Title of Project：Systems Science of Bio-Navigation

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【Purpose of the Research Project】

Navigation is a fundamental behavior of animals including human. In navigation, the following three functions are required: the acquisition of dynamically-changing information from external and internal environment, the choice of route and destination based on the information, and the behavioral regulation to reach the destination. We aim for **systems science of bio-navigation** to understand the "algorithms" for the navigation of animals. To this end, we bring together experts from control engineering, data science, animal ecology, and neuroscience, and jointly work on how to measure, analyze, understand, and verify bio-navigation.

Figure 1: Systematic studies of bio-navigation.

【Content of the Research Project】

We work on the topics of measurement, analysis, understanding, and verification of bio-navigation. In *measurement*, we develop Logbots by making conventional data logging devices more autonomous for measuring high-dimensional signal in bio-navigation. In *analysis*, we provide generic data analysis toolbox for bio-navigation. In *understanding,* we build bio-navigation models to explore commonality and diversity across species. In *verification*, we verify the models by using tools developed in neuroscience, such as genetic engineering, neuronal activity monitoring, and optogenetic regulations.
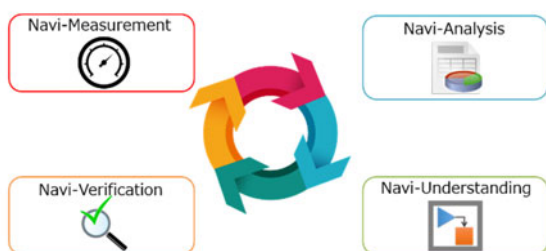

Figure 2: Four topics of bio-navigation studies.

【Expected Research Achievements and Scientific Significance】

The following three results are expected. (1) First, by developing Logbots, it would become possible to obtain novel and more accurate signals on bio-navigation over a long period of time. (2) Second, mathematical models of bio-navigation would be constructed, and they could be used for understanding the commonality and diversity across navigations of different species. At the same time, generic data analysis and modeling toolbox for bio-navigation studies would be developed. (3) Finally, by repeating the four processes in a synergistic way, each of control engineering, data science, animal ecology, and neuroscience fields could be largely progressed. In the future, the results obtained in this project will be extended for solving social and engineering challenges regarding navigations of humans and artificial things as well.
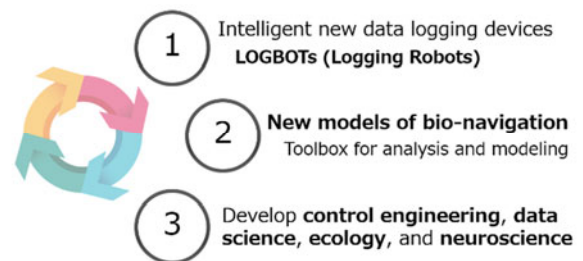

Figure 3: Expected results in this project.

【Key Words】

BIO-NAVIGATION: A general word representing a fundamental animal behavior to reach a destination in which animals acquire dynamically changing information from external and internal environment for the purpose of choosing a route to reach the destination.

LOGBOT: Logging device for measuring a variety of signals in bio-navigation over a long period of time by making existing data logging device far more intelligent and autonomous.

【Term of Project】　　FY2016-2020

【Budget Allocation】 1,087,100 Thousand Yen

【Homepage Address and Other Contact Information】
http://navi-science.org