Abstract ID: WSC18-1318

Design of Wrist Joint Exoskeleton for Post Stroke Neuro-rehabilitation

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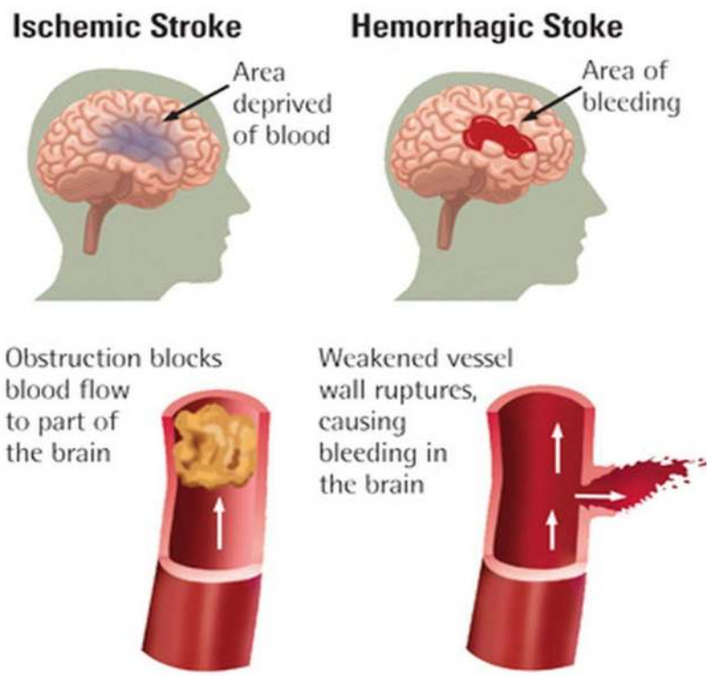
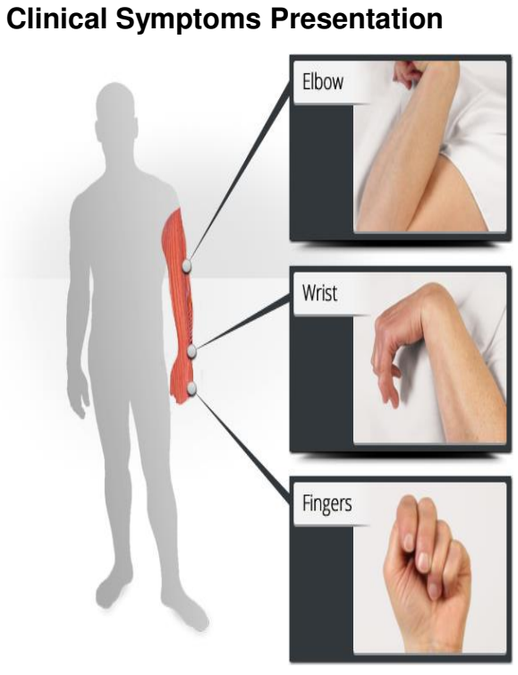
Introduction

STROKE : When blood flow to an area of brain is cut off, brain cells are deprived of oxygen and begin to die





Current Scenario

Neuro-Rehabilitation

Conventional

Other rehabilitation care under research

Physiotherapy *– standard*

Drawbacks:
- Subjective Assessment
- No objective quantification of voluntary trial
- Variation across physiotherapists & time
- No knowledge of performance
- Lack of motivation and time
- Compensated movement with other muscles
- High clinical load

Robotic Intervention

Drawbacks:
- Available devices focus on **proximal joints, are costly and grounded,** requires **large space** to be installed & **dedicated staffs** in **few hospitals** worldwide, ex.
  - *Amadeo*–104K$*3,
  - *Gloreha*-2025K$
- No **home** based rehabilitation device available

Methodology

- Force required to extend the wrist and fingers against spasticity (Modified Ashworth Scale 1 to 5, in abstract ID= WSC18-1151, Megha et al.,) was measured.

- Design of exoskeleton for distal joints for improving Activities of daily living (ADL) which is voluntarily triggered by forearm extensor muscle activity of patients

- Flexion and extension of wrist and finger joints.

