

Hong Kong Student Science Project Competition 2022

(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number:

Project Title: Piezoelectric speed bump

Project Type: Invention Design Proposal

To our best knowledge and after thorough literature research, as at 9/3/2023, there are similar works. If there are, the reference links are as below:

<https://www.sciencedirect.com/science/article/pii/S1875389215009438>

https://www.appropedia.org/Piezoelectric_Energy_Harvesting_Shoe

https://www.teachengineering.org/activities/view/uoh_piezo_lesson01_activity1

<https://www.autodesk.com/products/fusion-360/blog/piezoelectricity/>

The enhancement our project has made for the existing related products or research is summarized as below:

The first link references a research paper which investigates the possibility of using piezoelectric car dampers to generate electricity through absorbing the energy when a car hits an obstacle (e.g. a speed bump) and transforms it through piezoelectric materials into electricity, the result being power generation of about 0.5 mW. However, our design is likely to generate more electricity. Many drivers drive over possibly tens of thousands of speed bumps, meaning this would equal a lot of energy generated using this invention. Most speed bumps are used in areas like parking lots, many cars could potentially travel across the speed bump to access the parking lot, causing the speed bump to be able to harvest relatively more energy than a single car can. On the other hand, compared to the piezoelectric energy harvesting shoe, a stronger force will be exerted on the speed bump. As both inventions rely on the force of gravity, due to the larger mass of the object exerting pressure on the piezoelectric material for the speed bump (i.e. cars and trucks) as compared to the mass of the object exerting pressure on the piezoelectric material for the shoes (i.e. humans), the force exerted and therefore the energy gained will be higher.

I. Background

Over the past 2 decades, researchers have attempted to discover new energy harvesting technologies as an alternative for conventional power sources like fossil fuel energy sources. Piezoelectricity was one of the alternative energy harvesting solutions which were discovered by Pierre and his brother, Paul-Jacques Curie in 1880. They discovered that when specific crystals are compressed such as quartz, tourmaline and more, the voltage would be produced on the surface of the compressed crystal. This discovery led to modern piezoelectric technology, in which force is applied to certain piezoelectric materials leading to the production of electricity. Compared to other electricity generators like electromagnetic and electrostatic, piezoelectric is the better choice as it can produce electricity in a more effective, convenient and productive way. Although piezoelectric technology does not produce a large amount of electricity, it is extremely durable (Euklidiadas, Martinez). Piezoelectric materials can also generate electricity from sound waves. A research paper described how, when stimulated with acoustic waves, produced drastically more energy (Safaei, Mohsen et al.). So, piezoelectric materials would be perfect for speed bumps as both pressure and sound waves from the vehicle can result in a fair amount of electricity harvested and to be used.

[Research # 1 | Tomorrow City Research # 2 | Harvard.edu](#)

II. Objective(s)

We aim to propose a design for a piezoelectric speed bump which can harvest energy through piezoelectric materials while keeping the speed bump workable in slowing down the motion of vehicles.

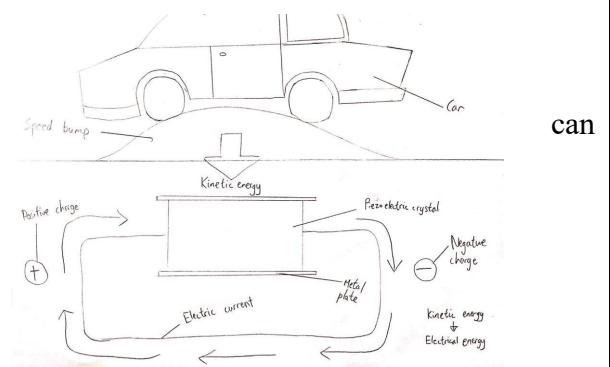
III. Methodology

Using a smaller model, we will test our invention by exerting force on the speed bump. Using a voltmeter, we can measure the amount of electricity our invention can generate. Firstly, insert the diadoes in the breadboard, followed by the piezo elements (a smaller model of our invention). Then connect the voltmeter with the breadboard. The voltmeter can record the amount of electricity harvested. The piezoelectric effect of the quartz allows an electric charge to build up between the two metal plates, and the charge runs down the wires connected to the voltmeter.

IV. Design of Invention

➤ Provide sketches or drawings of the invention

The piezoelectric quartz and two metal plates are used to convert kinetic energy to electrical energy. When the car collides with the speed bump, the kinetic energy of the car as well as its gravitational force exerts pressure on the piezoelectric quartz. It hits the plate and forces the electric charges in the crystal out. The excess positive and negative charges are at the sides of the crystal. Then, the metal plates take the charges and transfer them through an electric current. Therefore, electrical energy is generated through the kinetic energy during the collision between the speed bump and the vehicle. The wires can be connected to nearby electrical appliances so the electricity harvested charge the appliance. Even if the travel distance of the electricity can't be as far, little things add up and can genuinely change and overturn this climate crisis.



V. Application / Market Need

The market needs this invention which can generate a relatively high amount of energy as piezoelectricity is sustainable and also extremely durable, lasting for decades. This invention could introduce a green, sustainable source of energy that could in small ways reduce the number of fossil fuels and pollution our planet is currently facing. Compared to other sustainable sources of energy, for example, solar or wind-powered energy, the cost of this invention is relatively low and does not depend on external factors such as the weather. However, piezoelectricity only generates a small amount of energy and the energy generated has to be used in nearby places to minimize the energy loss. The current situation on climate change and global warming is worsening, but by using this piezoelectric effect, you can generate electricity just by normally driving your car through the road.

Conclusion

In conclusion, our project with piezoelectric materials would be convenient, effective, and productive, satisfying the needs of the market currently as well as in future as the HK government is planning to replace all cars with electric powered cars. Human activities emits a lot of greenhouse gases, and speed bumps can generate energy from them, making it a win-win situation.