Towards the Development of a Compact Tension Sensing Unit for Tendon Actuation Systems

Patrick Zheng[a], Kent K. Yamamoto[a,b], Y. Chitalia[b], P.J. Codd[a]
[a]Brain Tool Lab, Duke University, Durham, NC
[b]HeaRT Lab, University of Louisville, Louisville, KY

Introduction

- Tendon actuated robots face many challenges
  - Friction related model errors
  - Tendon elongation
- The Solution
  - Integrate tendon tension sensing for closed loop feedback
  - Compact Tendon Sensing Unit (CTSU) inspired by [1] & [2]

Design & Integration

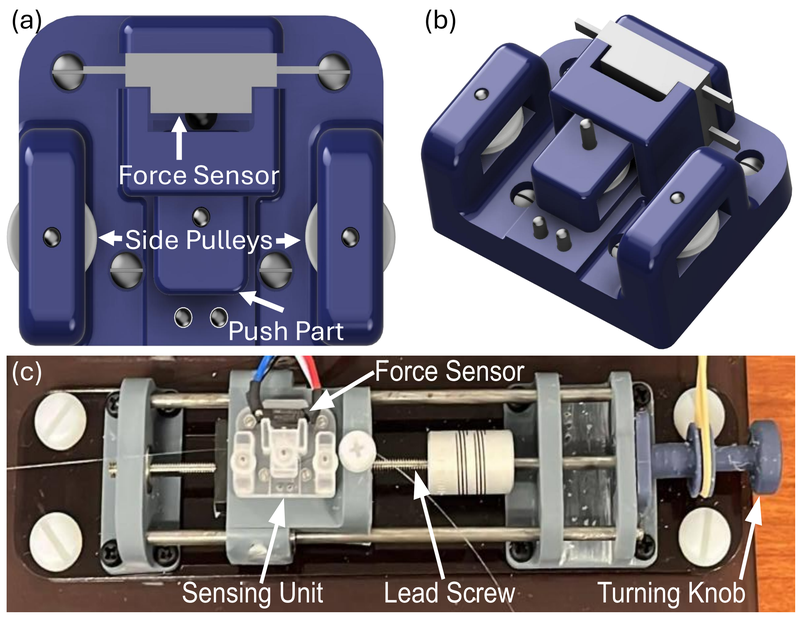


Figure 1. (a) CTSU Design Top View, (b) CTSU Design Isometric View, (c) Sensing Unit Integration into Tendon Actuation System

- Compared to [2], from 25x30x20mm *(LxWxH)* to 23.45x17.50x8.39mm

Methods

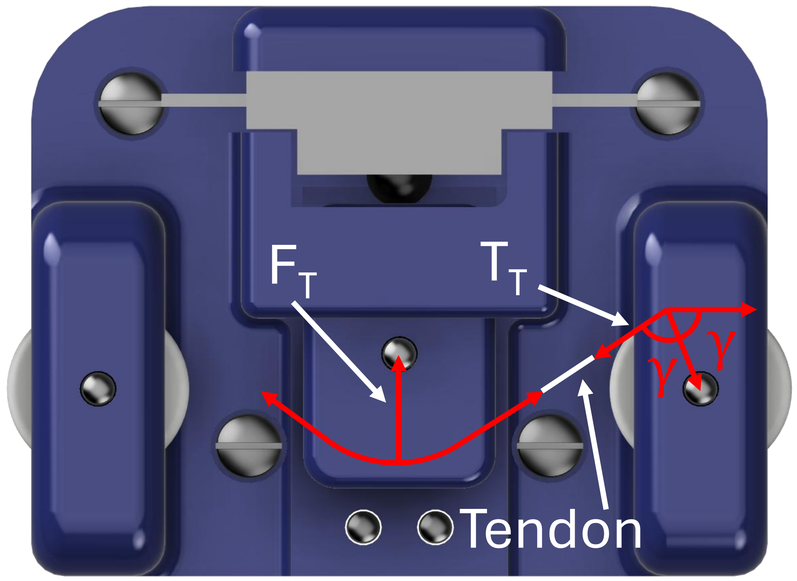


Figure 2. Geometric modeling scheme for CTSU

$$T_T = \frac{F_T}{2\sin(2\gamma)}$$

T_T is tendon tension
F_T is force sensor output

Experimental Setup

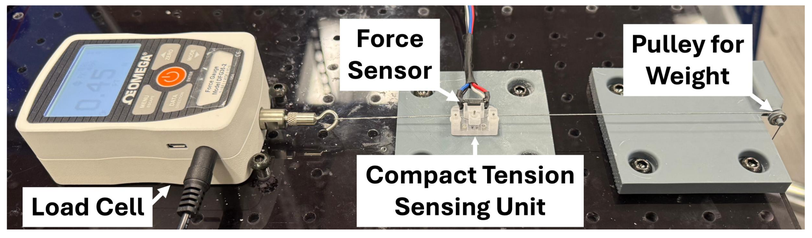
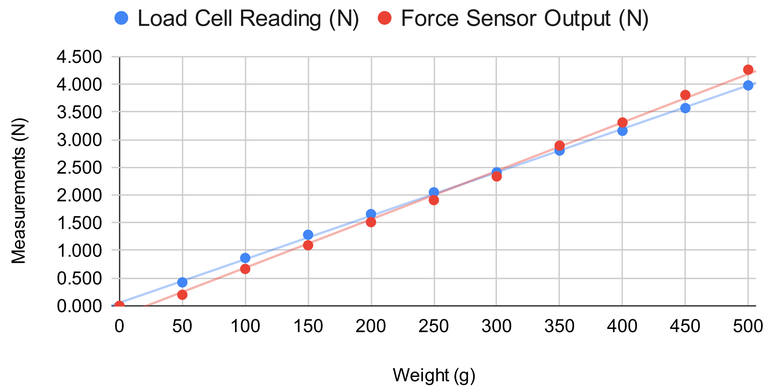


Figure 3. Proposed experimental setup combining CTSU, load cell, and pulley mechanism for attaching weights

- Incremented weight attached to pulley in 50g intervals up to 500g
- Compared to load cell readings

Results



Future Work

- Modify design to resolve stick-slip phenomenon
- Integrate into handheld actuation system

Contact

Patrick Zheng
pz65@duke.edu
Duke ECE/CS Undergraduate Student

References

[1] Tran P, Elliott D, Herrin K, Bhatia S, Desai JP. Evaluation of the FLEXotendon glove-III through a human subject case study. Biomed Eng Lett. 2023 Jan 27;13(2):153-163. doi: 10.1007/s13534-023-00262-2. PMID: 37124112; PMCID: PMC10130284.

[2] K.K. Yamamoto, T. J. Zachem, P. Kheradmand, P. Zheng, J. Abdelgadir, J.L. Bailey, K. Pieter, P.J. Codd, Y. Chitalia, “Tendon-Actuated Concentric Tube Endonasal Robot (TACTER)”, doi: https://doi.org/10.48550/arXiv.2504.19948