Energy Harvesting using Free Energy Sources

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Abstract:

We propose an innovative method that provides synergy between energy scavenging and energy harvesting architecture. Thermodynamics first law states that, "Energy can neither be created nor be destroyed, but it can be transferred from one form to another". As we solely agree upon this statement, we move forward with our proposal, as it depends on that in many ways. We develop this harvesting architecture to meet energy crisis problem, which could become a major threat in near future. We use two sources in our proposal which could provide more efficiency and backup if one environmental energy is unavailable. One of the sources is pressure and the latter is vibration. This could efficiently deliver us enough energy to power AC loads.

Keywords—*energy harvesting; free energy sources; multisource architecture*

I. INTRODUCTION

Numerous sources and methods are available for power generation. One of the most successful methods is burning of fossil fuels. Unfortunately, it also corresponds to the emission of greenhouse gases which ultimately paves the way for global warming and ozone depletion. This has damaged our planet a lot proving, once a fiction, such as Global warming and greenhouse effect to come true. As a development nuclear energy sources has been employed which also came with a better disadvantage. Renewable energy sources are a breakthrough in electronics which provide sensible power supply without any major hazards to the environment.Free energy sources on the other hand are available in our day to day life and its instalment cost is also not that large. Several free energy sources are pressure, temperature, vibration, humidity etc. Free energy sources on the other hand are available in our day to day life and its instalment cost is also not that large. Several free energy sources are pressure, temperature, vibration, humidity etc. They give us the independence we need in terms of any unexpected natural calamities or in unpredictable circumstances of power failures. The main objective of this paper is to use free energy as both primary and secondary source. Though renewable sources are with minimized disadvantage, they are almost economically not viable, which is a major letdown for social use.

II. ENERGY HARVESTING ARCHITECTURE

Energy harvesting using free energy sources is always a challenge for industrialists, since it has the capacity to provide limitless power to the operating chamber. But, due to more technological obstacles and economical wastage, it has been under the wraps for a course of time. Now, though power taken from this architecture is low, they can be boosted to power an AC supply. Through this technical advancement, the area of free energy application has been dramatically increased. Though many sources are available in our environment, we choose two of the most viable and easily available sources, they are pressure and vibration. The principle we use here for both the sources is piezoelectric principle. The piezoelectric effect is nothing but the generation of charged particles, when a mechanical stress is applied. Piezoelectric effect can be experienced in crystals of quartz, tourmaline and Rochelle salts. We employ any of the above crystals to get the required output from our project. Piezoelectric effect can be observed frompiezoelectric sensor, which has the capacityto provide power proportional to the applied pressure.

Table 1 : Comparison Of Energy Harvesting Interface Circuits

No. of Source	Source type	Max. input voltage	Harvested power	Efficiency
1	Piezo	5V	10 – 100 µW	85%
1	Piezo	n.a	3.96 mW	80%
1	Piezo	n.a	3 mW	n.a
2	PV, TEG	3V	0.225 – 2.5 mW	97%

n.a = data unavailable; TEG = Thermal gradients; PV= Photo Voltaic.

Analog to digital converter is used here to measure the level and intensity of the results from available sources. The power obtained from the sources is analog, which is then converted to digital, since microcontroller is capable of accepting only digital inputs. The microcontroller we use is ATMEL AT89S52, which has an operating voltage of +5V,

suitable for prototype levels. We also require a low power converter, which is very much essential in this project. The power obtained from the sources will be less, hence we use low power converter to boost the power to the required level. The power obtained now will be DC (Direct Current), which is stored in the ultra-capacitors. Ultra capacitors literally has the capacity to replace both primary and secondary batteries. Both primary and secondary batteries are avoided for this application because, the environmental sources can be extreme under certain circumstances and batteries are not suitable to work under extreme conditions. They would result in extreme calamities as they are explosive. Ultra capacitors on the other hand are somewhat expensive but would provide safety and can store virtually hundreds of volts higher than batteries, thus a potential opponent for batteries. The stored charge is given to a DC power bank for efficient storage and to prevent from discharge. The outputs from DC power bank and microcontroller reaches the relay switch, which controls the ON and OFF states of outputs. The states of relay are adjusted as per our requirements and required output can be obtained.

III. BLOCK DIAGRAM AND EXPLANATION

In this section, the block diagram which is explained above is elaborated technically. The main objective here is to make the device to keep working, even when the power is low or below the threshold level. However, that is possible only for few minutes. The next objective is to increase the efficiency of this energy harvesting application by eliminating batteries.

A. System Input Source

Since, this project focusses on multisource energy harvesting, we use two sources which are deemed to be primary source and secondary source. The primary source is Pressure and the secondary source is vibrational energy induced through cantilever. These sources provide mechanical energy which must be converted into electrical energy for our requirement. Hence, we use MEMS (Micro Electro Mechanical Systems), they has numerous application but typically, they are used to convert mechanical energy into electrical energy. MEMS are capable of detecting both dynamic and static acceleration. So, required input can be obtained through this process. Thus, the pressure and vibrational sources provide us with certain power in our hands through which we have to progress.

