Low Power Device Charging With Sound to Electric Conversion

Pritesh Kukadia[1] Palak Pandey[2] Benazir Sheikh[3]
[1]Department of Electronics and Communication Engineering
[2,3]Department of Computer Science & Engineering
[1,2,3]Institute of Technology and Management Universe, Vadodara, India

Abstract— This idea of implementation is to use renewable energy from environment for generating electricity from one of the renewable energy sources. Now a day many of items are electronic which requires electric power to operate. If we can generate that amount of electric power that can be used to operate low power electronics device, it will be very useful and notable amount of power can be saved. For this purpose we are using stray sound energy that can be converted into electric energy with the help of energy conversion methods and can be used further. A piezo-electric sensor is used as a transducer to convert sound energy into electrical energy and that energy is used to operate low power device. This idea is very simple, handy and convenient and can be used during festivals, parties or noisy industries etc.

Key words: Renewable Energy, Piezoelectric Material, Sound Energy, Sound Conversion

I. INTRODUCTION

In today's generation electricity is one of the major requirements in our community. We cannot imagine our life without cell phones, computers, and other electronic appliances which are being used in day to day life and all these needs electric power to run. According to Ministry of Economy, Trade and Industry (METI) long term vision, proposed on 2014, first and foremost ensure stable supply ("Energy Security"), and realize low-cost energy supply by enhancing its efficiency ("Economic Efficiency") on the premise of "Safety." As a result, the primary energy supply structure in FY2030 will be as follows: [16]

1) Improve energy self-sufficiency rate - approx. 24.3%
2) CO2 emissions from energy sources - 21.9% lower than the total GHG emissions in FY2013. The demand of the electricity growing in this world is going to be doubled in 2030.

Due to this condition it is compulsory to find a substitute method for the production of electricity to use renewable energy instead of non-renewable energy. Renewable energy can be solar energy, wind energy, hydro energy or sound energy.

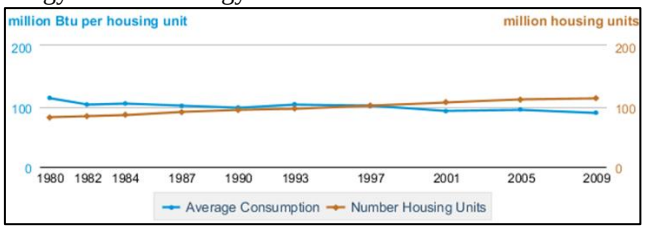

Fig. 1: Average Energy Consumption per Home and Number of Housing Units, 1980-2009[2]

Now a day the most common thing we stumble across almost everywhere is noise or sound, noise pollution is also a major issue in today's world. Noise can be found everywhere weather a class room, industry, roads, any festival (e.g.-Navratri, concert) etc. but the question is, can we use sound energy to convert it into electrical energy electrical for our purpose?

II. PROCEDURE

Sound is a mechanical form of energy which travels in the form of wave, mechanical wave is known for oscillation of pressure and the stress created by the sound can be used to convert this sound into electric energy or other form of energy. According to law of thermodynamics energy can neither be created nor be destroyed in an isolated system. According to law of conservation of energy any energy can be converted from one form to other form of energy as mechanical energy is the energy that is possessed by an object due to its motion or due to its position. Mechanical energy can be either kinetic energy (energy of motion) or potential energy (stored energy of position) i.e. It can also be converted into electric energy. Bar magnets with coil and also piezo material are used to converts mechanical strain into electric energy the property of piezo material could be used to make a device which would be able to sustainably convert the sound energy to electric energy as piezo material convert sound energy to electric energy. Transducer is also used to convert mechanical energy to electric energy i.e. It can convert sound energy to electric energy the simple e.g. Of use of transducer to convert sound to electric and vice versa is in speakers, headset...also it could be converted into electric energy.

We can use the sound from various sources like DJ parties in festivals like Navratri or Ganesh Visarjan, concerts, industries, car horns etc. The methods by which we can convert sound energy to electrical energy are given below.

