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Piezoelectric Keyboard Mat: Repurposing energy through Piezoelectric Generators

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Abstract

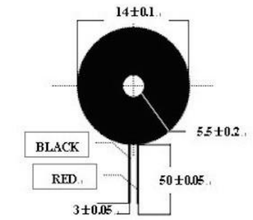
- As today's world becomes increasingly aware of the advantages of reusable energy, it is becoming very beneficial to look for sources of wasted energy in everyday life
- One source of mechanical energy comes from typing; the cumulative amount of wasted energy builds to a substantial amount
- Our goal is to build a piezoelectric energy harvester attached to a rubber keyboard mat and produce voltage from taps on the keyboard

Introduction

- The increase in pollution every year causes living organisms and their environments to suffer; air pollution alone costs an estimated $5 trillion annually [1]
- Pollution must be minimized one way or another; the answer lies in renewable energy
- Humans naturally create renewable energy through movement, but it is often lost to the surroundings
- Piezoelectricity is electricity produced by pressure on a material
- The piezoelectric effect involves squeezing piezoelectric crystals to create a current of electricity
- Keyboard strokes can potentially create significant amounts of piezoelectricity
- While piezoelectric keys have been subjects of past experiments [2], there is a need for a low-cost, easy-to-use keyboard

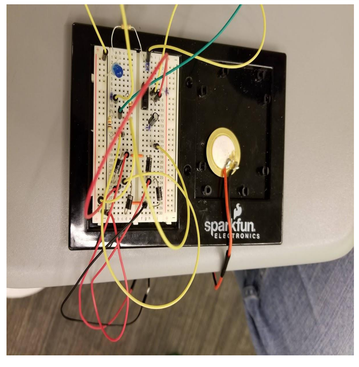
Method

- A single circuit of piezoelectric sensors is attached to a silicone keyboard cover
- Fifteen piezoelectric sensors used; each sensor covers one key on the keyboard
- All other keys have "dummy sensors," which are 3d-printed discs that have the same dimension as the sensors
- Sensors are wired in parallel
- Electricity produced is in alternating current (AC)
- For conversion to direct current (DC), a diode rectifier is used, which controls the flow of electricity into a single direction



Equipment

- 15 Adafruit 5.5mm piezoelectric sensors
- 4 diodes
- Wire for the circuit
- 2 silicone keyboard mats (one below and one above the circuit)



Data

Voltage ($V*10^{-2}$) vs. Piezos Pressed	Trial 1	Trial 2	Trial 3
1 piezo	4	9	8
2	17	10	23
3	41	38	30
4	68	74	62
5	85	93	95

68.4262
0.0000
0.0000
0.0000
0.0000
48.8759
0.0000
68.4262
0.0000
58.6510
0.0000
39.1007
0.0000
48.8759
0.0000
39.1007
0.0000
68.4262
0.0000
39.1007
0.0000
9.7752
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19.5503
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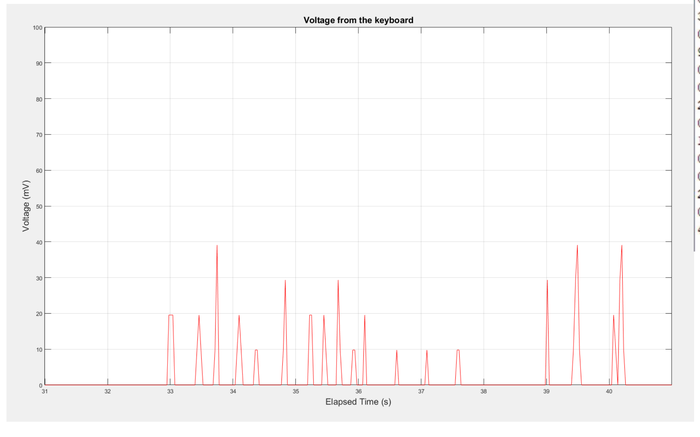
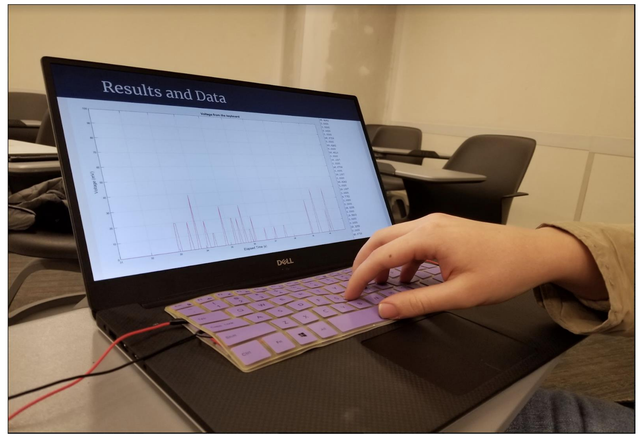


Results

- To test the board's functionality, we used the keyboard with the goal of lighting an LED
- Keyboard was connected to capacitor/LED circuit through Arduino board
- Voltage was also measured through Arduino board, and displayed live on a MATLAB plot
- In trials, one sensor produced up to 90 mV of voltage
- With 5 keyboard sensors pressed at once, a voltage of up to 950 mV was produced
- Due to the small size of the sensors and the high resistance of the diodes in the diode rectifier, the LED could not be lit directly
- To show the concept, a larger piezo sensor was used to light the LED
- The larger piezo lit the LED, proving that our keyboard can light up an LED with more efficient sensors
- If the keyboard is used one hour every day for a year, it would produce 11 Wh of energy, a small but significant amount

Conclusion

- This project proved that a piezoelectric keyboard is a viable source of energy
- Extra energy from keyboard use was successfully converted to usable electricity
- Design is portable and easily fits onto a laptop keyboard
- Installation and use of keyboard is fast and simple
- Design is adaptable for any keyboard, laptop or desktop, and can change sizes simply by adjusting the spacing of the sensors
- In future, a keyboard design with more efficient materials can be developed
- More efficient small piezoelectric dice sensors similar to the ones used in this design, or new technologies such as piezoelectric film [3] will help make the keyboard mat commercially viable



References

[1] Rempel, David, et al. "The Effect of Keyboard Keyswitch Make Force on Applied Force and Finger Flexor Muscle Activity." *Ergonomics*, vol. 40, no. 8, 1997, pp. 800–808.

[2] "Piezoelectric Keyboards Could Power Your Laptops by Typing." *Technabob*, 26 June 2011, technabob.com/blog/2011/06/26/piezoelectric -keyboard-power/.

[3] Piezoelectric Films | Kureha, www.piezofilms.com/products.html.