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# Mobile Charging using Footstep and its Wireless Transmission

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**Abstract—***This paper reviews the footstep power generation using piezoelectric material, and transferring of energy to the mobile phone using the power transfer through wireless energy transmission using magnetically coupled resonant system, dipole coupled resonant system(DCRS) and inductive powe transferr system(IPTS) wireless technology .The paper also directs towards the future application of this technology .*

**Keywords***: Piezoelectric, wireless transmission, IPTS, DCRS*

## 1. INTRODUCTION

Consumer use of wearable electronic devices has grown significantly in the present decade. With increasing use come demands for decreased size and enhanced capabilities, now it is the time for new ways to supply electric energy to these devices. An approach to power the devices by the daily works of our body without any extra efforts by scavenging waste energy from human activities. For example, the average person spends a significant part of the day on walking, dissipating abundant energy into the insole of a shoe, this wasted energy could be used in a variety of low-power applications, such as a a battery could be charged by the shoe which can provide the power to charge the cell phones (we can charge the devices by just walking) as the Smartphone today consumes a lot of power.


Thad Starner's benchmark conceptual investigation in 1995 analyzed various human activities and found that the heel strike during walking is the most plentiful and readily tapped source of waste energy [1]. Starner estimated that 67 watts of power are available in the heel movement of an average (68 kg) person walking at a brisk pace (two steps per second with the foot moving 5 cm vertically). Scavenging most of that energy would be impossible. But even a small percentage of it (up to a sizable fraction of a watt), removed imperceptibly, would provide enough power to operate many of the body worn systems on the market today and an approach to transfer this energy from the shoes to the cell phone is wireless transmission not by the cumbersome wire so as to make the walk easy

## 2. PIEZOELECTRICITY

The piezoelectric effect a material's capacity to convert mechanical energy into electrical energy and the inverse is observable in a wide array of crystalline substances that have asymmetric unit cells. When an external force mechanically strains a piezoelectric element, these polarized unit cells shift and align in a regular pattern in the crystal lattice.

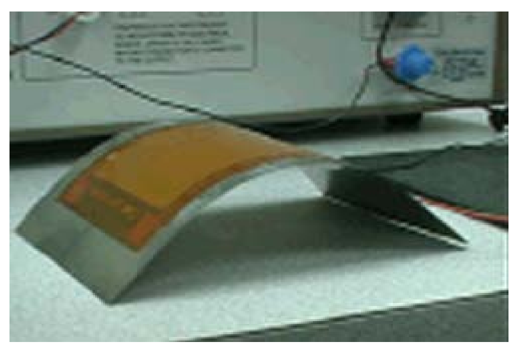

**Fig. 1: Piezoelectric material**

The discrete dipole effects accumulate, developing an electrostatic potential between opposing faces of the element. Relationships between the force applied and the subsequent response of a piezoelectric element depend on three factors:

1. The structure's dimensions and geometry

2. The material's piezoelectric properties

3. The mechanical or electrical excitation vector.

## 3. PIEZOELECTRIC MATERIALS

There are mainly two types of piezoelectric materials namely crystal and ceramics. Commonly known Crystal piezoelectric material is quartz ($SiO_2$) and the ceramic piezoelectric material is Lead Zirconate Titanate (PZT).PZT is the best piezoceramic. But to make an pure PZT perfect .doping of piezoelectric material is performed to modify its characteristics. especially the hardness or softness of the material, for example, doping the Sb2O3,Nb2O5,BaCO3 etc.

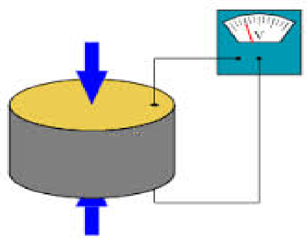

**Fig. 2: Piezoelectric material**

## 4. MODES OF OPERATION OF PIEZOELECTRIC CRYSTALS

The modes in which the piezoelectric crystals work are

1. Thickness shear
2. Face shear
3. Thickness expansion and
4. Transverse expansion

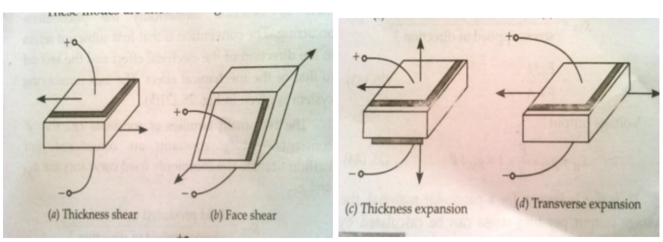


**Fig. 3 a) thickness shear b) face shear c)thickness expansion d)transverse expansion**

Mode of operation to scavenge the energy from the shoes is the thickness expansion mode.

