NON-CONVENTIONAL ENERGY HARVESTING USING FOOT PRESSURE

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ABSTRACT

There is driving force more powerful than steam, electricity and nuclear power- the footstep. In today's world energy is the major resource in which we humans relay on. This project brings an idea to produce electricity by a non-conventional source. A Non-conventional energy using footsteps involves a process in which mechanical energy is converted into electrical energy. This system becomes pollution free, eco-friendly and socially relevant by generating energy from non-conventional sources. It is designed to be applied in public areas where there is sufficient crowd such as complexes transportation hubs and schools. This system has to be placed at points where people travel through entrance or exit and they have to step on this device to get through. Then a voltage is generated on every footstep and when mounted in series they will produce a sizeable amount of electricity.

Index terms **-** Piezoelectric sensor, mechanical force, Non-conventional energy.

I. INTRODUCTION

The ability of a body or a system to do work or produce a change is energy. It's impossible to precede any activity without energy. With a wide expansion of industries and agriculture sectors, the available energy sources began to fall in their supply. Though many resources are there to generate energy like wind, thermal, water they all run out of time one day. If a foot step power generation device is embedded in places where there is steady movement, the electricity is generated from that device and can be utilized. The most habitual activity is walking. When a person walks on a platform where this device is embedded, energy is being loses to it. This energy can be utilized and con-verted in a usable form such as in an electrical form. For this purpose, to measure acceleration, force, pressure piezo-electric sensors are employed that use piezoelectric effect by its conversion into electrical signals.

II. PIEZO-ELECTRIC EFFECT

When a mechanical stress is applied to one pair of opposite faces of a quartz crystal, then equal and opposite electrical charges are developed on the other pair of opposite faces of the crystal. This is termed as piezoelectric effect.

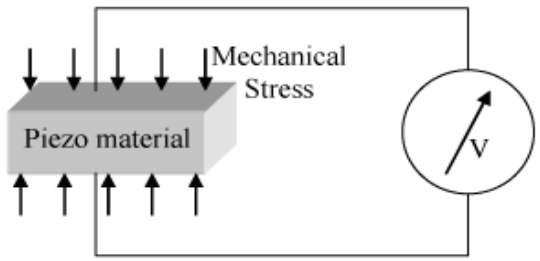

Figure 1: Piezoelectric effect.

III. MATHEMATICAL ANALYSIS

The concept which is prevailing is that the pressure is directly proportional to the amount of power generated

$$P \alpha Wt$$

K as constant of proportionality

$$P \alpha KWt$$

Where

Wt is the weight

P is the pressure

If wt=50kg, then voltage is 4v, and I= 0.015A.

$$P=V*I$$

Therefore, the power obtained after calculation is 0.06 Watts.

VI. BLOCK DIAGRAM

The block diagram of the proposed system is given in fig. 2.

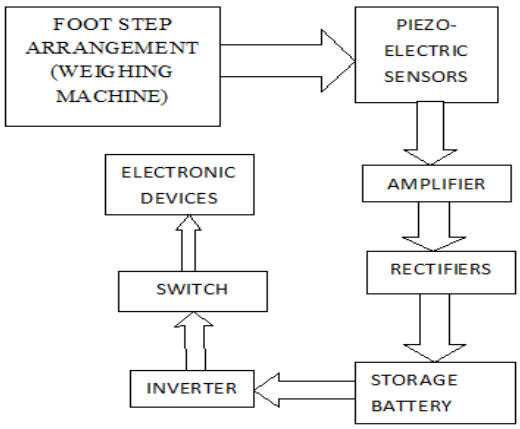

Figure 2: block diagram of a proposed system

COMPONENTS AND THIER FUNCTIONS

1. Weighing machine
2. Piezoelectric plates
3. Amplifier
4. Rectifier
5. Storage battery
6. Inverter

V. A. WEIGHING MACHINE

The weighing machine is implemented as a footstep arrangement. It is can balance and indicate the load. It has High Precision Strain Gauge Sensor System which helps in low battery indication.

