Smart devices, Behavior analysis

Machine learning techniques for understanding animal behaviors

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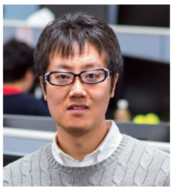
Researchmap https://researchmap.jp/takumae80/



Abstract

Sensing and analyzing animal behaviors can be a promising method for understanding the animals. In this study, we have developed state-of-the-art sensing and analysis methods for animal locomotion based on machine learning. It was difficult for existing camera-enabled animal-borne biologging devices for small animals to always record videos due to the limitation of the weight of their batteries, making it difficult to capture biologically important and infrequent events. Our research group developed AI-enabled biologging devices that automatically detect behaviors of animals using low-energy sensors, permitting to record videos only when an important event occurs (e.g., foraging). In addition, we have developed a deep learning method for supporting analysis of huge animal locomotion data. We focus on comparative analysis of animal trajectories (e.g., healthy vs. disease mouse groups) and develop a method that automatically detects sub-trajectories characteristic of a group. Thanks to the proposed method, we could discover several new biological findings such as a feature of the Parkinson's disease mice regarding frequency of exploring surroundings and a survival strategy of insects that perform "death-feigning".

Background & Results

Animal-borne biologging devices enable us to observe animal behaviors that are difficult for biologists to directly observe. However, the limitation of the battery size of a logging device attached to small animals makes it difficult to record biologically important and infrequent animal behaviors. Our research group developed AI-enabled biologging devices that automatically recognizes behaviors of animals using low-energy sensors such as GPS and acceleration sensors, permitting to record videos only when an important event occurs (e.g., foraging). Because the computation power of a micro-controller on a small and poor logging device is limited, our research group developed an activity recognition method that is computationally efficient and high accuracy. In an experiment of black-tailed gulls, we could successfully capture foraging events with 15 times the precision of a baseline periodic-sampling method. Thanks to our method, we could record new foraging behaviors of the birds (Fig. 1).

Animal trajectory data observed by sensing devices such as GPS have been analyzed by biologists to, for example, evaluate effects of diseases on animal behaviors by comparing healthy and disease animal groups and reveal the difference in survival strategies between male and female groups. However, existing analysis methods have relied on manual analysis by biologist, placing huge burdens on the biologists. Therefore, our research group developed a deep learning-aided method that automatically detects characteristic sub-trajectories to a group in comparative analysis. The proposed network model with the attention mechanism enabled us to discover new findings from various animals such as seabirds, bears, worms, mice, and insects (Fig. 2).

Significance of the research and Future perspective

These new sensing and analysis methods can accelerate understanding of zoonotic infection and symbiosis with wild animals.

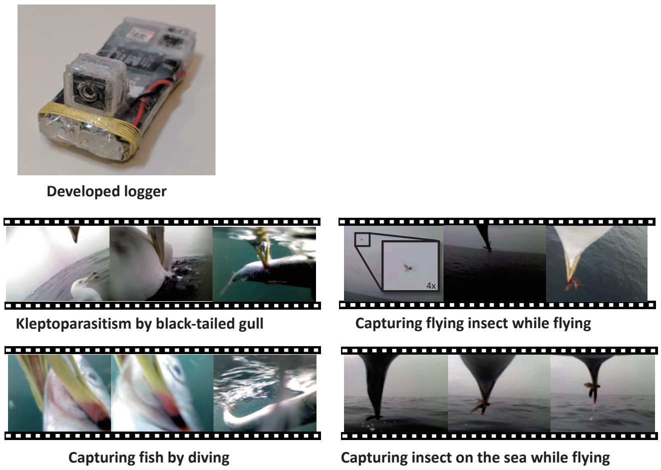


Fig.1

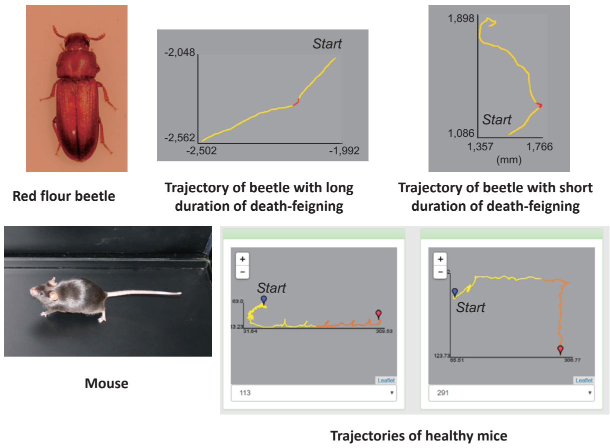


Fig.2 (Photos courtesy of Okayama University and Doshisha University)

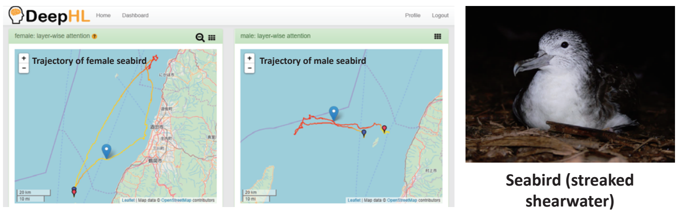


Fig.3 (Photos courtesy of Nagoya University)

Patent

Treatise
Maekawa, Takuya et al. Deep Learning-assisted Comparative Analysis of Animal Trajectories with DeepHL. Nature Communications. 2020;11:5316. doi: 10.1038/s41467-020-19105-0
Korpela, Joseph; Maekawa, Takuya et al. Machine learning enables improved runtime and precision for bio-loggers on seabirds. Communications Biology. 2020;3:633. doi:10.1038/s42003-020-01356-8

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Keyword biologging, machine learning, activity recognition