A. Method 1: By Creating Apparatus using Curtain (Diaphragm) Magnet and Conductor.

In this method a thin curtain like diaphragm is created which will be oscillated by the pressure created by the sound wave and a conductor will be attached to it which is to be placed in between bar magnets. This oscillation in the curtain will create some movement in conductor which will affect the magnetic field of the bar magnet and due to this, it will generate motional Electromotive force (emf) and will generate voltage across it. As the high frequency is present the movement will be fast due to it and it will get considerable amount of electric energy. This method is explained in fig. 2.

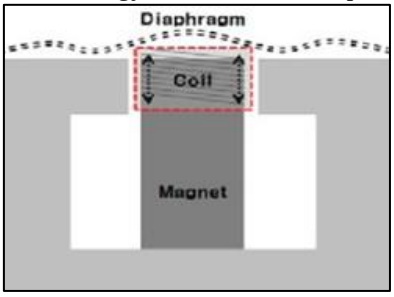

Fig. 2: Noise Energy Generating Device [4]

B. Method 2: By Converting Sound Energy to Heat Energy and Then Heat Energy to Electric Energy.

In this method sound is not directly converted into electric energy. First we convert sound energy into heat energy and then heat energy is converted to electric energy. For conversion in heat energy from sound waves, we require some denser medium with very high density. Sound waves that travel through the denser medium will disturb the other practical's that are present in denser medium. The disturbance created by the sound waves will collides with the neighboring particles in the same medium this collision will convert sound energy into heat energy as heat is produced and the production will also be more in denser medium. After converting sound energy to heat energy it will be converted into electrical energy. Figure 3 explains energy flow in this method.

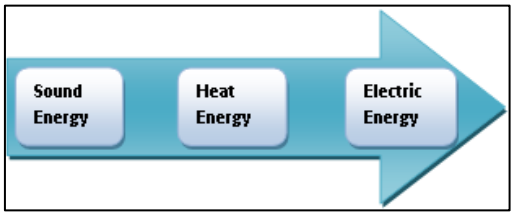

Fig 3: Energy Transformation [5]

C. Method 3: By Using Transducers Such as Piezo Electric Material Which Converts Mechanical Strain to Electric Energy.

We know that when mechanical strain is applied on crystal of piezo-electric material, it converts it into electric energy so using the same phenomena we can convert sound energy into electric energy. Piezo-electric material collects the sound wave or mechanical pressure generated by sound waves which are present in the surrounding. When sound wave strike on piezo- crystal, it will cause strain because of pressure created by the oscillation in the piezo crystal and then due to this disturbance of atoms present in piezo-crystal, it arise flow of electric energy thus sound energy could be converted into electricity. So this method can be use in various tasks where electricity is required. Figure 4 shows the piezoelectric crystal which can be used in this method.

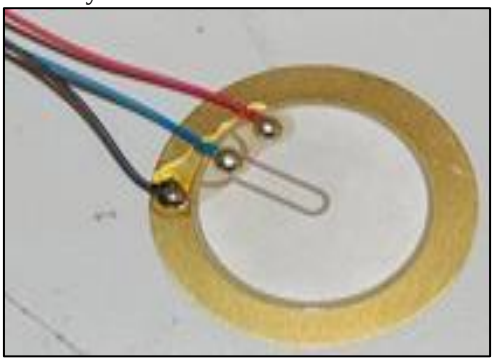

Fig. 4: Piezoelectric Crystal

D. What is Piezoelectric Effect?

Piezoelectric effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. The word piezoelectric is derived from the greek piezein, which means to squeeze or press, and piezo, which is greek for "push". One of the unique characteristics of the piezoelectric effect is that it is reversible, meaning that materials exhibiting the direct piezoelectric effect (the generation of electricity when stress is applied) also exhibit the converse piezoelectric effect (the generation of stress when an electric field is applied).

When piezoelectric material is placed under mechanical stress, a shifting of the positive and negative charge centres in the material takes place, which then results in an external electrical field. When reversed, an outer electrical field either stretches or compresses the piezoelectric material.

The piezoelectric effect is very useful within many applications that involve the production and detection of sound, generation of high voltages, electronic frequency generation, microbalances, and ultra-fine focusing of optical assemblies. The piezoelectric effect also has its use in more mundane applications as well, such as acting as the ignition source for cigarette lighters.

