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An Experimental Approach for Piezoelectric Sensor based Wireless Battery Charger

[1]Hara prasad Tripathy, [2]Priyabrata Pattanaik, [3]Susanta Kumar Kamilla

Abstract--- *According to the modern era the energy consumed by the human is in huge amount and it is increasing day by day as per the requirement, the modernisation in the society results the continuous increment of the energy. However, this results in exhausting and wastage of energy. This work is proposed for the proper consumption of the human locomotary energy which are wasted by the humans. The energy produced by the walking, running and jumping is very much relevant and important to the highly populated countries. This work demonstrates the construction and the implementation of energy collecting system with the conversion of energy by the human movement to operational form. This work describes the technique for the charging the electronic gadgets by producing said electrical voltage through said array by means of piezoelectric sensors mounted on the sole of the footwear.*

Index Terms— Wireless power transfer, piezoelectric sensors, rechargeable battery, wireless power transmission, cell-phone battery.

I. OVERVIEW

The concentration in the work and progress in an innovative cell phone technique is being improving particularly as in current years[1]. As per the growing technology the problem linked to it is also increasing continuously, among all problems the battery drainage problem is from one of them. The phone can be charged whenever and wherever you want. And this can be attained by the wireless piezoelectric power techniques for charging wirelessly. The bases for the particular technology are the piezoelectric and "wireless power transfer (WTP)[2]".

Ingathering mechanical energy by means of human movement approach that obtains eco-friendly & supportable electric energy. Said electrical energy is produced by means of mechanical force ("such as running, walking, jumping"). While a force applied on said piezoelectric crystal[3], a –ve charge generated on expanded part & a +ve charge on flattened part. Said electric current flowing through the material by way of relieved pressure. In unwired communication of energy, said communication of electrical energy in place of a power source ("piezoelectric power generator") or backup rechargeable battery to a load ("such as any electrical device") deprived of any physical connectors like conductors and wires[4].

Therefore, the energy is being harvested by means of human locomotion and being communicated wirelessly by un-

1,2,3, *Department of Engineering, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar*

haraprasadtripathy@soa.ac.in, priyabratapattanaik@soa.ac.in, sushantakamilla@soa.ac.in

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wired power transferring techniques employed for charging said mobile battery.

II. PIEZOELECTRIC GENERATORS

For the piezoelectricity there is two effects: straight piezoelectric effect & conversed piezoelectric influence[5]. The electric generation by piezoelectric is performed by applying mechanical stress on the piezoelectric materials for the piezoelectric effects; whereas said converse influences the distortion into the crystals initiated whenever electric voltage is applied on piezoelectric materials. The piezoelectric effects employed in manufacturing actuators. The manufacturing of the piezoelectric materials are artificial as well as natural. "Quartz" as a natural piezoelectric materials however "Lead Zirconate Titanate (PZT)" as a synthetic piezoelectric material. Particular equations defines straight piezoelectric influence & adverse effects where, D signifies "electric displacement vector", T signifies "stress vector"[6],

$$D = d.T + T.E \quad (3)$$

$$S = sE.T + dt.E \quad (4)$$

ƐT signifies dielectric permittivity on perpetual mechanical stress, sE signifies a "matrix for compliance quantities on constant electric field", S signifies "strain vector", d signifies "piezoelectric constant matrix", E signifies "electric field vector".

For piezoelectric belongings, charge density is being developed at the surface whenever external force is applied. The, charge density D, the electric charge Q.

$$D = Q/A \quad (5)$$

The accumulation at the surface, A is an area for the conducting electrode.

Table 1 Visualizes comparison by energy storage density in between three generators.

However, it can be observed that piezoelectric has more energy storage density whenever compared by supplementary procedures. PZT sensor can be employed for low level energy garnering for maximum power storing density.

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Table 1. Energy storage density comparison

Energyharvester Working Principle	Energy Storage Density (mJ/cm3)
Electromagnetic	24.8
Electrostatic	4
Piezoelectric	35.4

Piezoelectric Sensor

Mechanical force is converted to the electrical voltage by deploying Piezoelectric Sensors. Whenever, the mechanical force being applied at the sensor[7], electric charge gathered at the crystals surface mined by employing wires. Piezoelectric sensors in considering with an electric equivalent by the combination by resistance R, capacitance C and an alternating current source I coupled in parallel with as displayed in figure 1.

