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The Dynamic Control of Head Stabilisation in Cheetahs: A Computer Vision and Optimisation Approach

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The cheetah is a pinnacle of adaptation in the context of the natural world. It is the fastest land mammal and has multiple morphological specialisations for prey-tracking during high-speed manoeuvres, such as vestibular adaptations to facilitate gaze and head stabilisation [1]. Understanding the cheetah's head stabilisation techniques is useful in field such as biomechanics, conservation, and artificial and robotic systems; however, the dynamics of wild and endangered animals are difficult to study from a distance. This challenge necessitated a non-invasive Computer Vision (CV) technique to collect and analyse 3D points of interest. We collected a new data set to emulate a perturbed platform and isolate head stabilisation. Using MATLAB®, we built upon a method pioneered by AcinoSet [2] to build a 3D reconstruction through CV and a dynamic model-informed optimisation, which was used to quantitatively analyse the cheetah's head stabilisation. Using our new dataset, and by leveraging optimal control methods, this work identifiesand quantifies passive head stabilisation, in conjunction with AcinoSet data, to quantify the active stabilisation during locomotion. Since this work includes computationally heavy methods, the processing of these data using optimisations and computer vision rendering can be benchmarked and compared to parallel computing methods, to further support the viability of the 3D reconstruction methods for other animal or human models and applications of high-performance and low-cost markerless motion capture.
[1] Grohé, C et al, Sci Rep, 8:2301, 2018.
[2] Joska, D et al, ICRA, 13901-13908, 2021.

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