ROBOTIC REHABILITATION FOR PARALYZED ARM

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Keywords:

Robotics, Rehabilitation, Paralysis, Neuroplasticity, CIMT, Exoskeleton, Fugl-Meyer Assessment, Upper-extremities

Introduction:

Stroke is the leading cause of death and a major source of long-term impairment. It affects around 15 million people worldwide annually, with 5 million dying and 5 million becoming disabled. This imposes a strain on family caregivers and increases healthcare system utilization, with functional decline a frequent effect. The majority of post-stroke functional decline is caused by impairments in arm function or upper limb disability, which affects 80% of post-stroke patients. Upper limb deficiencies include muscle weakness, difficulty moving the arms, particularly the hand and fingers or elbow and shoulders, and diminished sensation, leaving survivors unable to function or engage in physical activities. Recent studies have reported the effectiveness of robotic rehabilitation for stroke patients. Paralysis and stroke-affected people are unable to move their upper and lower limbs. They need to get regular exercise. The shortage of physiotherapists and caretakers for physically disabled paralysis-affected patients is increasing day by day and become a serious problem shortly. At present there are more than 95,00,000 paralysis patients in India. But there are only near 30,000 physiotherapy doctors in India. As in the ratio 300:1 (1 doctor for every 300 patients). It is so difficult to give daily exercise to 300 patients by one physiotherapist. Hence, the rate of patient population in need of physical exercise of their paralyzed body parts is also constantly increasing.

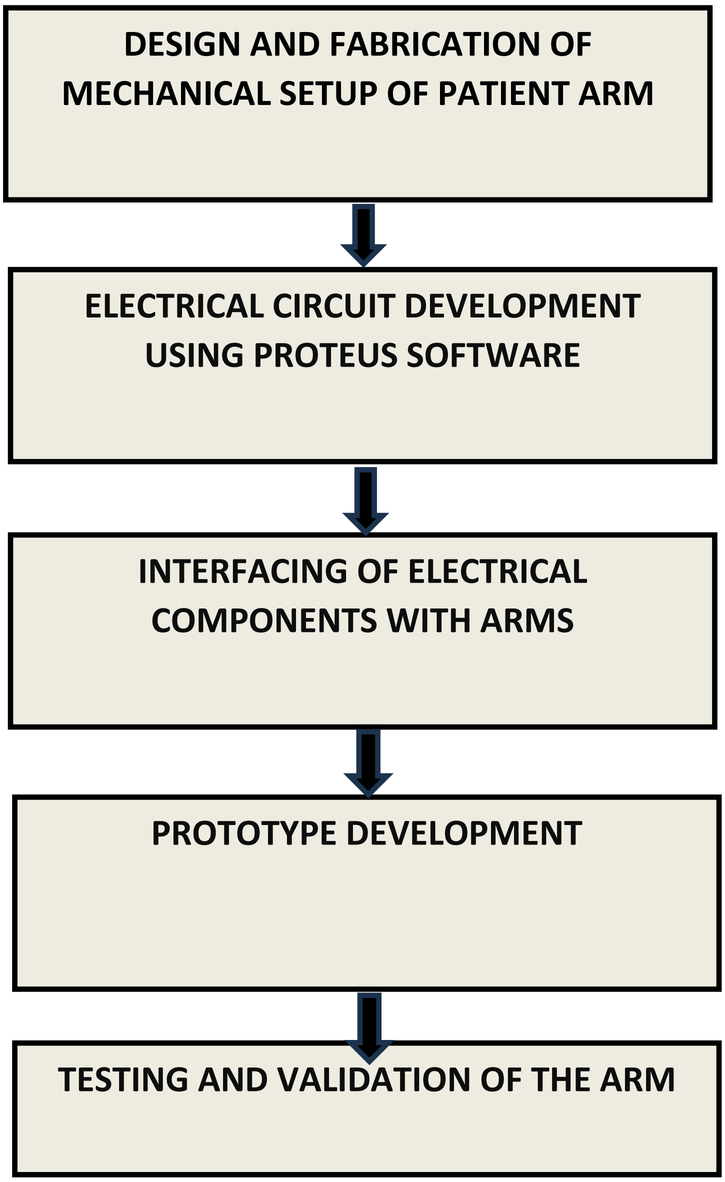
Rehabilitation is a vast science that require more time to be invested. The current robotic arm models are the systems that make patient perform the exercises. Our system strives to provide a therapy-based solution, that supplements the physiotherapists by covering the initial stage of rehabilitation of performing exercises with robotics assistance. The proposed system considers the therapy named CIMT, which ensures neuroplasticity, that helps the patient recover faster.

Objectives:

- To help the paralyzed patients regain arm function with Robotics Assistance
- To utilize the fundamental attributes of Robotic devices of performing a high number of repetitive movements for impaired upper limb rehabilitation.
- To implement the therapy of rehabilitative science called CIMT using the designed setup
- Reducing the physical demands on the therapists and allowing them to focus on other aspects of patient care.