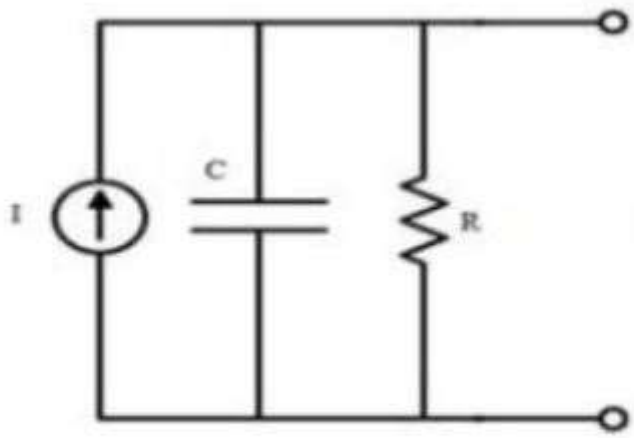

Figure 1. Electrical model of piezoelectric sensor.

The sensor employed in this project is prepared by piezoelectric materials "Lead Zirconate Titanate (PZT)[8]". That is circular in Outline that fits into the sole of the foot-wears very precisely

It must be eco-friendly and easily available.

In this paper, 8 piezoelectric sensors are coupled in parallel with the fitted into the sole of foot-wears.

At the time of jumping & jogging, mechanical force generated on the sole of footwear is changed in electrical voltage that is further provided to electronic equipments.

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Figure 3. Though normal walking a human generates 30W power on the ground & ideally out of which 100mW of the electrical power possible to attain deprived of distressing comfort level of particular person's life.

III. CONSTRUCTION

The construction consisting of 3 modules:

Generating module, storing module and transmitting-receiving module. The generating-storing module part consisting of Piezo-electric generator, rechargeable battery/capacitive bank (storing module). Particular module is being embedded into the shoe. Fig 3 visualize construction of proposed system[9].

Transmitting-receiving module consisting of capacitive bank, rectifier circuit and the charging circuit. Receiver attains the power and further that power is transformed to the DC supply by employing a rectification method & the output being fed into the battery of the attached device (mobile) by means of charging circuit. Similarly the comparator circuit is linked with system for indicating percentage level of the charging said rechargeable battery.

Design of Piezoelectric Generator

Eight array of the "piezoelectric sensors (PZT)" are combined to build a piezo electric generator that is placed into the sole of the footwear.

The toe & heel is that part where the maximum force exerted on the footwear by the person, so this is the perfect place to place the generating module. Fig 3 visualizes an arrangement of piezoelectric generator into the shoe.

Receiver and charger part extracts recurrent and continuous energy input by said piezoelectric generator and resourcefully stores that energy into three rechargeable batteries, individually of 4V or the capacitance bank[10].

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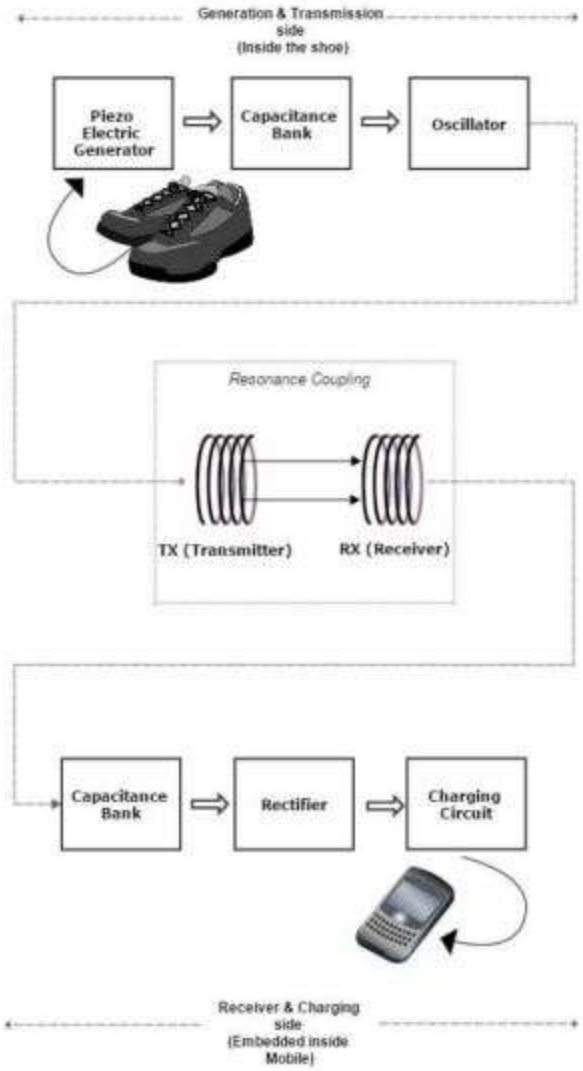

Fig.2: Piezo electric un-wired energy transmission cell-phone charging procedure

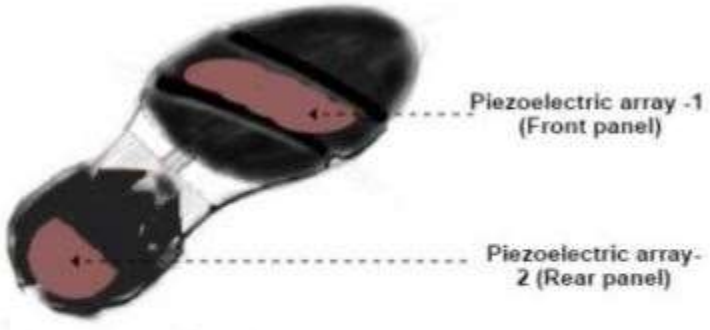

Fig.3. Arrangement of piezoelectric sensors in the piezoelectric generator in the shoe sole.

