INTELLIGENT TIRE– ENERGY HARVESTING FROM VEHICLE TIRES BY USING PIEZOELECTRIC CELL

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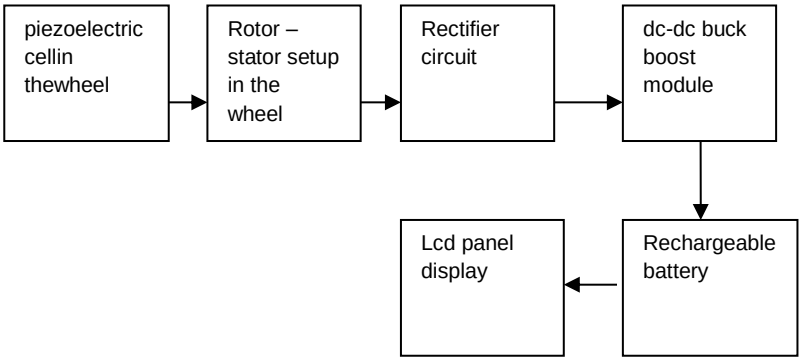
Abstract

Piezoelectric materials can be used to convert oscillatory mechanical energy into electrical energy. This technology, together with innovative mechanical coupling designs, can form the basis for harvesting energy from mechanical motion. Piezoelectric energy can be harvested to convert walking motion from the human body into electrical power. Energy harvesting systems can play an important role in extracting energy from sources that are already being wasted while there is a potential to sustain the amount of energy for sensors. In this project, a new geometry of strain-based piezoelectric energy harvester is proposed to preserve a significant fraction of tire strain energy. The output electric energy and voltage of the energy harvester are about 7 V, 5 mW and 90 μJ/rev, respectively. The obtained amount of output energy is sufficient to power many items in a vehicle. If the vehicle is electrical we can increase its mileage by adding this generated electricity to the main battery. Due to the nature of the piezoelectric material which can convert the stress or deflection to the electric charge, lately harvesting energy from different types of waste

Keyword: *piezoelectric ,energy harvester ,mechanical coupling designs ,mechanical energy, electrical energy*

Introduction

Piezoelectric cell can produce electricity from the mechanical energy applied on it . But the current technologies are not using this idea properly. The amount of energy produced from the piezoelectric is very low also. It is the main reason for avoiding piezoelectric cell . In the case of vehicle industry , there is lot of energy is wasted in wheels of it . We can restore it by placing the piezoelectric cell inside the wheel properly. This energy can be applied to the rotor-stator setup placed over the wheel centre . Then this energy will energize the coils in the rotor . As a result an electromagnetic field will develop over there. Then induced emf will produce over the stator coil . When the speed of rotation increases , emf produced also increases . This produced current will rectifies into dc and boost it using a buck boost module . And it will stores in a battery for further use.

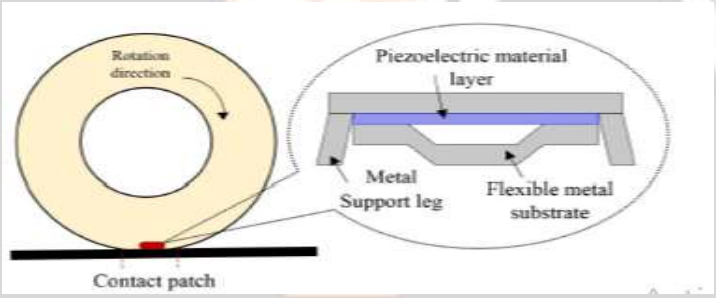


1.1 Block diagram of the working

Main components used here are piezoelectric cell , connecting wires , winding coils , dc-dc buck boost module , rechargeable battery , lcd panel display .The well integration of the above mentioned components make possible the energy harvesting in the vehicle

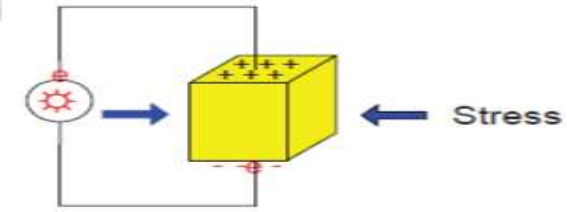
Construction and working

Construction of this project starts from the tire. First of all we have to place the piezoelectric cell inside the wheel . It is shown below in the figure 1.2 .



1.2 Arrangement of cell inside the wheel

This cell has a property called piezoelectric effect. It will helps the cell to develop electrical energy across the cell by applying mechanical energy across it and vice versa .

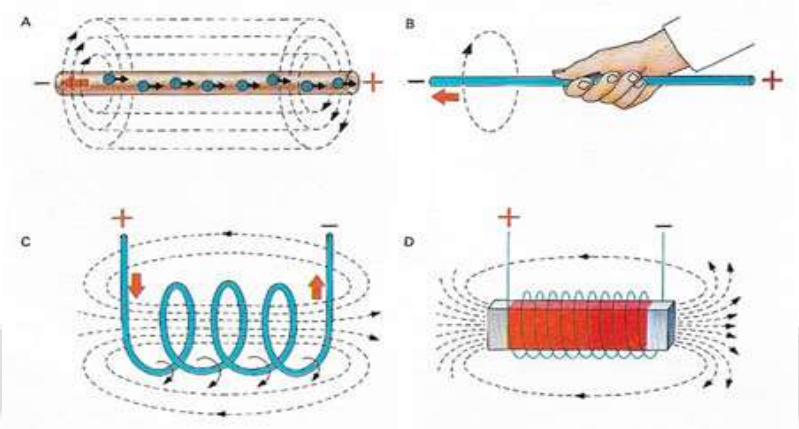


1.3 Direct piezoelectric effect

To make the energy harvester feasible for embedding on the inner layer of the tire, two support legs are designed and just the bottommost of the metal layer and leges are attached to the tire inner layer. The top metal layer is attached to the piezoelectric material layer. The middle art of the bottom metal layer is separating from the piezoelectric material layer with the use of a gap and the end parts are attached to the piezoelectric material layer . Because of the presence of the gap, the radial displacements is converted to the longitudinal displacement at the locations where the bottom layer of the metal is connected to the piezoelectric material. The area of energy harvester that is attached to the tire is roughly 0.3% of the tire inner surface area. The basic of strain-based piezoelectric energy harvesters is to use the longitudinal strain produced in tire while it is in contact patch as a mechanical input for direct piezoelectric effect. The inner surface of the tire becomes under tension.

