ISTeC

Colorado State University

The Information Science & Technology Center

ISTeC.ColoState.edu

Colorado State University's
Information Science and Technology Center (ISTeC)
presents <u>three</u> lectures by

Dr. José del R. Millán

Swiss Federal Institute of Technology Lausanne

ISTeC Distinguished Lecture

in conjunction with the
Computer Science Department
and Electrical and Computer Engineering Department
Seminar Series

"Non-Invasive Brain-Controlled Robots"

Monday, February 9, 2009
Reception: 10:30 a.m., Computer Science room 305
Lecture: 11:00 – 12:00 noon
Location: Computer Science room 130

•

Computer Science Department Lecture

"A Look Behind our Adaptive Brain Interface's Veil"

Monday, February 9, 2009
Lecture: 2:00 p.m.
Location: Computer Science room 130

•

Molecular, Cellular and Integrative Neurosciences Lecture

"Cognitive Signals for Brain-Computer Interaction"

Wednesday, February 11, 2009
Lecture: 4:00 p.m.
Location: Anatomy/Zoology Building room W1

ABSTRACTS

“Non-Invasive Brain-Controlled Robots”

The idea of moving robots or prosthetic devices not by manual control, but by mere "thinking" (i.e., the brain activity of human subjects) has fascinated researchers for the last 30 years, but it is only now that first experiments have shown the possibility to do so. Such a kind of brain-computer interface (BCI) is a natural way to augment human capabilities by providing a new interaction link with the outside world and is particularly relevant as an aid for physically disabled people.

In this talk I will review our work on non-invasive asynchronous BCI, with a focus on how brainwaves can be used to directly control robots. Most of the hope for such a possibility comes from invasive approaches that provide detailed single neuron activity; however, it requires surgical implantation of microelectrodes in the brain. For humans, non-invasive systems based on electroencephalogram (EEG) signals are preferable but, until now, have been considered too poor and slow for controlling rapid and complex sequences of movements. Recently we have shown for the first time that online analysis of a few EEG channels, if used in combination with advanced robotics and machine learning techniques, is sufficient for humans to continuously control a mobile robot and a wheelchair.

Finally, we discuss current research directions we are pursuing in order to improve the performance and robustness of our BCI system, especially for real-time control of brain-actuated robots. In particular, I'll mention work on recognizing cognitive states that are crucial for interaction.

“A Look Behind our Adaptive Brain Interface's Veil”

In my ISTeC lecture I will give a wide overview of our work on adaptive brain interfaces (ABI). Now it's time to take a deeper look at some of the critical components of our approach, from the statistical machine learning techniques to shared control for blending user's and robot's intelligence. I'll also give a more complete analysis of the wheelchair experiments and discuss alternative techniques for EEG analysis we are currently exploring.

“Cognitive Signals for Brain-Computer Interaction”

In a classical brain-computer interface (BCI) users interact with the brain-controlled device in a closed loop, where they deliver continuously mental commands and receive feedback from the device. But, on top of this loop, users are engaged in a higher loop whereby they monitor the quality of the interaction. What if we could recognize the cognitive states of the user while they are interacting with an intelligent device such as a wheelchair and incorporate those cognitive states into the decision-making process? In this talk I'll describe this general framework and describe our work on the recognition of cognitive states such as awareness to erroneous responses of the BCI or intelligent device, anticipation and alarms.

I'll also discuss a new framework for semi-autonomous robot navigation based in the Human-in-the-loop approach. In this approach, an intelligent artificial cognitive agent (e.g., an autonomous robot) makes decisions in order to solve a task, while a a human user monitors the agent's performance and provides asynchronous, corrective signals that can be used to correct erroneous actions, or to improve the autonomous controller following a process alike to reinforcement learning.

SPEAKER BIOGRAPHY

José del R. Millán (http://people.epfl.ch/jose.millan) is a professor at the Swiss Federal Institute of Technology in Lausanne (EPFL) where he explores the use of brain signals for multimodal interaction and, in particular, the development of non-invasive brain-controlled robots and neuroprostheses. In this multidisciplinary research effort, Dr. Millán is bringing together his pioneering work on the two fields of brain-computer interfaces and adaptive intelligent robotics.

He received his Ph.D. in computer science from the Univ. Politècnica de Catalunya (Barcelona, Spain) in 1992, where he was an assistant professor for three years. He was also a research scientist at the Joint Research Centre of the European Commission in Ispra (Italy), a senior researcher at the Idiap Research Institute in Martigny (Switzerland), and a visiting scholar at the Universities of Stanford and Berkeley.

His research on brain-computer interfaces was nominated finalist of the European Descartes Prize 2001 and he has been named Research Leader 2004 by the journal Scientific American for his work on brain-controlled robots. The journal Science has reviewed his work as one of the world’s key researchers in the field of brain-computer interfaces. Dr. Millán is the coordinator of a number of European projects on brain-computer interfaces and also is a frequent keynote speaker at international events. His work on brain-computer interfaces has received wide media coverage around the world.

To arrange a meeting with the speaker, please contact Chuck Anderson (Computer Science) at 970-491-7491 or anderson@cs.colostate.edu.

ISTeC (Information Science and Technology Center) is a university-wide organization for promoting, facilitating, and enhancing CSU’s research, education, and outreach activities pertaining to the design and innovative application of computer, communication, and information systems. For more information please see ISTeC.ColoState.edu.