## 5. PIEZOELECTRIC GENERATOR TYPES

Available piezoelectric generator types are [2]

1. Two terminal circle type
2. Three terminal circle with brim feedback
3. Three terminal circle with centre feedback
4. Two terminal square type

## 6. HOW TO SCAVENGE ENERGY FROM SHOES

Nathan S. Shenck and Joseph A. Paradiso at MIT Media Laboratory in 2001 [2] researched that for energy scavenging from shoes there are two main method.

1. One method is to harness the energy dissipated in bending the ball of the foot, using a flexible, multilaminar polyvinylidene fluoride (PVDF) bimorph stave mounted under the insole.
2. The second method is to harness foot strike energy by flattening curved, prestressed spring metal strips laminated with a semiflexible form of piezoelectric lead zirconate titanate (PZT) under the heel.

### 6.1. Setup And Equivalent Circuit Of Piezoelectric Crystal

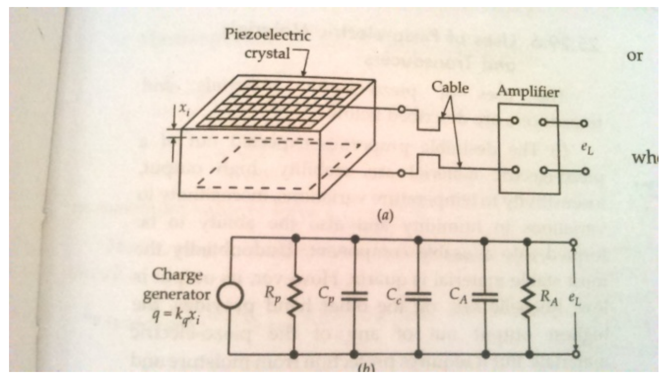


**Fig. 4 a) setup of a piezoelectric crystal b) equivalent circuit**

## 7. WIRELESS TRANSMISSION OF ENERGY

The energy transmission techniques can be mainly classified into 3-types [3].

1. The first category is electromagnetic radiation wireless energy transfer, also called the technology of far field wireless transmission. The technologies transfer energy by electromagnetic wave like radio frequency signals. The most commonly used technologies are microwave energy transfer (MPT) and laser energy transfer (LPT);
2. The second category is non-radiated inductively coupled energy transfer (ICPT) which belongs to the near-field wireless transmission technology and based on the law of electromagnetic induction. The technology is based on conventional transformer principles that both sides of the transformer are isolated and the energy transfer by one side of the transformer is coupled to the secondary side through the air gap or other dielectric induction.
3. The third category is the technology of non-radiation magnetic resonance wireless energy transmission which is also regarded as a near-field wireless transmission technology. According to the different transmission media, it can be divided into magnetic resonance wireless

energy transmission technology and electric resonance wireless energy transmission technology. The technology uses resonant body that has the same resonance frequency, when separated by some distance it can realize energy transmission by resonance with magnetic or electric fields as media interaction, and belongs to the revolutionary wireless energy transfer technology.

In 2006, a research team headed by Marin Soljacic, who is an assistant professor of physics in the Massachusetts Institute of Technology (MIT), proposed a new concept of magnetic coupling resonance wireless energy transmission [4]. Based on the coupled mode theory, they demonstrate the feasibility of the technology called “Witricity” which is able to transfer energy wirelessly. The experimental verification was conducted successfully in 2007. They think that a coupled resonators system which shares the same resonant frequency (such as sound, electromagnetic fields, etc.) can realize high-efficiency energy transfer, and the system have little effect on the surrounding environment which has different resonance frequency. In the experiments, they used two self-resonant spiral coil with radius of 30cm and high quality factor (Q = 950) as a resonance to transfer energy. When the operating frequency was around 9.9MHz, they successful lighted up a 60W bulb 2m away. The energy transmission efficiency was about 40% to 60% [5, 6].

