UNIVERSITÀ DEGLI STUDI DI VERONA

Dottorato di Ricerca XXVI ciclo – anno 2011
Borsa di Internazionalizzazione
- Scheda progetto –

Scuola di Dottorato di	**Scienze, Ingegneria e Medicina**
Corso di Dottorato in	**Informatica**
Coordinatore	**Prof. Luca Viganò**
Titolo del progetto	**Multi-modal modeling of epilepsy: EEG-based analysis of epileptic seizures**

Partner straniero:

La lettera di intenti o eventuale strumento convenzionale già esistente dovrà essere prodotta entro e non oltre la fine del mese di marzo 2011.

N.	Denominazione	Eventuale iniziative previste	Sede attività didattica	Periodo di permanenza previsto per il Dottorando*
1.	School of Electronic Engineering and Computer Science Queen Mary, University of London	☐ attivazione co-tutela di tesi X rilascio certificazione di "Doctor Europaeus"	X SI ☐ NO	6 mesi
2.		☐ attivazione co-tutela di tesi ☐ rilascio certificazione di "Doctor Europaeus"	☐ SI ☐ NO	.... mesi
3.		☐ attivazione co-tutela di tesi ☐ rilascio certificazione di "Doctor Europaeus"	☐ SI ☐ NO	.... mesi
4.		☐ attivazione co-tutela di tesi ☐ rilascio certificazione di "Doctor Europaeus"	☐ SI ☐ NO	.... mesi

* Periodo di permanenza complessivo previsto: minimo 6 mesi, massimo 18 mesi.

Docenti referenti presso gli Atenei partner

N.	Cognome	Nome	Ateneo	Indirizzo e-mail	Telefono
1.	Cavallaro	Andrea	Queen Mary, University of London	andrea.cavallaro@elec.qmul.ac.uk	+44 20 7882 5165
2.					
3.					
4.					

DESCRIZIONE del progetto (min. 2500 – max 5000 caratteri)

(si richiede di specificare il ruolo dell'Ateneo partner nel progetto di ricerca, al fine di giustificarne il carattere internazionale e l'eventuale compartecipazione finanziaria del partner).

Vedere allegato

Il Coordinatore del Corso di Dottorato

Data _____ _____

Allegato: Descrizione del progetto
Title: Multi-modal modeling of epilepsy: EEG-based analysis of epileptic seizures

Objectives

This project aims to link behaviour to the cortical signals (EEG) with particular focus on epilepsy.
The main goals are:

- To investigate the link between emotional and behavioural patterns and cortical signals;
- To design automatic tools to support clinical diagnosis and modelling of emotional patterns in this kind of disease (for instance for monitoring and preventing the onset of the crises) using simultaneous video and EEG signals.

Background

The analysis of video - EEG in epilepsy represents an important tool of diagnosis to detect seizures, to define the site of the seizures and the typology of clinical symptoms. In clinical practice, the EEG associated to the video is largely diffused in the main neurological centers. In the video EEG is used to define the onset of the seizures and to define the epileptogenic focus on the EEG associated to the clinical symptoms.

There are many different types of seizure with typical clinical features: mesial-temporal lobe seizure with gastric symptoms, horripilation, dizziness and then complex motor pattern as automatism, posterior temporal lobe seizures with aura (acustic, verbal hallucinations that can herald complex motor pattern as automatism and motor seizures) or frontal lobes with head version, vocalization, posturing and motor seizures. In most epileptic seizures emotional symptoms as fear, aggressiveness, hallucinations can be the first and misdiagnosed symptoms.

Rational

As in most clinical epileptologists the attention is addressed to the electrophysiological correlation with clinical pictures, most emotional pattern are usually lost or misinterpreted or supposed. The possibility to measure and to detect psychological events by video analysis is expected to be fundamental in improving the diagnosis. In order to have a good study of psychological patterns in video, the study will correlate this analysis with EEG patterns.

Psychogenic seizures or not epileptic seizures appear in most clinical patients with video EEG. The possibility to detect psychogenic pattern with normal EEG and therefore not epileptic can be fundamental for this type of diagnosis. Population studies based on pathologic and control groups will be needed for the identification of the (eventual) changes due to the onset of the pathological situation.

On the macroscopic scale, behavioural studies will be performed by observing the patient's activity in specific conditions using a (multi-)camera recording system. The subsequent processing of the resulting video sequences will allow the identification of behavioural patterns that are typical for a given pathology. The potential of this technique is enormous and would revolutionize the field of the diagnosis of epilepsy and pave the way for other pathologies. First, it will enable an objective validation of the theories that have been developed so far in the field by providing a means for detecting and measuring the presence of a-priori defined behavioural cues. Second, it will provide a framework for performing large scale multi-centric studies over a large population of patients based on an objective ground (the recordings). Third, the large scale analysis of behavioural data could lead to the identification of other cues thus improving the disease model.

