Brain Computer Interfaces for Communication and Control

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Abstract

Brain Computer Interfaces (BCI) is an area of research that is rapidly growing in the neuroscience and bioengineering fields. One popular approach to the generation of a BCI system consist in the recognition by a computer of the patterns of electrical activity on the scalp gathered from a series of electrodes. One of the problems related to the use of surface EEG is the blurring effect due to the smearing of the skull on the transmission of the potential distribution from the cerebral cortex toward the scalp electrodes. This happens since the skull has a very low electric conductivity when compared with the scalp or the brain ones. The blurring effect makes the EEG data gathered from the scalp electrodes rather correlated, a problem not observed in the cortical EEG data recorded from the invasive implants in monkeys and man. Such correlation makes problematic the work of the classifiers, since the features extracted from the different scalp electrodes tends to be rather similar and this correlation is hard to be disentangled with blind methods like Principal Component Analysis.

In the last decade, high-resolution EEG technologies have been developed to enhance the spatial information content of EEG activity. Furthermore, since the ultimate goal of any EEG recording is to provide useful information about the brain activity, a body of mathematical techniques, known as inverse procedures, has been developed to estimate the cortical activity from the raw EEG recordings. Examples of these inverse procedures are the dipole localization, the distributed source and the cortical imaging techniques. Inverse procedures could use linear and non linear techniques to localize putative cortical sources from EEG data, by using mathematical models of the head as volume conductor.

More recently, it has been suggested that with the use of the modern high resolution EEG technologies it could be possible to estimate the cortical activity associated to the mental imagery of the upper limbs movements in humans better than with the scalp electrodes.

In this presentation we will review main achievements in the field of the Brain Computer Interfaces and we will demonstrate how it is possible run a BCI system able to drive and control several electronic and robotic devices in a house environment. In particular, we first describe a BCI system used on a group of normal subjects in which the technology of the estimation of the cortical activity is illustrated. Then, we used the BCI system for the command of several electronic devices within a three-room environment employed for the neurorehabilitation.

Prof. Fabio Babiloni was born in Rome in 1961. He got the master degree in Electronic Engineering at the University of Rome "La Sapienza"and the PhD in Computational Engineering at the Helsinki University of Technology, Helsinki in the 2000 with a dissertation on the multimodal integration of EEG and fMRI. He is currently Associate Professor of Human Physiology at the Faculty of Medicine of the University of Rome "La Sapienza", Rome, Italy. He is author of more that 120 papers on bioengineering and neurophysiological topics on international peer-reviewed scientific journals, and more than 250 contributions to conferences and books chapter. His total impact factor is more than 255 and his H-index is 23.

Currents interests are in the field of multimodal integration of EEG, MEG and fMRI data, cortical connectivity estimation and Brain Computer Interface. Prof. Babiloni is currently grant reviewer for the National Science Foundation (NSF) USA, the Academy of Finland, Finland, the Austrian Fund of Research, Austria and the European Union through the FP6 and FP7 research programs.

Prof. Babiloni is president of the International Society of Functional Source Imaging, member of the Italian Society of Physiology and the Italian Society of Clinical Neurophysiology.

He is an Associate Editor of four scientific Journals "Frontiers in Neuroscience", "International Journal of Bioelectromagnetism","IEEE Trans. On Neural System and Rehabilitation Engineering", and "Computational Intelligence and Neuroscience".

Flexible License Plate Recognition

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Abstract

License plate recognition usually consists of three processes: license plate detection, character segmentation and character recognition. License plate recognition algorithms usually work under restricted conditions such as controlled lights, fixed backgrounds, designated moving routes and limited vehicle speeds. In this talk, I will briefly review the existing and related works on license plate recognition. Then, I will present an approach for license plate recognition under flexible conditions. For license plate detection, in this approach, both global edge features and local Haar-like features are applied to construct a cascaded classifier consisting of 6 layers with 160 features. For license plate recognition, an open source OCR is modified and used after a character segmentation process. The algorithm for segmentation is based on the connected component algorithms. This approach is efficient and can be applied in real-time applications. Unlike other approaches built on either fixed image backgrounds or fixed cameras, this approach does not use any inter-frame information and pre-knowledge.

Prof. Xiangjian He is currently with the University of Aizu, Japan and the University of Technology, Sydney (UTS), Australia. As a Chief Investigator, he has received various research grants including four national Research Grants awarded by Australian Research Council (ARC). He is the Director of Computer Vision and Recognition Laboratory at UTS, and a Deputy Director of UTS Research Centre for Innovation in IT Services and Applications (iNEXT). He is an IEEE Senior Member, and has been awarded 'Internationally Registered Technology Specialist' by International Technology Institute (ITI). He has been carrying out research mainly in the areas of image processing, pattern recognition and computer vision in the previous years. He is a leading expert and an internationally recognized researcher for work on image processing based on the Spiral Architecture. He has played a chairman role in various highly reputed international conferences including IEEE CIT and IEEE AVSS. He is in the editorial boards of seven international journals.

On the Size, Shape, and Search of WWW

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Abstract

Much like a black hole, the Web, since its birth, has been absorbing all sorts of data (information) around the globe, ever generated along the path of human civilization. On the other hand, the digitized and networked (webbed) nature of web data, which generally means "easy to access", gives rise to much imagination on re-discovering, re-engineering, and re-using of the oceanic information. There are unlimited directions to take for Web related research. In this talk, I'll address issues related to "Size, Shape, and Search of WWW". Starting from how people estimate the size of the Web, we provide a law of growth based on an empirical study for Chinese Web. In the study, the Web is viewed as a service and the duration between creation and deletion of a web page is viewed as service time. With an assumption of exponential service time, the study resulted in a model of growth, applied to Chinese Web, which has been verified by CCNIC survey data for several years. In terms of shape, we discuss a result based on a crawl of 830 million web pages, which shows the evidence of a "Tea Pot", instead of "Bow Tie" as people generally assume. For search, I'll first introduce Web InfoMall (http://www.infomall.cn), the Chinese web archive we have been constructing since 2001. And one can easily realize a step beyond the web archive, namely searching and more accurately mining based on Web InfoMall, to make use of the data in the web archive. With a web archive and associated capability, "web mining" here has a more or less different meaning, which spans from the structure analysis of the web to named entity and relation extractions, from spatial (if we consider URL as a space) information discovery to temporal information exhibition. I'll show some unique examples along this line, including HisTrace (a search facility based on Web InfoMall) and Tianwang Digest for Olympics 2008 (an event analysis system with Beijing Olympics as an instance).

Prof. Xiaoming Li received his Ph.D. in Computer Science from Stevens Institute of Technology (USA) in 1986 and has since taught at Harbin Institute of Technology and Peking University. He has founded the Chinese web archive WebInfoMall (http://www.infomall.cn), the search engine Tianwang (http://e.pku.edu.cn), the peer-to-peer file sharing network Maze (http://maze.pku.edu.cn), and other popular web channels. He is a member of Eta Kappa Nu, a senior member of IEEE, currently a Vice President of China Computer Federation, International Editor of Concurrency (John Wiley), Associate Editor of Journal of Web Engineering (Rinton), and editor of Electronics Letters (Chinese Edition, IET, UK). He has published over 100 papers, authored Search Engine – Principle, Technology, and Systems (Science Press, 2005), and received numerous achievement awards from the Ministry of Science and Technology, Ministry of Education, Beijing Municipal Government, and other agencies.