Talk 3.3, Poster 33

Innovative technologies inspired by biosonar

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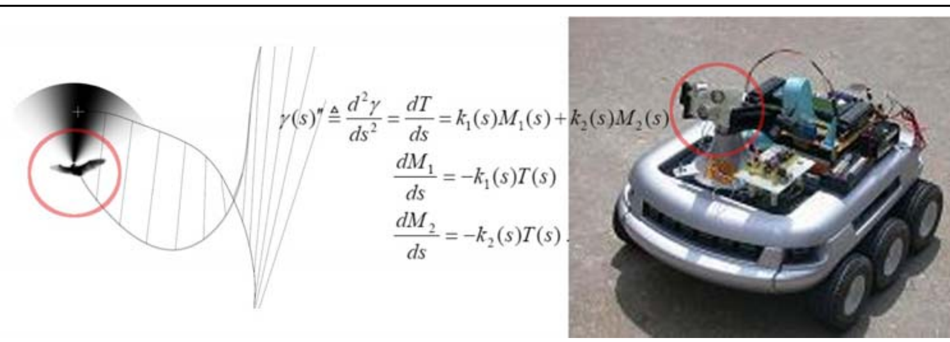
Our collaborative research group combines empirical and theoretical work to develop and test models of central nervous system (CNS) control in adaptive sensorimotor behaviors. In turn, these studies are used to guide the fabrication of artificial neural systems whose architecture and design principles are based on those of biological nervous systems. Our empirical studies employ an animal model that has evolved a highly successful adaptive sonar-guidance system, the echolocating bat. This mammal actively controls the temporal and spectral characteristics of its sonar vocalizations as it negotiates obstacles and pursues flying insect prey. We can therefore utilize the animal's flight trajectories, dynamic patterns of sonar signal production and CNS recordings to measure and model behavioral state changes that vary with task and information load. Our project includes three inter-related research thrusts: 1) Behavioral and neural recording telemetry studies of free-flying echolocating bats engaged in insect capture and obstacle avoidance tasks. 2) Control systems modeling of flight trajectories and vocalizations of echolocating bats to characterize changing behavioral states in a dynamic environment and 3) Extracting control systems synthesis principles for applications in robotics and neuromorphic engineering. Collectively, our research has wide-ranging impact on neuroscience, techniques in neuroscience, robotics, control theory, and the design of assistive medical devices.



Project (or PI) Website

http://www.isr.umd.edu/crcns_batsonar/

Publications

1. Ghose, K. Horiuchi, T.K., Krishnaprasad, P.S. and Moss, C.F. Echolocating bats use a nearly time-optimal strategy to intercept prey. *Public Library of Science Biology*, 2006, 4(5): 865-873.

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3. Horiuchi, T., "A Neural Model for Sonar-Based Navigation in Obstacle Fields," to appear in the Proceedings of the International Symposium on Circuits and Systems (ISCAS 2006) May 2006, in Kos, Greece (4 pages).

4. Jensen, M.E, Moss, C.F., and Surlykke, A,. Echolocating bats and their use of landmarks and spatial memory. *Journal of Experimental Biology*, 2005, *208*: 4399-4410.

5. E.W. Justh and P.S. Krishnaprasad (2006). "Steering laws for motion camouflage," accepted for publication, *Proceedings of the Royal Society of London A*, (also preprint arXiv:math.OC/0508023).

6. E.W. Justh and P.S. Krishnaprasad (2005). "Natural frames and interacting particles in three dimensions," *Proceedings of the IEEE Conference on Decision and Control*, pp. 2841-2846, IEEE, New York.

7. Moss, C.F., Bohn, K and Gilkenson, H. and Surlykke, A. Active listening for spatial orientation in a complex auditory scene. *Public Library of Science Biology*, 2006, 4(4): 615-626.

8. P.V. Reddy, E.W. Justh and P.S. Krishnaprasad (2006). "Motion camouflage in three dimensions," submitted for publication, also preprint *arXiv:math.OC/0603176*.

9. Shi, R. and Horiuchi, T., "A VLSI Model of the Bat Dorsal Nucleus of the Lateral Lemniscus for Azimuthal Echolocation" Proceedings of the International Symposium on Circuits and Systems (ISCAS 2005) May 23-26, 2005 in Kobe Japan, pp. 4217-4220.