Investigating various parts of the nervous system to model motion

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Research Question

What is the role of the different parts of the brain in generating movement?

Introduction

The motion control system involves a complex network of structures that are observed at all levels of the central nervous system. Different parts of the brain, especially the cerebral cortex, the cerebellum, and basal ganglia, have an important role in the motion system. Motion commands are transmitted through the motor neurons in the spinal cord to the muscles and motion organs. At the level of the spinal cord, some control operations are performed on the motion system, such as reflexes and adjustment of motor neuron coefficient. The harmonious and complex movements that require skill are performed through the circuits that exist between the cortex, the basal ganglia, and the cerebellum. In this study, we examine the factors affecting movement and propose a rhythmic and discrete movement modeling based on the role of the cerebral cortex, the cerebellum, and basal ganglia.

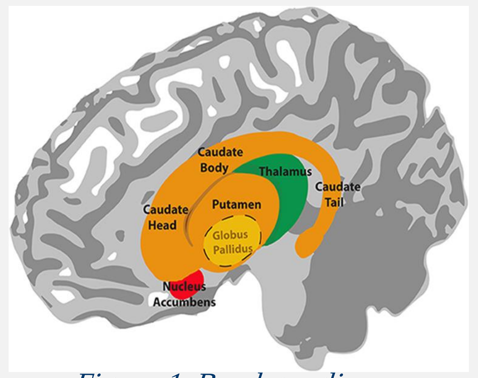

Figure. 1. Basal ganglia

Source: Wikipedia Commons, https://en.wikipedia.org/wiki/File:Anatomy_of_the_basal_ganglia.jpg

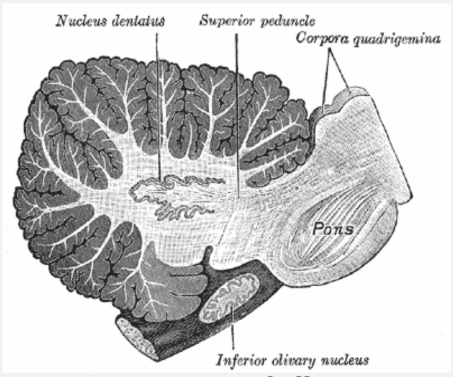

Figure. 2. Cerebellum

Source: Wikipedia Commons, https://en.wikipedia.org/wiki/File:Gray707.png

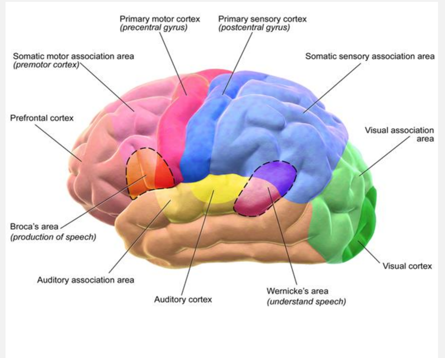

Figure. 3. Cerebral cortex

Source: Wikipedia Commons, https://en.wikipedia.org/wiki/File:Blausen_0102_Brain_Motor%26Sensory.png

Results

In this study, the role of different brain parts that were involved in control and production and type of movement was investigated. Then, we modeled rhythmic and discrete movement concerning the role of the cerebral cortex, basal ganglia, and cerebellum on the move. As a result, fig. demonstrates the type of rhythmic movement, and fig. shows discrete activity from our modeling.