V. B. PIEZO ELECTRIC PLATES

Piezoelectric plate shown in fig. 3 produces piezo-electric effect. Due to this effect, the moderation in pressure, strain, acceleration will give rise to an electric charge. Piezoelectric plates are made of piezoelectric materials like quartz, gallium phosphate and aluminium nitride. The commonly used piezoelectric materials are quartz, gallium orthophosphate, barium titanate and lead zirconate titanate.

Among these the commonly used piezoelectric material that is used in piezoelectric plate is Quartz.

Figure 3: Piezoelectric plate

The piezoelectric plates produce piezoelectric effect. Though the piezoelectric plates are not arranged symmetrically, the charges will remain in balanced condition. The balanced charges get cancelled exactly, leaving no net charge on the plate faces. After certain point the charges no longer cancel one another out and thus generate a net positive and negative charge on opposite plate faces.

By applying some mechanical pressure or stress to the plate, a voltage is produced which is directly proportional to the velocity of the piezoelectric plate.

V. C. STORAGE BATTERY

Lead-acid battery is adapted as the storage battery. Lead acid battery is called as the secondary battery which is the senior type, where electrical energy can be stored as chemical energy and this chemical energy can be converted into electrical energy when required. They are high authenticity and cost effective. During charging of battery, some chemical changes occur due to the passing of current through it. The active material used is lead peroxide(PbO_2), Sponge lead (Pb), Dilute sulphuric acid (H_2SO_4).

V. D. AMPLIFIER

This system uses a Bipolar Junction transistor (BJT). The power or the energy obtained is amplified by an amplifier. An amplifier controls the output to match the input signal shape but has larger amplitude. It basically takes power from power supply. Based on the properties of the input signal the amplifier modulates the output of the power supply.

An amplifier is a discrete piece of device or an electrical circuit which is contained in another circuit. Thus the output obtained from piezoelectric crystal is amplified, that is the power of the signal is doubled using an amplifier.

V. E. RECTIFIER

For converting alternating current into pulsating direct current an electronic device known as rectifier is used. The rectifiers are categorized into two types which are known as half wave rectifiers and full wave rectifiers. In this project a full wave bridge rectifier shown in fig.4 is used due to its good strength and full wave rectification. A bridge rectifier circuit converts an ac voltage to dc voltage using both half cycles of the input ac voltage.

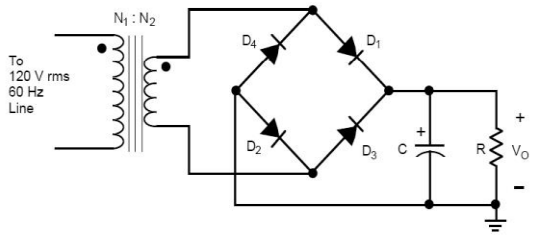

Figure 4: Full wave bridge rectifier

The rectification process happens efficiently. Due to rectification process done by the rectifier, the current flows in only one direction.

V. F. INVERTER

For converting direct current into alternating current an electronic device known as inverter is used. An inverter can consist partially of mechanical effect or can be totally electronic. The important factor about inverter is that it does not provide any power it only converts the power from one form to another.

Solid state inverter is used in this project. This type of inverter can be used for many purposes and the major benefit of using solid state inverter is that it does not have any moving parts.

By using appropriate transformers, the alternating current can be converted to voltage or current, this can be used for switching and controlling circuit. Inverters are known to be high power electronic oscillator.

VI. WORKING

A series of 20 (or above) piezoelectric sensors are interconnected. These interconnected sensors are mounted in a weighing machine. On an application of force or pressure on the piezoelectric sensors which are mounted on a weighing machine, a piezoelectric effect is experienced around it. Due to this piezoelectric effect, an electric current (alternating current) is obtained.

Since the power obtained by a piezoelectric effect is less, it must be amplified and increased. The obtained current is amplified by using an amplifier. Then the amplifier is connected to a rectifier, in order to convert the amplified alternating current into direct current and to allow the current to pass only in one direction. Along with rectifiers, ripple neutralizer can also be used. Hence a rectifier is bonded to the amplifier. The output is then stored in a storage battery. For this storage purpose lithium ion or lead acid batteries can be used preferred. As lithium ion battery is dangerous and hazardous the lead acid battery is preferred.

