Executive Summary

PHOTOGRAPH

(please send High resolution JPEG file as a separate attachment through email)

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1. **Title of the Project:** Robotic Exoskeleton and Augmented Reality Virtual Reality Technologies in Rehabilitation for upper limb disability
2. **Date of Start of the Project:** 1 October 2022 (Ref: INAE/121/AKF/38)

3. Aims and Objectives:

1. To design and develop a device for Augmented Reality Virtual Reality (ARVR) platform for rehabilitation of distal upper extremities in patients with stroke for home-based settings
   - Design and optimize the patient-specific joystick device for wrist and fingers according to the movements used in activities of daily living (ADL)
   - Optimize the ARVR tasks according to ADL
   - Optimization of these developed ARVR tasks based on spasticity score for a specific group of patients to assess the variability of the clinical effect of ARVR
   - Aesthetics and the portability of the device will be improved
2. An android app will be designed for remote monitoring of patients' rehabilitation at home-based settings
3. A randomized clinical-trial to evaluate the therapeutic impact of designed VR platform and compare it with standard physiotherapy control.
   - Clinical data acquisition on patients with stroke (n=60) and subjective and objective outcome measures.
   - Evaluation of its clinical impact by comparing pre- and post- outcome measures.

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

Patents:

1. Provisional Indian Patent, "A Bio-signal guided System for Rehabilitation of Patents with Disability", Indian Application no. 202311077660 dated 15 November 2023".

International Journal Publications: 1 (1 In review)

1.) Nath, D.; Singh, N.; Saini, M.; Banduni, O., Kumar, N., Padma Srivastava, M.V., **Mehndiratta, A.;** (2023). Clinical potential and neuroplastic effect of targeted virtual reality-based intervention for distal upper limb in post-stroke rehabilitation: a pilot observational study. *Disability and Rehabilitation*. doi:10.1080/09638288.2023.2228690. **Impact Factor: 2.439**

2.) Nath, D.; Singh, N.; Saini, M.; Banduni, O.; Kumar, N.; Srivastava, MV.P.; **Mehndiratta, A**. Distal Upper Limb Targeted Therapy with Non-Immersive Virtual-Reality Based Tasks in Post-Stroke Rehabilitation: A Pilot Clinical Study. Virtual Reality (***In Review*****)**

International Conference Proceedings: 2

3.) Nath, D.; Singh, N.; Banduni, O; Kumar, N.; Vishnu, V.Y.; Srivastava, M.V.P.; **Mehndiratta, *A*** *Clinical Potential of Virtual Reality Based Task for Post-stroke Neurorehabilitation of Distal Upper Extremities: A Pilot Study*. **Accepted** in 13th World Congress for Neurorehabilitation (WCNR), May 2024

4.) Nath, D.; Singh, N.; Saini, M.; Banduni, O; Parial, A.; Kumar, N.; Vishnu, V.Y.; Srivastava, M.V.P.; **Mehndiratta, *A*** *Non-immersive Virtual Reality Based Training in Inducing Neuroplastic Effect for Distal Upper Limb Rehabilitation*. **Accepted** in 16th World Congress of International Neuromodulation Society (INS), May 2024.

Prototype Development:

Fig. Experiment to calculate the force exerted by different springs during the joystick movements. The tensile force was measured using a digital force meter. The mapped joystick movements were checked using an online gamepad tester and at the maximum range of motion, the exerted force is recorded

5. Concluding remarks

- Design modifications were made in a commercially available joystick leading to development of an alpha version of our solution. Novel ARVR module were developed inhouse for upper limb rehabilitation and it were evaluated in a cohort of stroke patients (n=18). Patient feedback is being gathered with the support of one neurologist and two physiotherapists at Department of Neurology, AIIMS New Delhi.
- A variable resistance mechanical improvisation were further performed in beta version of the joystick. It has been bench tested for force measurements and feedback from healthy subjects.
- The prototype design for the novel force sensitive joystick (gamma version) is under development. It will be bench tested in next few months in the third year of this project, initial patient testing and feedback will be performed by the mid next year. The design finalization is expected by the end of third year (Sep 2025).
- The ARVR joystick for patients with different spasticity is being tailored to individual needs. This approach will be generalized for a larger patient cohort in the upcoming clinical study.
- Feedback from stakeholders, including a neurologist (n=1), physiotherapists (n=2), healthy subjects (n=3), and stroke patients (n=11), has been collected at multiple stages of the development process.