Some of the important properties of piezoelectric materials are given below:

- High value of the dielectric constant
- Presence of spontaneous polarization in some zones (domains)
- Presence of hysteresis loop in polarization-electric field and strain-electric field curves
- Dielectric constant increases with increase of temperature
- Ferroelectric properties disappear above a special point in dielectric constant - temperature curve (curie point)
- Appearance of the residual polarization and a double electric layer on the surface of sintered samples after exposure to a strong electric field, which causes the display of the piezoelectric effect in the material (conversion of the mechanical energy into an electrical one and vice versa)

III. BLOCK DIAGRAM AND SYSTEM WORKING

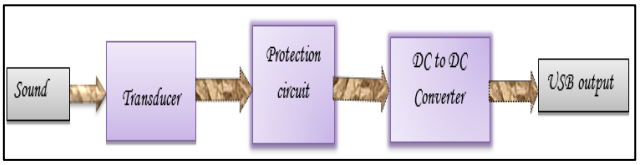

Fig 5: Block diagram for the process

A. Sound Input

This is the input given to the device from the DJ speakers, car horn or any other sound source. The sound is of high intensity and of high frequency.

B. Transducer

It is used for conversion of sound to electricity. Transducer is connected to protection circuit via connecting wires with proper soldering. It is a type of electro acoustic transducer that convert the electrical charges produced by some forms of solid materials into energy. The word "piezoelectric" literally means electricity caused by pressure.

C. Protection Circuit

It is used to prevent the opposite/reverse flow of current from the charging device, back to transducer. Protection circuit is

connected to dc to dc converter and transducer via connecting wires with proper soldering.

D. DC to DC Converter

It takes the ac input and convert it into dc output. This dc to dc converter is then connected to multimeter for measuring output. After getting the output we can connect the ultra-low power devices and charge them with this device.

E. USB Output

This is the output taken from the device to USB port that can be used to charge ultra-low power device.

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IV. RESULT

A. Model 1

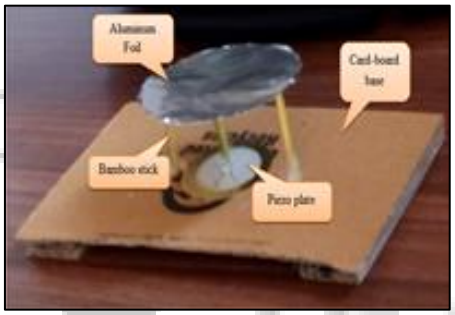

Fig. 6: View of Model 1

In this design, number of piezo electric transducer used is one. The piezo was mounted on a cardboard with 3 bamboo sticks of 4cm in length and 3 mm diameter, out of which 2 sticks are for support and one is connected to diaphragm and piezo. We used aluminum foil of 5.76cm radius as diaphragm which was connected with bamboo stick. The complete structure was kept in front of sound source and following result was recorded.

Sound source	Sound intensity (dB)	Output (mili volt)
Mobile speakers	No sound	3 – 10
Mobile speakers	55-65	20 - 25

Table 1: Model 1 Observations

B. Model 2

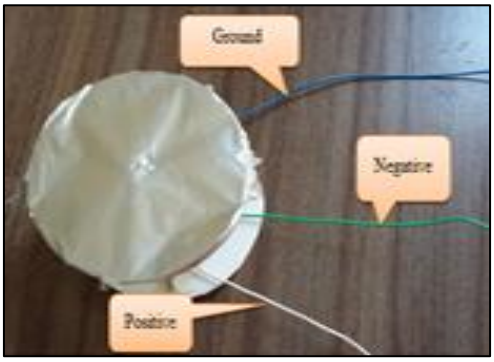

Fig. 7: View of Model 2

In the design, the piezo was mounted on a PVC base with 5 bamboo sticks of 4cm in length mounted on the piezo unit of which 4 bamboo sticks for support and one is connected to diaphragm and piezo. We used aluminum foil of 5.76cm radius which was stick on the bamboo stick. The complete structure was kept in front of sound source and following result was recorded.

