MECHANICAL ENGINEERING
TEXAS A&M UNIVERSITY
HUR (HUman Rehabilitation) Group
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PILOT STUDY WITH A GYROSCOPIC HAND REHABILITATION DEVICE

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INTRODUCTION AND OBJECTIVE

- About 795,000 people experience strokes in the US, annually [1]. Many stroke victims suffer from hand disabilities such as weakened grip strength, lack of muscle coordination, and hand spasticity [2, 3].
- Develop a portable and compact gyroscopic device hand rehabilitation, named *Gymball*.
- Conduct pilot study to validate the device's design and assess the prospect of using it for therapy.
- Study whether:
  - the gyroscopic torque, generated by the device, can induce passive movement of the user's hand.
  - the produced hand motion can be controlled.
- There are two kinds of therapies that can be implemented with such a device:
  - One involving synchronization of the hand movement with the generated torque – leading to hand muscle relaxation.
  - Another requiring the user to resist the torque – potentially increasing hand muscle strength and coordination [4].

DESIGN

- The HRD is a fully-actuated rotor-gimbal assembly that, when actuated, imposes a gyroscopic torque on the user's hand.

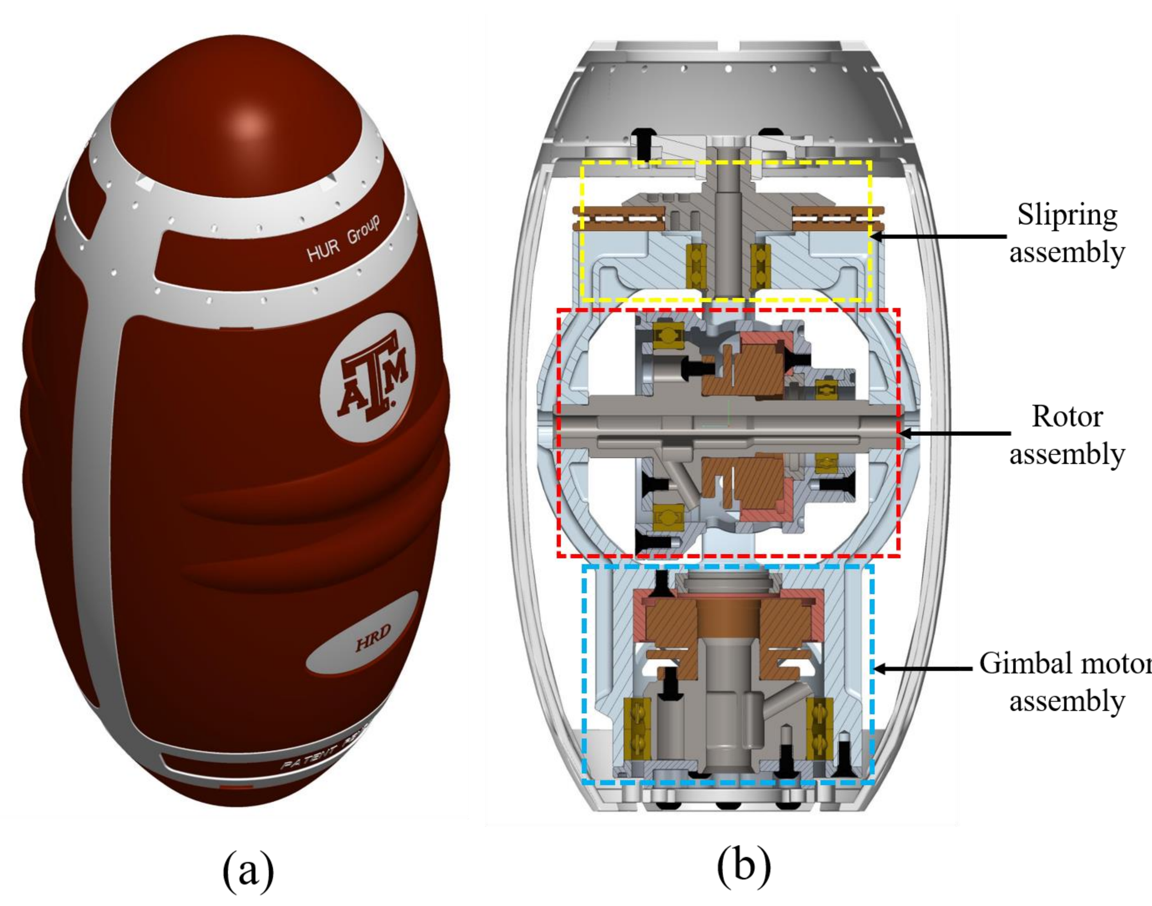

Fig. 2 (a) Isometric view of the device, (b) Cross-sectional view of the device highlighting major components

Fig. 1 Image of the *Gymball* being gripped by a human hand. Finger holds facilitate the user to grip the device comfortably.

