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An Implantable Variable Length Actuator for Modulating in Vivo Musculo-Tendon Force in a Bipedal Animal Model

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Motivation

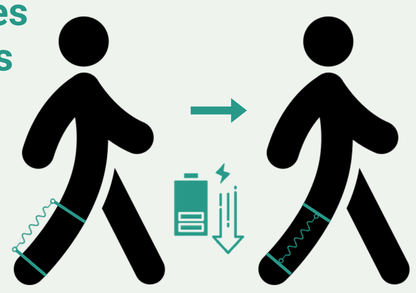
In older adults, **diminished walking capacity** drastically **affects quality of life** and is even a predictor of **mortality**.

Create an **implantable** solution

Externally worn solutions are **cumbersome** and difficult to use everyday and therefore, go **unused**

Goals

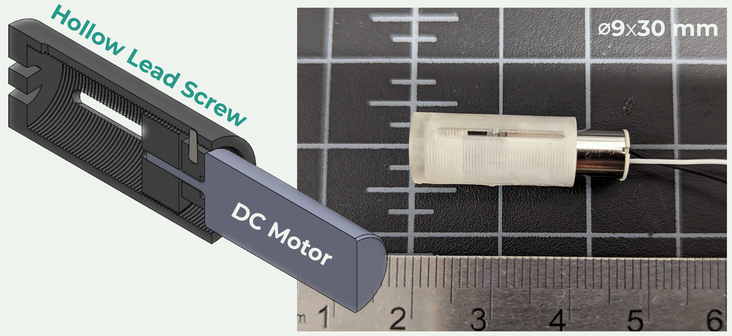
- **Metabolic cost** of walking can be **reduced** using **springs** to store and return energy during each step[1]
- The actuator **emulates** the **in vivo mechanics** of **isometrically** functioning leg muscles and use **tendons** to **store and release** mechanical **power**



[1] S. H. Collins et al. (2015)

Results

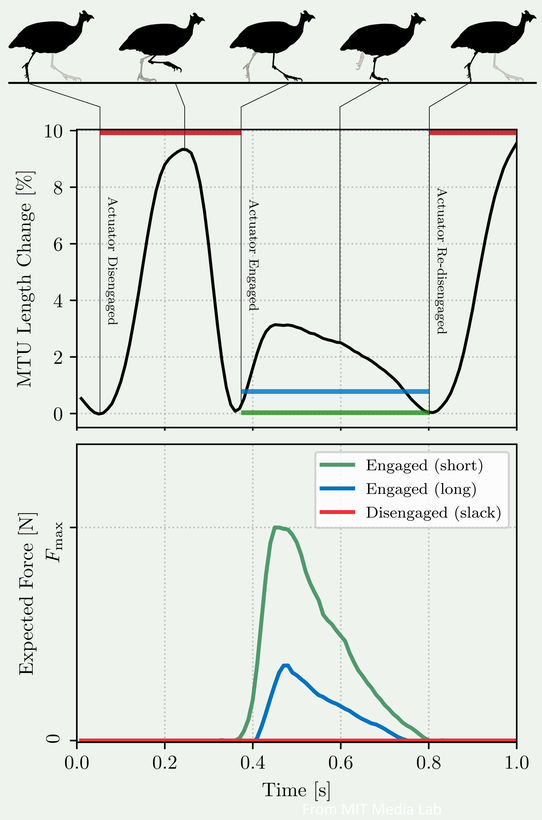
Fabricated variable length actuator measuring ⌀9 x 30 mm and fully implanted within the leg replacing the lateral gastrocnemius muscle.



- Generates **isometric force** similar to the native muscle during gait (~40N).
- **Stroke of 10 mm** that operates up to **770 mm/s**, capable of rapid contraction and elongation under low load.
- **Rapid clutching** and a **tuneable slack length** to **modulate** the timing and level of **assistive force** during gait.
- **Surgical viability** showing no signs of device rejection.

Control Strategy

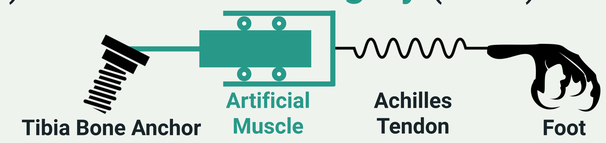
- Provide **slack** during the **swing** phase and supplement the biological isometric forces **acting as a strut** during the **stance** phase
- Actuating only when **minimally loaded**, the **size** of the **motor** can be **minimised**



From MIT Media Lab

Implantation

- Implantation developed on **cadaver specimens** (n= 3) and in **survival surgery** (n = 3).



- The **lateral gastrocnemius** (LG) was **resected**, creating functional deficit and room on the LG tendon for the **distal attachment** of the actuator.