Development of a wireless electronic device for sleep monitoring and disorder detection

Supervisor: Eric CAMPO, Professor, University Toulouse, LAAS-CNRS

Co-Supervisor: Damien BRULIN, Assistant Professor, University Toulouse, LAAS-CNRS

Keywords: microsystems, measurement, data processing, sleep monitoring, signal analysis, detection, sensing

Description of the research work proposed:

In Europe, France is the country number one for the consumption of sleeping pills (3 or 5 times more important than other countries). This assessment is even higher and unmarked for elderly. Indeed, one third of people of more than 65 years old (3.5 millions of people) and 40% of 85 years old and more use sleeping pills regularly. Furthermore, benzodiazepines (anxiolytic, hypnotic) for sleeplessness are usually used during a long period (7 months on average) while the maximum medical advice duration is 30 days. However, half of these treatments are inappropriate, elderly rarely suffer from sleeplessness: in more than 80% of cases, sleep troubles for elderly are usually an alert sign for other pathologies (night-time pain, sleep apnea, periodical leg movement, urinary problem, depression...).

Elderly are more exposed to sleep pills risks for many reasons: less physical resistance, slower metabolism, interactions with other drugs...Taking sleep pills is generally in their disadvantage as these drugs have several unwanted effects more or less serious and source of hospitalization: falls, cognitive or behavior troubles, loss of autonomy.... Combined with other drugs, sleep pills are often the origin of medicinal iatrogenic effects avoidable.

The sleeplessness seems difficult to diagnose and is essentially detected by a clinical evaluation: detailed interview concerning the feeling of the person, its psychological condition and its environment and an historical study of the sleep. Finding the origins and reasons of sleep trouble is usually realized with a sleep agenda or questionnaire, or more invasive devices like EEG (Electroencephalography) and ECG (Electrocardiography). More than the diagnosis, the monitoring of the sleep and medicinal advices seems to be a major issue.

In this context, the main objective of this PhD is the development of a simple and non invasive wireless electronic device, for the sleep monitoring. The population is focused on the elderly complaining of sleeping trouble or requiring a new evaluation of a hypnotic treatment. The aim is not to analyze precisely the different phases of sleep (wakefulness, slow sleep, rapid eye movement) but to answer the question “Is the person sleeping? (yes/no)” and “what is the quality of the sleep?” This device would allow:

- To give objective information and observations concerning the trouble to the doctor;
- To ensure the monitoring of the advices;
- To inform the person suffering from sleep trouble;
- To realize motivational coaching.

N2IS team of LAAS laboratory has a recognized experience in the design and development of human monitoring systems (modeling of behavior and detection of deviations compared to a “usual” behavior. Whatever the sensor (infrared detector, camera, accelerometer...), it has to be as unnoticeable as possible for the person that induces demand with regards to autonomy, miniaturization, communication and energy management. The purpose of previous projects consisted in the detection of behavioral slide (PROSAFE, HOMECARE...) or to prevent/detect frailty appearance (fall) for the elderly (SACHA, HOMECARE, FOOT-TEST). Microsystems used in these projects focus on measurements of parameters, communication and information processing.

Relying on these previous works, the candidate will have to propose solutions to this problematic of sleep monitoring and information delivery, with regards to non intrusively and acceptability. The choice of sensors and wireless technology will be realize after a specification phase which will also concerns the formulation of operating mode used to evaluate reliability and to validate uses: accelerometer, gyrometer, microphone...

1 consequence of medical treatment or advice to a patient
A modeling-integration-validation approach will be realized in collaboration with doctors and manufacturers:

- First, the candidate will realize a state of the art of the related works on the sleep monitoring in order to identify possible approaches (body movement, eye movement, sound, and heart frequency, breathing frequency…) and to study the integration and miniaturization of a hardware solution.
- Works will be based on the progress of N2IS projects (conception of miniaturized patch for access control, geolocalization and fall detection for Alzheimer patients). During this second step, the candidate will propose and develop suited devices and architecture to survey people suffering from sleep troubles.
- The solution will have to transmit data to the outside. The communication and data mining will be the aim of a third step based on SACHA and HOME CARE projects.
- Finally, a validation step will be realized after technical developments. Besides the technical aspects of the validation, evaluation process in living lab environment (ADREAM and Smart home of Blagnac) and in real environment would have to be considered in order to guarantee reliability and acceptability in natural conditions.

The Gérontopôle laboratory and the sleep unit of Toulouse Hospital will be directly involved in this work respectively for the writing of medical research protocol and the implementation of clinical tests with frail people, but also the recruitment of insomniac young people for sensors selection step (in comparison with the gold standard : holster EEG).

References of publications:


Integration of wearable device with actimetry system for monitoring alzheimer's patients. Bourennane W., Charlon Y., Chan M., Estève D., Campo E. International Conference on Wearable Micro and Nano Technologies for Personalised Health (pHealth 2011), Lyon (France), 2011.