FEASIBILITY STUDY

- A healthy 25-year-old male was recruited for this study. The subject was asked to relax the hand while exerting minimal effort to hold the *Gymball*.
- The experiment involved six different sets of operating conditions which have been tabulated in Table 1. Two trials were conducted for each set.

Table 1: Sets of operating conditions: the velocity of rotor (R) and gimbal (G) in rad/s

#	1	2	3	4	5	6
R	150	150	−150	−150	150	−150
G	37	−37	37	−37	$37\sin(0.63t)$	$37\sin(0.63t)$

FEASIBILITY STUDY

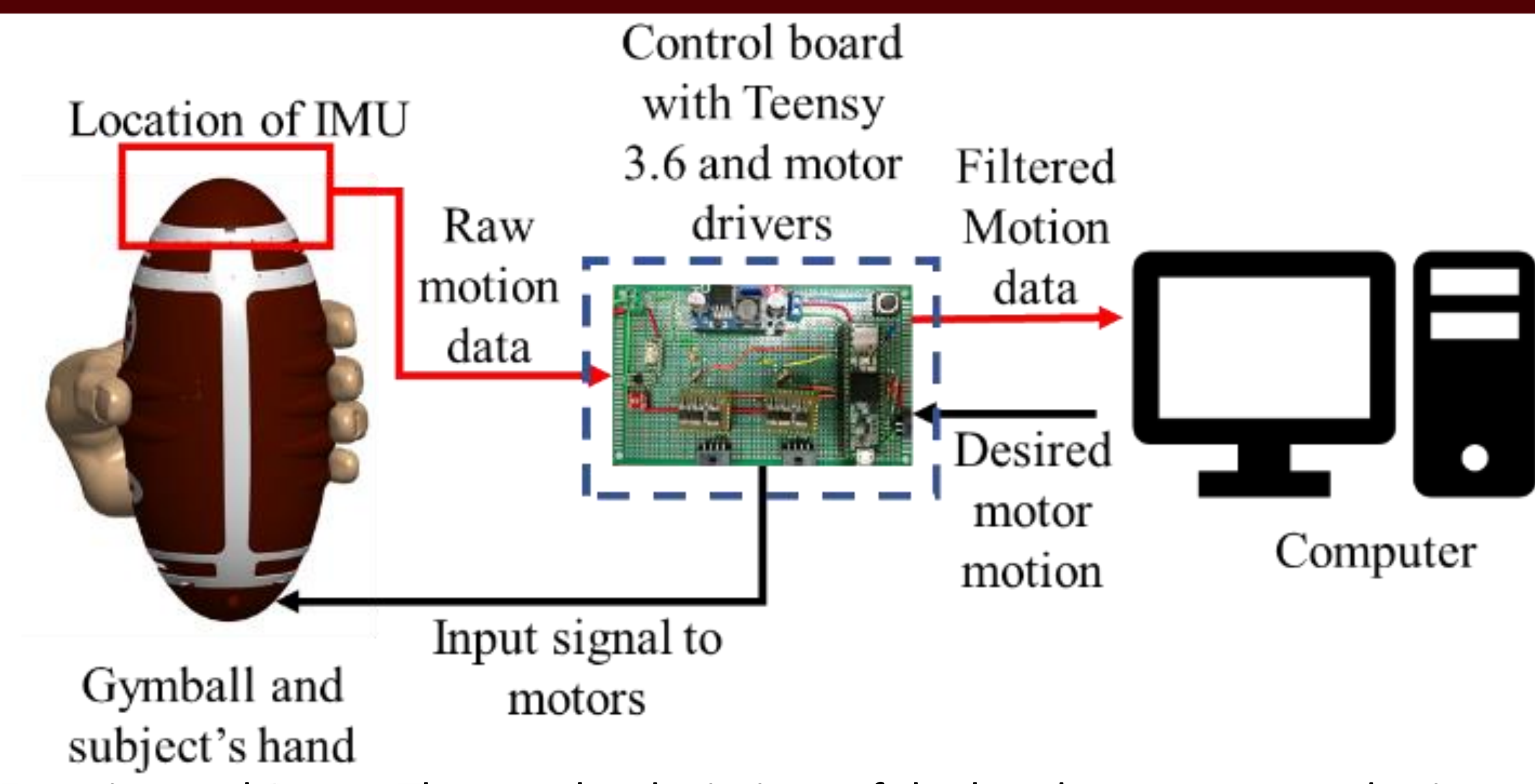

Fig. 3 Experimental Setup: The angular deviations of the hand were measured using an IMU placed as shown

OBSERVATIONS

- The observed hand motion imposed by the *Gymball* was considerably higher about the roll axis (pro/supi-nation) than the pitch (radial deviation).
- The supinated angular displacements were greater in magnitude than the pronated ones.
- Finally, the direction of the hand's circumduction is dictated by the direction of the gimbal's motion.

