Engineering Seminar # 6: Structural Controls

Speaker: Mr. Elad Kivelevitch, Visiting Research Associate, Department of Aerospace Engineering, University of Cincinnati
Date: July 23, 2009
Time: 3:00 to 5:00 p.m. (2 hours)

Prepared by:
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This seminar was given by Mr. Elad Kivelevitch, Visiting Research Associate, Department of Aerospace Engineering on July 23, 2009 in 641 Baldwin Hall from 3:00 to 5:00 p.m.

Mr. Kivelevitch holds a B.Sc. and M.Sc. in aerospace engineering, both cum laude, from the aerospace engineering program at the Technion, Israel Institute of Technology. He served in the Israeli Air Force for 7 years, two as a flight principles instructor at the Flight Academy, and five years as a systems engineer for ground control systems of UAVs. Between 2004-2008 he was working as a systems engineer for Ness Advanced Technologies, a global information technology company, in the fields of UAVs, command and control systems, and data fusion. In the past year he has been a visiting research associate in the University of Cincinnati and has done research in the fields of decision making and cooperative control of multi-agent systems.

Mr. Kivelevitch gave a very fascinating seminar related to control systems, which is his area of research. There are three main categories of control systems: passive control, open loop control, and active (feedback) control. Passive control involves structural modifications to change the plant dynamics (where plant is defined as the physical system). This technique should be used whenever possible because it is a cheap and robust option. The real life example that Mr. Kivelevitch gave was parkour, a type of sport involving moving quickly, smoothly, and efficiently from one point to another using only the abilities of the human body. Because the person makes the movements simply by modifying the position of their body, this is defined as passive control.

Open loop control involves exploiting knowledge of system dynamics to compute appropriate inputs. The downfall of this method is that it requires a very accurate model of plant dynamics in order to be used successfully. An example of an open loop control system would be a sprinkler irrigation system that could be programmed to turn on and off at specific times.

The third type of control system is active (or feedback) control. Active control systems use sensors and actuators connected by a computer to modify system dynamics. This allows uncertainty and noise to be taken into account. Active control methodologies can be further broken down into two additional categories. The first is black box methods that learn by observation or training. The second is model based methods that uses a detailed model for analysis or design. Both are important and have numerous applications in the engineering world.

There are numerous biological examples of control systems, most notably in species that are characteristically found in groups, using schooling or swarming behaviors. Some of the examples Mr. Kivelevitch gave were bees swarming, ants marching in lines, birds flying in unison flocks, and fish moving in schools.

One of the demonstrations of his research given by Mr. Kivelevitch was a group of computerized robots as agents (something capable of sensing the environment) working their way through a maze. This active control system allows the robots to communicate with each other and build a shared knowledge base in order for every robot to exit the maze by the most efficient route possible.

This information regarding active control systems is very useful to the RET earthquake research project. Active control systems are the most effective way to prevent serious structural damage as a result of earthquake disturbances.