Personalized Monitoring Systems: a New Tool for Mental Healthcare

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A personal, cost-effective, multi-parametric monitoring system has been developed. Textile platform and portable sensing devices have been used for long term and short term data acquisition from selected classes of patients with mood disorders. The system allows the medical staff to monitor patients 24 hours a day and provides physiological parameters, indexes and trends that will be used to estimate the mood status, to provide patient support, to predict and anticipate treatment response, and to generate an alarm in case of critical events and relapse. The monitoring system is ready to be evaluated in clinical studies.

Clinicians are facing a difficult problem when trying to normalize the mood variations of bipolar patients (i.e. patients oscillating between manic and depressive phases). The major difficulty results from the latency between the prescription of a new treatment and the observation of its effectiveness. The situation is generally worsened by the premature interruption of the treatment by the patient. The development of new techniques allowing a faster evaluation of the suitability of the treatments and actively including the patients in the evaluation loop would provide an important improvement.

The mood of the patient cannot be observed directly but can only be estimated indirectly from other functions of the body. The main variables that are related to mood variations are the control of the autonomic nervous system, the psycho-motor control and the social activities.

Information about the control of the autonomous nervous system can be derived from the combination of the electrocardiogram, the respiration activity and the body movements (*e.g.* an increased average heart rate and decreased heart rate variability are indications of depression). During depressive phases, the psycho-motor control undergoes a retardation, which is reflected in the speech and certain body movement acceleration signals on a short- and mid-term scale. Eventually, information about social interaction can be derived from the statistics about the use of the cellular phone and from some environmental signals (*e.g.* ambient noise).

A novel system enabling the assessment of the mood state of bipolar patients based on the monitoring of physiological and behavioural signals has been developed throughout the European project named PSYCHE [1]. The monitoring system consists of smart sensors integrated into garments that are worn by the patient, a non-obtrusive electronic device that can be interfaced to the sensing garments to record multiple signals during the routine working activity of the user, and a standard smart phone (see Figure 1).

Figure 1: PSYCHE garments with sensors and signal processing units

The core of the electronic system has been developed by CSEM and is based on a scalable low-power processing unit that can be designed according to different application needs [2]. A library of specific functions implemented in the electronic device preprocesses the observed signals. Both, raw and preprocessed signals are stored on a flash memory card and can be streamed to a smart phone for visualization and transmission to a central server, accessible by researchers and clinicians. The system provides a direct feedback to the patient and to the clinician when the mood state is detected.

For each observed signal, different features will be estimated and combined. The features will be extracted from the following observed signals:

- Electrocardiogram, recorded by dry textile electrodes;
- Respiration activity, acquired by variable textile resistance integrated in the garment;
- Body movements, measured at the sternum position with the help of a 3D-accelerometer integrated in the electronic device;
- Voice, acquired either in a controlled environment using high quality audio recording equipment or in daily-life conditions with a smart phone.

Additional stand-alone sensors (*e.g.* environmental signals) can be integrated in the system through an ANT-based body area network.

The PSYCHE system has been successfully used to record a database with both healthy volunteers and patients. The preliminary results obtained with the recorded data have shown promising results [3]. An evaluation study will begin in June 2012 and results are expected by the end of the year.

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[1] http://www.psyche-project.org/

[2] O. Schleusing, P. Renevey, M. Bertschi, St. Dasen, J.-M. Koller, R. Paradiso, "Monitoring physiological and behavioral signals to detect mood changes of bipolar patients", Proc. ISMICT, (2011) 130

[3] O. Schleusing, P. Renevey, M. Bertschi, S. Dasen, R. Paradiso, "Detection of mood changes in bipolar patients through monitoring of physiological and behavioral signals", Proc. IFMBE, 37 (2011) 1106