The Construction of the First Bio-inspired Tendon Driven Robot Actuated by DC Motors

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Introduction

In 2019 Ali Marjaninejad, et al, [**Ref 1**] showed how to control a tendon driven robotic leg with G2P (General to Particular) algorithm. This was performed in a single leg robot because of the complexity involved in controlling tendon driven anatomies.

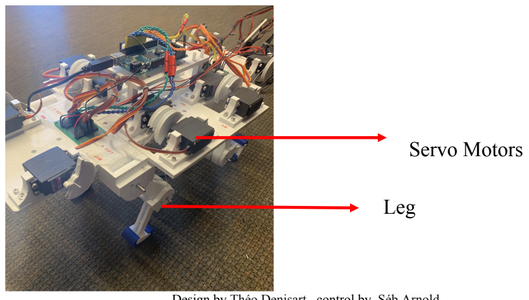
After the uniped, a biped with a similar anatomy was created. Based on the biped, a new version of Kleo was design, having as two main characteristics its tendons driven anatomy actuated by DC motors. In this poster we present our work, which consisted on modifying the motor mounts to be able to withstand bigger stresses and by changing tendon attachments to the legs. Then we construction of Kleo using 3D printed parts. The 3D printed parts allow for mechanical robustness and this is important for further research to be accurate.

Our Objective

To understand biological aspects in animals by creating bio-inspired robots. For our study, the biological aspects are not only limited to how the leg of a cat moves, it also takes in account how a cat learns to move. This is why this robot will serve as a test platform for different control strategies and architectures developed in the Valero Lab.

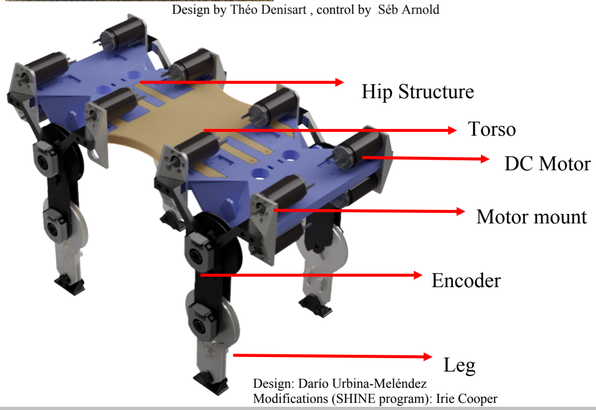
Past vs. New Cat

Kleo 2017



Design by Théo Denisart , control by Séb Arnold

Kleo 2019



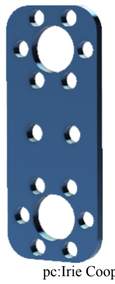
Design: Darío Urbina-Meléndez
Modifications (SHINE program): Irie Cooper

Modified Parts (During SHINE 2019)

Motor Mount

- Reasoning for Modification
  - Bending
  - Potential Breakage
- Requirements
  - Reduce Bending
  - Limit Potential Breakage
  - Simple
  - Don't interfere with tendon routing
  - create lightweight support

Original



pc:Irie Cooper

Modified

pc:Irie Cooper

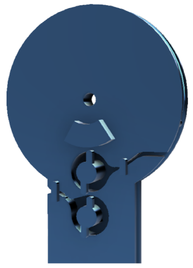
Leg

- Reasoning for Modification
  - Difficult Tendon Access
  - Difficult Interchangeability
- Requirements
  - Easy Tendon Access
  - Easy and Consistent Interchangeability
  - Ability to manage all forces
  - Consistent tendon trajectory
  - Don't interfere with the encoders

Original

pc:Irie Cooper

Modified

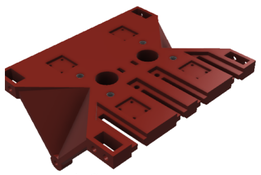


pc:Irie Cooper

Hip Structure

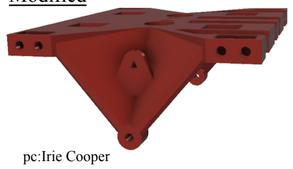
- Reasoning for Modification
  - Lack of String Attachment
- Requirements
  - Create Supportive String Attachment
  - 4 string attachment locations

Original



pc:Irie Cooper

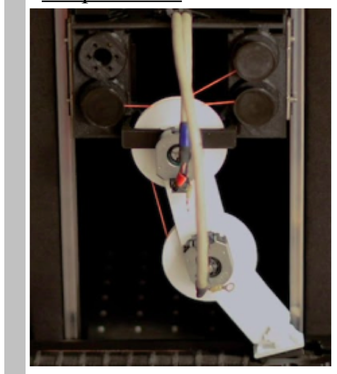
Modified



pc:Irie Cooper

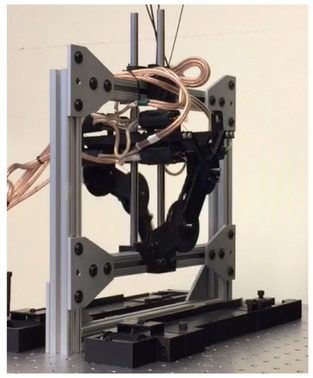
Kleo's Foundation

Uniped 2018



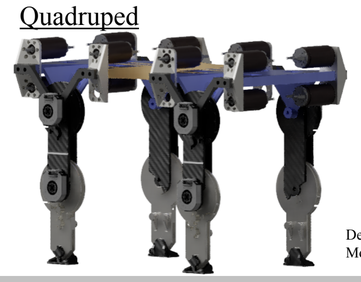
Ref 1

Biped 2019



pc: Darío Urbina-Meléndez

Quadruped



Design: Darío Urbina-Meléndez
Modifications (SHINE program): Irie Cooper

Skill Exercised

- Communication/ Problem Solving
  - constant communication
  - thinking in the future
    - Considering every small detail
    - 3D printing shinkerage
- Report
  - Consistency throughout report
  - formality of report
- Don't make the perfect the enemy of the good

Acknowledgement

I would like to thank Byrant for discussing with me the pros and cons of each design and the construction of Kleo. Thank you to the whole Valero lab team for teaching me new things. Thank you Dr. Katie Mills for allowing me be apart of SHINE for a second year.

References

Ref 1: Marjaninejad, A., Urbina-Meléndez, D., Cohn, B. A., & Valero-Cuevas, F. J. (2019). Autonomous functional movements in a tendon-driven limb via limited experience. *Nature machine intelligence*, *1*(3), 144.