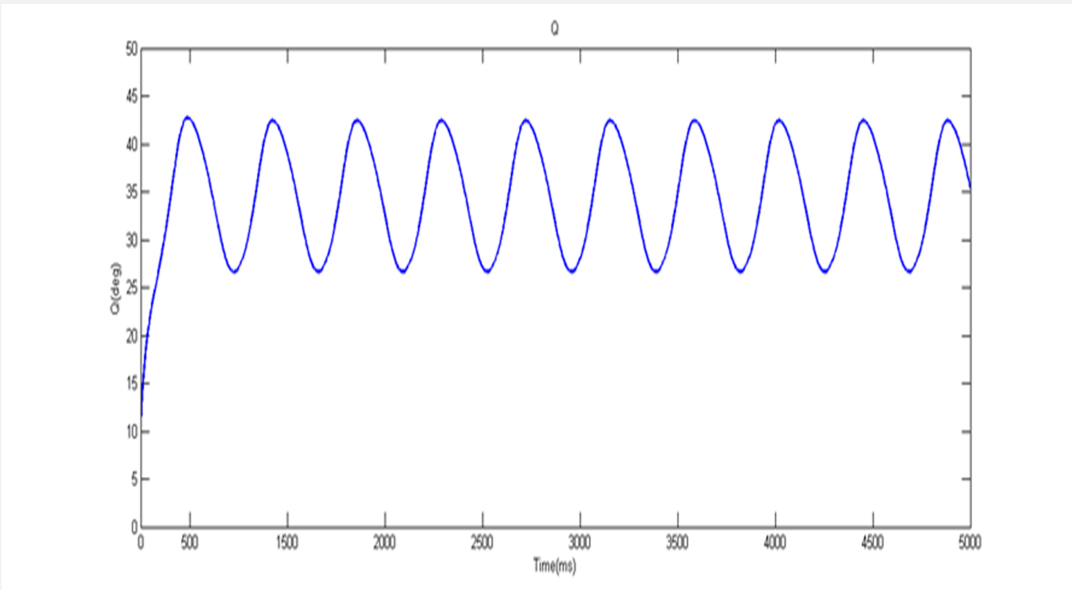

Figure. 4. Rhythmic movement

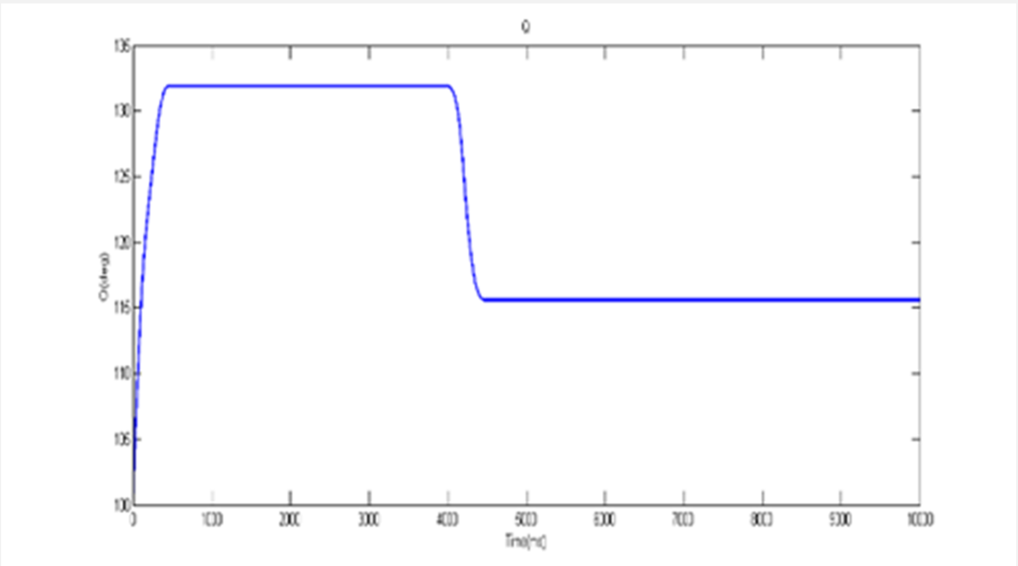

Figure 5. Discrete movement

Methods

The central nervous system and its components have an essential role in the motor control system. Coordinated and complex movements that require skill originate in the cerebral cortex. The motor function is performed through circuits between the cerebral cortex, the basal ganglia, and the cerebellum. The most critical role of the basal ganglia is to control the movement and regulate the body's position. The cerebellum alone can not control muscle function. Instead, it always works in conjunction with other motion control systems. The cerebellum plays a significant role in scheduling motor activities and moving quickly and smoothly from one movement to the next.

In this study, we modeled the nervous system to control movement using the rules governing dynamic systems. For this purpose, we investigated the role of various factors that cause changes in limb movement through the branch diagram and system nullclines.

Conclusions

Researchers are always trying to draw inspiration from natural patterns and design different systems. Many of them have also considered the movements of living systems as a pattern of behavior in nature and have taken ideas from them to model movement systems. The movements are controlled and directed by the central nervous system. In this study, we evaluated the motor control system through dynamics analysis. To this end, we investigated the role of various factors involved in the production and control of movement through bifurcation diagrams and system nullclines. Finally, we could model both rhythmic and discrete movement by applying the role of the cerebral cortex, basal ganglia, and cerebellum.

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