Methodology:

a) Block diagram:



b) Flow diagram:

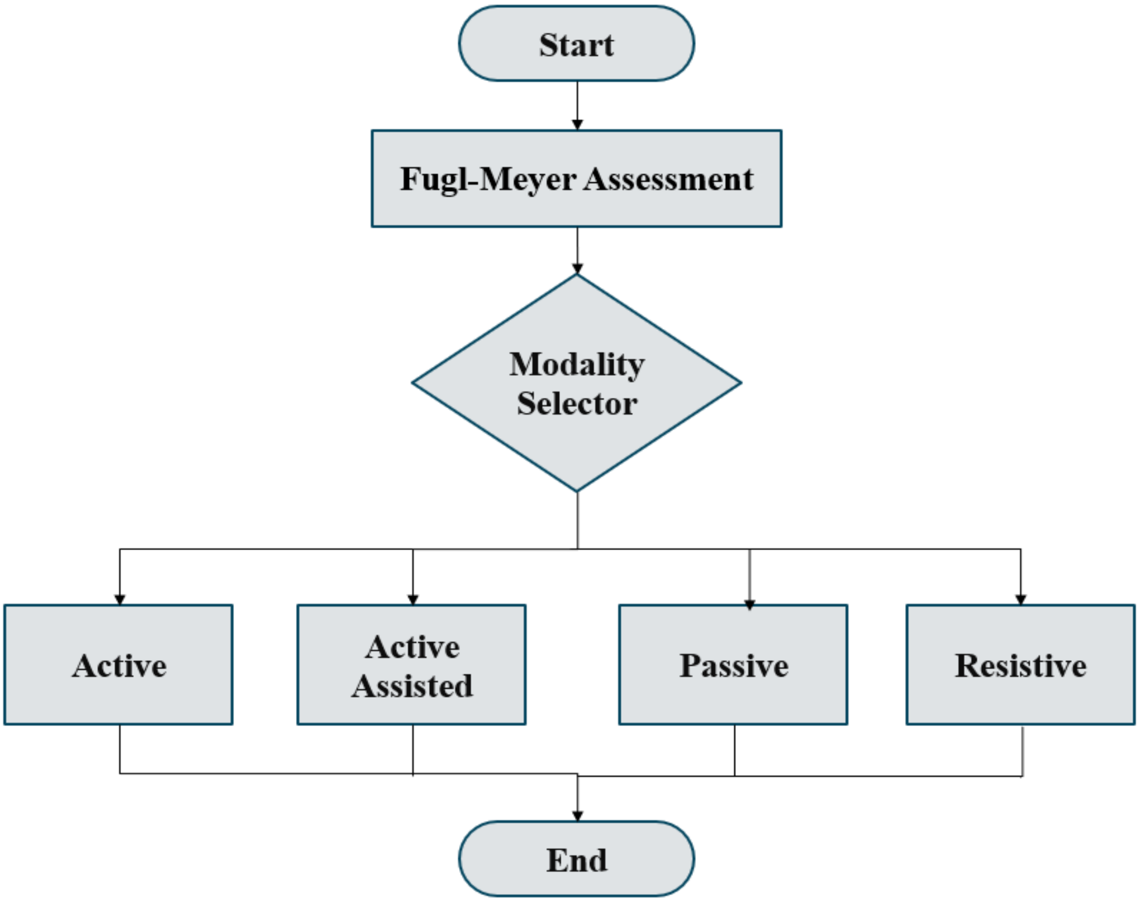


Fig. 2 Flow Diagram

About Fugl Meyer Assessment

The Fugl-Meyer Assessment (FMA) is a stroke-specific, performance-based impairment index. The Fugl-Meyer Assessment is the gold standard to assess motor function of post-stroke hemiparesis. The Fugl-Meyer Assessment for Upper Extremity (FMA-UE) has sound psychometric properties of reliability, validity and responsiveness.

Modality:
1. Active
The robot is being used as a measurement device, without providing force to subject's limb.
2. Passive
Robot performs the movement without any account of subject's activity.
3. Active- assistive
Assistance towards task completion is supplied only when the subject has not been able to perform actively. At this stage, the subject experiences passive movement of the limb.

Therapy involved

Existing image

- CIMT: Constraint Induced Movement Therapy

Constraint-Induced Movement Therapy (CIMT), also known as CI, is a "rehabilitative strategy". It is aimed at improving the functional use of an affected extremity for those who are impacted by stroke or other neurological conditions. It uses principles of mass practice while restraining the neurologically stronger limb. It has also been defined as a behavioural approach to neurorehabilitation, making use of simple behavioural techniques - shaping being a predominant theme.

The focus of CIMT is to combine restraint of the unaffected limb and intensive use of the affected limb. As a result of the patient engaging in repetitive exercises with the affected limb, the brain grows new neural pathways. This change in the brain is referred to as cortical reorganization or neuroplasticity.

Conclusion:

Hand dimensions were considered by performing the statistical survey of people. Taking into account the considerations of hand dimensions, our team has successfully designed an exoskeleton for paralyzed arm and the design is 3d printed with the specific material. The desired material chosen for our setup is PLA and TPU. Finger modules are 3d printed with TPU. The 3d setup of upper and forearm is printed using PLA. Electronic circuits are integrated with the printed 3d setup and implemented.

The whole setup is operated for different ranges of motion, by considering the score of Fugl-Meyer Assessment where the setup performed number of exercises in a repetitive manner

Scope for future work:

In the future, some improvements are to be made on the proposed hand exoskeleton prototype from both the mechanical design and the control. In the future, some improvements are to be made on the proposed hand exoskeleton prototype from both the mechanical design and the control. The development of robotic technology, coupled with advancements in clinical rehabilitation medicine, presents a significant opportunity for the global research and development of rehabilitation robots. This synergy has led to the emergence of innovative rehabilitation robots, integrating cutting-edge robotic technology with rehabilitation engineering. This fusion exemplifies the ideal combination of rehabilitation medicine and robotic technology, paving the way for enhanced therapeutic outcomes worldwide.

Advancements in neuroplasticity research could lead to more effective use of brain-computer interfaces (BCIs) in exoskeletons