

Heritage Institute of Technology

(An Autonomous Institute)

**Department of
Electronics and Communication Engineering**



----FOOT STEP POWER GENERATING SYSTEM----

Affiliated

To

Maulana Abul Kalam Azad University of Technology

(Formerly WBUT), 2020

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----FOOT STEP POWER GENERATING SYSTEM----

Has been successfully completed by

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*In partial fulfillment for the award of the degree in
Bachelor of Technology*

In

*Electronics and Communication Engineering
Maulana Abul Kalam Azad University of Technology
(Formerly WBUT), 2020*

Under the Supervision of
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Certificate of Recommendation

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Signature of the students:

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ABSTRACT

The production of electric power from the foot step movement of the people and the pressure exerted during walking which is fritter away is the main theme of this paper .The mechanical power transformation into electrical power as the pressure exerted by the footstep and by using transducers is basically called as "Foot step power generation system". Power is produced by the power generating floor and it is basically the production of electrical energy from kinetic energy. As today electricity demand is increasing and it is unable to overcome this global issue by using the traditional power generating sources. Demand and supply gap is the major issue of energy crisis.

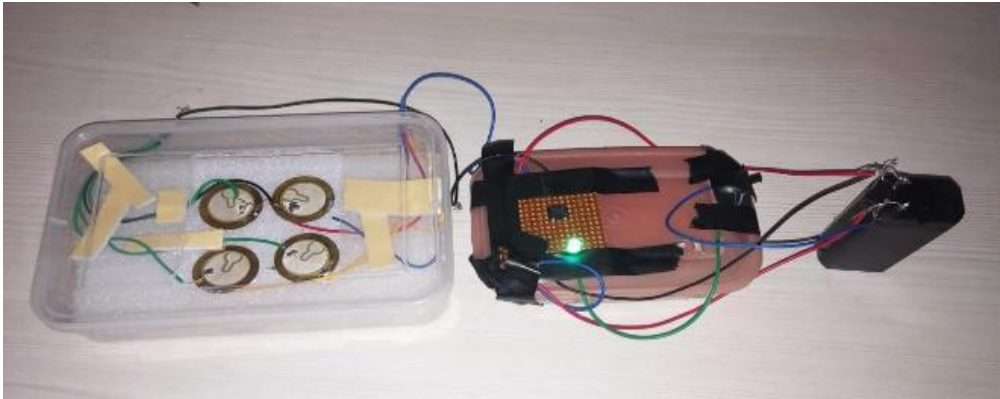
The main aim is to overcome the power crisis throughout the world although it is not enough to fulfill over excessive demand of electrical energy but it will be able to change and decrease reliance on old method of generating electricity. We can generate 1 megawatt of power if we have a 100 floor, as we are able to model a power production floor which can generate up to 1000 Watt on just twelve footsteps means one unit and it is capable to generate 10000W power for just 120 footsteps. It can be installed on road side footpath, parks and jogging tracks and many other public places, airports etc. And have great impact of this and will create great difference in the electrical power generation system.

Due to our hectic and torpid lifestyles, health has been on the receiving end. Herein we discuss a device using piezoelectric material that furnishes as an alternate means for powering mobile devices, etc. Additionally, it can also be intended for emergency lighting solutions like flashlights and emergency torch. Noting that it is an energy regeneration device it encourages walking and thus can also be acknowledged as an electrical health gadget which endorses physical fitness. One more feature which has been incorporated into this gadget is a battery bank which is used to store the charge when the phone is 100 per cent charged or there is no need for emergency lighting. The piezoelectric crystals are incubated into the sole and the heel of the shoes as they are considered as the maximum pressure points and via trotter moment and vibrations on the crystals they generate voltage pulses and minute quantities of current
keywords: Piezoelectric materials, Nano generators, Walking charger, emergency lighting.

