Executive Summary

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1. Title of the Project: Intelligent Wearable Hand Exoskeleton for Robotic Neurorehabilitation

2. Date of Start of the Project: October 1, 2022.

3. Aims and Objectives:

Aim: Incorporate advances in AI and robotics combined with insights into neuroscience for development of a wearable hand exoskeleton for effective neurorehabilitation.

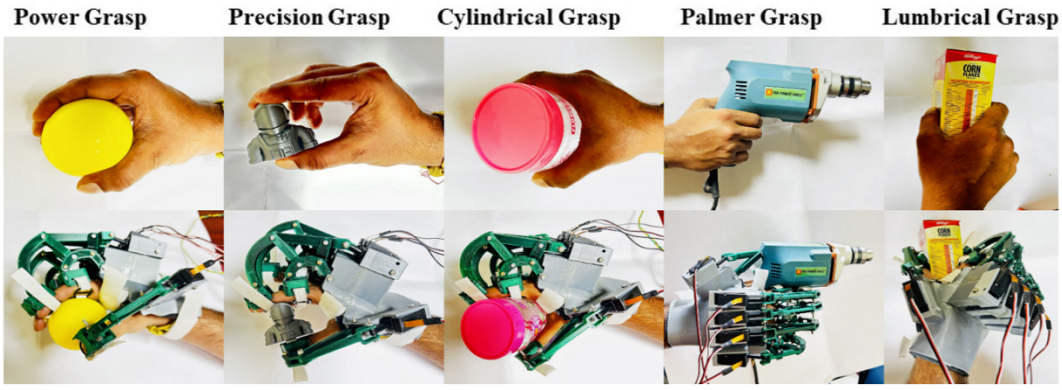
Objectives:

1. *Optimized Design of a Wearable Hand Exoskeleton* for neurorehabilitation.
2. Integrate a human-machine interface[1] for *Real-Time Control of the Intelligent Wearable Hand Exoskeleton.*
3. Exploit coupling between *EEG and EMG for Adaptive Control of Hand Exoskeleton.*
4. Critically assess *Cognitively Enhanced Intelligent Wearable Hand Exoskeleton and Reinforcement Learning for Effecting 'Assistance-As-Required'.*

4. Significant achievements (not more than 500 words to include List of patents, publications, prototype, deployment etc)

An intelligent five-fingered hand exoskeleton is being developed. The design of the BRAIL hand exoskeleton involved the use of an underactuated, linkage-based mechanism. The five-fingered BRAIL Hand Exoskeleton Prototype 1.0 is 3D printed. PLA is chosen to ensure durability and minimize the overall weight of the exoskeleton. Mechanical characterization involved analyzing the physical and mechanical properties

of the hand exoskeleton in order to evaluate its performance and safety. Functional characterization involved analyzing performance and effectiveness of the device in achieving its intended function, i.e., enhancing mobility, strength, or dexterity in the user. The performance metric proposed by Popov et. al was used for evaluating the wearability score the BRAIL Hand Exoskeleton 1.0. Six parameters of the exoskeleton, namely the overall weight of the system, weight of only the wearable part, pinch force, fingers being assisted, free wrist and bidirectionality were used. Based on that, the score is compared with the existing hand exoskeletons. The score obtained by our proposed BRAIL hand exoskeleton is 83.3%; comparable to the performance of existing hand exoskeletons. Fig below shows the hand exoskeleton in operation; able to perform Power, Precision, Cylindrical, Palmer and Lumbrical grasps.



5. Concluding remarks

Work is in progress for EEG-EMG Adaptive Control of the above hand exoskeleton exploiting *muscle-synergy* for providing assistance-as-needed.