CLEMSON BIOENGINEERING

Author Contacts:
iholmgr@clemson.edu
jlondhe@g.clemson.edu
jwmorto@clemson.edu
wwangar@g.clemson.edu

DynaGait: Responsive Transtibial Ankle Prosthetic for Amputees in Tanzania

Joshua Londhe, Ian Holmgren, Joshua Morton, Will Wangard
Dr. Delphine Dean, Dr. John Desjardins, Dr. Melinda Harman, Jeremiah Carpenter, Diego Nigoa
Dept. of Bioengineering, Clemson University, Clemson, SC

CLEMSON CREATIVE INQUIRY

Introduction

- Of the 40 million amputees residing in developing countries, only 5% to 15% receive prosthetics.[1]

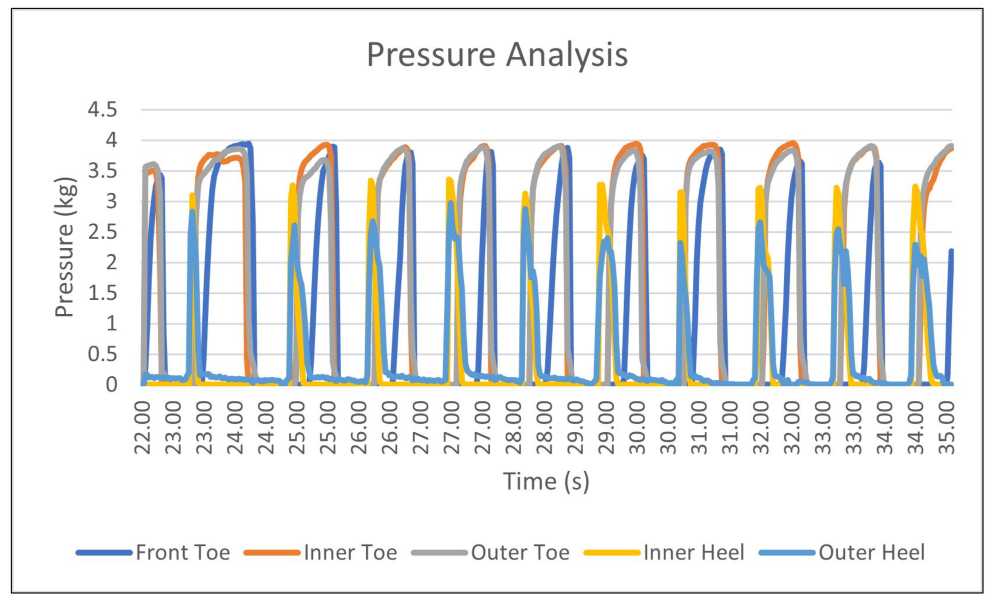
Purpose: Design a robust and affordable ankle prosthetic that promotes mobility through a biomimetic design that ensures a normal gait cycle and adaptation to various terrains.

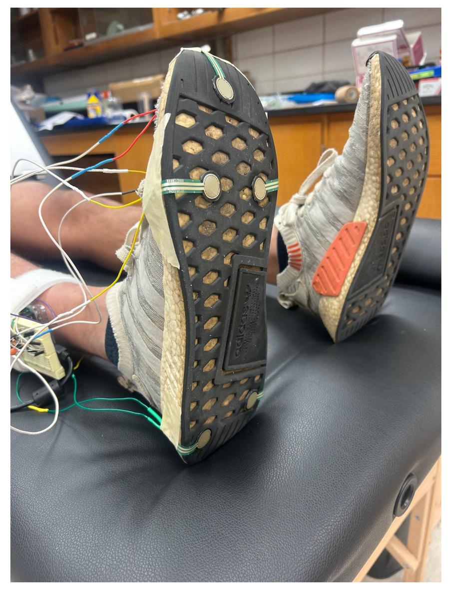
Global Health Impact: Partnership with Arusha Technical College (Tanzania) to address socio-economic and functionality needs of amputee populations in Tanzania while maintaining affordability, durability and easy use.