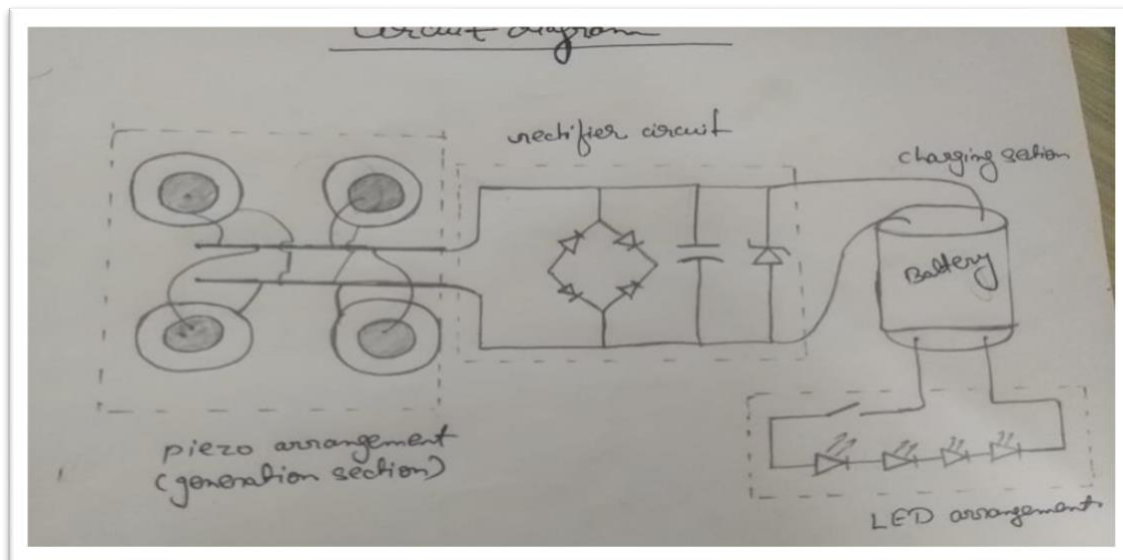
1. INTRODUCTION

The formation of electrical energy from the force exerted by footstep on the floor is illustrated in this research work. It will be surprising to know that the normal footstep movement on the floor can generate how much energy. As thousands of step per day is taken by each person. Electrical energy is generated by the footstep taken by the peoples as a result of walking. It is a fact that large amount of energy is lost by each person during routine walk which is the main source for this system. The approach of this electro- kinetic energy floor is to convert kinetic energy into electrical energy by walking on floor. The energy that is produced from a person walking on floor is noise and pollution free. That type of energy is advantageous and even not need any type of fuel or power source to run. By implementation of this renewable energy in today's world while the demand of energy is increasing day by day is the current solution of this modern world. In this research work a system is designed which generate power through non-conventional energy source technique such a walking on the gardens, grounds, and floors etc. This system is established in heavy populated areas. Basic way of the "Foot Step Power Generation" is based on the piezoelectric sensor to apply this system wooden plates up and down will be placed and adjusted on the piezoelectric sensor and moving spring. The force is applied when the person is walking on that mat and the magnet is fixed on the upper portion of the wooden sheet as a result of force, and moves into the cavity. However, the cavity is fixed on the bottom wooden sheet of the mat. A compatible system have been design to complete the procedure through which the load will run, home appliances will work on alternating current output voltage. And the task is with the help of direct current to charge battery and then using inverter to convert direct current into alternating current for normal usage. At last designing for the power generation of such types are very useful as compare to the demand of energy all over the world.

1.1 PROJECT MODEL



1.2 CIRCUIT DIAGRAM



1.3 BASIC BLOCK DIAGRAM OF FOOTSTEP POWER GENERATION SYSTEM USING PIEZOELECTRIC SENSOR

With application of force on piezoelectric transducer, it converts force into electrical energy. AC ripple neutralizer controls the fluctuation in generated voltages and unidirectional current controller controls the battery charging current with the help of pic16f877A pic microcontroller. The voltage generated by series of sensors is stored in Lead Acid batteries. This voltage can be used to drive either DC or AC loads. For AC loads, pure sine wave inverter circuit is used. Inverter converts dc voltages stored in lead acid batteries in 220 volt AC. AC voltage can be used to drive AC loads. User can use any type of inverter according to his/her requirement like pure sine wave inverter, square wave inverter and modified sine wave inverter. Rating of battery charger also depends on amount of power generation from footstep. PIC16F877A microcontroller displays the amount of battery charging.