Sound source	Sound intensity (dB)	Output (millivolt and volt)
PC speakers	No sound	3 – 10 mv
PC speakers	60 – 70 approx.	45 - 70 mv

Table 2: Model 2 Observations

C. Model 3

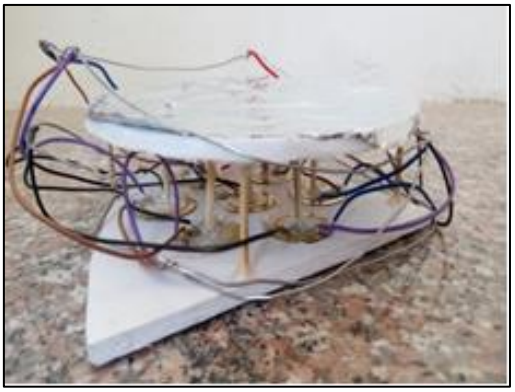

Fig. 8: View of Model 3

In this design, total 7 piezos are used which are mounted on a PVC sheet of 5mm thickness. The diaphragm is mounted on piezos with the support of 4 cm long bamboo sticks. Diameter of the diaphragm is about 15 cm. All the pizos are connected in the parallel and the observed output is given below.

Sound source	Sound intensity (dB)	Output (mili volt and volt)
Small DJ speakers	No sound	3 – 15 mv
Small DJ speakers	90 – 95 approx.	30 - 50 mv

Table 3: Model 3 Observations

D. Model 4

Fig. 9: View of Model 4

In this design, total 6 piezos are used which have more diameter then the previous design pizos. All are mounted on a rigid base of circular PVC sheet and the diaphragm is supported on the pizos with the help of bamboo sticks of length 4cm. In this design specifically, the diaphradm shape

is made such that the periphery part is bend upside so that collection of sound can be made effectively. Output observed by connecting all pizos in series is given below.

Sound source	Sound intensity (dB)	Output (millivolt and volt)
Normal Dj speakers	No sound	3 – 20 mv
Normal Dj speakers	90– 95 approx.	800 - 950 mv

Table 4: Model 4 Observations

E. Model 5

Fig. 10: View of Model 5

In this design, total 10 pizos are used and they all are mounted on a circular plate of sun mica. Here the diaphragm of approximate diameter of 17 cm is supported on the pizos by the bamboo sticks of legth 4cm. The observed output by connecting all pizos in the series is given below.

Sound source	Sound intensity (dB)	Output (millivolt and volt)
Dj speakers	No sound	3 – 20 mv
Dj speakers	135 approx.	250 - 300 mv

Table 5: Model 5 Observations

F. Model 6

The figure shows design of model 6 in which total number of pizos used are 19 which are mounted on circular sun mica sheet. The diaphragm in this design is of around 20 cm in diameter and is mounted on piezos by the support of bamboo sticks of 4 cm long. After connecting all piezo's output in series, the total output observed is given in the table below.

Fig. 11: View of Model 6

In this model, the diaphragm design is made in such a shape that the boundary area is folded down side compare to the center so that the sound pressure available is maximum compare to previous 5 models.

Sound source	Sound intensity (dB)	Output (millivolt and volt)
Multimedia speakers	No sound	3mv – 25 mv
Multimedia speakers	80 – 85 approx.	900 mv – 1.4 v
Car Horn	No sound	3mv – 25 mv
Car Horn	107 – 109 approx.	2.7v – 3.248 v

Table 6: Model 6 Observations

From model 1 to model 6 we got different outputs based on intensity of the sound and modification in model. In this model the sound is inputted on the diphagram which is connected with the piezo device and the output is taken in different environments. Output is satisfactory and it can be generated and used in many low powered devices. By using different sound sources we can increase outputs on the basis of our requirements.

V. Discussion and Conclusion

The above experiment's results show that Piezo electric transducers successfully converts sound energy into electric signals. It is seen from model 1 to model 6, as the number of piezo electric transducers increases, total output also increases. As far as the diaphragm is concerned, if the area of diaphragm increases, the pressure created on piezo electric transducer is also increased.

With the help of this type of energy conversation, we can utilize non-conventional energy for low power devices which are going to be used in large spectrum in the upcoming era. Also it is seen that the amount of noise pollution available around us is going to be utilized for powering the low power electronic devices.

VI. Acknowlegement

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