Northeastern University

Boot The Boot

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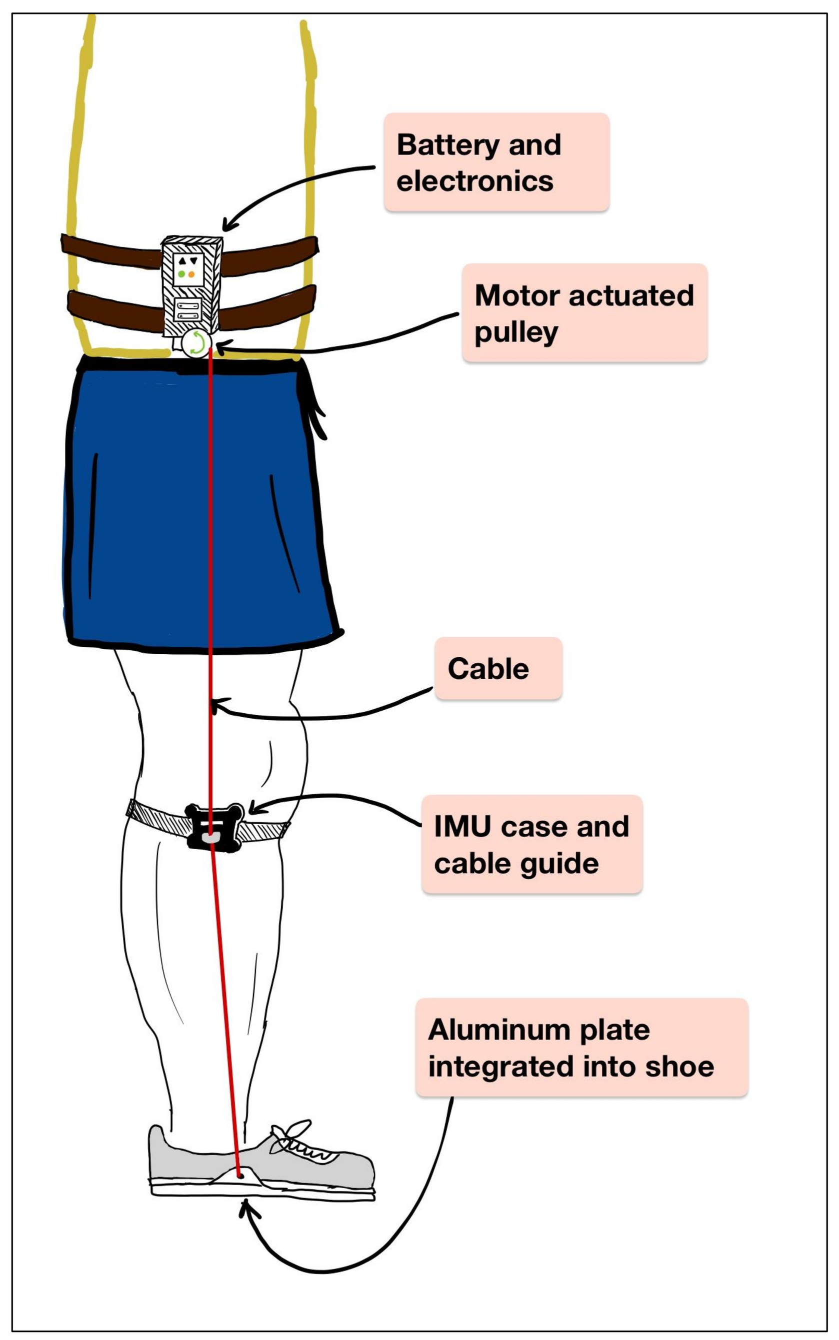
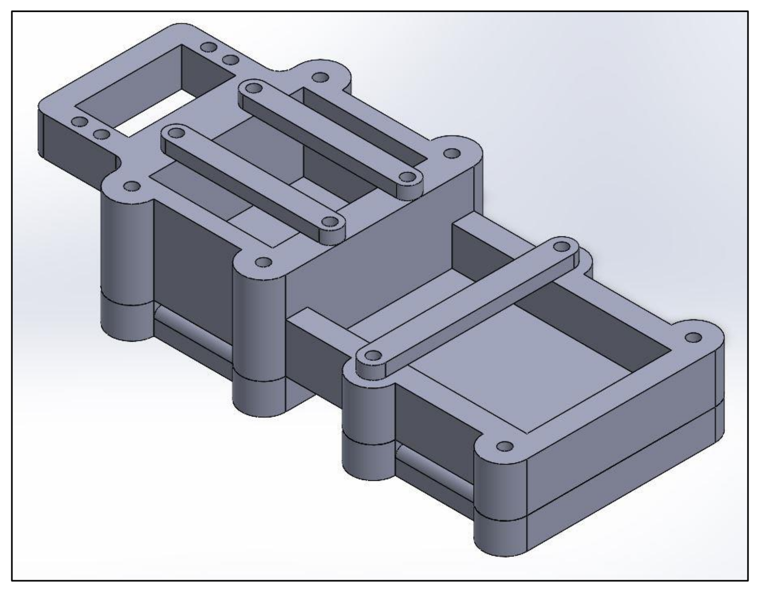
ME6250 Wearable Robotics Final Project • Northeastern University • Instructor: Max Shepherd