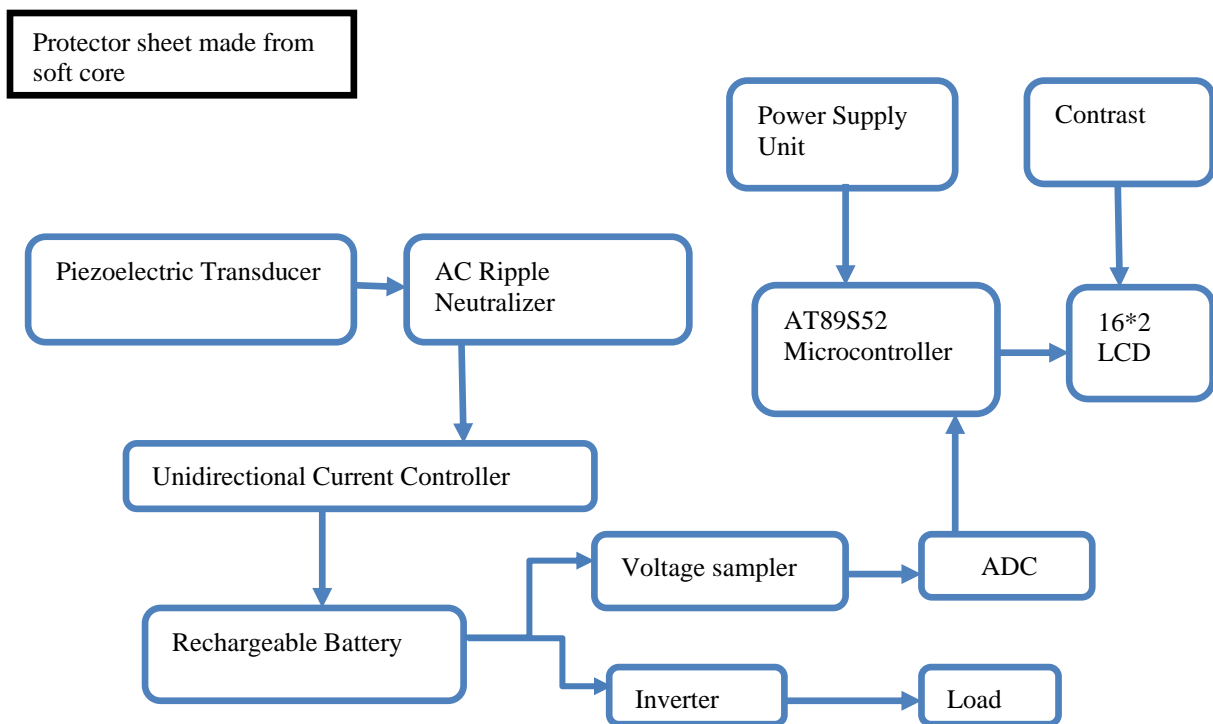


Fig.1.3: Block Diagram of Foot Step Power Generation System

1.4 CIRCUIT DIAGRAM OF FOOT STEP POWER GENERATION

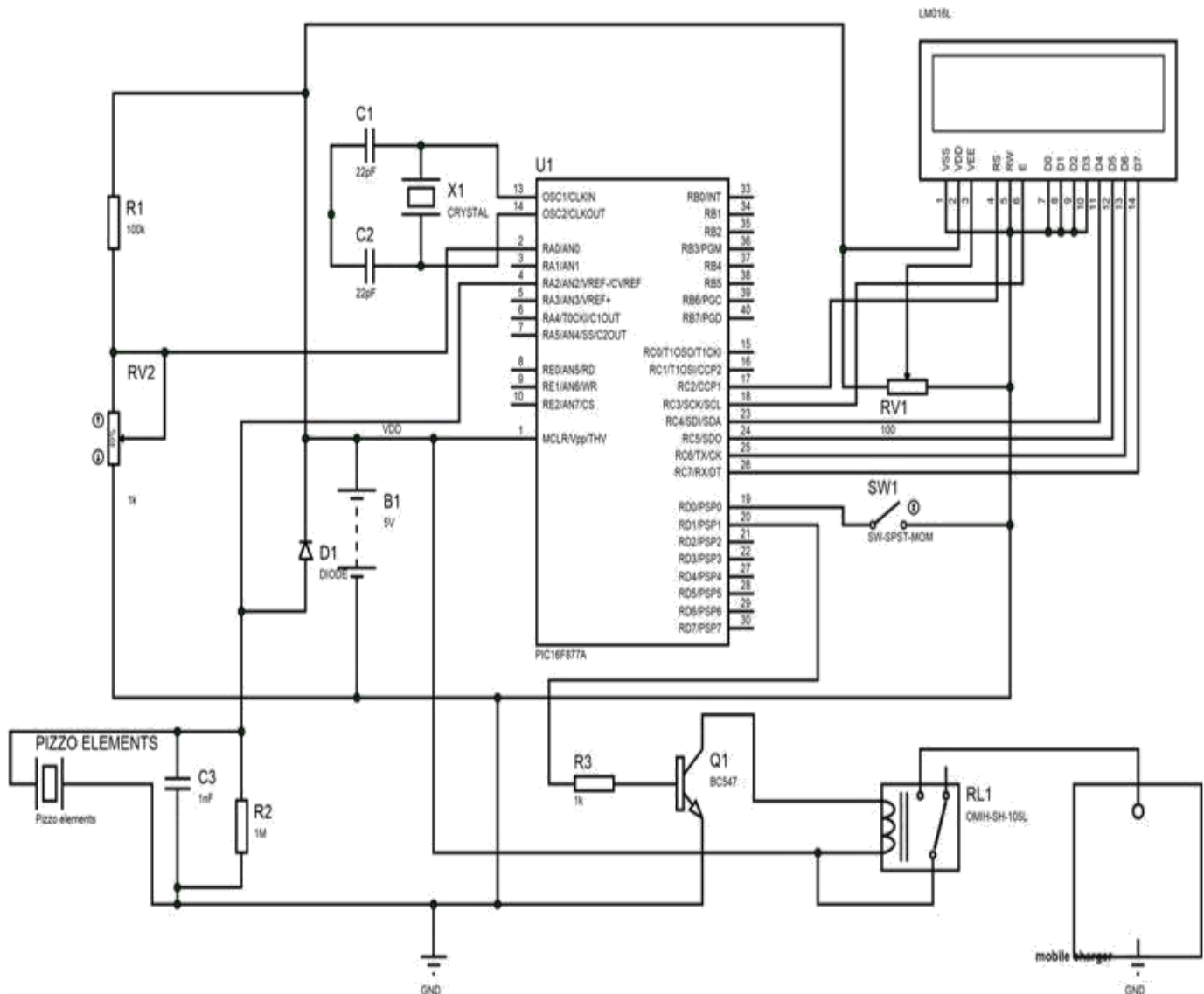


Fig. 1.4: Circuit Diagram of Foot Step Power Generation System

1.5 ADVANTAGES

- Simply walking on the step generates power.
- This is a non-conventional system.
- No need of fuel input.
- Battery is used to store the generated power.
- Self-generating no external power required.
- Compact yet highly sensitive.
- Reliable, economical, eco-friendly.
- Extremely wide dynamic range, almost free of noise.

1.6 DISADVANTAGES

- Only applicable for particular places.
- The initial cost of the arrangement is high.
- Care should be taken for batteries.

2. COMPONENTS REQUIRED

- AT89S52 MICROCONTROLLER
- PIEZOELECTRIC SENSOR
- AC RIPPLE NEUTRALIZER
- UNIDIRECTIONAL CURRENT CONTROLLER
- VOLTAGE SAMPLER
- 16X2 LCD
- LEAD ACID BATTERY
- ADC (ANALOG TO DIGITAL CONVERTER)
- INVERTER

2.1 ABOUT THE COMPONENTS

2.1.1 AT89S52 MICROCONTROLLER

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in system programmable flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the Industry-standard 80C51 instruction set and pin out.



Fig. 2.1.1: AT89S52 MICROCONTROLLER

FEATURES

- 4.0V to 5.5V operating range.
