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PIEZOTRANSDUCER GENERATOR ENERGY HARVESTING BIKE VIBRATIONS

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ABSTRACT:-The process of acquiring the energy surrounds a system and converting it into usable electrical energy is termed power harvesting. With piezoceramic materials, it is possible to harvest power from vibrating structures. It has been proven that micro- to milliwatts of power can be generated from vibrating systems. This paper express transformation of mechanical vibration into electrical energy using piezoelectric material. This paper presents a model of a piezoelectric transducer, a mechanical vibration spectrum, the simulation of the model, prototype of the power scavenging circuit, experimental results and its future perspectives.

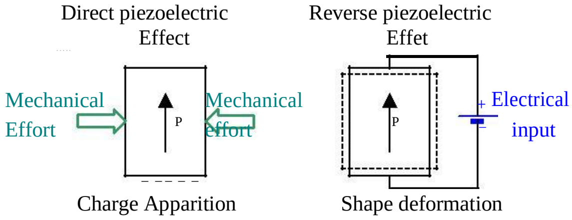
KEY WORDS:

Bike mechanical vibrations, energy harvesting, piezoelectric material, uninterrupted power supplies, portable device.

1. INTRODUCTION

Recent advances in wireless and micro electromechanical systems technology, the demand for portable electronics and wireless sensors is growing rapidly. Because these devices are portable, it becomes necessary that they carry their own power supply. In most cases this power supply is the conventional battery; however, problems can occur when using batteries because of their finite lifespan. For portable electronics, replacing the battery is problematic because the electronics could die at any time and replacement of the battery can become a tedious task. Supplying power through a long cable can be impractical, hard to install and maintain. Advances in integrated circuit manufacturing and low power circuit design have reduced the total power requirements of a wireless sensor node to well below 1 mW. The requirement of a power supply for small power electronics, a sensor in this case in the mining environment, is the main motivating factor of this project**.** Today we see more and more applications using piezoelectric transducers. Their use as a source electrical energy presents increasing interest for embarked electronic devices, low power consumption (less than 1 Watt) such as lamps based LED (Light-Emitting Diode), displays or sensors [1,2]. Noticing the a bike in movement is vibrating permanently, and that these vibrations are vectors of mechanical energy .we can recover and convert the mechanical energy contained in these vibrations into electrical energy by using electromechanical transducers [1,2,3], such as piezoelectric materials. The electrical energy thus produced can be used to power devices aboard the bike, or other portable devices that the cyclist uses.

This paper capture energy from the everyday motion of people traveling up and down a bike. We can modify a normal bike move a small distance and the vibrational energy will be converted to electrical energy using Piezo-electric Generator. From there, the energy will be stored in a battery for future use. Our main goal is to harvest as much energy as possible, without compromising the reliability and safety of tradition bike.



(Figure 1)

2. DESIGN

I. MOVING BIKE:

The bike will be start in daily. There will be a moving bike, which rebounds to its raised position via several springs under the moving tread plate. The tread plate will be hinged in the back to restrict the tread to one degree of motion. The tread will be limited in its vertical travel to about a half inch. We will be able to adjust the vertical travel of the bike via screw with an adjustable wing nut.

II. PIEZO-ELECTRIC MATERIAL:

The Piezo-electric material placed in the gap between the tread plate and the base is used to convert the mechanical energy (Vibrations) into electrical energy with the Piezo-electric generator.

III. LED OR OTHER LIGHTINGS:

The Electrical energy thus produced is used to power the LED's in the bike or the other lightings for the surroundings depending upon the amount of power produced.

