Wearable devices and innovative technologies for sleep analysis

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Moving the care center from the hospital and the clinics to the patient home has always been the main pillar of telemedicine. The downward spiral of high request, long queues and short monitoring intervals often leave pathologies undiagnosed, and this is especially true for those related to sleep. Long-term monitoring for sleep, and non-sleep, disorders is becoming more and more essential to really understand the condition of a patient. Not to talk about the scarce availability of the Polysomnography (PSG), the gold standard exam for sleep, which only few medical structures can perform, thus inevitably causing enormous waiting times. That is why, first of all, effectively screening sleep disorders with wearable devices would be a true helping hand for medical structures. Only the patients highlighted by the screening service would be pointed through PSG, making the exploitation of the health service more efficient and allowing for longer individual monitoring sessions. That is why research in electronics is focussing on improving one of the actual limits of wearable sensors for long home monitoring sessions, which is low battery life, by proposing new, low-power technologies.

As a first example, we demonstrated that a wireless system composed by an integrated Photoplethysmography (PPG) sensor and a MEMS accelerometer properly worn on the nose can be as accurate as a traditional Holter in detecting apnea episodes during a whole night, and distinguish between the obstructive and the central pathology.

For pathologies like Rem Behaviour Disorder (RBD) using a home monitoring device becomes a must, since its symptoms do not appear every night and its diagnosis is, therefore, not an easy task. On the other hand, studying sleep disorders of the REM sleep phase is fastly growing interest since they are currently considered common warning signs of severe neurological diseases. We demonstrated how a commercial, extremely low-power, and cheap electrostatic sensor for presence tracking is able to acquire biopotentials (the ST- Qvar sensor). If appropriately adapted to the task, it can acquire ECG, EOG, EEG and EMG with a current absorption of just 15 μA, which is several orders of magnitude less than its traditional counterparts, thus enabling acquisition sessions as long as several days.