Background and Motivation

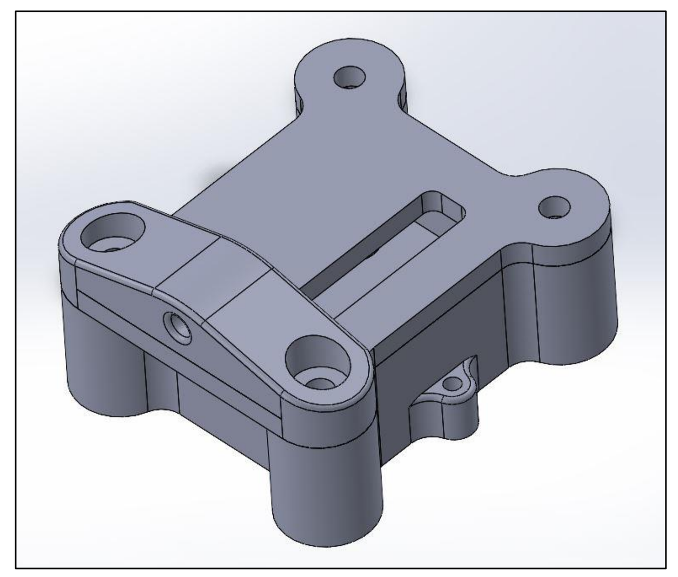
Our project targets patients with ankle instability issues and provides them with a lightweight and more versatile solution to keep their ankle stabilized throughout everyday tasks. Our device is mounted at the hip and applies tension using a motor actuated cable to the outer side of the foot to prevent ankle inversion. The existing solutions for ankle stability are bulky and not very adjustable; this leads to people rejecting their stability device before their ankle is fully healed. Our goal is to prove that our concept can be refined into a device that patients will not mind wearing, therefore allow them to complete a full recovery.

