Enormous approach of Energy scavenging from human activities for embedded systems

Sweta Kumari[1,] Poonam Priyadarshini[2]
swetajha.ec@gmail.com[1] , ppbitpatna@gmail.com[2]
Birla Institute of Technology, Mesra, Patna Campus

ABSTRACT

As battery has been the source of energy for most mobile, wireless, embedded and remote system applications. This era is fully dependent upon novel technologies which is to be associated with battery operated terminals. Now, there is an alternative method for ubiquitous computing requirements in the fields of embedded systems, wireless sensor networks and low power electronics such as MEMS devices, which is known to be an Energy Harvesting. The process of extraction of ambient energy from the surrounding environment is called Energy Harvesting. The main aim of project is using green energy of sources for several applications such as consumer electronics, medical applications and sports training areas. In this paper, several methods of energy harvesting are employed from human's activities like movements, body heat etc for optimizing the life time of devices.

INTRODUCTION

The extraction of energy from one form to another is known to be Energy Harvesting.
Today, we are surrounded with several technological devices like Mobile, Laptop, RFID cards, watches, calculators, pacemaker, ECG etc, which can be operated with the help of batteries inside it. So there is the one driving force behind the search for new energy harvesting techniques to power sensor networks and mobile devices without batteries. As the storage energy of harvester circuit is used for low power applications viz. glowing LEDs, charging of mobile and laptop and also for medical applications like pacemakers, ECG, EEG, Blood sugar measurements, etc. It uses simple harvester circuit for getting better life span for many applications. And also uses different types of materials like piezoelectric and thermoelectric harvesters. It is safe and pollution free techniques towards global warming.
The energy burnt by human body in their daily activities like walking or straightening the joints or carrying a backpack is 10.5 MJ. Just going into a fast sprint from resting, the human body dissipates approximately 0.1 – 1.5 kW [1]. Harnessing this energy dissipated by human could potentially solve the problem of replacement of biomedical implants by acting as a source of energy for such devices.

Background of the technology

The most vital factors arise in the world are Global Warming and climate change and to minimise the impact of this problem, there is the novel techniques of energy harvesting which have few benefits towards the older technologies. [2]

1. It Reduces dependency on battery power: Harvested ambient energy may be sufficient to eliminate battery completely.
2. Reduce installation costs: Self-powered wireless sensors do not require wires, conduits and are very easy to install.
3. Reduce maintenance costs: Energy harvesting allows for devices to function unattended and eliminates service visits to replace batteries.
4. Provide sensing and actuation capabilities in hard-to access hazardous environments on a continuous basis.
5. Reduce environmental impact of hazardous chemicals.

The energy harvesting sources can be used to increase the lifetime and capability of the devices by either replacing or augmenting the battery usage [3-8]. The devices powered by energy harvesters can be used to provide vital information on operational and structural circumstances by placing them in inaccessible locations.

Basic Energy Harvesting Circuit

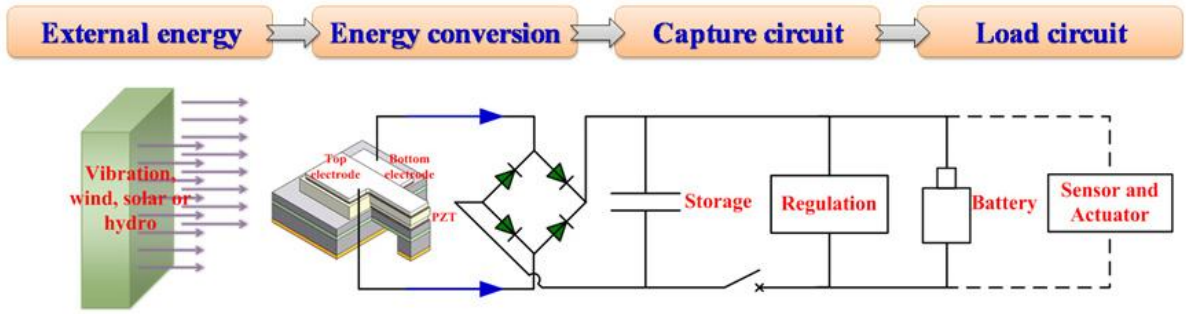

Fig.1. Basic Energy Harvesting Circuit

Several methods for Energy Harvesting

In this paper we are discussing the energy harvesting techniques used in two different ways. One is piezoelectric and other is thermoelectric energy harvesting. Mechanical energy is the process of extracting energy form of enforcement or displacement excitation while Thermal energy depends upon body heat and employs the property of thermoelectric materials.

Concept of Piezoelectric / Thermoelectric energy:

The piezoelectric effect is the linear electromechanical interaction between the mechanical and the electrical state in crystalline materials with non-inversion symmetry [9]. It was first discovered by Jacques and Pierre Curie in 1880 when they found that certain ceramic crystals when subjected to mechanical strain became electrically polarized and the degree of polarization was proportional to the applied strain. The main advantages of using the piezoelectric transducer over the inductive or the capacitive ones are direct generation of

suitable voltages and currents [10], and small mechanical damping. Unlike the variable capacitors, they do not necessitate of separate voltage source [11].
Thermoelectric generator (TEG) is used for converting human body heat energy to electrical energy. Thermoelectric generators follow the principle of thermoelectricity to produce the required electrical energy. The phenomena of creating electric potential with a temperature difference and vice-versa can be termed as thermoelectricity. Here, the thermal energy is scavenged to obtain electrical energy to power the electronic devices. And among various energy harvesting methods, thermoelectric energy harvesting on human body has advantages that human body heat is steady and large [13].

