Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

SIRe Project Number

2022-01-07

(will be assigned by SIRe)

PhD Project

Project Details	
Project Title	Assistive Technologies for Neuro-rehabilitation
Project Summary	**Project Summary**: Stroke, a neurovascular disorder, has been identified as a global medical emergency and the third leading cause of death and loss of motor function worldwide. The number of deaths due to stroke was reported to be 5.87 million in the Statistics of the Global Burden of Diseases (GBD) study in 2010, which is predicted to increase further because of the increase in the ageing population. In addition, the prevalence of stroke especially in low- and middle-income countries is very high, thus creating a challenge to the present health-care system. In India alone, the incidence of stoke ranges from 108-172 / 100,000 population per year. Post-stroke outcomes such as functional impairment associated with motor and cognition, are observed among patients (~66%) which hinder them from actively performing the Activities of Daily Life (ADL). As per the report of WHO, approximately 5 million stroke-survivors are left permanently disabled. Almost 80% of the survivors experience a declined quality of life due to physical, emotional, social limitations associated with it. If not rehabilitated, spasticity and pain resulting from stoke may deteriorate the muscle movements and ability. Although traditional physiotherapy is suggested to re-learn the lost functionalities, its efficiency is limited on account of the associated high clinical burden, requirement of experienced physiotherapists, high cost and lack of quantitative assessment tools. Therefore, neuro-rehabilitation robots and Virtual Reality (VR) assisted rehabilitation have emerged as safe, customizable and patient-centric approaches in clinical practice. Robotic devices are now increasingly being used for rehabilitation purpose. A few of the available devices targeted for proximal joints are e.g., MIT-MANUS, GENTLE, MIME, CADEN-7, UL-EXO7, INMOTION robot, ARMin, etc. These devices are either inherently large, complex, stationed in a facility, require trained staff to operate, or are highly expensive and compel patients to visit the hospital every day. Though there are available robotic devices for distal joint rehabilitation such as RAPAEL Smart Glove, Amadeo and Hand Mentor, very few of them facilitate synchronized hand and wrist motions. Our team has developed a novel robotic exoskeleton prototype for distal upper extremity rehabilitation of sub-acute and chronic patient population and it was optimized after multiple iterations and clinical trial. The device is light-weight, easy to wear and operate, active precision repetition time, performance feedback and showed potential in low-resource settings. The introduction of simulated gaming environments and appropriate performance-derived feedback (visual, auditory, and haptic) through VR technology enhances user motivation, thereby encouraging higher repetitions and exercise adherence. VR tasks have been successfully integrated with external wearable hand gloves such as CyberGlove, RAPAEL smart glove, and gaming consoles such as Microsoft Kinect, Nintendo Wii and Sony PlayStation. However, such commercial gaming consoles are not specifically customized for rehabilitation purposes. In addition, very few studies emphasized on targeted rehabilitation of distal upper extremities. Considering the critical role of distal joints in ADL and the intensive practice required for these joints to overcome functional loss, targeted distal joint rehabilitation is the need of the present. In India, very limited research has been devoted for using such technology in rehabilitation**.** Our team is developing novel VR tasks for assessment of patients' performance can be objective and quantified through task-related metrics, benefitting both the therapist and the patients, which traditional rehabilitation lacks. The task performance metrics could be monitored for the purpose of clinical evaluation, appropriate modifications of VR tasks, tailoring task difficulty levels as per individual requirement, and can further monitor the response to intervention. The

