MFB 제어 기반의 비둘기 학습제어 시스템의 설계

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A Design of MFB based Training System for Pigeon based Telemetry

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Abstract

In this paper, we describe a telemetry stimulation system that controls animal-robots. In our system, we send the main control command from PC to the controller embedded in the pigeon based animal-robots. Once the controller receives the control signal, it makes biphasic stimulation pulses to medial forebrain bundle neurons to control the pigeon behavior as we want. We design the embedded controller using CUBLOC, which is lightweight for attaching on the pigeon.

1. Introduction

With the rapid development of the electrophysiology, people combined it with ethology and made it as a completely new research domain of animal-robot [1]. However, the micro-electromechanical intelligent robots, even the most intelligent robots, are not as good as human in many aspects. Because robots, especially micro-electromechanical robots, was restricted to its self-structure and energy, thus they could not implement some complex tasks of long-distance movement.

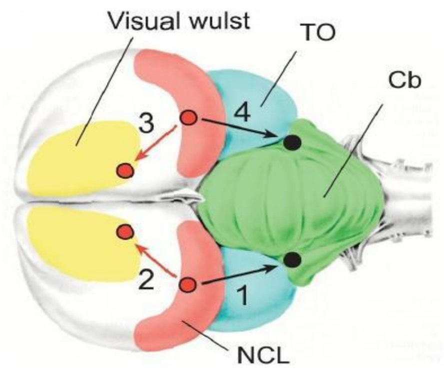
Compared with the traditional electromechanical robots, animal robots possess better movement function, superior power support, excellent concealment, and better mobility. These features make them have a wide range of applications in many special circumstances, such as antiterrorism, dangerous environment rescue and little space exploration.

In this paper, we describe an animal based telemetry system using pigeons. We design the main controller based on PC and the embedded controller based on pigeon tapped lightweight processor. In section 2, we review the previous research works, and we design our telemetry system in section 3. We conclude in section 4.

2. Previous Research Works of Animal-Robots

System of animal robots is usually a micro-remote control navigation system consisting of two components: the remote controlled multimode micro-stimulator, which is fixed on the back of an animal and connected with the implanted electrodes, and the remote control station, which is a commonly used PC [2, 3]. As shown in Figure 1, the control command from the PC can be sent to the stimulator fixed on the animal robots, and then the stimulator sends biphasic stimulation pulses to the nucleus of animal robots' brain to control the behavior of animals.

Intelligence training of animal robots is first demanded to establish a positive means of strengthening. Traditional procedures to train animals usually incorporate operant learning paradigms in which the animals are taught to produce particular responses to external cues (such as aural tones) in order to obtain rewards (such as food). But during training the animals robot, food rewards is replaced with electrostimulation. Here, mini-electrodes were implanted into six or more brain locations, as shown in Figure 2: TO – Tectum opticum, Cb – Cerebellum, NCL – Nidopallium caudolaterale [4]. The visual wulst is said to be equivalent of the striate cortex in mammals.



(Fig 1) Electrode placements as related to structures of the pigeon brain

In the past, scientists tended to use electronic stimulation to nervous system of animals to explore the neural basis of animals' behavior. However, these methods are invasive and may affect the animals' behavior, even make it paralytic. And electrodes cannot come into contact with each neurons of a full nervous system. Currently, photostimulation method is widely developed and scientists have begun to employ them to address questions about brain function. One new idea is to replace the metal electrodes by fiber-optic probes that carry light deeply inside the brain to observe the activity of only those neurons that need it [5, 6].

3. Neuro-physiological Training of Animal-Robots

Researchers used electrostimulation as 'virtual' cues and rewards, respectively, to deliver to freely pigeons, as shown in Figure 3. The experimenters could send signals by remote equipment to the microprocessor to conduct electrodes over a few hundred meters. When the right and left soma-sensory cortex is stimulated, the animal has a sense of illusion in the left and the right side of the body. So the animals are conducted to accomplish scheduled actions via artificial electric signals to the nervous system, used the micro electrodes to command the bird to fly right or left, and up or down.

As shown in Figure 2, our system comprises two components: (1) main controller unit for directional cue such as LEFT, RIGHT, UP, DOWN, FORWARD; (2) embedded control which gets main control from the main controller and activates bipolar signal on the corresponding control points for the directional cue. Our system is based on the reward-based learning system using medial forebrain bundle (MFB) neurons to achieve maximum learning curves. The embedded controller has six electrodes implanted on five control points for directional guide, and one control points for MFB neuron control for reward activation.

4. Conclusions

This paper designs a bio-platform to control animal behavior. Our system comprises two components: main controller unit for four directional cues and embedded controller which activates bipolar signal on the corresponding control points from the main directional cue. Our system uses bipolar stimulating pulse for stable animal implantation. To educate pigeon as we dictated, we use a reward-based learning system using medial forebrain bundle (MFB) neuron control. The embedded controller has one control points for MFB neuron control for reward activation which makes strong motivation. Bio-platform research works can be applied to many fields such as human's daily life, the detection and rescue of the disaster, and clinic rehabilitation training to patients with motor function disorders.

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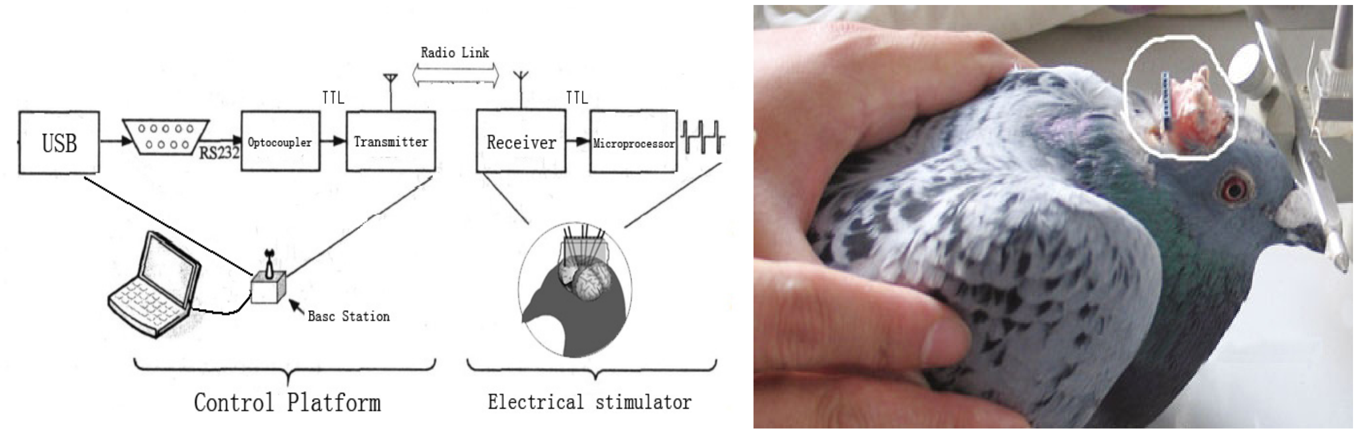

(Fig 2) (a) Pigeon based telemetry stimulation system, (b) The practical controller animal-robots