UPTC UNDERWATER VEHICLES LAB
Universidad Politécnica de Cartagena

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1. Core research themes and interests

The UPCT Underwater Vehicles Lab is a multidisciplinary research group with expert in biological oceanography, Naval Architecture, Oceanic Engineering, robotics and artificial neural networks, Electronics and ITs the goal of this team is the development of equipment and techniques useful for oceanographic exploration. This lab has been constituted during 2010, and in this moment disposes several granted project for Mar Menor exploration and underwater vehicles design. One of the research lines in the field of artificial intelligence is the application of neural network biologically inspired to the control and trajectory generation. Another important research line is the design of marine vehicles for oceanographic exploration. The lab has an underwater vehicle remotely operated for mine searching donated by the Spanish Army which is being remodeled and a towed vehicle with an 8 meter vessel for operations.

2. Current maturity of our technology

Neural networks based controllers have been deeply investigated since can be used to learn nonlinear functions, representing direct dynamics, inverse dynamics or any other mapping in the process. A typical approach is to use neural networks for nonlinear system modelling, including for instance the learning of forward and inverse models of a plant, noise cancellation, and other forms of nonlinear control. An alternantive approach is to solve a particular problem by designing specialized neural network architecture and/or learning rule. It is clear that biological brains, though exhibiting a certain degree of homogeneity, rely on many specialized circuits designed to solve particular problems. We are interested in understanding how animals are able to solve complex problems such as learning to navigate in an unknown environment, with the aim of applying what is learned of biology to control of robots. The study of autonomous behaviour has become an active research area in the field of robotics. Even the simplest organisms are capable of behavioural feats unimaginable for the most sophisticated machines. When an animal has to operate in an unknown environment it must somehow learn to predict the consequences of its own actions. Biological organisms are a clear example that this short of learning is possible in spite of what, from an engineering standpoint, seem to be insurmountable difficulties: noisy sensors, unknown kinematics and dynamics, nonstationary statistics, and so on. A related form of learning is known as operant conditioning.
Psychologists have identified classical and operant conditioning as two primary forms of learning that enables animals to acquire the causal structure of their environment. In the classical conditioning paradigm, learning occurs by repeated association of a Conditioned Stimulus (CS), which normally has no particular significance for an animal, with an Unconditioned Stimulus (UCS), which has significance for an animal and always gives rise to an Unconditioned Response (UCR). The response that comes to be elicited by the CS after classical conditioning is known as the Conditioned Response (CR). Hence, classical conditioning is the putative learning process that enables animals to recognize informative stimuli in the environment.
In the case of operant conditioning, an animal learns the consequences of its actions. More specifically, the animal learns to exhibit more frequently a behavior that has led to reward in the past, and to exhibit less frequently a behavior that led to punishment.
In the field of neural networks research, it is often suggested that neural networks based on associative learning laws can model the mechanisms of classical conditioning, while neural

3. List of projects our group has worked on within the last 3 years and who has funded it

•Sistema de Control de Vehículos Submarinos Autónomos para Tareas de Inspección y
Maniobra. Programa DN8644. Ministerio de Defensa. (2005).
•Registrador de Inmersiones para Submarinos de la Armada Española. Ministerio de
Defensa. (2007).
•Diseño de un vehículo de Inspección submarina autónoma para misiones
Oceanográfica UPCT. DPI2009-14744-C03-02 (subprograma DPI). (2010).
•Laboratorio de Vehículos Submarinos de OOCMUR. Fundación Séneca. (2009).
•Taller de Vehículos Submarinos de OOCMUR. Fundación Séneca. (2009)

4. Most relevant citations including web pages

• F. García-Córdova, A. Guerrero-González, and F. García-Marín, Design and
implementation of an adaptive neuro-controller for trajectory tracking of nonholonomic
wheeled mobile robots, Nature Inspired Problem-Solving Methods in Knowledge
Engineering, J. Mira, and J.R. Alvarez (Eds.), IWINAC 2007, Part II, LNCS, vol. 4528,
2007, pp. 459-468. Springer, Heidelberg.
• F. García-Córdova, A. Guerrero-González, and F. García-Marín. Neuronal Architecture for Reactive and Adaptive Navigation of a Mobile Robot.(Computational and Ambient Intelligence). Lecture Notes in Computer Science. ISBN: 978-3-540-73006-4. Pag. 830-838, Berlin 2007.
• F. García-Córdova, A. Guerrero-González, and F. García-Marín, Neural Control
Systems for Autonomous Vehicles. Enciclopedia of Artificial Intelligence. Information
Science Reference. ISBN: 978-1-59904-849-9. (2008).
• Javier Busquets, Antonio Guerrero, Javier Gilabert, Francisco García-Córdova. "Reconstruction of an AUV as a Platform for Oceanographic Research and a Test bed for Implementation of Control Systems Based on Neurobiological Networks". AUV2010. California. USA.
• Antonio Guerrero-González, Francisco García-Córdova, Francisco de Asis Ruz-Vila, A Solar Powered Autonomous Mobile Vehicle for Monitoring and Surveillance Missions of Long Duration. International Review of Electrical Engineering (I.R.E.E.), August 2010.