

**Project ID :**

**25-26J-027**

1. Topic (12 words max)

**IOT base System for Paralyzed Hand Control**

2. Research group the project belongs to

**AIMS - Autonomous Intelligent Machines and Systems**

3. Specialization of the project belongs to

**Computer Systems and Network Engineering(CSNE)**

4. If a continuation of a previous project:

Project ID	
Year	

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

Hand paralysis arises from damage to the peripheral or central nervous system—such as stroke, nerve compression, multiple sclerosis, spinal cord injury, head trauma, or congenital defects—which disrupts the neural pathways controlling hand movement. This impairment severely limits basic activities of daily living, often requiring continuous therapist supervision and human assistance. Traditional rehabilitation methods rely on in-clinic mirror therapy and manual muscle testing, which are resource-intensive, lack objective progress metrics, and are inaccessible in remote settings.

- While the therapy movement patient heart rate can excessively heart rate increase. If the heart rate increases excessively, it can be a sign of physical or emotional stress, pain or discomfort, cardiovascular strain, autonomic nervous system imbalance, especially in neurological patients [1].“The absence of direct heart rate measurement in therapy”. Traditional methods are time consuming progress the process of controlling paralysis hand using functional hand is a treatment to recover patient [2]. This research aims to address the problem of limited motor rehabilitation and functional movement restoration in individuals with unilateral hand paralysis by developing a Robotic Hand Mirror System that replicates the motion of the healthy hand in real-time onto the paralyzed hand using a master-slave control mechanism.[3]

- The recovery process of hand after a paralysis may be slow, however speed of recovery rises by increasing the exercises and activities for this purpose. The traditional method continuously practiced are done by the physiotherapists. That are resources intensive, and lack of patient engagement. That method is very costly when patient is in faraway to physiotherapist. Due to the cost patient skip the therapy session. In the traditional method patient and therapist are engaged of short period of time in a day with exercises. Access to the therapy session is limited for many individuals, particularly in remote or underserved areas.[4][5]
- Traditional grip-strength tests rely on intermittent, manual assessments that can be inconsistent and fail to capture day-to-day improvements. By integrating miniature pressure sensors into a soft rehabilitation ball, continuous real-time data on force exerted and repetition counts can be recorded and transmitted to a monitoring app. This system offers objective, quantifiable metrics of hand function over time, enabling therapists and patients to track progress accurately and adjust therapy parameters instantly based on performance trends.[6][7]
- Current therapy systems cannot monitor patient emotions in real-time, causing poor treatment results and increased patient stress. Existing tele-rehabilitation systems have limited AI integration for monitoring patient emotions during sessions [9]. Facial emotion recognition through AI has advanced significantly, but its use in therapy control is still underdeveloped [8]. Recent studies show AI in mental health focuses mainly on diagnosis, not real-time treatment changes [10][11]. This research fills this gap by creating edge AI systems that detect facial emotions during therapy sessions and automatically adjust treatment intensity to improve outcomes and reduce patient stress.

**References:**

- 1) Characterization of heart rate changes associated with autonomic dysreflexia during penile vibrostimulation and urodynamics  
Lauren Rietchel, View ORCID ProfileAndrea L. Ramirez, Shea Hocaloski, Stacy Elliott, View ORCID ProfileMatthias Walter, View ORCID ProfileAndrei V. Krassioukov  
<https://doi.org/10.1101/01.04.03.154489>
- 2) How does Paralyzed Arm Heal? Paralyzed Hand Treatment (10/11/2024)  
by Engin Çakar  
<https://engincakar.com/en/how-does-paralyzed-arm-heal-paralyzed-hand-treatment/>
- 3) Robotic Mirror Therapy for Hemiplegic Arms  
Yi J-H et al. (2016) — “Robotic mirror therapy system for functional recovery of hemiplegic arms”  
<https://pubmed.ncbi.nlm.nih.gov/27583794/>
- 4) Kwakkel, G., Kollen, B. J., & Wagenaar, R. C. (2002). Therapy impact on functional recovery in stroke: a critical review of the literature. *Physiotherapy*, 88(3), 155–163.  
[https://doi.org/10.1016/S0031-9406\(05\)60139-8](https://doi.org/10.1016/S0031-9406(05)60139-8)

