Is The Pizzicato Energy Harvester Viable In Real World Applications?

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Introduction

Energy is becoming a far more precious resource, modern requirements demand more energy than ever before. An energy harvester is designed to scavenge energy from various sources that would otherwise be wasted, this particular design aims to scavenge kinetic energy from a person, specifically from the knee joint. This research aims to further improve the understanding of the technology by collecting new data to improve future versions.

Aims

- Test the 2nd prototype of the Pizzicato Energy Harvester Prototype on simulator
- Design and construct an ergonomic brace to mount the harvester on the knee
- Test the harvester in real world applications
- Compare the differences in performance to investigate the viability of the harvester for assessed applications

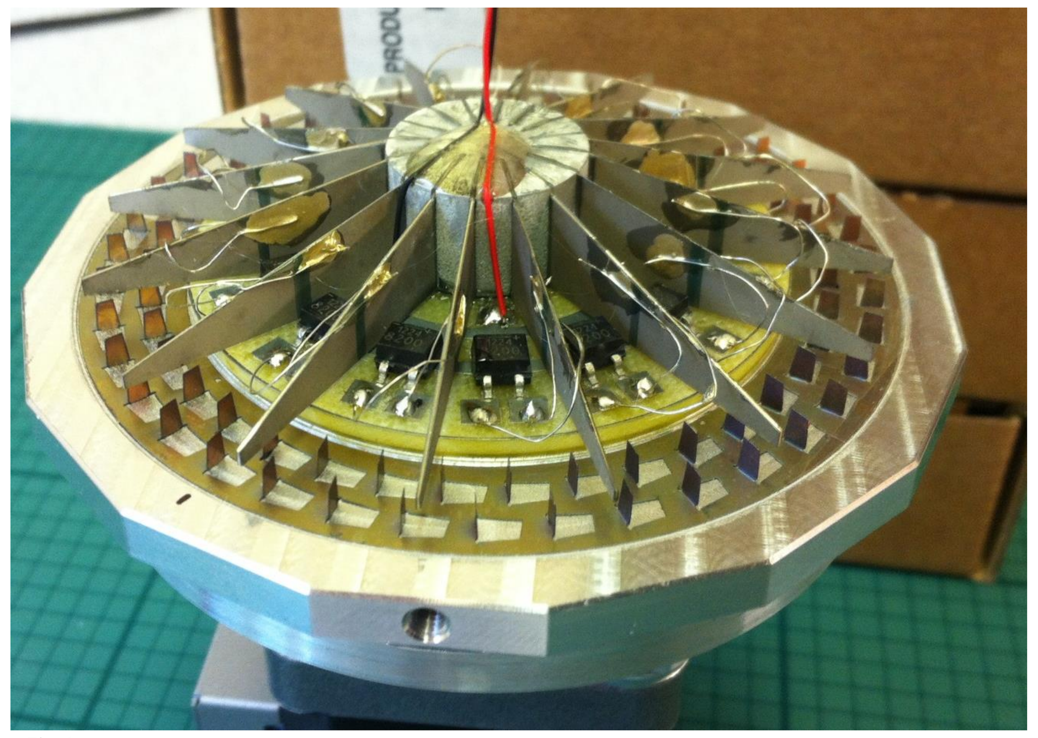
Fig 1


Fig 2

Method

- Mount 2nd prototype on simulator
- Collect gait data from study[1] to use in simulator
- Find optimum electrical load for maximum power output with trial and error testing
- Design brace to mount harvester on knee
- Manufacture brace
- Test harvester in real world applications, mimicking actions of gait data selected for simulation
- Compile data from all testing and compare the average energy harvested, see figures 3-5