Specifications

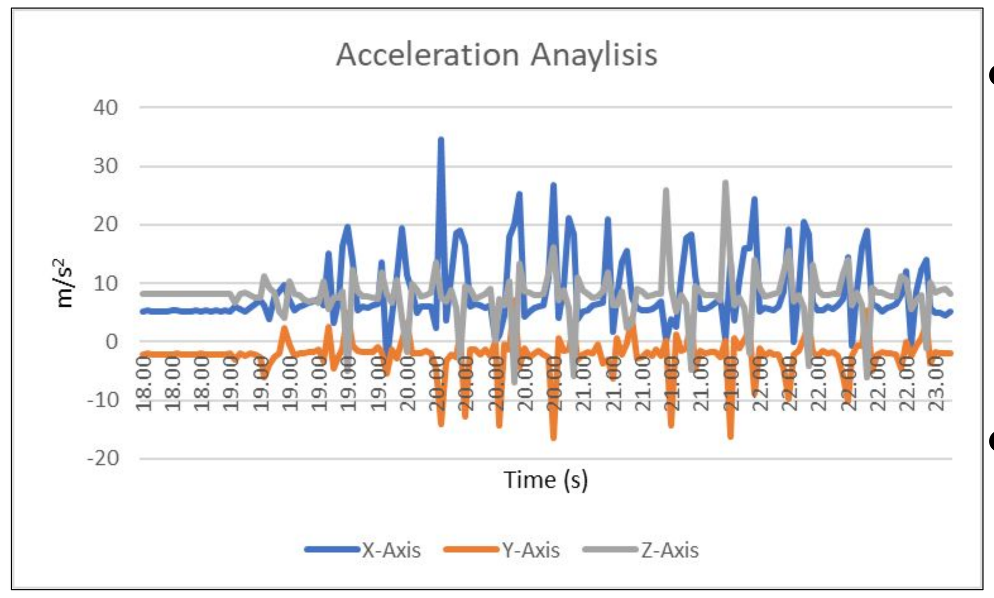
- **Prosthetic:** TPEG, 2.26 lb weight, 21.1 lb force to bend
- **Springs:** 16.5 lb working load
- **Hose Clamps:** Adjusts tension of springs
- **Sprocket:** Locking mechanism
- **Total Cost:** ~$100

Gait Cycle Analysis

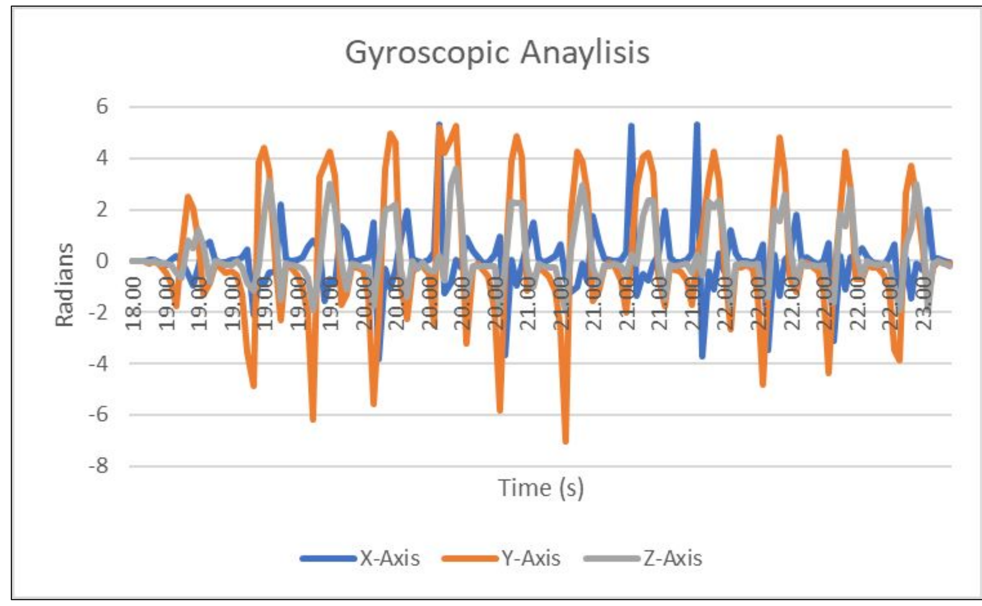




Experimental Setup for Pressure Analysis



- Pressure data acquired via pressure sensors under foot while accel/gyro data acquired via IMU on top of foot.
- User walked on treadmill to acquire data from Arduino.



