Gait Efficiency Enhancing Shoe (GEES)

Benjamin Matlack, Kyle B. Reed
University of South Florida College of Engineering

Introduction

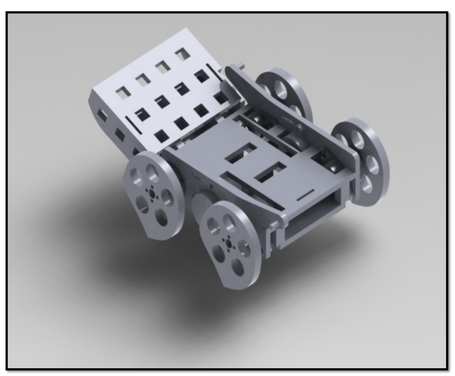
We developed a device worn on the feet that propels the wearer forward or backward while they are walking over ground. The goal was to aid in the rehabilitation of stroke victims suffering from asymmetric and inefficient walking patterns. The initial results showed positive results in changing gait patterns when worn on only one foot. In addition to correcting gait, this version uses two shoes to help healthy individuals walk faster and with less effort than normal walking requires.

The ability to walk around using less effort could be a beneficial tool for those on the go constantly throughout the day. The Gait Efficiency Enhancing Shoe (GEES) is a completely passive device that requires no external power and attaches to each of the user's feet. The vertical force that naturally occurs based on the weight of the user walking is used and converted into a horizontal motion using a novel spiral-shaped wheel. By wearing the GEES, all the user has to do is walk like they normally would and the device propels them forward by approximately 7 cm more than they would during a regular walking stride. Based on initial testing, the GEES shows great potential to be useful, but some design modifications are necessary to improve the comfort and stability for the user.

The Motivation

Everyone has their own unique walking stride, or gait, that will look different for each individual but contain the same motions as described in the figure for the "Human Gait Cycle". This project strived to develop a device that could improve the user's natural walking speed. Other goals hoping to be achieved from this include fixing any gait impairments and using less energy while wearing the device.

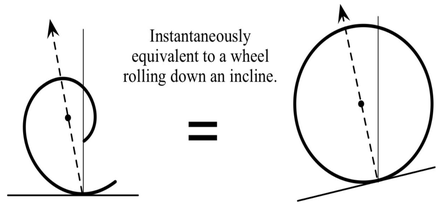
Human Gait Cycle



Solidworks® 3D rendering of GEMS, the design concept that inspired the look of the GEES

The Gait Efficiency Enhancing Shoe (GEES) is inspired by previous work done to assist in the rehabilitation of stroke victims with a device that can be attached to the user's foot. This device, the Gait Enhancing Mobile Shoe (GEMS), was developed as an alternative to using a split-belt treadmill to rehab those who suffer from hemiparesis, or an asymmetric gait. The GEES took the basic design of the GEMS and altered it to use more as a training tool for healthy individuals as opposed to a rehabilitation device.

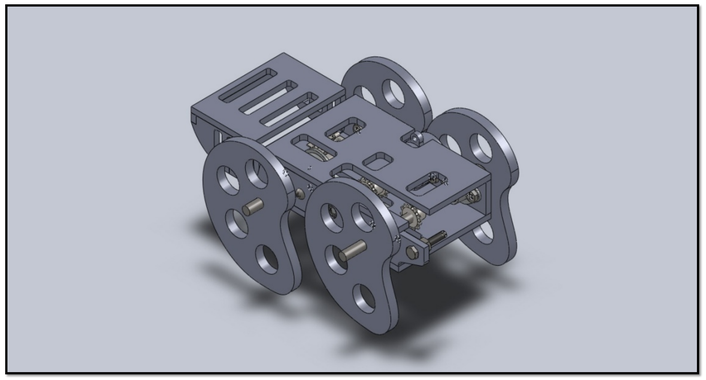
Schematic



Model of Archimedean Spiral Used for Wheel Design

To generate the forward motion for the device, an Archimedean spiral was used. This type of wheel shape:

- Provided very positive results when part of the GEMS study
- Redirects the wear's weight during the stance phase into a forward motion
- Allows for movement in the device to be completely passive
- Can be increased in size to allow for greater travel distances as the user becomes more comfortable wearing the device



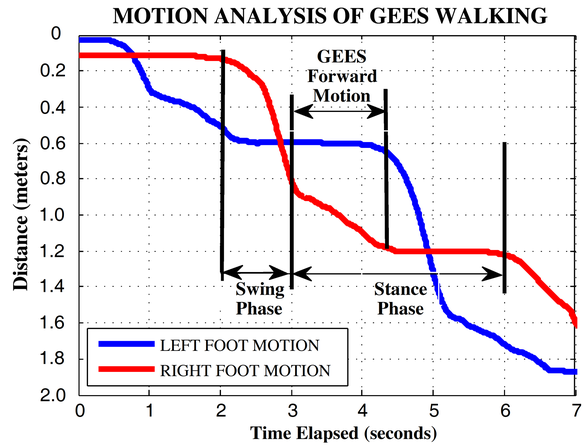
Solidworks® 3D rendering of GEES, Without Sandal Attachment

There are three main parts to the body of the GEES which is made entirely from delrin plastic.

1. The front piece is hinged to the back pieces and is designed in such a way that allows for there to be foot flexion when the user makes ground contact
2. The bottom back piece holds all of the mechanical components in place to create one fluid system to control the motion of the device
3. The top part has the sandal attachment bolted on and is easily removed to allow access inside

Results

A motion analysis of the GEES was done using the 3D VICON motion capture infrared camera system. The results below were taken from one trial and showed us the potential of this device. From the study we calculated a mean distance traveled of 0.3 ±0.09 feet and a mean velocity of 0.72 ±0.15 ft/s while wearing the device. A few minor mechanical issues within the GEES got in the way of longer trials being run but we found the initial results to be very positive.



Future Design Considerations

When moving forward with this project there are a few areas to look into adding improvements to the next iteration of the GEES

- Design the GEES to be more lightweight and comfortable to allow for a easier learning curve to walk in them
- Increased durability of mechanical components to allow for the testing of the device to last longer
- More room for components to function inside the body of the GEES as some objects were getting in the way of each other
- Testing of various wheel sizes to find which will provide the best comfort and performance for the any type of individual

Conclusion

The Gait Efficiency Enhancing Shoe was designed to allow healthy individuals to increase their walking distance as well as potentially correct any gait abnormalities that they may have. While it is early to tell if the GEES can provide all these benefits, the early results from testing have shown very positive results for increasing walking distance while also pointing out some areas for improvements in future designs. With the right combination of comfort, durability, and performance the next iterations of the GEES should be able to build upon what has been found in this study to produce the long term testing we need to show what this device can really do.

Acknowledgments / References

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