3.PIEZOELECTRIC MATERIAL

The conversion of mechanical energy into electrical one is generally achieved by converters alternator type or commonly known dynamo. But there are other physical phenomena including piezoelectricity that can also convert mechanical movements into electricity. The piezoelectric effect exists in two domains, the first is the direct piezoelectric effect that describes the material's ability to transform mechanical strain into electrical charge, the second form is the converse effect, which is the ability to convert an applied electrical potential into mechanical strain energy figure 1.
The direct piezoelectric effect is responsible for the materials ability to function as a sensor and the converse piezoelectric effect is accountable for its ability to function as an actuator. A material is deemed piezoelectric when it has this ability to transfoelectrical energy into mechanical strain energy, and the likewise transform mechanical strain energy into electrical charge.

***A*.Experimental results on the bike**

We then mounted on the handlebar of the bike experimental piezoelectric generator supplying a lamp, which consists of a high brightness LED (Figure 2) associated with an electronic circuit that permit to have either a continuous lighting or flashing lighting

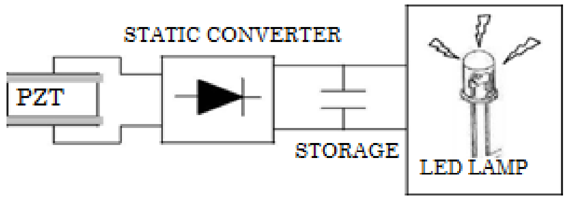


Fig 2: Bike LED lamp supply using piezoelectric material

Experiences reveal that on smooth track, such as a bike path, the light produced is lower than that obtained on uneven surface tracks, such as a paved runway. Those statements show at one side that the vibrations of the bike on uneven surface tracks are vastly superior to those obtained on a cycle track and at the other side that piezoelectric generator is a clean power source that could be an alternative to dynamo and improve battery lifetime.

GENERATOR PRINCIPLE

The vibrations energy harvesting principle using piezoelectric materials [4] is illustrated in figure 4. The conversion chain starts with a mechanical energy source: bike. Bike vibrations are converted into electricity via piezoelectric element. The electricity produced is thereafter formatted by a static converter before supplying a storage system or the load (electrical device).

In this study, before developing bike piezoelectric generator, it was essential to begin with mechanical vibrations sources identification that means carrying out vibrations accelerations and frequencies measurement and analysis. So we have carried out measurement at different locations of an experimental bike to identify the place where harvesting more energy is possible. We could then develop a piezoelectric generator adapted to the identified natural mode of vibration of the bike

BIKE MECHANICAL VIBRATIONS

We have equipped the bike with four accelerometers and a mobile vibrometer "SVAN 948" which includes 4 channels of data acquisition. It is then possible to carry out four simultaneous measurements of vibrations acceleration respectively at the fork, the handlebars, the saddle, and the frame. The accelerometers are mounted vertically to measure only the vertical component of acceleration. Figure 6 shows the four simultaneous vibrations spectra, respectively, at the fork, handlebars, seat and the frame. We noticed that it is at the handlebar or at the fork where the vibration is maximal the vibration acceleration is even more important when the displacement speed of the bike increases.(figure 2)

The first peak corresponds to the natural frequency of bike + cyclist. This peak is observed around 12.5 Hz, regardless of the speed and the track. The interesting frequency band to harvest energy, where 80% of the energy of the vibrations is concentrated, is approximately between 10 Hz and 30 Hz.