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Wireless Power Transfer

Non-portable & portable applications are allowed by wireless supply. With elimination in wire the installation cost can be reduced and the particular feature is important for the source where wired power are locally unavailable. According to modern era, as the research and development interest in increasing day by day by wireless power skill that eliminates the 'last cable" afterwards Wi-Fi that becomes widely accepted. For transferring power wirelessly amongst strongly coupled electromagnetic coils by employing un-wired technology. Fundamentally, electromagnetic coils consisting of a transmitting and receiving coils. The transmitting coil is being powered of an AC power that produces a magnetic fields, which results induction of a voltage into the receiving coil[11].

Transmitting to receiving module inductive energy transmission by means of an oscillated magnetic field involved by WPT. For attaining DC power, which is being supplied by said power source, that is converted in to high-frequency AC power by expressly constructed electronic circuit build into the transmitting module[12].

As in transmitting module, An AC power boosts a copper-wire that generates a magnetic field. As the receiving coil is being placed into the closed locality by magnetic field, said fields can induce the AC power into the receiving coil. Free electrons present into the receiving module, further converts that AC power into DC power that becomes working power[2].

Wireless transmission process:

- The power transfer is performed in between two coils by induced magnetic field. Though, the distance between said coils must be very small (almost in centimetres). The main motive of the mutual induction in between two coils for transferring electrical energy deprived of employing wires. Transformer demonstrates best mutual induction working, however there is no physical contact in between the secondary and primary coils. Energy transfer developed by the electromagnetic coupling in this manner relating two coils.

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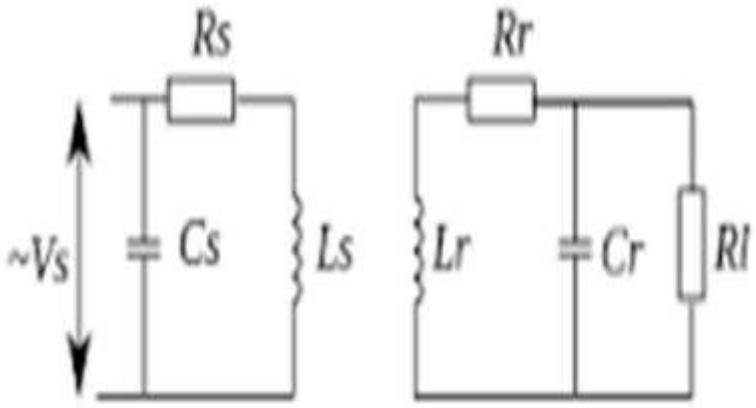

Fig 4. Inductive coupling

- **Resonant induction Coupling/Evanescent**

"Wave coupling researchers" discovered a substitutive way for wireless power transmission by employing "non-radiative electromagnetic energy resonant tunnelling". Meanwhile electromagnetic waves will tunnel, as they can't circulate by air that absorbing or wasted, and couldn't generally interrupt or cause injuries such as microwave and radio transmission. It projected about range of 5 meters. As per them, an electro-magnetic wave in an extremely high precise waveguide is called as transitory waves which convey no vitality, when on the off chance that an appropriate resounding waveguide is brought at the transmitter, at that point the passage is framed towards power drawing waveguide and this can be changed over in DC utilizing rectifier circuits. The model is accomplished with 5 meters of reaches utilizing this technique.

- **Radio/Microwave Energy Transfer**

By employing the proposed process the long range can be achieved. Particular method sends the microwave to long distances that are received through antenna. Antenna attains microwave power by electrical energy. Key problem with particular approach is that the diameter of the antenna require in kilometres. Transmission of power through radio waves may be generated more directional, that allows long distance power beaming, with shorter "wavelengths of electromagnetic radiation", in conversion of efficiencies exceeding 95% that are truly recognized[13].

