APPLICATION OF MULTIPLE SUPERVISED AND NONSUPERVISED ML/AI TECHNIQUES TO DIRECT AND INDIRECT BRAIN MONITORING SYSTEMS

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Several possibilities of brain monitoring technologies are available for physiological analysis nowadays. From the highly reliable functional MRI exam which can create a high resolution image of the brain regions, going through multimodal EEG-fNIRS systems, to dry electroencephalogram sensors for home applications, which can also provide a sufficient reliability, even though not for medical diagnosis purposes. In addition, new possibilities with graphene-base sensors are quite exciting and bringing new possibilities to the healthtech applications ecosystem. In this variety of solutions, brain signals are still complex and multidimensional, creating a vast area of application for the use of Machine Learning / Artificial Intelligence techniques to support diagnosis or signal interpretation. This work presents a series of results achieved at the Laboratory of Applied Neurosciences LAN/USJ from Macau China, in cooperation with international institutions from Brazil and Portugal. Different biometrics/biosignals are analyzed, not only measuring directly brain activity. First, the heart rate (HR), for the analysis of the HR variability and the balance of the sympathetic-parasympathetic modules of the Autonomous Nervous System (ANS), the Galvanic Skin Response (GSR) for the detection of emotional arousal, the automatic classification of emotions based on Facial Expression Analysis (FEA). Relevant preprocessing techniques are discussed such as Noise Filtering, ICA (Independent Component Analysis) and PCA (Principal Component Analysis), followed by supervised and non-supervised ML/AI techniques. Nonsupervised clustering algorithms are presented and compared for the identification of non-previously classified groups and classification tools are implemented to create a reliable discrimination computerized tool. Research designs with innovative monitoring and new sensors are also presented as exciting steps for the continuing research projects.

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BIOGRAPHY:

Joao Alexandre Lobo Marques is PhD in Bioengineering. He works as Associate Professor and Research Coordinator at the University of Saint Joseph-USJ, Macao SAR, China. In 2019, he founded the Laboratory of Applied Neurosciences. In 2021 he co-founded the Institute of Data Engineering and Sciences (IDEAS/USJ). His research interests are data analytics, artificial intelligence, applied neurosciences, and chaotic and nonlinear analysis of time series.