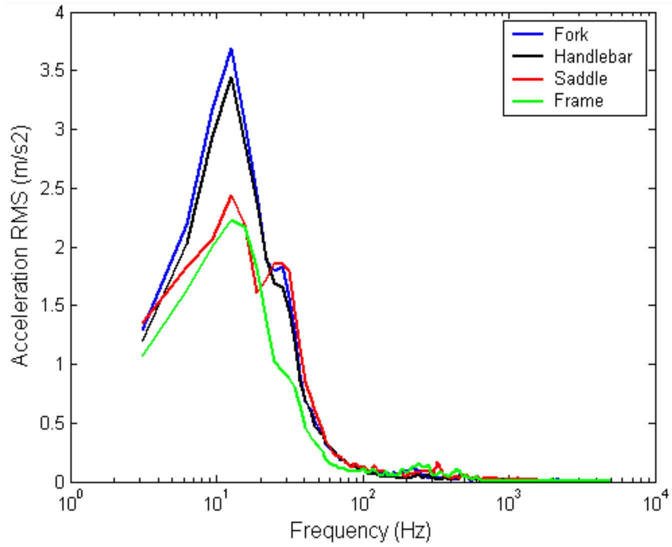
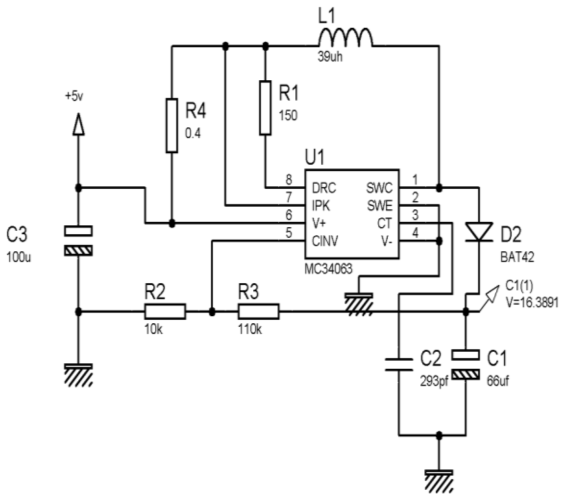


Fig 2: Vibrations acceleration measurement for the case of a bike rolling on uneven path at 8 km/h speed

Dynamo collects a small part of the mechanical energy provided by the cyclist to convert it into electricity. Normally, with dynamo, one never needs to worry about changing or recharging the batteries. Nevertheless, it often breaks down, or causes a rolling resistance excessive. But as everything is a matter of quality and price: it is true that the standard dynamos installed on new bike are often of poor quality, there are also some very good products [5]. There are three types of dynamo: The most popular type is the sidewall-running bottle dynamo, it runs on the side of the tire, costs inexpensive, starting from 5. Their major drawback is to slip under the rain, unless to take a top model, for example Dymotec S6 of Busch and Miller, which can be fitted with a wire brush roller "guaranteed" anti-slippage. Standard dynamos present low efficiency of about 20%. So for a cyclist who provides on average 100W power, 20% efficiency means that 15W is taken from the cyclist to run the dynamo. The "bottom bracket" models mount just behind the crank set and run on the centre of the rear tire. Their largest area drive limit slipping and their performances are often higher. There is currently a model manufactured by Basta, 50 euro's. One disadvantage: they are very vulnerable to projections of mud and water, and must therefore be strong for any challenge. The "hub dynamo" models are contained within the hub of the front wheel, and produce the least drag, but require change or rebuilding of the front wheel, and are the most expensive to purchase. Hub generators have some residual drag even when the lights are off, since the generator is always running. Their performance is exceptional, they never break down. By way of comparison: if in general sidewall dynamos have 20% efficiency, the same kind but more expensive can reach 40% to 70%; "bottom bracket" dynamos efficiency generally range from 50% to 70 %, and that of hub dynamos up to 90%. Some classical dynamos to piezoelectric generator. It must be noticed that this study is a prospective, thus, the generator that we have developed exhibits poor performance and is far from a marketable prototype. It is interesting to notice today that the benefits which can offer such a generator are for instance light weight because less than 50g, no drag and no wear because there is no friction on the tire and the mechanical energy recovered comes from the waste, but not an extra energy dragged from the cyclist, reliable because doesn't suffer from the weather (if placed in a waterproof box). Unlike the classic sidewall dynamo that slips when there is rain or snow.

