

## **Title:** Empowering Cognitive Stimulation Therapy with Socially Assistive Robotics and Emotion Recognition

**Abstract:** Motivated by the benefits offered by Socially Assistive Robotics (SAR) in mental health service and research, we envision that SAR can also benefit cognitive rehabilitation of individuals struggling with a wide range of mental health concerns. In this thesis, we investigated the benefits of robot assisted cognitive rehabilitation for individuals with intellectual developmental disorders (IDD). In the first part, we evaluated the fitness of robot assisted interventions for cognitive rehabilitation of individuals with IDD. The results reported positive effects of robot interventions on the users, mainly an increase in the engagement. We further evaluated the impact of robot-assisted mental health interventions on the caregivers in multi-center trials. The results of the research confirmed a significant reduction in the caregivers burden during execution of cognitive stimulation interventions for individuals with IDD and raised a concern about the need of a specific training of the caregivers to take maximum advantage of SAR in health care. The second part concerns itself with automated and online emotion recognition. We conducted a series of cognitive stimulation sessions among individuals with IDD in nearly real world settings to obtain a first ever annotated multimodal dataset (MuDERI) of individuals with IDD. We further proposed an efficient wavelet-based method for artifacts attenuation of Electro-dermal activity (EDA) signal during the online collection and analysis, while minimizing distortions, using a stationary wavelet transform (SWT). The proposed method was tested on EDA recordings from publicly available driver dataset collected during real-world driving, and containing a high number of motion artifacts, and the results were compared to those of three state-of-the-art methods for EDA signal filtering. The results evidenced that the prediction of arousal states can be significantly improved after motion artifacts removal, and that the proposed method outperforms existing approaches and it has a lower computational cost. Taken together, these results evidence the effectiveness of the proposed method for online EDA filtering in real world scenarios. Further, we reviewed feature extraction methods for emotion recognition from EDA based on 25 studies. We compared these features for feature selection using machine learning techniques on a publicly available AMIGOS dataset. Mel-frequency cepstral coefficients (MFCC) and related statistical features were explored for the first time for the emotion recognition from EDA signals and they outperformed all other feature types, including the most commonly used Skin Conductance Response (SCR) related features. We also compared our results with methods employed by researchers of AMIGOS dataset for classification of emotional states and they show that the EDA features explored in this study provided better performance, validating our findings. By developing robot-assisted cognitive rehabilitation interaction and including real-time emotion recognition, I have expanded the scope of SAR in mental health scenarios in which adaptive robot interaction can be integrated. I have further motivated future research that can be benefited by the rich modality of the human emotions expressed in the pure unaltered form of physiological signals, to the advancement of socially and emotionally intelligent interactions.

**Bio:** Dr. Jainendra Shukla completed his Ph.D. from Universitat Rovira i Virgili (URV), Spain in 2018 and his doctoral thesis was “Empowering Cognitive Stimulation Therapy with Socially Assistive Robotics and Emotion Recognition”. He was awarded excellent grades with Industrial Doctorate Distinction and International Doctorate Distinction by URV, Spain. He is the recipient of the prestigious industrial doctorate research grant by AGAUR, Government of Spain. Earlier, he obtained his M.Tech. degree in Robotics from Indian Institution of Information Technology, Allahabad (IIITA) in 2012 and B.E. degree in Information Technology from University of Mumbai in First Class with Distinction in 2009. He is enthusiastic about empowering machines with adaptive interaction ability that can improve quality of life in health and social care. His research interest lies in the intersection of Human-Robot Interaction, Machine Learning and Psychology.