- Flexibility to choose
  - Initial & final angle of Range of Motion (ROM),
  - Speed through ROM , Height of finger support
  - 4 different pre-defined thresholds of muscle activity of patients

- Performance based adaptive visual biofeedback in real time

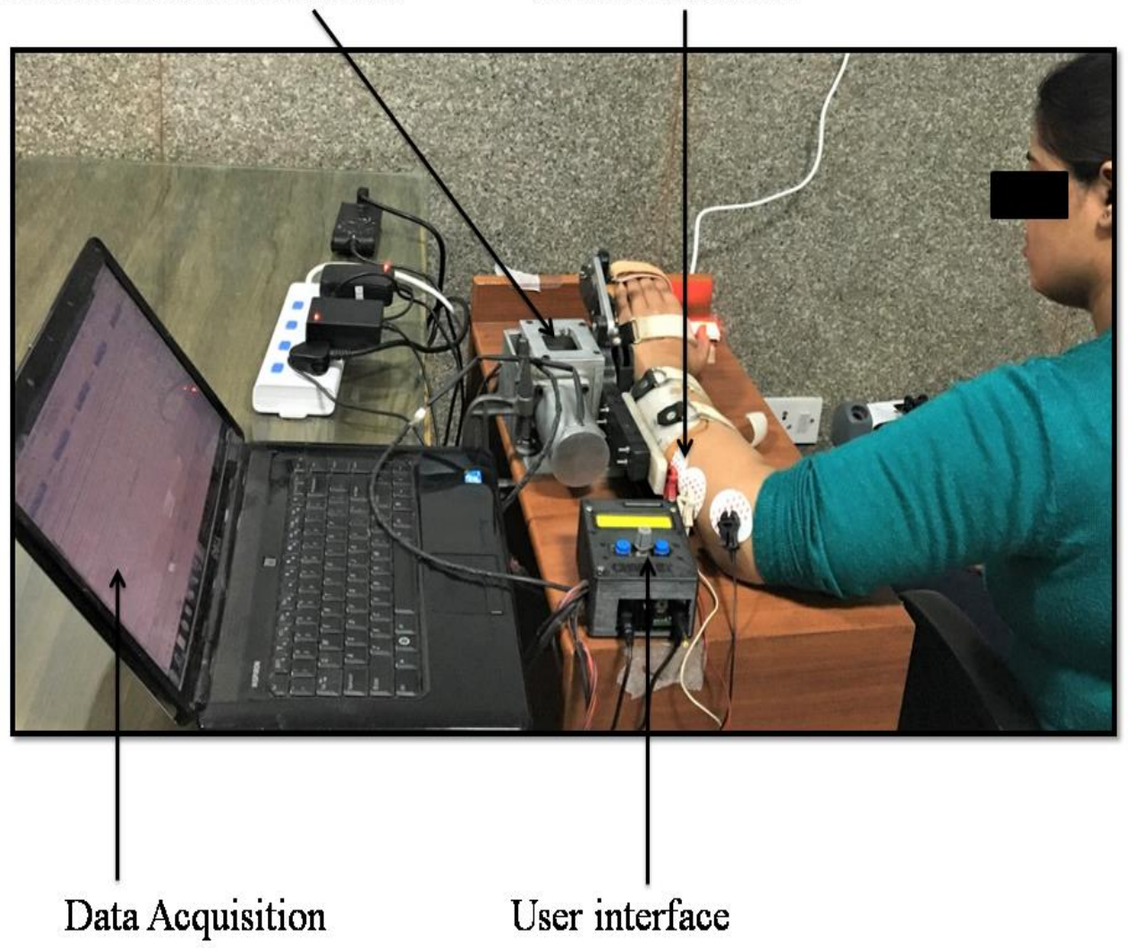


Fig 1: Set-up of the design prototype with user interface

Results

- Subjective questionnaire feedback & **System Usability Scale** (SUS) (Table-1) from **6** patients with chronic-stroke was used to assess usability after 2 hours of testing on each patient.
- Average SUS score = 92.1±7.31 indicates "excellent", perceived as high acceptance across patients.
- Easy don & doff, average 48 sec and 23 sec respectively time individually by unaffected hand by the patient.
- Light weight (2.3 Kg), Low cost ($400 – R&D cost of the current prototype), Portable

Table 1: System Usability Scale

Questionnaire Items	Average score of 6 patients of each question
I think that I would like to use this system frequently.	4.83 ± 0.4
I found the system unnecessarily complex.	1.16 ± 0.4
I thought the system was easy to use.	5
I think that I would need the support of a technical person to be able to use this system.	1.33 ± 0.81
I found the various functions in this system were well integrated.	4.16 ± 0.75
I thought there was too much inconsistency in this system.	2
I would imagine that most people would learn to use this system very quickly.	5
I found the system very cumbersome to use.	1.66 ± 0.81
I felt very confident using the system	5
I needed to learn a lot of things before I could get going with this system.	1
Average SUS Score	**92.1 ± 7.31**

Conclusion

- **Robotic exoskeleton** has been designed
- Patient feedback shows **high acceptability in Indian scenario**
- **For low resource settings**
- Can be used as **home based rehabilitation device**.

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