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IV. CIRCUIT CONSTRUCTION

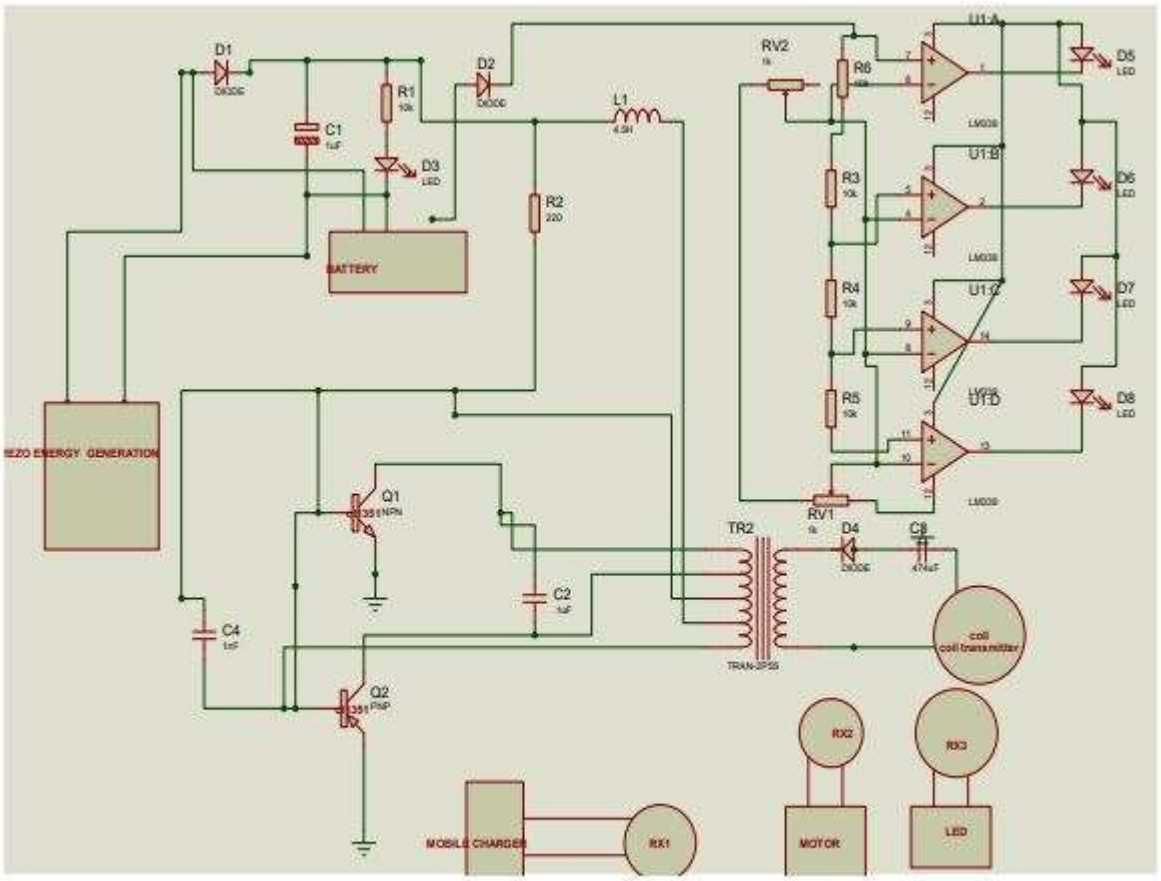

Fig 5 : prototype circuit diagram

V. WORKING

DC rectifier i.e. basically a bridge rectifier in employed into the circuit for converting AC power that is generated by the piezoelectric generator into the DC power. The converted power is later filtered by means of filtering components. Filtered power is further regulated deploying regulator, further the regulated power is converted into high frequency AC employing high frequency inverter.

Power transmission is performed by wireless power transferring technique, in this project inductive coupling technology is deployed for the transmission of the power effectively. Further this power is received into the receiving coil & attained power is later rectified by means of bridge rectification circuit. Meanwhile output voltage that received by the rectifying circuit is insufficiently low that charges electronic energy.

This work shows an idea about battery charging level employing LM339 comparator IC that verifies the battery status and shows it through a LED indicator in percentages (25%, 50%, 70%, and 100%).

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In this work two circuit Tx and Rx. Tx module consisting of piezo materials for generating electrical energy being stored into battery. High oscillating circuit generating high frequency further provided to the powering amplifier & that is converted in high voltage and being sent wirelessly by employing transmitting circuit.

On receiving end the receiver coil being deployed and said noise is rectified. The final signal can be used for charging battery of cell-phone.

VI. CONCLUSION

This work represents the construction of device that is capable of harnessing the energy that is generated by human locomotion and transfers that energy into a device wirelessly. It is being believed that this work holds key of interruptive way of employing cell-phones and additional devices. Particular device can be built as shoe self-determining also as a compact version that can be strapped on any footwear.

This philanthropically useful work is solution of the almost every cell-phones user faces. Around millions of people uses modern cell-phones and all of them requires more battery capacity and the charging system that can be used anytime and anywhere for charging it.

It is very appreciable approach for generating clean & sustainable energy from the locomotion of the human in the field of generation. This work spreads future work that includes constructing verification and supervising systems for the particular project.

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