Power Density Observed by Different Techniques

Table 1.

Harvesting Technology	Power Density
Solar cells (at noon)	15 mW/cm^3
Piezoelectric (shoe inserts)	330μW/cm^3
Vibration (small microwave oven)	116μW/cm^3
Thermoelectric (10°C gradient)	40μW/cm^3
Acoustic noise (100dB)	960nW/cm^3

Applications evolved in different energy harvesting methods

Power generation through Subway

The piezoelectric crystal arrays are laid underneath pavements, sidewalks, speed-breakers for maximum voltage generation. The voltage thus generated from the array can be used to charge the chargeable Lithium batteries, capacitors etc. These batteries can be used as per the requirement [2].

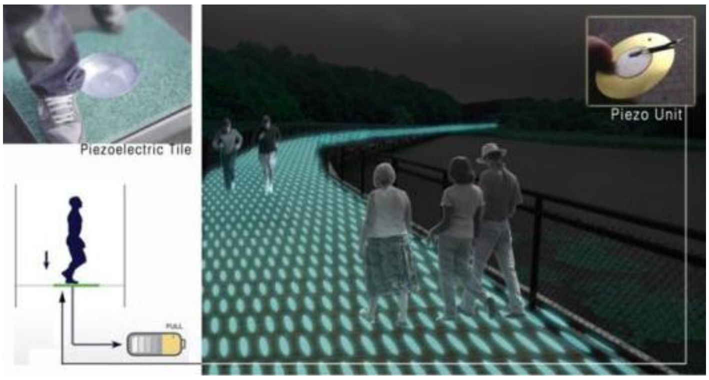

Fig.2. Harvesting energy by side walks

Gyms And Workplace

Researchers are also working on the idea of utilizing the vibrations caused from the machines in the gym. At workplaces, while sitting on the chair, energy can be stored in the batteries by laying piezoelectric crystals in the chair. Also, the studies are being carried out to utilize the vibrations in a vehicle, like at clutches, gears, seats, shock-ups, foot rests [2].

Fig.3. Gym & workplace extracted Energy

People Powered Dance Clubs

In Europe, certain nightclubs have already begun to power their night clubs, strobes and stereos by use of piezoelectric crystals. The crystals are laid underneath the dance floor. When a bulk of people use this dance floor, enormous amount of voltage is generated which can be used to power the equipments of the night club [2].

Fig.4. Electricity Generation in Night Clubs

Mobile Keypad & Keyboards

The piezoelectric crystals can be laid down under the keys of a mobile unit and keyboards. With the press of every key, the vibrations created can be used for piezoelectric crystal and hence can be used for charging purpose [5]. The energy produced from the mechanical pressure on the buttons is directly stored in the systems battery passing through a rectifier.

Fig.5. Keypad Touching Energy

Muscle Movement Driven Nanogenerator

We demonstrate a piezoelectric nanowire based nanogenerator that converts biomechanical energy, such as the movement of a human finger and the body motion of a live hamster (Campbell's dwarf), into electricity. A single wire generator (SWG) consists of a flexible substrate with a ZnO nanowire affixed laterally at its two ends on the substrate surface [14-16] . Muscle stretching results in the back and forth stretching of the substrate and the nanowire. The piezoelectric potential created inside the wire leads to the flow of electrons in the external circuits.

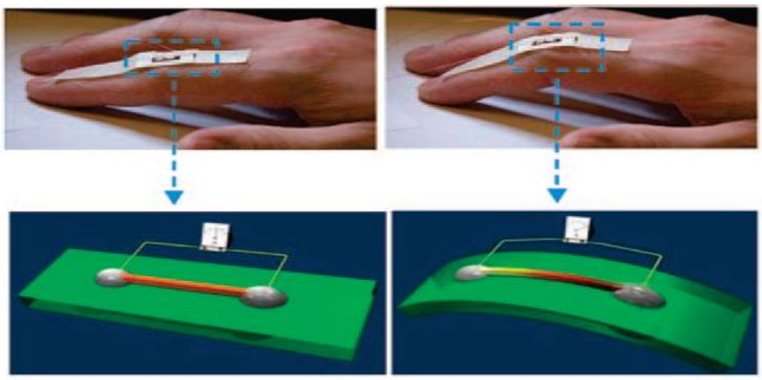

Fig.6. Muscle –Movement SWG

Conclusion & Future Work

We have discussed several approaches for energy harvesting from human activities. Hence this review is expected to increase research efforts to develop the battery-less implantable devices with reduced over hole size, low power, high efficiency, high data rate, and improved reliability and feasibility. Many more approaches of energy harvesting should be used in future from human body such as chemical energy, urine & feces, sleeping mattress for embedded systems. As human body energy is safe and pollution free. It will be tremendous innovation in future of making battery-less devices in every field e.g. medical applications, consumer & military applications.

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