B. Processing the Obtained Power

The power obtained from the MEMS and piezoelectric sensor will be lower than required. Hence, we use ultra-low power converter to boost the acquired power to get required power. This project employs switching regulators, which are much efficient than linear regulators. Switching regulators can be used to boost, invert and reduce the given input. The charge phase is typical for almost all switching regulators, where the current that passes through the inductor rises linearly with time at a rate proportional to the input divided by the inductance.

The discharge phase of the switching regulators determine its application in this project. To boost the output from a lower input, naturally the duty cycle of the regulator must be reduced. For boost converter, the output voltage obtained will be,

$$V_{out} = V_{in}\left(\frac{1}{1-D}\right);\ D = \frac{Ton}{Ton + Toff}$$

where V_{out} is the output voltage, V_{in} is the input voltage, D is the duty cycle, Ton is charge timeand Toff is discharge time.

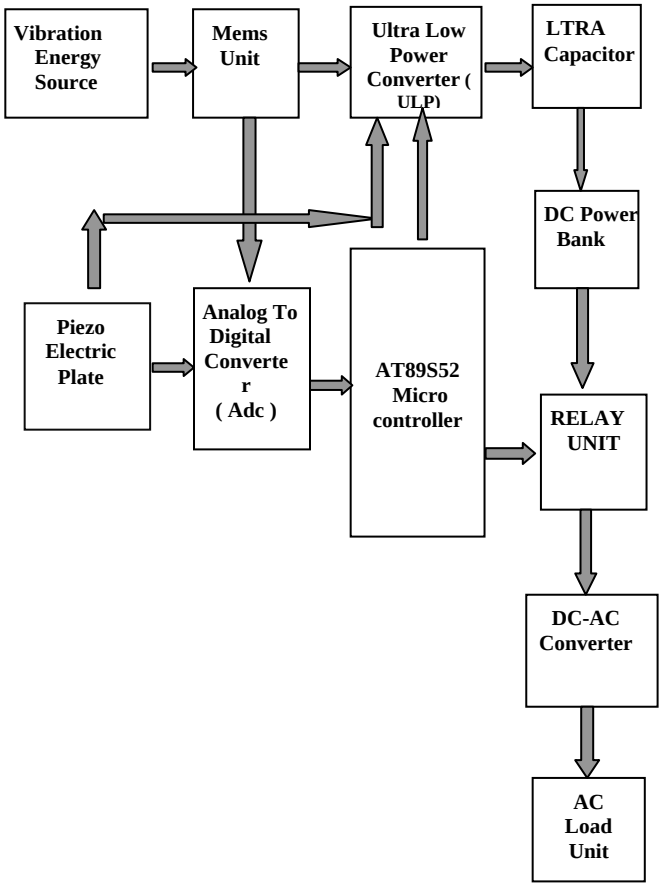

Fig 1. Block Diagram of Multisource Energy Harvesting Architecture

C. *Energy Storage*

The power obtained after so many process is DC current source, hence a sufficient storage space is needed for the energy we have harvested so far. The use of battery is already compromised due to the harsh environmental conditions, hence ultra-capacitor is used. But due to the discharging capacity of ultra-capacitor, we use DC power bank to store it in a safer way. Then a relay unit is added to control the functioning of the device. Now, the obtained power is ready to be employed. There must be no limitation in usage, hence a rectifier is used along with a filter and a regulator for the safety of the host devices. This obtained power can now be used to run AC appliances or to power batteries etc. depending on the user.

IV. NEED AND APPLICATION OF THIS PROJECT

One of the main objectives of this project is to meet the challenges regarding power crisis. The problem of Power crisis in our country is increasing day by day and lavish measures are taken for it, ignoring simple and constructive methods such as free energy harvesting applications. As already mentioned, free energy sources are available in our environment vastly as in the form of

- Thermal gradients.
- Acoustics.
- Vibrations.
- Pressure etc.

The application of the sources in free energy harvesting architecture may vary depending on the availability of the environmental energy. Hence, no matter whatever the application, any source can be utilized. The project undertaken uses pressure and vibration as its sources, which can be applied effectively in speed breakers, laptop or PC keyboards, pedestrian pavements etc. By executing this application in busy places such as pedestrian pavements, subways, in the speed breakers of busy roads etc., we can provide enough power to illuminate the light used in that areas and no need of allocating separate branch for those lights from transmission lines. Hence usage of power can be reduced and saved.

This application has its limitations, as every potential application poses i.e. this application might not be suitable to be used in large area usability. By using these in large area applications, they pose some serious economic weightage, instead the effective alternative will be renewable energy sources such as solar energy, windmill, ocean tides etc. Thus, not only this project but every other domain will also cherish depending upon the applications.

V. CONCLUSION

We all live in the era of technological breakthrough where one day supersedes another day by a new technical achievement. But no matter how far we evolve, we search for something new, failing to utilize the resources available now. Free energy sources are a great boon to mankind by our nature, where it helps us to meet the synergy between the energy scavenging and energy harvesting technology. Effective usage of these resources could help our people in a large scale by saving power and economy. The multisource architecture proposed in this paper is one way of using free energy sources effectively, since it increases the efficiency of the device considerably as shown in Table 1. As of now, this architecture is capable of running numerous small applications and future technologies could make certain advancements, where the free energy sources might be able to power for more time and for lager area with less economic constraints.

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