The investigation of the co-occurrence of the fingerprints of the considered disease at different scales over a wide population will allow for the definition of a global diagnostic index based on an illness specific pattern accounting for both neurophysiological and behavioural features.

The thesis

The thesis project will investigate the co-occurrence of events as revealed by multi-modal signals, including EEG and video recordings in order to investigate the relation between emotional and cortical signals in both control and pathological groups.

Multi-scale analysis and modeling will be used to disambiguate the cortical signals that are elicited either during the epileptic crises or during the resting state as well as to detect hidden variables that could have a role in the onset

and development of the crisis. Time/scale analysis methods will be used to de-noise the EEG signals, de-trend them as well as to detect typical patterns in different conditions.

Feature detection and pattern recognition methods such as Hidden Markov Models, Support Vector Machines and kernel-based methods will be applied for the analysis of the recorded video to enable the extraction of emotional patterns and the investigation of their correlation with the neurophysiological ones.

The project will be performed in collaboration with Dr. Paolo Manganotti, Dept. of Neurological, Neuropsychological, Morphological and Movement Sciences , University of Verona. Dr. Manganotti will be responsible for data collection in the pathological and control groups as well as for the management of all clinical aspects of the proposed research, including the validation of the target model.

Partner institution: profile and role

Dr. Andrea Cavallaro received the Laurea (Summa cum Laude) in Electrical Engineering from the University of Trieste in 1996 and the Ph.D. in Electrical Engineering from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, in 2002. In 1996 and 1998, he served as a research consultant at the Image Processing Laboratory, University of Trieste, Italy, working on compression algorithms for very low bitrate video coding and on digital image sequence de-interlacing. In 1997 he served the Italian Army as lieutenant at the 33rd Electronic Warfare Battalion in Treviso, Italy. From June 1998 to February 2002 he was a research assistant at the Signal Processing Laboratory of the Swiss Federal Institute of Technology (EPFL). From March 2002 to April 2003, he was a senior researcher at EPFL. Since May 2003, he has been with Queen Mary, University of London (QMUL), UK, where he is now Reader (Associate Professor), Director of UG Studies for Electronic Engineering at the School of Electronic Engineering and Computer Science, and counsellor for the local IEEE Student Branch.

Dr. Cavallaro was awarded a Research Fellowship with British Telecommunications (BT) in 2004/2005; the prestigious Royal Academy of Engineering teaching Prize in 2007; three student paper awards on target tracking and perceptually sensitive coding at IEEE ICASSP in 2005, 2007 and 2009; and the best paper award at IEEE AVSS 2009. Dr. Cavallaro is Associate Editor for the IEEE Signal Processing Magazine, the IEEE Transactions on Multimedia, the IEEE Transactions on Signal Processing and for the EURASIP Journal on Information Security. He is an elected member of the IEEE Signal Processing Society, Multimedia Signal Processing Technical Committee (term expires Dec 2009), and has acted as Guest Editor for several journals including Computer Vision and Image Understanding (Elsevier) the International Journal of Computer Vision and the IEEE SPM. He has served as General Chair for IEEE/ACM ICDSC 2009, BMVC 2009, M2SFA2 2008, SSPE 2007, and IEEE AVSS 2007. Dr. Cavallaro was Technical Program chair of the European Signal Processing Conference (EUSIPCO 2008), of WIAMIS 2010 and has been a member of the organizing/technical committee of several conferences, including IEEE ICME, IEEE ICIP, SPIE VCIP, ACM Multimedia, IEEE AVSS, ACM/IEEE ICDSCECCV-VS, PETS; and act as reviewer for several international IEEE conferences and IEEE journals. He has authored more than 100 papers, including 10 book chapters.

Dr. Cavallaro current research includes multimedia signal processing, perceptual semantics and interactive media computing. In particular, I am interested in audiovisual content analysis and performance evaluation with application in advanced surveillance, semantic coding and multi-sensor systems.
The role of QMUL will be mainly concerned with the video analysis and will contribute to modeling of emotional and behavioral patterns through the definition of the experimental set-up and the management of the experiments.
Dr. Cavallaro's laboratory is equipped with a high-quality eye-tracker that could be used to design other experiments to be performed by non pathologic patients. Furthermore, his large experience in the field of video processing and image and video analysis is an important added value to the proposed research activity.