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On Understanding Biosonar Deformations Using Deep Learning-Based Video Interpolation

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I. Introduction

The deformation of a horseshoe bat's parietal plays an important role in its biosonar system, by understanding which we may gain an insight on the functionalities and geometric structures of the complex bionar system in the hope of building an artificial alternative with comparable features in the future. However, this promising research direction is not well investigated yet, limited by either the availabilities of experimental horseshoe bats or the capabilities of physical devices, namely, existing high-speed cameras fail to record videos of a quality enough for correlating parietal deformations and ultrasonic pulses in a fine-grain manner.

II. Method

To address above issues and carry on with explorations in detailed deformation patterns of biosonars, we first capture three adult horseshoe bats (rhinolophus ferrumequinum) from the Liantai Mountain in Jinan, China, and place them in an artificial lab with proper temperature and humidity in correspondence with bats' normal living environments. We then use a standard camera of 60 frame-per-second (fps) to record the bats' behaviours, based on which we leverage recent advances in deep learning and train an end-to-end convolutional neural network for video interpolation, where motion and occlusion are jointly modeled. This effort increases the frame rate to 240 fps with visually convincing quality, and we accordingly align and analyze deformation geometrics and ultrasonic pulses, and obtain a new insight of biosonars qualitatively and quantitatively.

III. Experiment and Discussion

Fig. 1 demonstrates experimental results that deformations of the biosonar of a greater horseshoe bat (rhinolophus ferrumequinum) change from degree zero to degree twelve over time (a: original, b: four degree, c: eight degree, d: twelve degree). Experiments support the effectiveness and feasibility of the proposed method and preliminary analysis reveals that deformations of horseshoe bats' parietals impact certain acoustic properties of the biosonars.

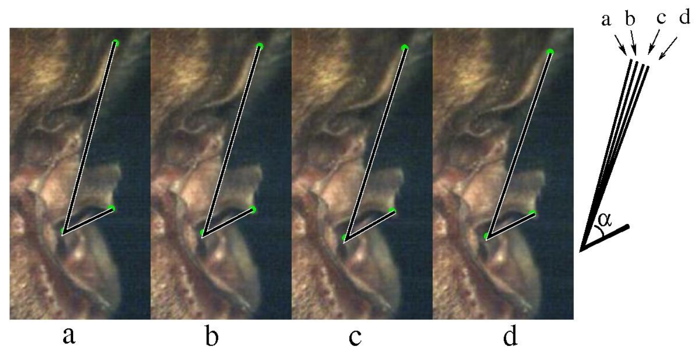

Fig. 1. Deformations of the biosonar of a greater horseshoe bat (i.e., rhinolophus ferrumequinum) change from degree zero to degree twelve over time (a: original, b: four degree, c: eight degree, d: twelve degree).

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