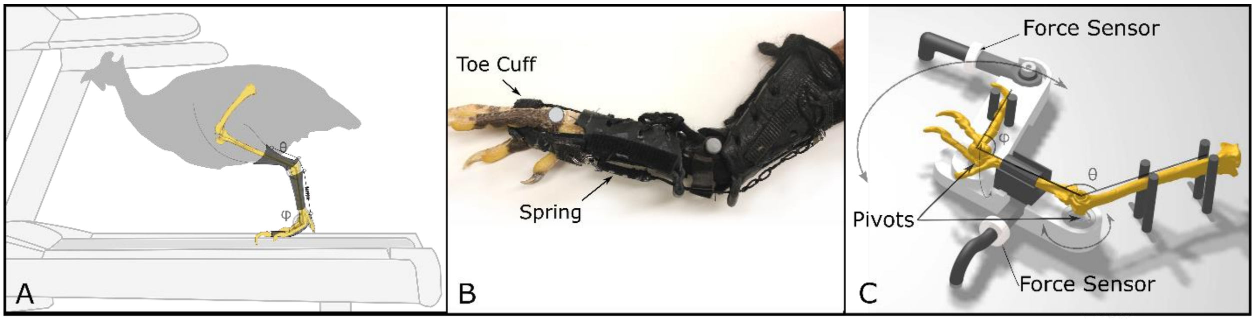

Figure 1: A) Experimental setup B) Exo-tendon design C) Jig for exo-tendon moment quantification

Limb orthoses, including exo-skeletons, are externally worn braces or devices used to improve locomotor deficits, aid rehabilitation or augment human locomotor performance[1]. While robotic and passive exo-skeletons have been shown to improve locomotor performance[1] , the limitations of human experimentation have left many important questions unanswered. More specifically, how does exo-skeleton design influence muscular-tendon function[2], and, in turn, locomotor performance?

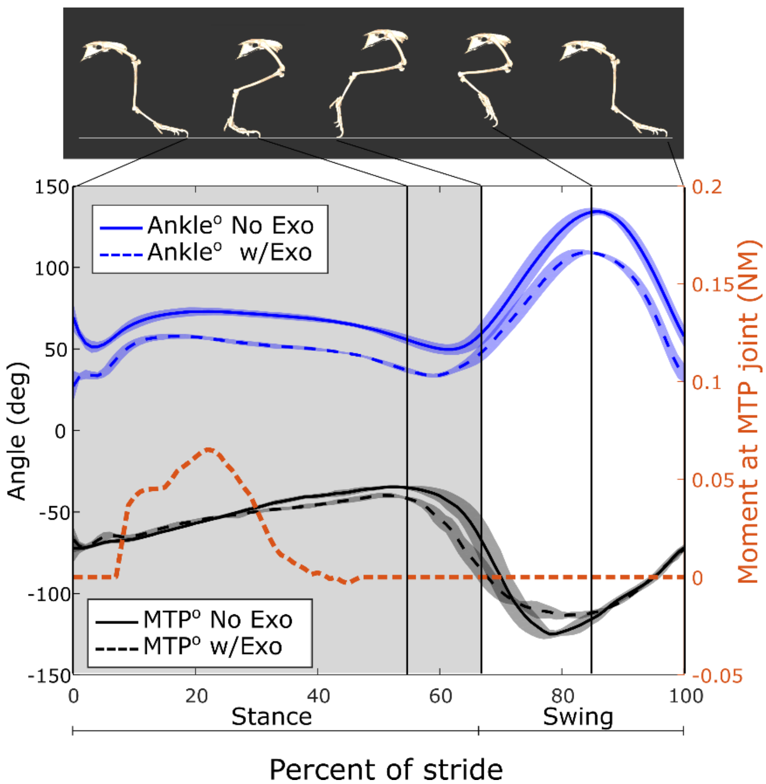

Figure 2: Exo-tendon moment contribution and its influence on lower limb kinematics

Here we present pilot data on a limb orthosis for a bipedal avian model (*Numida melaegris*) that replicates the functionality of current human passive ankle-foot orthoses. In our design, the spring path spans the ankle and metatarsophalangeal (MTP) joints, mirroring the path of several digital flexors and supplementing elastic energy storage during stance phase (Fig 1B). Flexion of the phalanges acts as a natural clutch, disengaging the device during the swing phase. Unaided joint moments at the MTP and ankle (without the exo-tendon) were subtracted from aided moments to quantify contribution of the exo-tendon across the span of limb configurations (Fig. 1C). On combining these data with kinematic analyses of a bird running on a treadmill (*n=1*; Fig 1A) with and without the exo-tendon, we observed a 5-10% exo-tendon contribution to the moment at the MTP joint during stance phase (Fig 2).

1. Viteckova, S., Kutilek, P. & Jirina, M. Wearable lower limb robotics: A review. *Biocybern. Biomed. Eng.* **33,** 96–105 (2013).
2. Young, A. J. & Ferris, D. P. State-of-the-art and Future Directions for Lower Limb Robotic Exoskeletons. **4320,** 171–182 (2016).