COMPUTER AND CONTROL ENGINEERING

DAUIN - Evaluating work-induced stress and cognitive decline using wearables and AI algorithms

Funded By	Dipartimento DAUIN

Supervisor	OLMO GABRIELLA - gabriella.olmo@polito.it

Contact	OLMO GABRIELLA - gabriella.olmo@polito.it DI CARLO STEFANO - stefano.dicarlo@polito.it

Context of the research activity	The level of emotional activation is recognized to affect both a person's work performance and his/her safety at work, as well as general health. On the other hand, the work environment is one of the major sources of dysfunctional stress. This proposal refers to the development and implementation of a protocol for objective quantification of work-related stress conditions, and to the identification of possible correlation with the decline in cognitive abilities caused by work-related stress.

	The primary objective of this proposal is to design and implement a prototypal BAN (Body Area Network) made of low-cost, low-impact commercial wearables, to evaluate working-related distress and its correlation with cognitive decline. Specific objectives consist in the implementation of Artificial Intelligence (AI) algorithms working on heterogeneous and multidimensional health data, with attention to interpretability and generalizability of the results. It will be possible to validate the prototype against gold standard instrumentation available at PolitoBIOMedLab, and to discuss the clinical implications of the results, increasing the clinical and psychological knowledge on the correlation between stress and cognitive decline. To this end, a clinical trial is being set-up in collaboration with the Department of Neuroscience "Rita Levi Montalcini" of the University of Turin and the Molinette Hospital ? Neurology Department, and under an INAIL grant devoted to occupational health and safety (www.insic.it/sicurezza-sul-lavoro/bando-bric-cose-come-funziona-e-tutti-gli-aggiornamenti/). It consists of identifying a study population, implementing appropriate inclusion and exclusion criteria (absence of conditions that may alter the results such as serious pathologies or particularly negative socio-economic conditions), enrolling voluntary participants from Politecnico and Molinette Hospital, evaluating their general and cognitive state via a general visit, cognitive tests administering such as MOCA or MMSE, quality of sleep and mood questionnaires. Participants will also compile questionaries for self-assessing stress conditions. Then, subjects will be convened in the PolitoBIOMedLab premises and tested

Objectives	using the developed prototype and gold standard instrumentation in a simulated working environment. They will be asked to perform tasks (e.g., writing a text, answering questions, compiling an Excel data sheet, memorizing sequences), first in relaxing conditions to create a baseline; then, environmental stress will be simulated according to the European Commission - Directorate-General for Employment and Social Affairs guidelines: unpleasant working conditions in terms of lightning, temperature, noise, interruptions, inadequate time, messy instructions. Stress quantification will be performed and compared with subjective scales. Cognitive fatigue will be measured (e.g., number of errors, time employed to carry out the tasks) and put in correlation with environmental conditions and stress measures. A second phase will encompass tests on clinical personnel of the Molinette Hospital while performing normal inpatient activities and wearing the BAN. The work is divided into different phases (tentative). First year. Literature review on the objective assessment of working related stress and its correlation with cognitive decline. Identification of the elements that will be part of the prototype. These will likely encompass one or more ECG channels, blood pressure, respiratory rate, galvanic skin response. Sleep quality may be correlated with heart rate variation and/or with 1 or few EEG/EMG electrodes and amount of movement (IMU). Analysis of available commercial devices enabling direct access to raw data, e.g.: chest straps for ECG detection, Empatica EmbracePlus, (www.empatica.com/en-eu/), smartwatches (www.garmin.com/it-IT/c/sports-fitness/activity-fitness-trackers/), wearable EEG (www.emotiv.com/blogs/glossary/eeg-headset), inertial sensors (IMU) (shimmersensing.com/product/shimmer3-imu-unit). Selection of devices, their synchronization, management of the data repository using the REDCap protocol for the integrated collection and management of clinical data and signals. Set up and implementation of the protocol at the PolitoBIOMedLab, including available gold-standard instrumentation such as near-infrared spectroscopy (NIRO-NX200, Hamamatsu Photoniks K.K.) to monitor cerebral metabolic activity, eye tracking device (eye tracking EyeLink 1000 Plus) to elements focusing the person's attention, electromyographic tracking (?WavePlus? COMETA and ?Trigno Research System? DELSYS), possibly integrable with stereophotogrammetric motion capture (VICON Nexus). Implementation of the first version of AI/ML algorithms aimed at dynamically quantifying the level of stress and its correlation with cognitive decline. First validation and testing on public datasets (e.g. PhysioNet resources). Second and third years. Data collection on healthy volunteers and comparison with gold-standard instrumentation available at PolitoBIOMedLab. Processing of data and correlation with perceived and clinical levels of cognitive deterioration. Possible fine-tuning of the algorithms. Second trial phase on clinical personnel recruited at the Molinette Hospital. Making the results obtained available and discussing them with clinicians and neuropsychologists to assess the correlation of the results with the cognitive tests.
Skills and competencies for the	Expertise in the fields of Signal Processing, Data Analysis, Statistics and Machine Learning (e.g. feature selection and ranking, supervised and unsupervised learning). Basic knowledge of bio-signal data processing (EEG, ECG, EMG, EOG). Good knowledge of C, Python, Matlab, Simulink

development of the activity	programming languages. - Good relational abilities and knowledge of the Italian language, to effectively manage interactions with participants during the evaluation trials.