Experimental Setup for Accel/Gyro Analysis

Mechanical Design

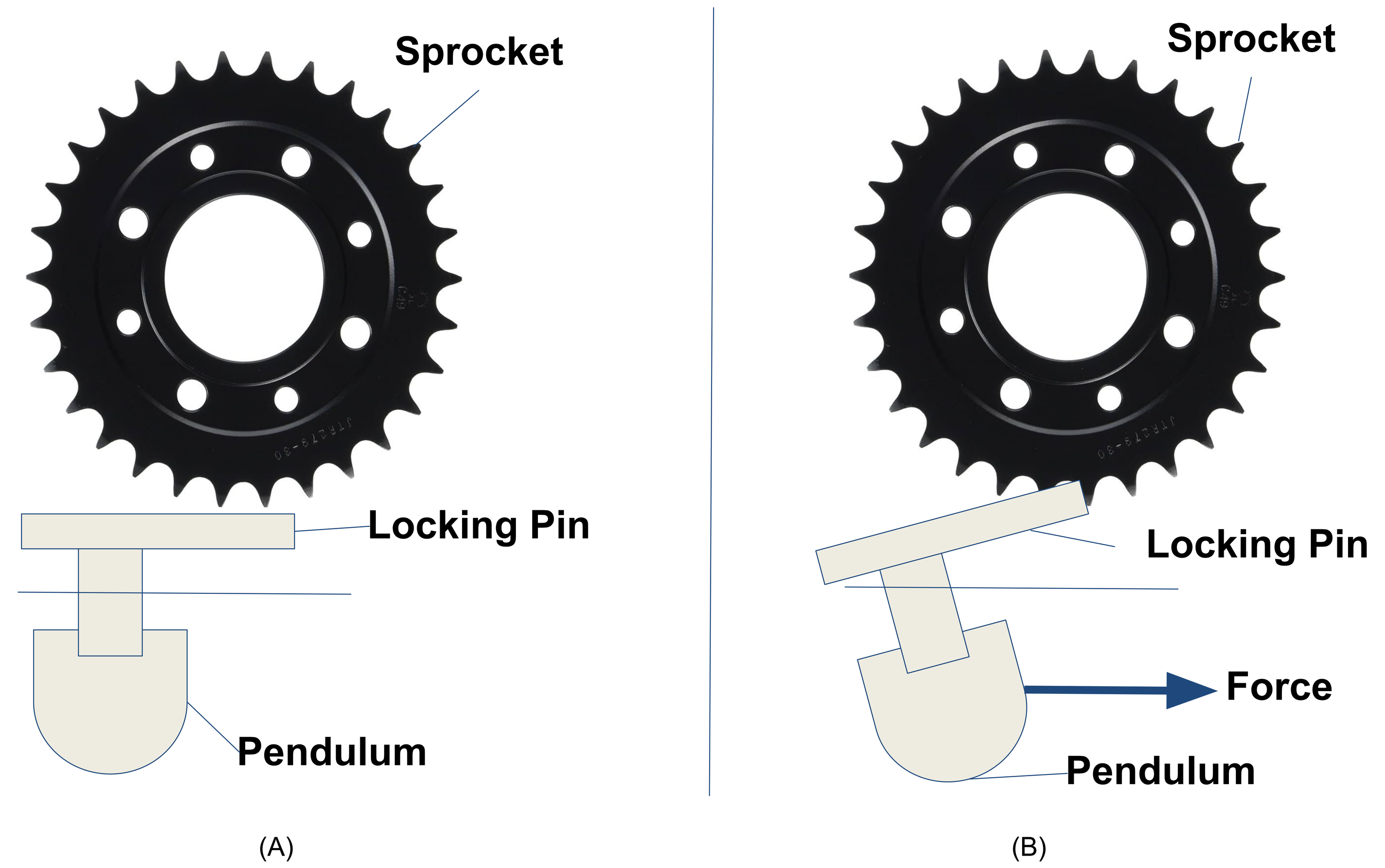
- Biomimetic design through SolidWorks[2]
- Four springs mimic the muscles of the ankle giving support and adaptation to the walking cycle
- Hose clamps are used to secure springs to the foot and ankle and can be easily tightened or loosened with a flathead screwdriver. This allows for the prosthetic to adapt its flexibility or rigidity, enabling optimal performance in diverse environmental conditions.

SolidWorks Model

Volunteer Wearing Prototype Model

- Ankle mechanically locks during pre-swing motion due to a sprocket gear locking ankle in place during swing stage
- Physical testing included two volunteers walking on the prosthetic across various terrains using an able-bodied prosthetic testing adapter, demonstrating the ability to withstand the walking force of an average male.

Locking Mechanism



- Sprocket placed on side of ankle joint and rotates freely (A).
- When a force is applied through heel strike, the pendulum at the base of the ankle joint moves, locking the sprocket in place (B).
- Achieves prevention of foot drop, allowing prosthetic to swing freely and clear the ground.
- Prosthetic returning to ground moves pendulum back into neutral position (A) to prepare for next gait cycle

Conclusion

- Gait cycle analysis gives insight on natural biomechanical movements of the foot and establishes criteria for success of biomimetic prosthetic design.
- Prosthetic mechanically adapts across various terrains while providing robust stability.
- Foot drop is addressed through lock/release system enabled sprocket mechanism

Further Research

Improve lock/release mechanism → Further material investigation → Compare prosthetic and normal gait

Acknowledgements

This work was supported in part by the Clemson University Creative Inquiry Program and VentureWell Program Grant (#52). We also thank Dr. Delphine Dean, Dr. John Desjardins, Dr. Melinda Harman, Jeremiah Carpenter and Diego Nigoa

References

[1] Martin Marino, M.M., Access to Prosthetic Devices in Developing Countries: Pathways and Challenges. 2015. 1-2.
[2]: Habib Masum, H.M., Conceptual Design of a Powered Ankle-Foot Prosthesis for Walking. 2014, 229-231