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Robotic Rehabilitation for Paralyzed Arm

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Abstract: *This paper involves the design and implementation of a wearable 3D printed robotic hand controlled by motion of human hand. In the recent trend in technology, the demand and number of studies in Robotics field has been increased. In the literature there are number of studies on Robotics systems in various fields to facilitate the human life.*

Keywords: Robotics, Rehabilitation, Paralysis, Neuroplasticity, CIMT, Exoskeleton, Upper-extremities

I. INTRODUCTION

Stroke is identified as the long term impairment which is affecting considerably people worldwide. Statistics go around 15 million for stroke-affected, death of 5 million and 5 million people with disability. Because it affects the functionality of the body, it impacts the family. Paralysis is the immediate effect of stroke. It can be seen as the inability to perform routine tasks because of muscle weakness. It includes difficulty moving the arm and parts of the arm such as hand, fingers, elbow or shoulders, lessened sensation and many more. The rehabilitation for this is usually a set of exercises performed repetitively with a known degree of intensity for different levels of stroke.

But there is no match between the number of stroke patients in need of rehabilitation and the number of physiotherapists available for rehabilitation. The ratio goes roughly to 300:1 which means for 300 patients there is one physiotherapist available. This creates a difficulty as treating 300 patients simultaneously by one physiotherapist is practically impossible.

One of the interventions that proved to be efficient in rehabilitation of upper extremities is robotics. If robotics assistance can supplement the physiotherapist in treating more patients at a time, it is possible for him to concentrate on the other aspects of patient care as well.

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.

II. 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.

III. LITERATURE SURVEY

1. N. Muralidharan, C. Maheswari, S. V. Kumar, B. Lokesh, T. Manivannan, International Journal of Scientific and Technology Research on "Physiotherapy Robotic Arm", Vol. 9, pp no. 3988-3991, January 2020.
   Summary: This International Journal Paper, proposes a robotic arm that supports physiotherapists, by automating the exercises thereby improving performance of upper limbs.
2. AnupMisra, Arvin Agah, Paper on "Design of A Robotic Exoskeleton Arm for Rehabilitation", Information and Telecommunication Technology center, The University of Kansas, Lawrence.

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Summary: This Research Paper, not only implements an ideal physical therapy tool, but also indicates the recovery level of impaired upper extremities.

3. Tommaso Proietti, Emilia Ambrosini, Alessandra Pedrocchi, SilvestroMicera, IEEE Journal Paper on "Wearable Robotics for Impaired Upper-Limb Assistance and Rehabilitation: State of the Art and Future Perspectives", Vol. 10, pp no.106117-106134, September 2022.
   Summary: This IEEE Journal Paper, discusses the state of art, different technologies and compares the clinical outcomes to determine the potential directions.
4. Long Cheng, Miao Chen, Zhengwei Li, IEEE Journal Paper on "Design and Control of a Wearable Hand Rehabilitation Robot", Vol. 6, pp no. 74039-74050, December 2018.
   Summary:This IEEE Journal Paper, contributes the idea on robots modularized structure design and the proposed ILC controller.
5. Villafañe JH, Taveggia G, Galeri S, Bissolotti L, Mullè C, Imperio G, Valdes K, Borboni A, Negrini S, Journal Paper on "Efficacy of Short-Term Robot-Assisted Rehabilitation in Patients With Hand Paralysis After Stroke: A Randomized Clinical Trial", Hand (N Y), January 2018.
   Summary: This Journal Paper, discusses in the treatment of pain and spasticity in hand paralysis after stroke, robot-assisted mobilization performed in conjunction with traditional PT and OT which is as effective as traditional rehabilitation.

IV. CONCLUSION

A robotic hand needs to be designed and implemented along with testing for the motion of human hand. The master glove circuit will consists of the flex sensors and the robotic hand circuit being actuated by the servo motors with Arduino Uno as the processing unit. Hence, carrying out the exercises based on the neuroplasticity it is possible for upper extremities to regain the primary function in carrying out routine activities.

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