Purposive Locomotion of Insect in Indefinite Environment

Masafumi YANO

Research Institute of Electrical Communication, Tohoku University, Sendai 980-8577, Japan,
masafumi@riec.tohoku.ac.jp

1. Introduction

The real world is unpredictably and dynamically changing, so it is impossible to objectify it in advance and to apply the traditional methodology to it. This real world problem is crucial in information processing systems, that is, the recognition and the control systems coping with the real world. Since the real world is essentially indefinite, it is impossible to prepare the complete information in advance. It means that the information processing systems coping with the real world should have the ability to self-emerge the information needed for.In the case of robot in the real world, to attain the purpose a robot is usually required to solve the inverse problem adjusting the changes of the real world. It is always an ill-posed problem. When the robot autonomously solves the ill-posed problem, some proper constraints should be self-organized in the robot. In addition to the self-organization of the constraints, the robot is required to satisfy the constraints in real time.

The motor systems of the animals are generally controlled through three sub-regions in a hierarchical way, the brain, the central pattern generator (CPG) and the effector organs. The flexibility of the movements is generated by the neural network as a control system, indicating that they can organize dynamically their gait patterns quickly in response to the changes of the environment. To coordinate the movements of the muscles in response to the unpredictably changing environments, the control system should be indefinite. Indefinite system means that the properties of the elements of the system and the relationship of them are not specified in advance. If the control system is definite, it is impossible to adapt to the unpredictably changing environment.

Here, we will show that a new control mechanism installed in the insect robot, which can walk attaining more complex purposes of the system as possible as it can operate at higher efficiency of energy conversion under unpredictable changes of the environment. This control mechanism is derived from a metarule to determine the constraints on the motor system. In case of turning walk, the destination takes the priority over all other purposes. So the constraints are self-organized every moment depending on the current state of the system and the environment to attain the purpose. And the constraints may be always fulfilled with more optimal efficiency. As the result the optimal trajectory and the walking patterns emerged.

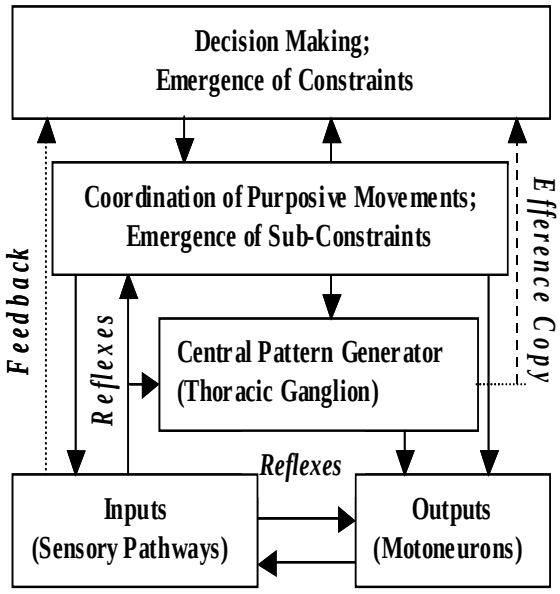

Figure 1: Hierarchical organization of motor control.