Computational-based Biomarkers for Mental and Emotional Health

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Editorial

Medical problems derived from elderly or from behavioural diseases continue to pose important challenges in improving the quality of life, early identification of diseases, recognition of variations in the behaviour of the limbic system and their consequences in learning, memory or in managing emotions. Nowadays, there are several computational-based approaches to gather physio-psychological data from persons, enabling determining the state of well-being or the degree of development of certain symptoms or diseases. The elements that objectively and quantifiably identify these relevant data through usable, portable, implantable or digestible devices are called digital biomarkers (DB). Although as a general rule the design of DB requires multidisciplinary work teams, the current trend is the design and development of them using Artificial Intelligence (AI) techniques.

To that end, the Computational based biomarkers for mental and emotional health track was organized in the Computer-based Medical Systems on 2021, with the intend to provide a discussion forum for the most recent and innovative work on the study and application of digital biomarkers in the compelling scenarios of mental and emotional health. In the track, a wide spectrum of applications were covered, from those aimed at easing and supporting healthcare professionals' work to those devoted to improving patients' lives. This Topical Collection (TC) includes 8 studies selected and extended from this special track addressing the problem from quite very different points of view.

To start, an experimental review of different algorithms regarding Parkinson's disease with non-control clinical features is conducted by Martinez-Eguiluz et al. in [1]. Non-motor symptoms in Parkinson disease are related to main difficulties stem from depression, anxiety, psychosis or cognitive issues. The experimental analysis is based on two databases: Biocruces (96 subjects) and PPMI (687 subjects). Results are encouraging regarding the prediction of Parkinson's patients, with high accuracy (>80%). In that case, Support Vector Machine and Multi-Layer Perceptron provide the more remarkable results. To highlight that it was possible to achieve an accuracy of 84.4 by using only two features, enabling the development of an screening protocol tool.

Feature extraction and dimensionality reduction was addressed in by Boeker et al. in [2]. The application field in this work was schizophrenia, and use information about the motor activity over time. The authors propose the use time dependent Hidden Markov models to represent features of the motor activity, and use them in a logistic regression model to separate schizophrenia patients from healthy subjects. Results are quite encouraging as the accuracy achieved by the best model configuration reaches 98%.

A very interesting discussion on whether visual imagery and perception represent valid paradigms for Electroencephalogram (EEG) Brain-Computer Interface (BCI) is presented in Llorella et al. [3]. This research demonstrates the feasibility of EEG-based BCI for visual imagery. Visual imagery enables more natural BCI that facilitates cognitive activities as drawing or generating art. The authors achieve accuracies in their experimentation of higher than 88% when using visual data. To do so, the authors propose a Black Hole algorithm to find the most promising Convolutional Neural Network structure for a subject; once trained, the obtained model is proposed for classifying the visual imagery.

Also related to EEG and BCI is the research proposed in Moncada et al. [4], addressing the problem of photo-paroxysm response (PPR) detection. Interestingly, the approved protocol still uses equipment designed in the 1930s of the last century; this study proposes to update this protocol using Virtual Reality plus the automated detection of the PPR to assess the experts in labeling the EEG signals. Interestingly, this is one of the few examples of research on PPR detection in the literature. Results prove the approach valid, although further research is still needed for a good description of the PPR time series.

Different sensory systems have also been studied for their use in pursuing biomarkers for mental and emotional health in Silva et al. [5]. The authors studied the use Photoplethysmography (PPG) and Electrodermal Activity (EDA) for this concern, and focused on different aspects from feasibility to device design decisions such as battery consumption or sampling rate, determining the minimum sampling rate requirements for each signal, as well as the impact of interpolation methods on signal waveform reconstruction.

Also, Electrocardiograms (ECG) and EDA are combined to develop the response towards relaxation (RResp) of subjects [6], one of the main problems in mental and emotional health nowadays. In this case, the research is mainly focused on labelling the current mental state as relaxed, resting, or stressed; a sample of 20 university students participated in the experimentation stage, and the approach was validated later using a reference data set. The authors used Machine Learning techniques to address the problem modeling, revealing the most discriminant features among a subset of 50 transformations.

Rua et al. [7] study whether factors related to chronodisruption of circadian rhythms motivated by shift works influence on reproductive health or not, focusing on four particular aspects: reproductive health disease, first pregnancy attempt, problems during pregnancy and gestation period. In particular, data from 697 women health professionals was used, including information about classical biomarkers, sleep quality indices and also other new variables related to eating jet lag, sleep hygiene and how the sleep is affected by shift works. The ranking aggregation function used with the most relevant variables arised from different explainable machine learning models, showed that these novel biomarkers were significant for the issues studied in relation to reproductive health. The authors concluded that a simple intervention on some of these new factors can contribute to improve both mental health during pregnancy and the development of the pregnancy itself.

Focusing on physiological data acquisition tools Bota et al. [8] highlight the benefits of designing technology able to acquire the response in groups, since it provides information of two types of emotions, the individual one (influenced by the group) and group-based emotions (towards the group as an identity). Aiming to fill the existing gap in this area, they introduce a biocybernetic engine for collective multi-modal physiological data acquisition in unconstrained scenarios. The toolbox presented can accurately perform data acquisition from multiple devices simultaneously in a real-time setting, providing a local infrastructure with a end-user interface for monitoring the data acquisition process, as well as a local and cloud-based data storage. This will contribute to create large databases in diverse real-world

scenarios, such as health and well being, simplifying widespread biosignals data collection from unobtrusive wearables.

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