An inverter is connected to the storage battery. The inverter circuitry is implemented to convert the direct current to alternating current so that it can be connected to any electrical devices for sprinting. An alternating voltage is generated. By increasing the number of piezoelectric sensors, battery capacity and inverter circuit, the rating of the power is increased.

A microcontroller can also be used to implement the above system to get accurate results. The desired voltage that is being obtained is stored in the lead acid battery and that can be used to charge mobile phones, etc with the appropriate USB ports and cables. The system including a microcontroller may be in need of an Ardino board and an LCD display.

VII. APPLICATIONS

One of the important applications is the **"shoe charger"** like fig. 5. The above-mentioned method-logy can be adapted in the shoe as well. This system is fixed in the shoe sole using the exclusive piezoelectric generator prototype that is designed to produce enough power to operate GPS receivers, a cell phone, etc. The advantage of using solenoid is that these have a spring loaded shaft mechanism, which means only the gravita-tional force which is the effective force required for generating electricity while the feet is at rest, and when the feet is being lifted, the spring action of the solenoid complements the action making the system extremely efficient. This technology could be useful for hikers that who needs emergency location devices or beacons. For more normal use, it is used for power portable devices without hazardous batteries.

Figure 5: shoe charger

The various other applications are

- In crowded areas, it can be employed as a floor.
- It can be employed in the boots of a soldier and generated power is utilized to charge the battery or any other load device carried by them. Research has been going on by scientist for the above mentioned process.
- It can also be implanted in disco, gym centers, metros, rural applications, etc.
- The generated power through foot pressure can be utilized for agricultural purposes, home appliances, and street lighting.
- This system can be adapted in emergency power failure situation.

Thus, this type of arrangement can be placed in shop-ing complexes, colleges and wherever there is a large group of people walking on their foot simultaneously.

VIII. ADVANTAGES

- ❖ It can be adopted for both roads and footsteps.
- ❖ Since the current or voltage produced by piezoelectric material is directly proportional to the velocity, the plate distorted and there will be no external power. Thus, the power consumption is less.
- ❖ The system remains uninfluenced by external magnetic fields.
- ❖ The temperature and humidity will not affect the frequency of the system.
- ❖ The system is pollution free and environment friendly.
- ❖ It is more user friendly and cost effective.

VIII. DISADVANTAGES

- ❖ The piezoelectric crystals get easily affected by breakage or cracks if they are overstressed.
- ❖ Though the power generated by the system is large. The power generation speed is less when compared to other methods of power generation.

IX. RESULTS

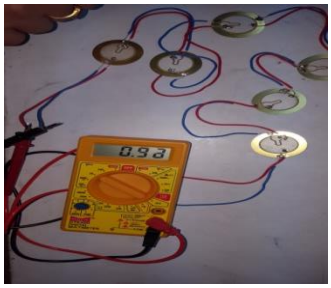

Figure 6: Arrangement of piezoelectric plates

A series of six piezoelectric sensors is being conn-ected as per fig.6. On an application of pressure to one of these sensors a voltage in the range of 0.8 to 2 volts is being generated. To increase the voltage an amplifier is used being employed in the system.

X. CONCLUSION

This research was started but is not implemented in real. In mere future, by improving some of the defects, this method can be executed. The economic feasibility aspects of this device will be acknowledged after sufficient data is collected.

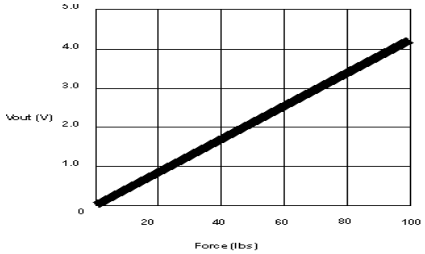

Figure 7: Graph between force and output voltage

From the graph, it is intelligible that voltage gene-rated is to have a linear relationship with applied force. This power generation method can be used in many rural applications where power availability is less or absent. Wherever water and power is saved, money is definitely saved. This way of generating power will bridge the innovations of future generations.

XI. REFERENCES

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