8. DC-DC CONVERTER TECHNIQUE



Due to stress and strain caused by vibration to the piezoelectric material, dual polarity of charge results in an alternating current (AC), which is then converted into direct current (DC) by a full bridge rectifier. The rectified current is then used to charge a capacitor or a battery, which can hold energy. The maximum power transfer technique will be used to design the circuit for this energy conversion. DC-DC converter is used to maximize the power transfer to the load. The reason to use DC-DC converter is to convert a variable input voltage into a constant output voltage. For example, if the bucket. Capacitor 100 uF charges up with DC coming from the rectifier, the capacitor will have different values of charges stored at different times, and if we use PWM charging for the battery, the current into the battery will be regulated at desired level by changing the duty cycle of the PWM signal at the output of the DC-DC converter.

CONCLUSION

We aim to finish the initial Stage of our design as quickly as possible. This will give us another month to implement some improvements to our project which would expand the scope.

- Stage 2 of the project involves a microcontroller and a lighting system. We will put sensors on the stair steps to get signal of people walking on the bike. A good way to incorporate the lighting system into the bike is that when people are walking up or down the bike, LEDs for the next two or three steps will light up.
- Another marketable system is to put advertisements on the front panel of the bike and they will light up as people are walking up the bike. These ideas will be implemented with LEDs as output from the sensors and the microcontroller.
- We also considered making a display that could be placed besides the bike to inform users how much power they were generating. This would help promote the idea of “Green Design” by showing users that they really were generating energy. For this we would need a small microcontroller and some form of display. We would measure the voltage and current output of the generator.The cost of the Piezo-electric generator may come up to Rs.500 and the setup for the staircase was designed by us. The Li battery is available in the market for Rs.800 and the other circuits add up to Rs. 500. So the final budget for this project is around Rs. 1800. Advantages of this paper Harvest small, but still significant amounts of energy.An innovative approach to a device that people use every day.No compromise to safety or reliability.Marketing and appearance could encourage people to take the bike instead of energy intensive alternatives such as an elevator or escalator.

We have designed a piezoelectric generator and installed it on a bike handlebar; the first experiments we have conducted have shown that the few mW that produced the piezoelectric generator is able to power LED-lamp. Under ideal conditions such as pure sinusoidal vibrations at 5 ms^{-2} and 12.5 Hz, the power harvestable measured achieved 3.5 mW for an optimal resistive load of 100 kohm, power that is sufficient to recharge a battery, or to power low consumption devices.

REFERENCES

1. U. K. Singh and R. H. Middleton, "Piezoelectric power scavenging of mechanical vibration energy", Australian Mining Technology Conference, 2-4 October (2007), pages 111-118.

2. Roundy S., Wright P. K. and Rabaye J., "A. study of low-level vibrations as a power source for wireless sensor nodes", Computer Communications 26 (2003) 1131–1144.

3. Steven R. Anton and Henry A. Sodano, A review of power harvesting using piezoelectric materials (2003-2006), Smart Materials and Structures 16 (2007) R1–R21.

4. Y. C. Shu and I. C. Lien, "Analysis of power output for piezoelectric energy harvesting systems", Smart Materials and Structures 15 (2006), pages 1499-1512.

5. Jan Heine and Andreas Oehler, Vintage Bike Press Vol. 3, No. 4, 2005.

6. Chandrakasan, R. Amirtharajah, J. Goodman, W. Rabiner, Trends in low power digital signal processing, Proceedings of the 1998 IEEE International Symposium on Circuits and Systems (1998) 604–607.

7. W.R. Davis, N. Zhang, K. Camera, F. Chen, D. Markovic, N. Chan, B. Nikolic, R.W. Brodersen, A design environment for high throughput, low power dedicated signal processing systems, Proceedings of the IEEE Custom Integrated Circuits Conference (2001) 545–548.

8. M. Stordeur, I. Stark, Low power thermoelectric generator-self-sufficient energy supply for micro systems, 16th International Conference on Thermoelectrics (1997) 575–577.

9. T. Starner, Human-powered wearable computing, IBM Systems Journal 35 (3) (1996) 618-6.