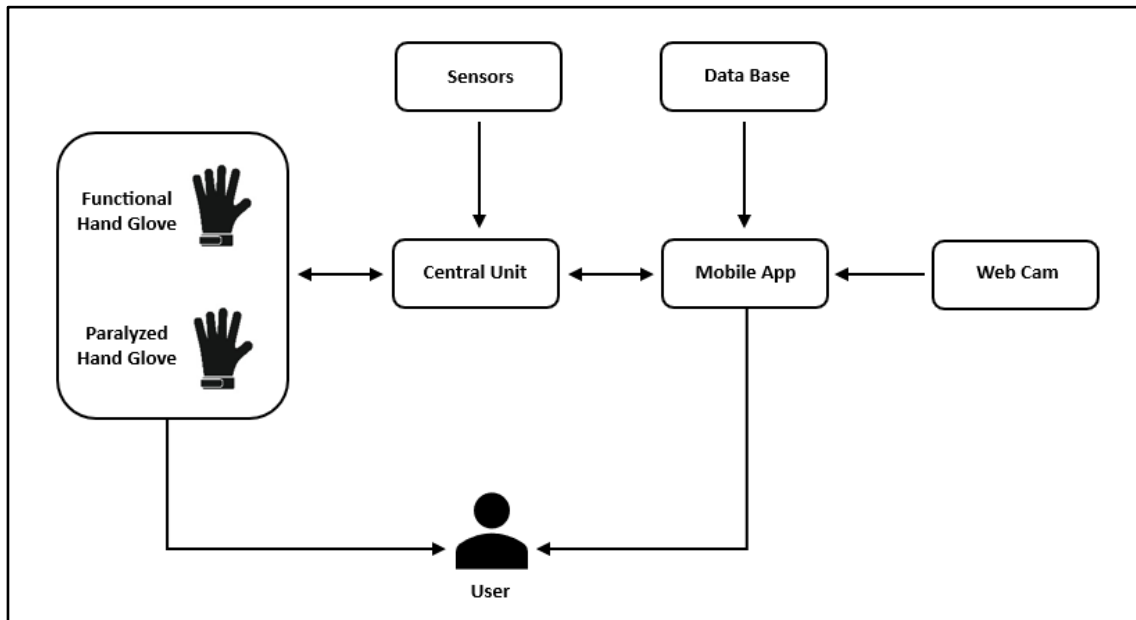
- 5) Balasubramanian, S., Klein, J., & Burdet, E. (2010). Robot-assisted rehabilitation of hand function. *Current Opinion in Neurology*, 23(6), 661–670.  
<https://doi.org/10.1097/WCO.0b013e32833e99a4>
- 6) K. C. Eldahan et al., “Autonomic dysreflexia after spinal cord injury: Systemic pathophysiology and methods of management,” *Autonomic Neuroscience*, vol. 212, pp. 5–15, Jan. 2018.
- 7) H. Zhang, X. Ding, X. Zhang, and F. Xu, “A smart ball sensor fabricated by laser kirigami of graphene for personalized long-term grip strength monitoring,” *npj Flexible Electronics*, vol. 6, Art. no. 28, 12 May 2022, doi:10.1038/s41528-022-00156-w.
- 8) S. Kaur et al., "Facial emotion recognition: A comprehensive review," *Expert Systems*, vol. 41, no. 12, 2024.
- 9) A. Cañigüeral et al., "Facial expression recognition based on emotional artificial intelligence for tele-rehabilitation," *Engineering Applications of Artificial Intelligence*, vol. 133, 2024.
- 10) M. Gutierrez et al., "Artificial intelligence in mental health care: a systematic review of diagnosis, monitoring, and intervention applications," *Psychological Medicine*, pp. 1-15, 2024.
- 11) R. Singh et al., "Enhancing mental health with Artificial Intelligence: Current trends and future prospects," *Current Research in Behavioral Sciences*, vol. 6, 2024.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

The objective of this project is to design IOT base System for Paralyzed Hand Control system with the help of smart wearable gloves and develop an application to assist people suffering from hand paralysis. The system would be designed to facilitate the restoration of motor function through physical interaction and visual feedback.

- The intelligent glove on the paralyzed hand, operated by the movement of the healthy hand through sensors or the other glove. This mimics "mirror therapy" by deceiving the brain into believing both hands are moving, which has the potential to stimulate motor recovery in a stroke or spinal injury patient. Also wish to keep track of the patient's heart rate continuously. It assists doctor in making decisions.

