**Dynamic control modeling using flexible robotic design architecture**

**Proposal by William Xing Xia**

**Overview:** Finding out how the brain works has been one of the most vexing problems in history. A major reason why this task is so difficult is that there is no analytical method to locate the center of control. Most current robotic machines are based upon one single control schema, the centralized controller. Such design philosophy is great for its intuitiveness and ease of use. However, the lack of flexibility compromises the ability for the device to function as a scientific instrument to test unconventional or higher-dimensional control hypotheses.

The SOC, or system on a chip, has allowed complex circuitry to be installed in a tiny chip no greater than the size of a thumbnail. Using this technology, it is possible to create new robotic machines capable of processing and computing large amounts of data. In the School of Physics, Dr. Sponberg’s Lab researches insect locomotion; part of the lab’s objective is to examine control systems and comparing the models to learn more about how an insect’s neurology interacts with its physical dynamics.

**Background and Related Work:** For the past semester, I have worked on obtaining kinematic data from *Blaberus Discoidalis* cockroaches in order to examine hypotheses regarding legged locomotion (Koditschek et. al. 2004). Using these data, we plan to test different control hypotheses, and design a robotic system based off of these ideas.

This first project helped expose me to how to interface with MEMS devices and handle insects. I looked at the data sheet for the IMUs and edited software on an external microcontroller to access multiple capabilities of the chip. Also, due to the low-weight requirements of the cockroach, I have also had to learn how to use EagleCAD software to design a small PCB based on the MPU9250 and 6050 IMU chips that is mounted on a cockroach.

I will apply this knowledge to design a robotic system that can test multiple hypotheses about control. My work will be based off of RHex, a robot that uses principles derived from a cockroach to move itself around.

**Objective:** The device we are planning to create will primarily function as a means to test hypotheses regarding centralized and decentralized control architectures. This novel design will allow a user to program complex control schemas and mathematical models to test a variety of theories regarding control.

Koditschek, D.E., Full. R.J., Buehler, M., 2004. Mechanical aspects of legged locomotion control. Arhtropod Structure and Development 33, 251-272.