Results

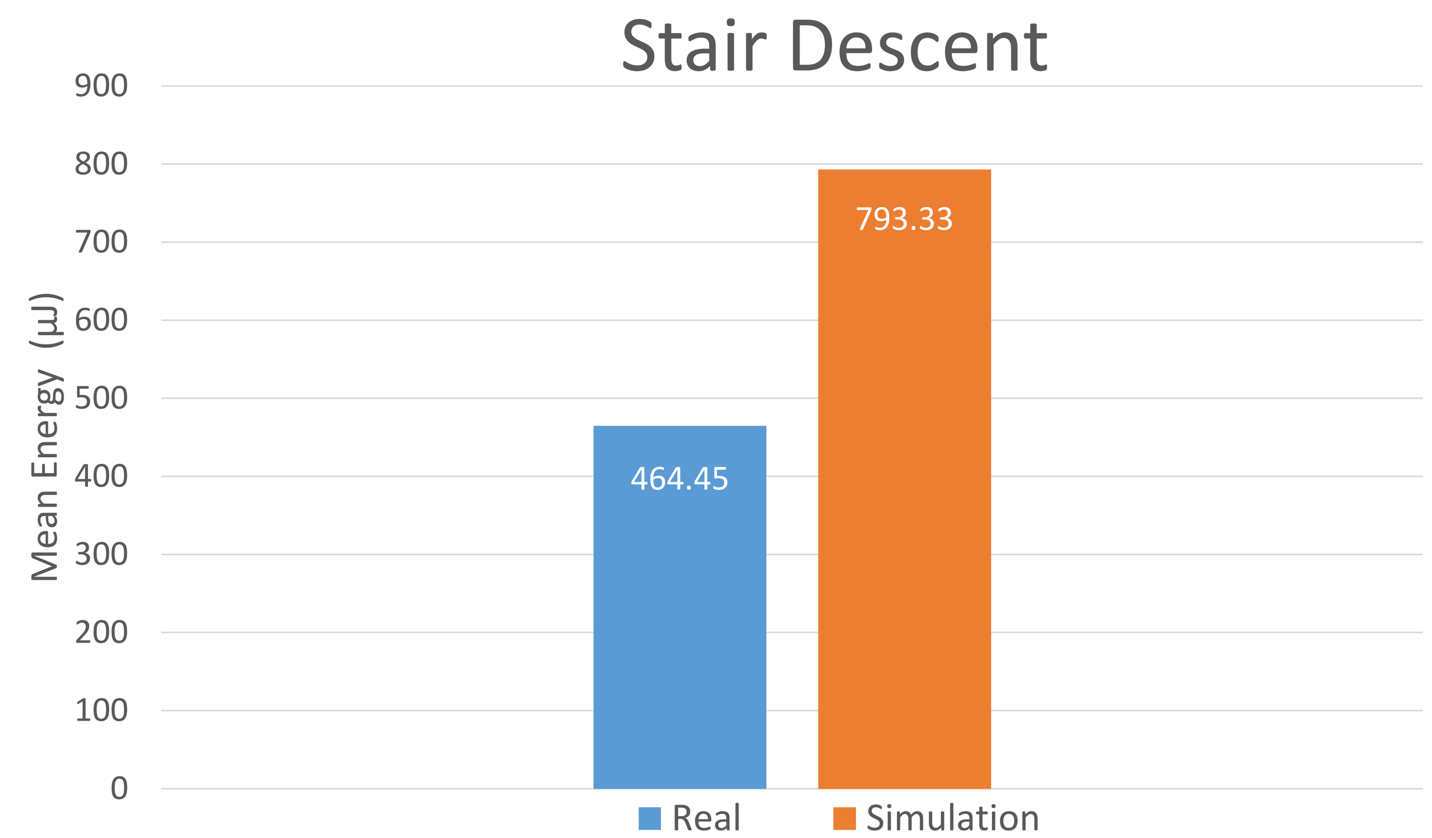

Fig 3

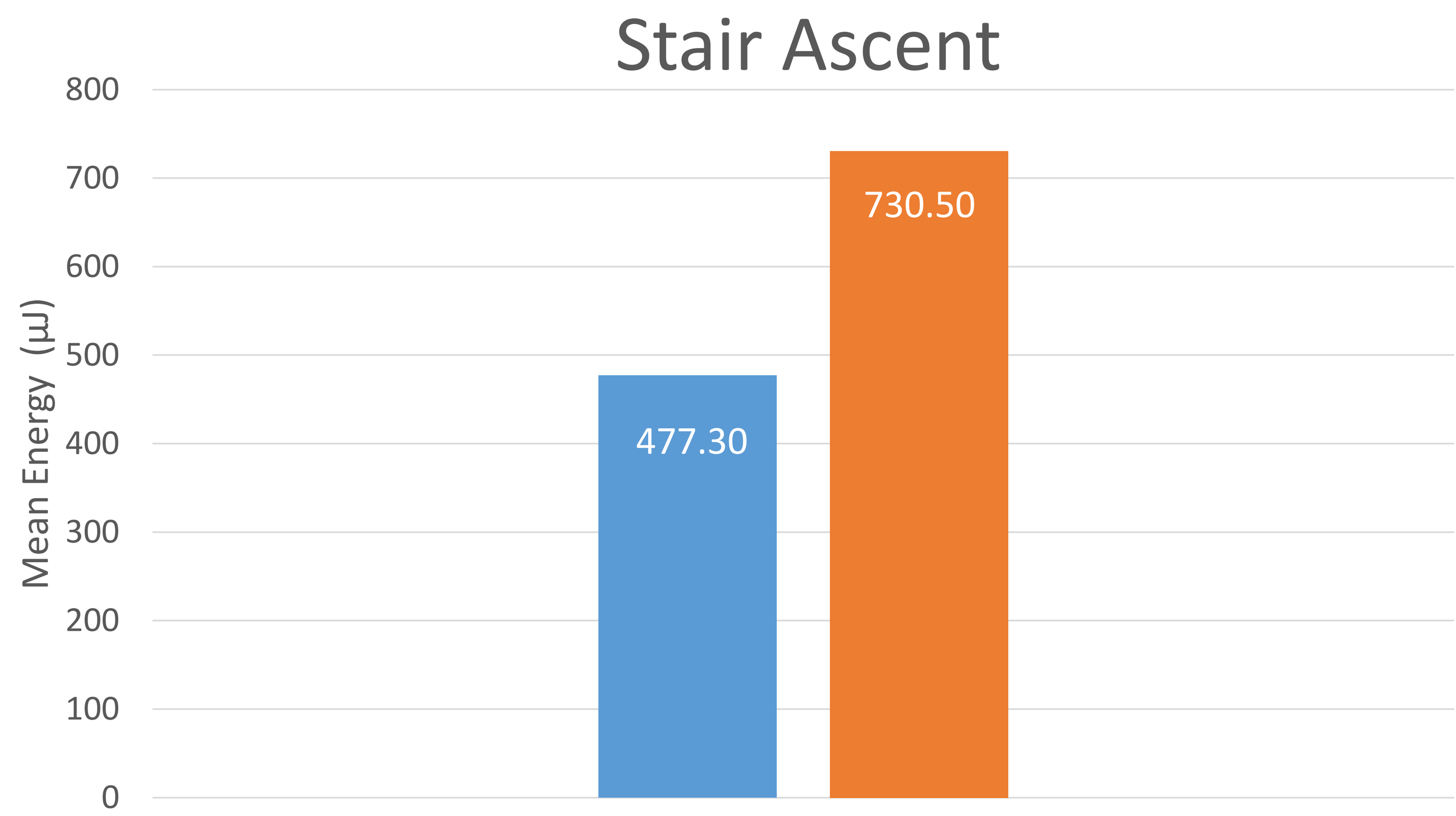

Fig 4

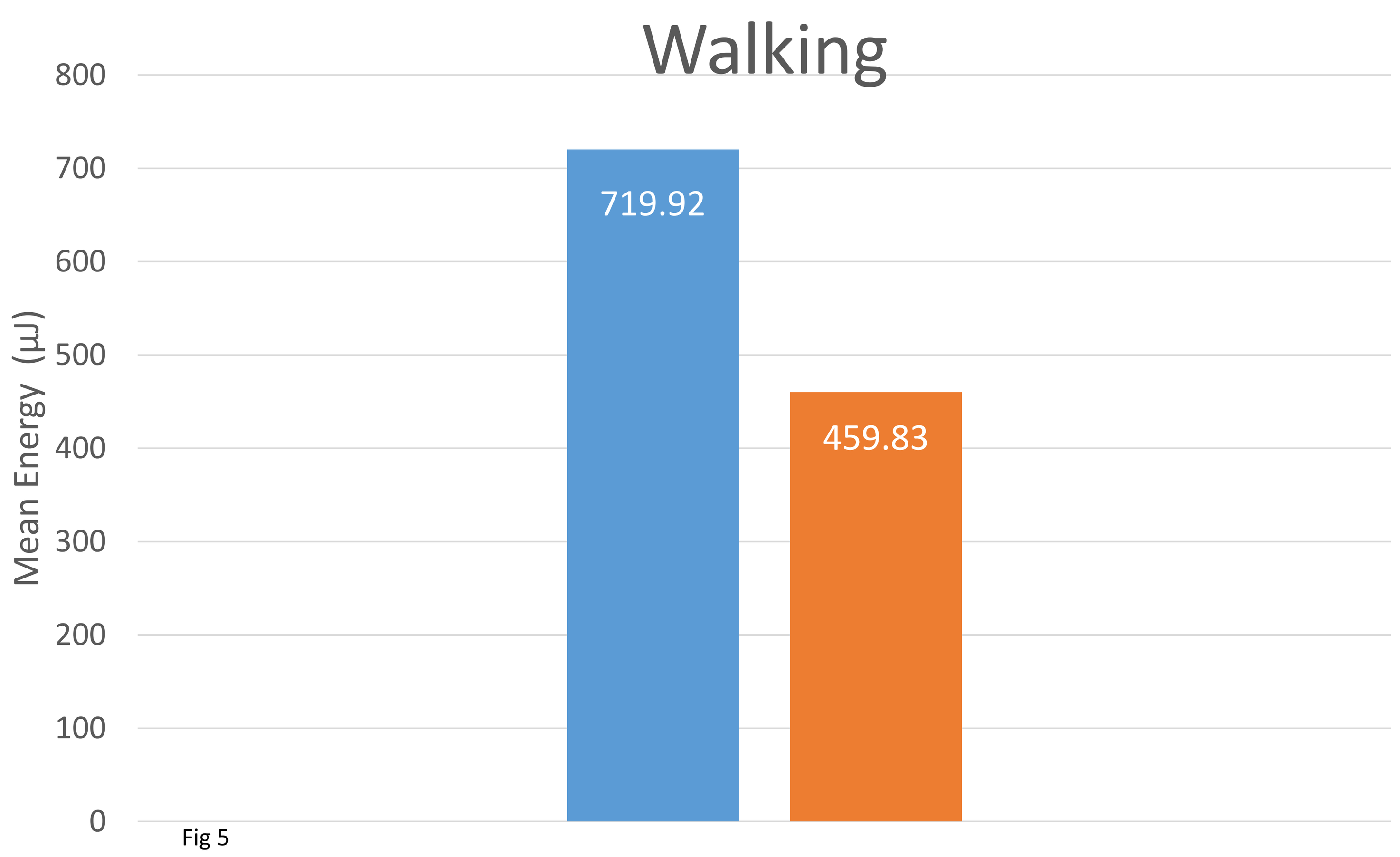

Fig 5

Discussion

Comparing the data between simulation and real world testing has shown a disparity in energy production. More energy was produced in simulation when ascending and descending stairs than when tested in a real world scenario, see figures 3-5. This is relatively unsurprising given the kinetic energy losses in the system; as the harvester may not have been located in the optimum position on the joint , furthermore valgus and varus movements are not accounted for in the simulation

Conversely, greater energy was harvested whilst walking in the real world scenarios, this seems unlikely given the previous results. However the simulation does not account for:

- Heel strikes
- Faster walking speed
- Greater flexion

The knee brace had varying degrees of success, it held the motor in position and allowed energy to be harvested. However it was found that during muscle contraction/expansion the brace would slip down the leg, causing the harvester to slip below the knee joint. Further to this excessive rotational movement of the harvester around the axis of the leg, led to misalignment. This, coupled with poor adhesion between the suspension strips, lead to the braces' failure. Better adhesive, less stiff suspension and increased rigidity in the brace could minimise these shortcomings.

Conclusion

- The principle behind the 2nd prototype is correct, that more piezoelectric bimorphs will create more charge
- Harvester is viable for tested conditions,
- Greater energy harvested in simulation when ascending and descending stairs, less harvested when walking
- The brace failed to securely hold the device due to adhesive failure and frequently required re-adjusting.
- A new plectra material needs to be considered as Kapton over relaxed with steel being too stiff, this could yield more energy
- As the simulation data was taken from a study[1] using a different test subject, more accurate results could be achieved if the same subject was used for both tests.
- A 2nd prototype of the brace should aim to move less on the knee and provide a softer suspension on the harvester

[1] *Gait characteristics of patients with knee osteoarthritis (Kenton R. Kaufman, Christine Hughes, Bernard F. Morrey, Michael Morrey, Kai-Nan An)*