- The smart gloves function via a mobile application. The physiotherapist can prescribe exercises, and the patient can do exercises daily without any physiotherapist according to the prescribed routine by the physiotherapist.
- The smart glove, worn on the paralyzed hand to sense movement attempts and provide feedback. It transmits this data to a application and monitor the patient progress with the help of sensors.
- Monitor emotions and stress of the patient from facial expressions and give feedback to adjust therapy intensity. It is helpful in the patient's convertibility.



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

The development of this IOT base System for Paralyzed Hand Control system demands expertise in various allied fields. Expertise in biomedicine will be required in order to familiarize oneself with human hand anatomy, neurologic disorders like stroke and nerve damage, and rehabilitation. Physiotherapist consultation is required to define acceptable exercise protocols, milestones of motor function, and schedules for recovery. The incorporation of this domain knowledge guarantees that the smart glove design and therapy routines are in agreement with real clinical needs.

Technically, high levels of IoT and embedded systems expertise are required to create the smart glove. This entails integrating sensors, programming a microcontroller, and robust wireless communication. Additionally, software development skills are required to create an accessible mobile app that is capable of receiving sensor signals, offering real-time feedback, and facilitating remote monitoring by physiotherapists. Signal processing and data analysis are also paramount in converting sensor outputs into useful information.

Lastly, the project involves handling sensitive information regarding health, so there is a need for data privacy, ethical practice, and awareness of medical regulation. Skills in AI and computer vision will be needed to support emotion detection from facial expressions from live video input, which will enhance the emotional feedback loop for therapy. The system will need to be safe, GDPR/HIPAA-compliant, and patient-safety- and patient-consent-based. Real-world rehabilitation data and regular feedback from subject-matter specialists will also improve the efficiency and accuracy of the solution.

8. Objectives and Novelty

<p><b>Main Objective</b> The main objective of this project is to design and implement an IOT base System for Paralyzed Hand Control System with intelligent wearable gloves and a mobile application to assist hand paralysis patients in recovering motor function. The system should provide ongoing, interactive rehabilitation through sensor-based monitoring, real-time feedback, and remote monitoring for physiotherapists, as well as heart rate monitoring and emotional feedback to maximize and personalize the recovery process.</p>			
Member Name with Registration No	Sub Objective	Tasks	Novelty
IT22365378 W.M.S.L. Wickramasungha	Monitoring heart rate and Control paralyzed hand using other hand	Hardware implementation. Continuously monitor the heart rate. Communication both hand for mirror movement	Every patient's health is not same. So, continuously checking the patient's heart rate and glove work according to it.
IT22884992 V.K. Liyanage	Give exercise to the Paralyzed hand according to the Doctor's recognition	Hardware implementation. Connect with the mobile app. Give exercises to the hand.	The mobile app records the functional hand glove movements and smart glove following that instructions
IT22083050 R.K. Kaween Rashmika	Measure and monitor paralysis improvement using a pressure ball	Integrate a pressure sensor into the rehab ball, stream grip-strength data, and build a simple dashboard to log reps and alert on progress.	First home-use pressure ball offering real-time, objective grip-strength tracking with instant feedback.
IT22574336 C.S.B.Hettihewa	Real-time emotion detection with therapy control Tasks	Set up camera for facial monitoring Deploy emotion detection model Create music player for stress relief Integrate system with therapy controls	Real-time emotion-based therapy adjustment using edge AI processing

9. Individual component description of how it is complied with the specialization.

Member Name with Registration No	Description
IT22365378 W.M.S.L. Wickramasinghe	Measure movements of the functional hand and it followed by the Paralyzed hand. Also continuously monitoring heart rate and give an alert for avoid or continuous exercises for controlling paralyzed and using functional hand.
IT22884992 V.K. Liyanage	Doctor can enter the exercises to the app for the specific time and the glove connect with the app and follow the instructions and give exercises to the paralyzed hand.
IT22083050 R.K. Kaween Rashmika	Measure the patient improvement using pressure a pressure ball and collect data daily and monitor it during a specific time. Improvement give to the mobile application.
IT22574336 C.S.B.Hettihewa	This feature uses edge AI to detect patient emotions through facial monitoring. It adjusts therapy intensity and plays relaxing music during stress, ensuring a more personalized, emotionally aware rehabilitation experience that improves comfort, motivation, and overall recovery effectiveness.

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor				
Co-Supervisor				
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				



Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

\* Detailed comments given below

Comments

Staff Member's Name	Signature

**\*Important:**

1. According to the comments given by the evaluator, make the necessary modifications and get the approval by the **Evaluator**.
2. If the project topic is rejected, identify a new topic, and request the RP Team for a new topic assessment.