In addition just after and before the contact, the inner surface of tire becomes under compression. It is obvious that the tension of the tire inner surface is higher than the compression before and after the contact patch.

The energy output from the piezoelectric cell is given to a motor setup(rotor and stator) over the centre of the wheel . rotor is attached to the wheel and stator is attached to the body of the vehicle . both this are placed 15 cm apart .the electromagnetic field produced in the rotor (by the energy from piezoelectric cell) will cause the formation of induced emf over the stator . it will depend upon the speed of the wheel and strength of the field . we can increase the field strength by adding some permanent magnet parallel to the temporary magnets(winding coils in the rotor)



1.4 Electromagnetic field

The output voltage of the energy harvester is an AC signal, an AC-DC convertor can be used if sensors need DC input voltage. In addition, vehicles travel with different speeds thus the output AC signal at different speeds is not uniform and using the AC-DC convertor can either used to have a consistent input power to the sensors.

1.5 Buck boost module

The **buck–boost converter** is a type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. the operation of the buck-boost is best understood in terms of the inductor's "reluctance" to allow rapid change in current. From the initial state in which nothing is charged and the switch is open, the current through the inductor is zero. When the switch is first closed, the blocking diode prevents current from flowing into the right hand side of the circuit, so it must all flow through the inductor. However, since the inductor doesn't allow rapid current change, it will initially keep the current low by dropping most of the voltage provided by the source. Over time, the inductor will allow the current to slowly increase by decreasing its voltage drop. Also during this time, the inductor will store energy in the form of a magnetic field.

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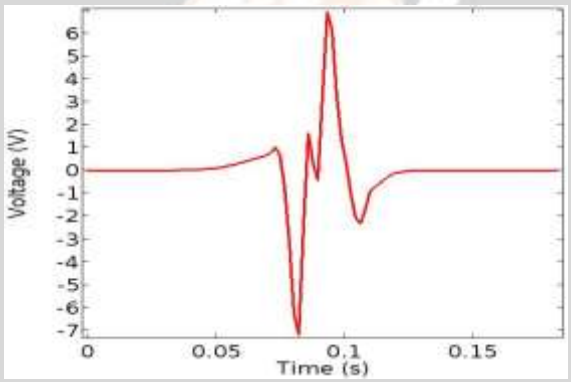
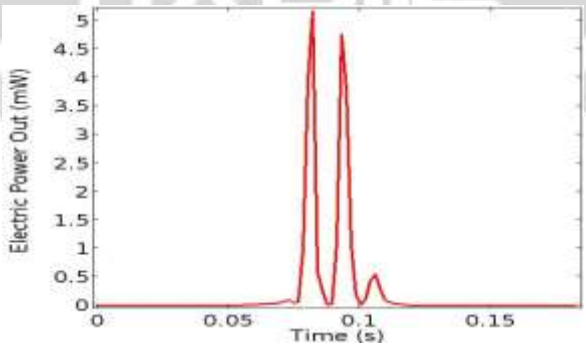
1.6 Rechargeable battery

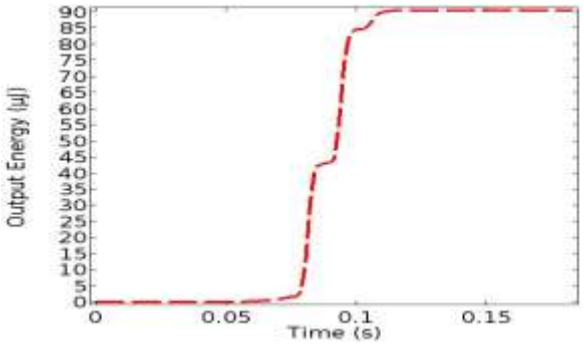
A rechargeable battery, storage battery, or secondary cell, (or archaically accumulator) is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of electrode materials and electrolytes are used, including lead–acid, zinc-air, nickel–cadmium (NiCd), nickel–metal hydride (NiMH), lithium-ion (Li-ion), and lithium-ion polymer (Li-ion polymer).



1.7 Output electric voltage for tire one complete rotation



1.8 Output electric power for tire one complete rotation



1.9Output electric energy for tire one complete rotation

Conclusion

We refered many paper related to our topic .Studied about different type of piezoelectric material and their power rating.when tire comes in contact with these piezoelectric material there is compression or tension happens and an energy is produced . This energy is enough to build an electromagnetic field in the coils and using this field we can produce emf over other coil by the rotational motion of the wheel . Proper conditioning of this signal will result a good storage of energy in the battery .The Piezoelectric materials have the ability to sense the mechanical strain and transform it into mechanical energy and further converted to electrical energy. The amount of energy generated depends on the number of passing vehicles and the number of piezoelectric elements on and around the road. Then this received energy is stored in batteries. This idea can be used anywhere to generate electricity and is also very cost effective.

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