System Design and Methods

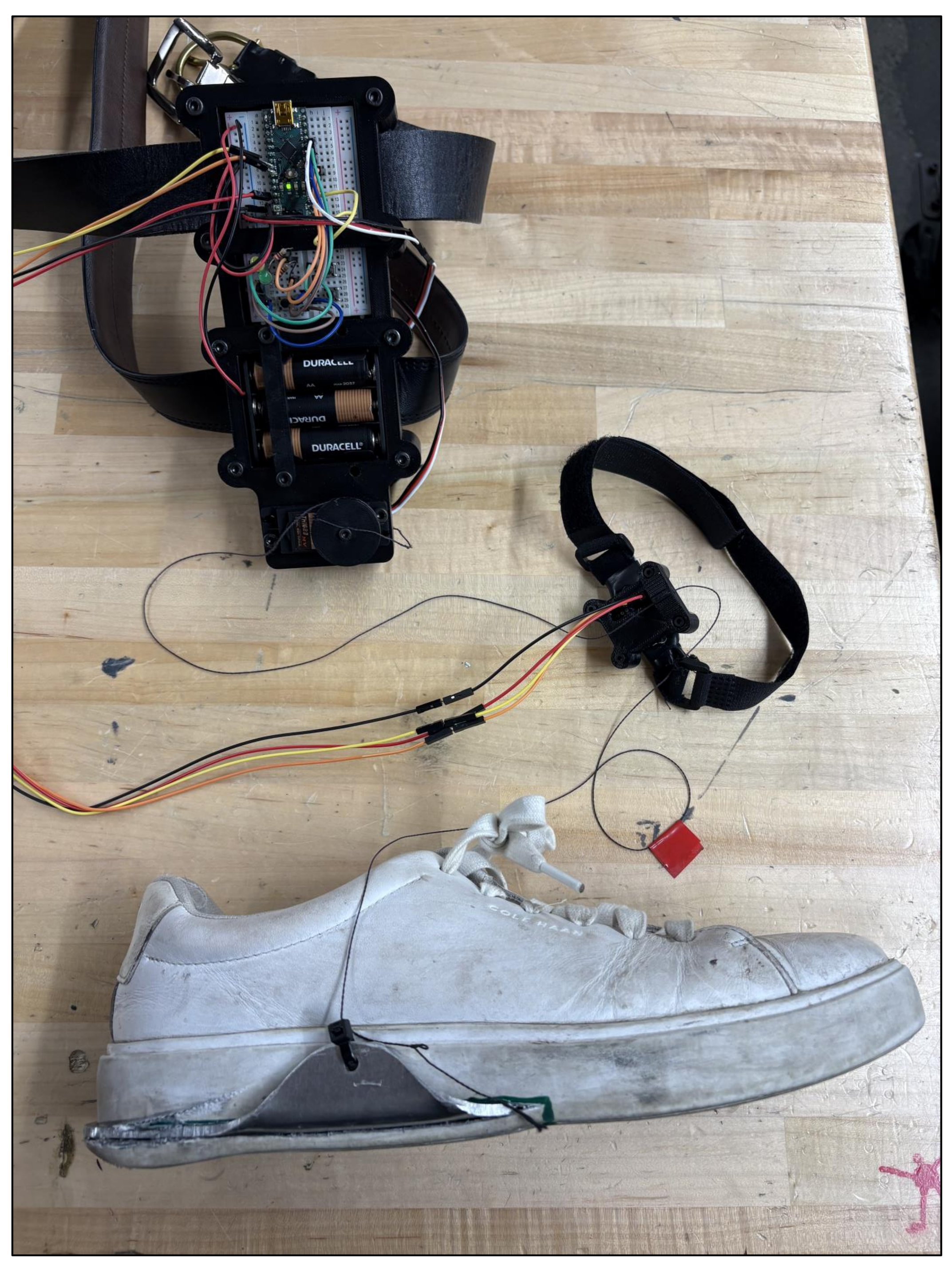




Battery and Electronics Case

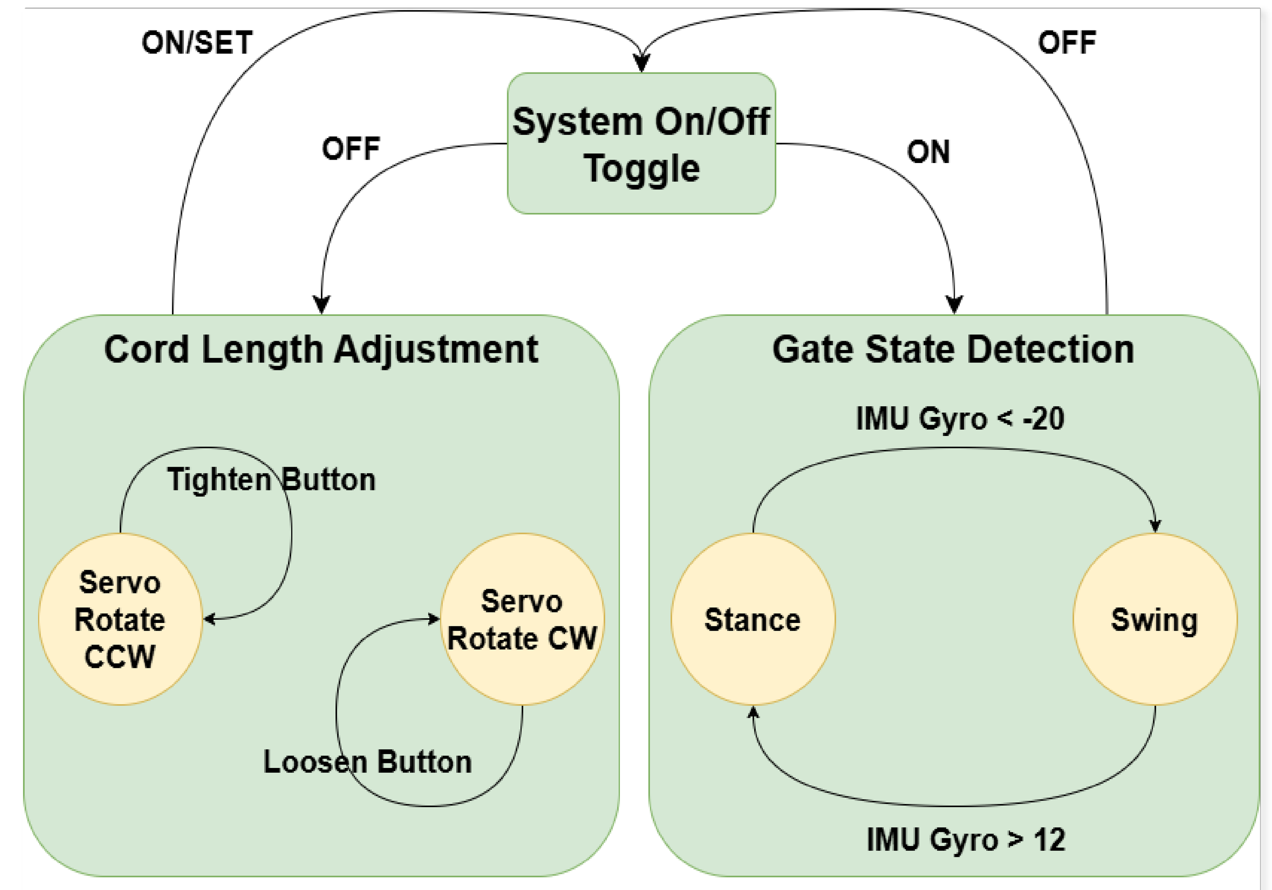


IMU Case

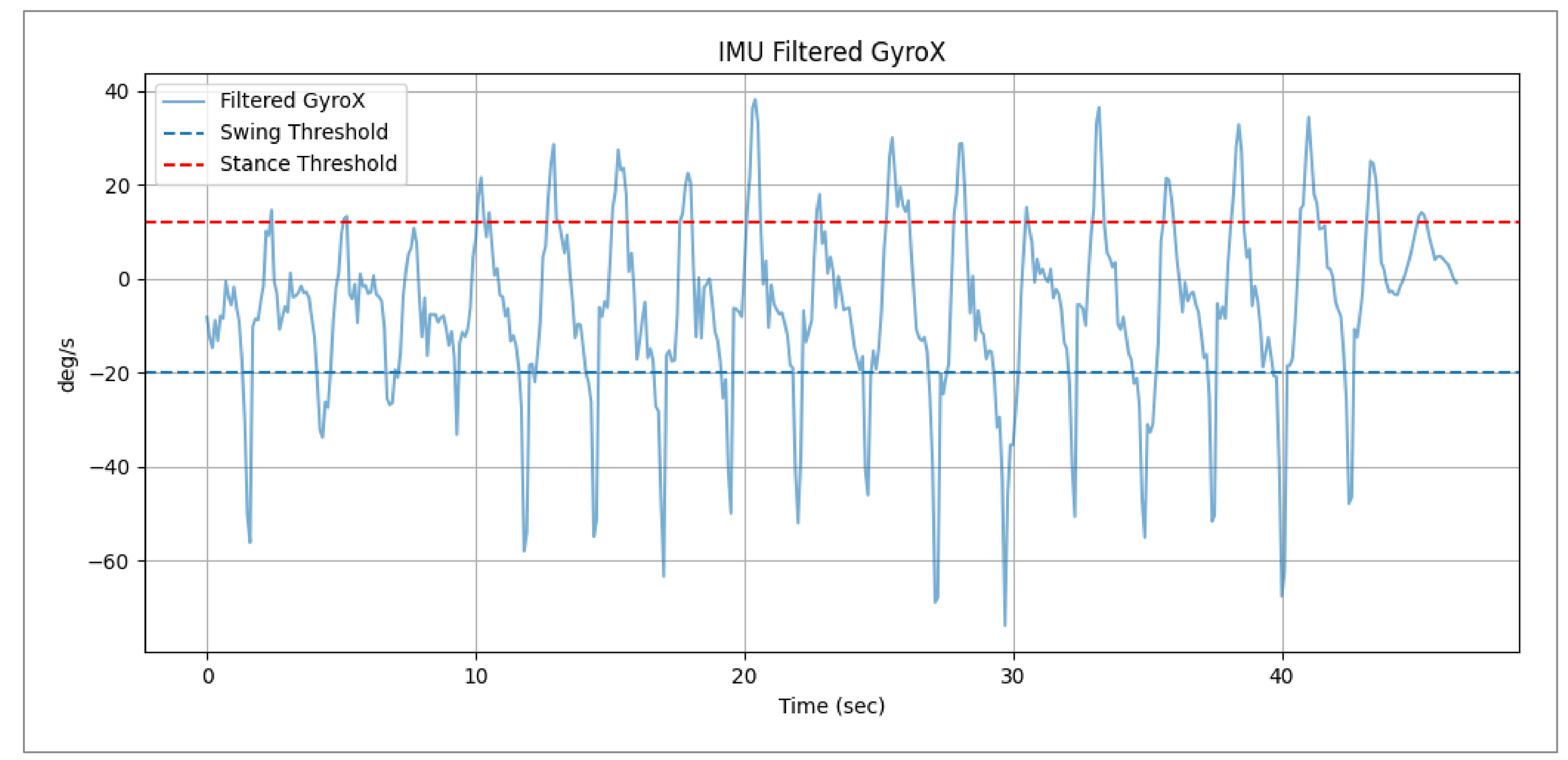


Our device consists of three main components; hip unit, knee strap, and shoe plate which are all connected with a Kevlar based cable. The hip unit is mounted using two belts around the waist and applies either tension or slack to the cable using a servo motor. The knee strap acts as a stop to mount the IMU case which doubles as a cable guide. The final connection point of the cable is on the shoe plate. This is an 1/8” aluminum plate installed into the sole of a shoe. This allows us to distribute the force applied with the cable throughout the base of the foot and not just the side of the shoe.

Prototype, Results, and Evaluation



The control board on the device has three buttons, each with a different function. One toggles the system on and off. While the system is off, the user can tighten or loosen the cable using the other two buttons (upper = tighter or lower = looser). This allows the device to be adjusted based on the user's height. If the system is on, the gait detection control is enabled. The control uses Gyro data from the IMU to predict stance or swing. The plot below shows lowpass filtered data, which lead us to select stance vs. swing control thresholds. When stance is detected, the cable tightens to support the ankle. When swing is detected, the cable is slacked, allowing free movement.



Conclusion

Our project displays how dynamic and adjustable wearable devices can provide a solution that patients can use in everyday life. By combining mechanical hardware and a sensor-based control system, we were able to create an ankle support device that adapts in real time to the user's gait, engaging support during stance and allowing free movement during swing.

In the future, we would be eager to implement another servo motor on the device, to add support torque for push off. Also, to create a sleeker device, we would make a PCB to condense all of the hardware and make a cover for the device only showing the LED lights and easy access to buttons.

Team roles & References

Joseph D’Anna: Mechanical design and Prototyping

James Walsh: Coding and Electronics