## 8. CONCLUSION OF WIRELESS TRANSMISSION OF ENERGY

Changbyung Park, , Sungwoo Lee, Gyu-Hyeong Cho, and Chun T. Rim on this year February[7] given the conclusion that the 5m-off-long-system of inductive power system technology(IPTS) The dipole structure coil with a ferrite core instead of conventional loop type coils used in the CMRS is more effective for a power supply and is size is also small which can be carried out easily.[7]maximum output powers and primary-coil-to-load-power efficiencies for 3, 4, and 5 m at 20 kHz were 1403, 471, 209 W, and 29%, 16%, 8%.

As it is proposed to be used in a mobile so the 5W power with zero frequency is transferred.

## 9. SYSTEM BLOCK DIAGRAM

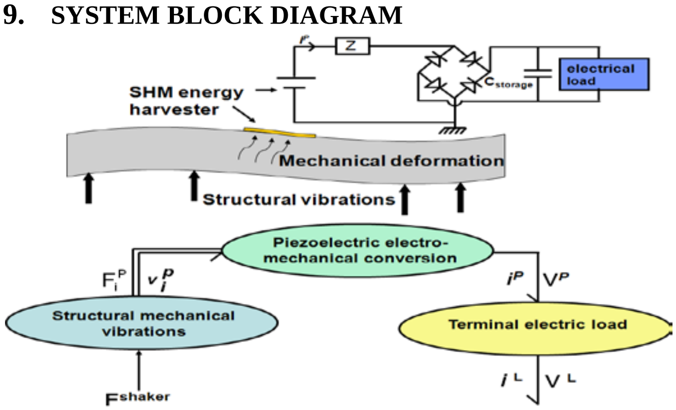


**Fig. 5: Schematic diagram of piezoelectric harvesting process**

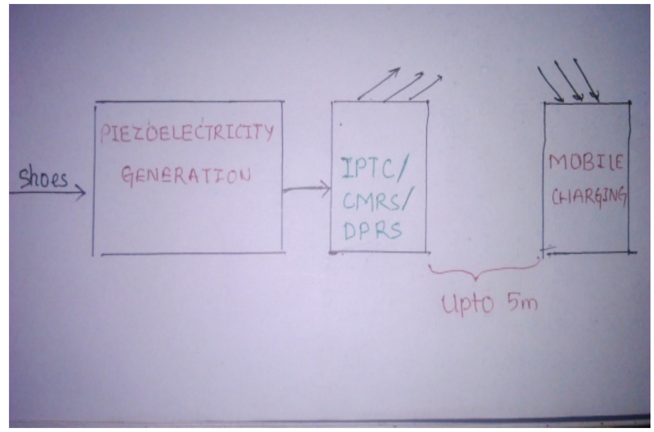


**Fig. 6: Block diagram of generation and transmission of energy**

## 10. CONCLUSION

From the above discussion we can conclude that piezoelectric material can scavenge energy from the vibration of the sole of shoes during walking and it can be scavenged quiet easily by using the circuit shown above in fig.4.Now after generation of energy it is important to send it to the destination (mobile),to send it to the mobile using a wire is cumbersome, so as using the wireless transmission in which IPTC is most efficient till now for wireless transmission[7] .we have to send 5W of energy not more than a distance of 2m(as it will be the distance of the shoes to the maximum height of a person).

As this technology is highly efficient and it will satisfy the power required for mobile charging, therefore in very near future it will share the loads on power plants as it will act as a renewable source of energy.

The efficiency of wireless transmission is not that much high ,in future the transmission efficiency more than this, it will be used as if battery is discharged while travelling, or at some remote area where electrical charging is not possible just take a walk for few minutes your battery will be charged.

## 11. ACKNOWLEDGEMENT

This project would not have been possible without the guidance of my parents, teachers and my friends. I want to thank everyone who encouraged me during my tough time. Their continuous invaluable knowledgably guidance throughout the course of this study helped me to complete the work up to this stage and hope will continue in further research.

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