Guest Editorial: Special Issue on Pervasive Sensing and Machine Learning for Mental Health

MENTAL health is one of the major global health issues affecting substantially more people than other non-communicable diseases. Much research has been focused on developing novel technologies for tackling this global health challenge, including the development of advanced analytical techniques based on extensive datasets and multimodal acquisition for early detection and treatment of mental illnesses. Recent advancements in imaging and sensing have facilitated the acquisition of detailed neurological signals and images for better understanding of the disorder. In addition, new wearable technologies have enabled continuous sensing of neurological, physiological, and behavioral information of the users. These technologies have led to new insights into mental illnesses providing the needed data to improve the diagnosis, identify triggers of episodes, and enable preventative interventions with diverse machine learning approaches.

This special issue is dedicated to cover the related topics on technological advancements for mental health care and diagnosis with a focus on pervasive sensing and machine learning. Thirty four high-quality contributions were received, and seven papers are selected to exhibit the recent developments.

In the first work, Bonilla-Escribano *et al.* propose a novel Poisson process mixture model to assess the e-social activity of psychiatric disorders using information and communication technologies. Specifically, they revealed the similarity of daily usage patterns of phone calls and social and communication apps among patient cohorts. Truncated Fourier series has been proposed to capture the circadian rhythm presents in the considered application. Both clinical and algorithmic point of view has been interpreted using patterns analysis and EM (Expectation Maximization) algorithm, respectively. The method exposes patterns of nocturnal activity and reduces social interactions which could be served as the basis to diagnose and treat mental disorders.

The work of Arsalan *et al.* presents a new feature selection algorithm which selects features from appropriate frequency bands from the acquired data using a publicly available electroencephalogram (EEG) headband to classify mental stress. Each participant's stress level was divided into three classes (non-stressed, mildly stressed, and stressed). Five feature groups are extracted from five bands of each EEG channel. A multi-class classification was performed on pre- and post-activity phases of EEG recordings using three machine learning classifiers, among which MLP classifier gave the best results for two- and three-class stress level classification. They found that the pre-activity phase EEG recordings are more discriminative for better classification of perceived stress.

The work from Zhang *et al.* analyzes the physiological and behavioral perspectives simultaneously by fusing pervasive EEG and vocal signals to detect depression objectively and conveniently. The data were recorded using three-electrode resting-state EEG signals and vocal signals during face-to-face interview, respectively. They perform multi-agent strategy using six representational classifiers on each modality based on the co-decision tensor. Additionally, they employ a dynamic late fusion strategy to fuse single-modal classifiers to achieve a better multimodal depression detection. The experiment shows that the exchanging of information on different classifiers can improve the performance of depression detection and make the model more effective.

Rosa and Yang proposed a low power flexible and multimodal sensing device with electrocardiogram (ECG), galvanic skin response (GSR), temperature and bio-motion detection channels to assess patients' and healthy individuals' mental health during daily activities (exercise, rest and mental activities) at home and/or work. Specifically, the main objective of this work is to provide an easy-to-wear and unobtrusive mental health monitoring tool. The experiment shows satisfactory results in terms of the electronic performance, signal range, and drift levels achieved for the several sensing modalities.

The work proposed by Peis *et al*. presents a novel method to predict suicidal ideation by combining Electronic Health Records (EHR) longitudinal data along with the ecological momentary assessment (EMA) question forms using sequential Recurrent Neural Network (RNN) models. Both EHR longitudinal data and EMA question forms are defined by asynchronous, variable length, randomly-sampled data sequences, and these sequences are aligned by concatenating the hidden state of each of them using temporal marks. They also incorporate attention schemes to improve performance in long sequences. Finally, by combining pre-trained feedforward Neural Networks (NNs) and attention models, they demonstrated that the proposed method outperforms other existing methods in the literature.

McGinnis *et al*. present a new approach to identify children with an internalizing disorder using a 3-minute speech task and machine learning-based analysis of audio data from the task. The speech features include: speech epoch duration, zero-crossing rate (ZCR) of the audio signal, Mel Frequency Cepstral

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Coefficients (MFCC), dominant frequency, mean frequency, Perceptual Spectral Centroid (PSC), spectral flatness, etc. Logistic Regression (LR), Support vector machine with a Linear kernel (SL), support vector machine with a Gaussian kernel (SG), and Random Forest (RF) based binary classification was performed using leave-one-subject-out (LOSO) cross-validation. This new tool outperforms clinical thresholds on parent-reported child symptoms.

In the paper by Deligianni *et al.*, a survey is presented highlighting the recent approaches in capturing the changes in gait and body movements due to emotions and mood disorders. Notably, they stated the potential of merging the physiological signals and home-based monitoring system for early detection and management of mood disorders. They emphasized the link between gait and emotions brain connectivity networks as well as their circuitry interaction based on evidence from lesion studies and neurological diseases. In addition, privacy required in regular monitoring is also discussed highlighting the importance of the subject should always be in control of his/her conditions.

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