Pseudo-Piezoelectric Foam Shoe

Sriraj Srihari; Wairimu Mwangi

Faculty Advisor: Dr. Mandar Kulkarni

Embry-Riddle Aeronautical University
Daytona Beach, Florida

Abstract

Due to the depleting levels of fossil fuels and their increased damage to the Earth, new methods of energy harvesting that do not have the same negative effects as fossil fuels need to be found. To overcome that, a new method of generating or conserving energy that uses energy from daily activities like running, walking, or cycling is proposed. A study into molecularly doped Polyurethane (PU) foam was done to find out if making a shoe sole that was partially piezoelectric would assist a piezo patch to generate more energy. This method was found to be ineffective as the process to make the foam piezoelectric was far too difficult to outweigh the benefits [5]. As a result, the shoe sole was developed without poling chemicals and only the patch was implemented to generate energy. A prototype is under development with the patch and other boards that are required to generate a direct 3.3V DC connection to the charging circuit so that every step assists in the charging of the shoe battery.

Introduction

The motivation in researching, synthesizing, and commercializing a pseudo-piezoelectric polymer foam lies in its mechanical properties and ability to retain thousands of load cycles. Doping foams with small polar molecules can create a system of polar moments within the foam skeletal structure. This in turn produces dipoles and long-range polar order within the modified foam. Though none of the materials used in the synthesis of this modified foam are inherently piezoelectric, when combined properly, a piezoelectric effect is present [3].

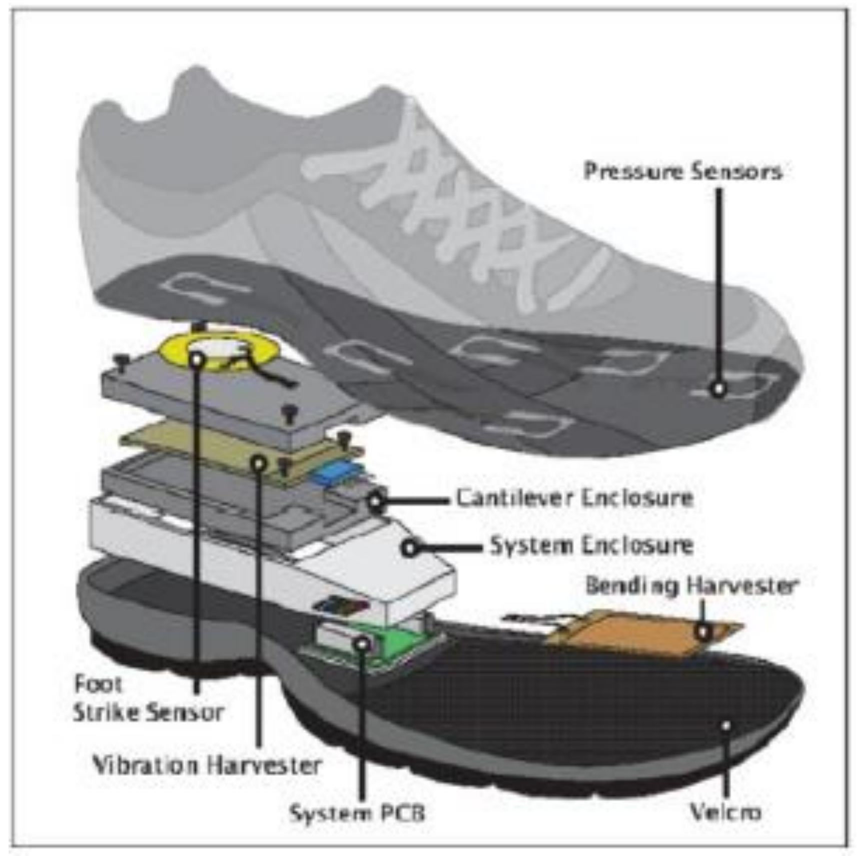

Figure 1 Basic composition of a smart shoe [1]

Despite the disadvantage of piezoelectric decay in pseudo-piezoelectric foams, it has been hypothesized that this can be combatted by the choice of precursors used during synthesis [3].

Future iterations of this project will incorporate poling techniques to successfully create a piezoelectric foam to assist the patch in generating even more energy.