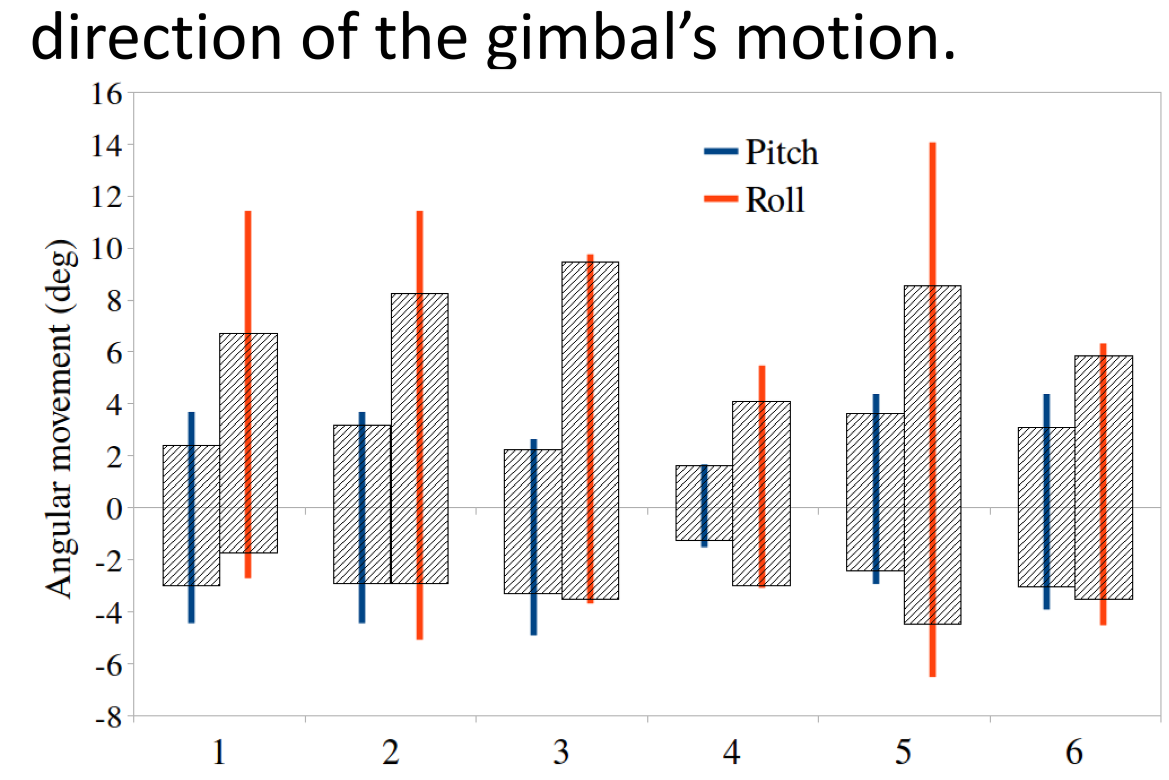

Fig. 4 Range of hand motion about the pitch and roll axis. The hatched section represents the average range of motion while the vertical line signifies the maximum and minimum angular displacements across the two trials..

CONCLUSION

- The *Gymball* can be currently used for generating motions, about the wrist, of at least 10°.
- Changes in the gimbal's rotational direction demands the same of the user's hand.

FUTURE WORK

- Develop a controller to generate several hand motion patterns.
- Conduct studies with stroke patients (where tools such as Fugl Meyer and Modified Ashworth Scale will be used to judge the efficacy of the device).
- Measure the contact forces between the hand and the device.
- Increase torque generated by increasing rotor inertia and speed.

ACKNOWLEDGEMENTS

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REFERENCES

1.Stroke center http://www.strokecenter.org/patients/about-stroke/stroke-statistics/
2.Smania, N et al. European Journal of Phy. and Rehab. Med. 2010
3.Kuchinke, LM, and Bender, B, IEEE RAS and EMBS International Conference on Biomed. Rob. and Biomech. 2016
4.Sequeira, G., et al., Arch. Of Phy. Med. and Rehab. 2012
5.Lambercy, O. et al., IEEE Trans. on Neural Sys. and Rehab. Engg. 2007