	performance metrics of healthy subjects for distal joints was used as a reference to compare and differentiate it with the performance of patients with stroke in clinical settings. The subjective feedback and the learnings obtained from the healthy subjects and patients could be helpful in establishing the protocol and rehabilitation framework dedicated to patients with stroke. The aim of this proposal would be to design innovative solutions for neuro-rehabilitation after immersion program with the clinical partner. The goal of this project is to design novel neuro-rehabilitation solutions such as assistive technology device for upper-limb, especially focusing on distal joints. After prototype development during the course of Ph.D., the product/solution is to be pilot-tested for further optimization with feedback from clinicians and patients. After optimization, the product/solution will be clinically evaluated with clinical partner with a large cohort of stroke patients for evaluating its usability and clinical efficacy. **Need for Interdisciplinary Research:** Rehabilitation research is a complex and dynamic approach aiming to provide optimal functionality and independence to stroke survivors. Traditional physiotherapy requires experienced physiotherapists to be present throughout the training sessions. The efforts from peoples of various disciplines such as Doctors, Clinicians, Physiotherapists and Engineering disciplines such as Mechatronics, software, Biomedical and Design play a crucial role for such research. The research work involves clinicians, physiotherapists and Engineers who have experience in the area of stroke rehabilitation to be able to monitor and evaluate the appropriate health status of patients. However, in a developing country like India, there is a high clinical burden because of huge population. The efforts of engineers are needed to assist them in developing tools and interventions, designing and having feedback from patients and further optimizing the neuro-rehabilitation robots with rehabilitation strategy and conducting clinical trials on the patients to evaluate the clinical effectiveness of the developed devices. The experience and feedback from the clinicians and physiotherapists hold importance in each of these stages for proper customization and suitability of the developed tools with a wider patient population. Therefore, a collaborative and interdisciplinary approach bringing clinicians and engineers under one roof will help in comprehensive understanding of the research problem and conduct longitudinal stroke recovery research. This research will involve Engineers from various disciplines under the supervision of Neurologists, physiotherapists, and Biomedical Engineers.

PhD Supervisors			
Role	**Faculty**	**Academic Unit in IITD**	**Email ID**
Supervisor 1	Prof. Amit Mehndiratta	Centre for Biomedical Engineering	amehndiratta@cbme.iitd.ac.in
Supervisor 2	Prof. Dr. M.V. Padma Srivastava	Department of Neurology, AIIMS, New Delhi	vasanthapadma123@gmail.com

Project requirements (Student qualifications, experience required, etc)

- **Mandatory** – BTech (Electrical or Electronics or Instrumentation or Mechatronics or Computer Science or Biomedical Engineering)
- **Mandatory** – Experience in research project, hardware development, circuit designing, Mechatronics, Good scientific writing skills
- **Optional** – MTech (Electrical or Electronics or Instrumentation or Mechatronics or Biomedical Engineering)

Source of funding (IRD/FITT Project details, if any)

- No Funding,
- Only part-time student or students with secured fellowship from other agency may apply for this project

Role of Faculty Members involved:

PI from IIT, Delhi:

Prof. Dr. Amit Mehndiratta is currently working as an Associate Professor at Centre for Biomedical Engineering, Indian Institute of Technology, Delhi. His areas of interest include Biomedical imaging, Image processing, Physiological modeling and Quantitative image analysis, Image guided intervention, Mobile assisted healthcare (m-Health), Machine learning and actively working on neuro-assistive technologies for rehabilitation of patients with stroke. In 2021, he has established a "Center for Advanced Research and Excellence in Disability & Assistive Technology (CARE-DAT)", a joint venture Centre of Excellence (CoE), among IIT Delhi and AIIMS, New Delhi, under the aegis of the Indian Council of Medical Research (ICMR). With his guidance and support, the engineering team will work in development of innovative, cost-affordable and efficient research products to assist the clinicians in rehabilitation program.

PI from AIIMS, Delhi:

Prof. Dr. M.V. Padma Srivastava is currently working as Head of Department of Neurology, and Chief Neurosciences, Centre of All India Institute of Medical Sciences, New Delhi, India. Her Primary area of interest is in Stroke, Vascular Dementia and Multiple Sclerosis. With her clinical support and out-patient facility at AIIMS, the patients with stroke can be clinically assessed and recruited for enrolment in research intervention and clinical trials. The feedback from the physiotherapists and the patients will provide more insights into formulation of research design and development of proper devices to help the patients achieve functional independence.