Prototype Design

Figure 2 Initial Shoe Interior before shoe insert

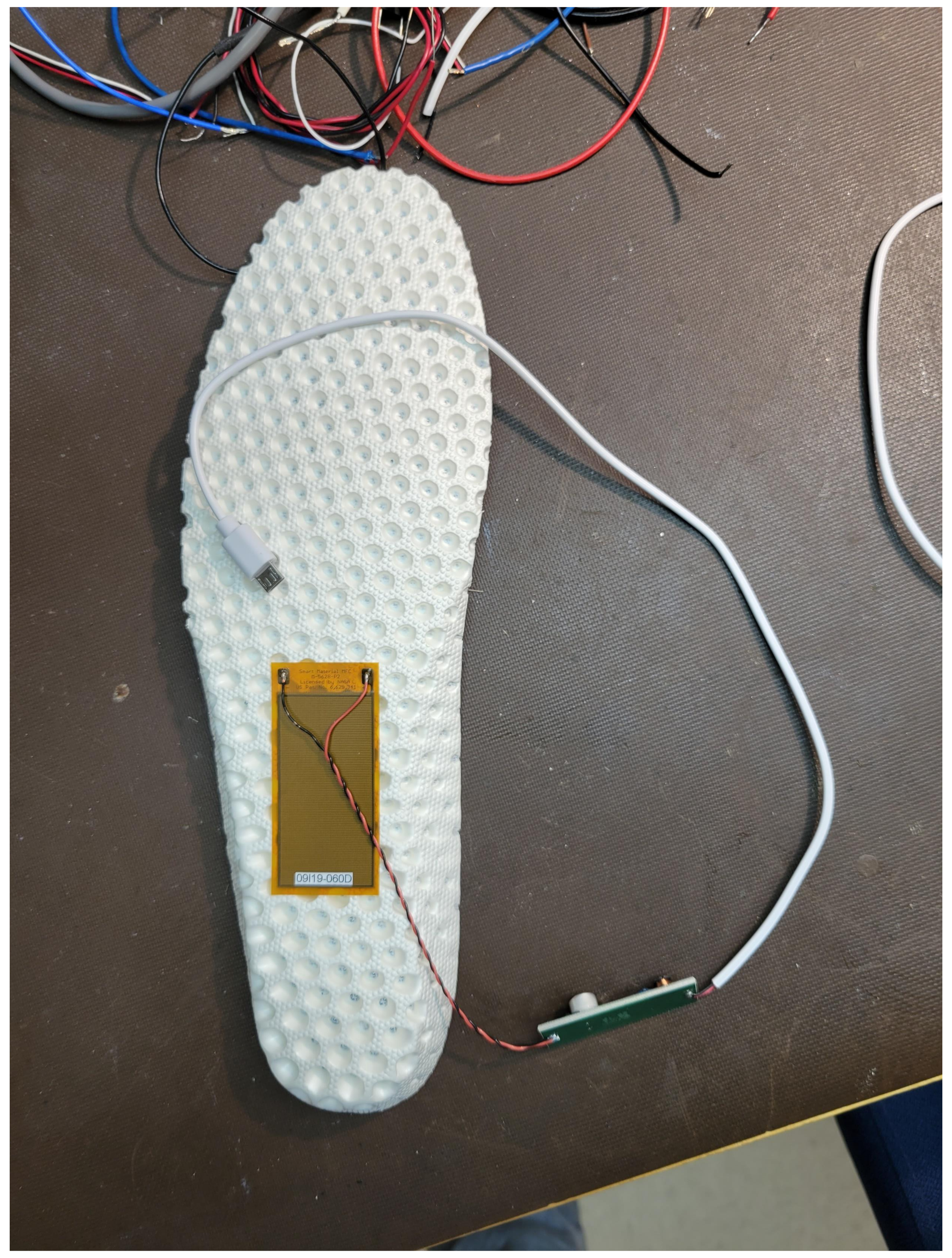

Figure 3 Sole insert with Patch, stabilizer circuit, and cabling

Method and Setup

Figure 4 M8528P2 Type Piezo-Patch

Figure 5 Shoe with Embedded Charging Circuit

The following processes were followed to install the piezoelectric patch on the shoe:

1. A 2-stage epoxy/hardener was used to adhere the patch to the shoe sole
2. The CL-50 chip had its PWM extensions removed, and lead cabling attached through soldering
3. Micro-USB cable used on the CL-50 output pins
4. Positive and negative cables attach the patch outputs to the CL-50 inputs
5. The sole is reinserted into the shoe with wires routed in the undersole plastic, cable plugged into the charging port

Figure 5 shows the internal setup of the prototype, including:

- A simplistic electrical design to minimize space
- P2 Piezoelectric Sensors (Contractor form) [2]
- CL-50 stabilizer circuit to output 3.3V DC [4]
- MicroUSB Cable into shoe charger
- Outputs approximately ~0.5 to 2 mJ per step [4]

Future Work/Innovations

- Investigating methods that track and report the energy produced by the patch
- Finding alternative polling methods that do not require large voltage
- Refining the shoe design – placement of wires, sole comfort, etc.
- Investigating industry and research applications of piezoelectric energy

Various Innovations can be developed through this project:

- Nonintrusive patch assistance would mean that the lightweight foam would not interfere with the patch behavior but still assist in energy generation
- Negligible weight of prototype (Prototype shoe barely any heavier than normal shoe)
- Easy to manufacture product that is useful in many fields

Figure 6 Final Shoe Prototype

References

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