- Fully static operation: 0 Hz to 33MHz.
- Three-level program memory lock.
- 32 programmable I/O lines.
- Three 16-bit timer counters.
- Dual data pointer.
- Watchdog timer

2.1.2 PIEZOELECTRIC SENSOR

It is a sensor which converts force applied on sensor into voltage with the help of mechanical vibrations. It basically converts kinetic energy into electrical energy. Array of sensors should be connected in series to generate reasonable amount of electrical power. For example 10 piezoelectric sensors are connected in series; they will generate 9 volt and 100mA current. Two types of such sensors are available in market lead zirconate titanate (PZT) and PVDF. The output voltages of these sensors are controlled by filters.

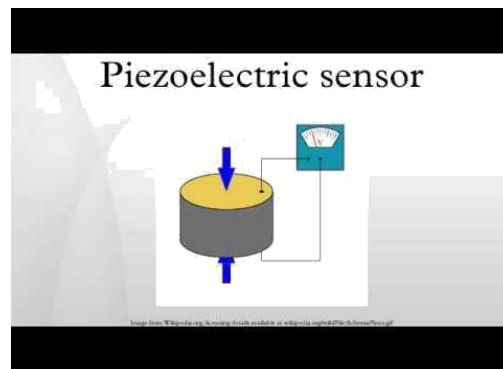


Fig.2.1.2: PIEZOELECTRIC SENSOR

2.1.3 UNIDIRECTIONAL CURRENT CONTROLLER

As term specifies this circuit lets only one direction current flowing. They are diode and thyristor. In this project diode (D=1N4007) is used as a unidirectional current controller. The main function of the diode is, it allows the flow of current in only one direction while blocking current in the reverse direction.

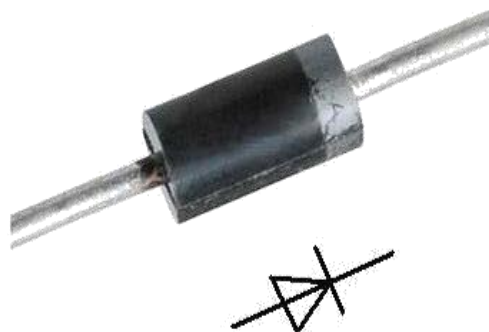


Fig. 2.1.3: UNIDIRECTIONAL CURRENT CONTROLLER

2.1.4 LEAD ACID BATTERY

Lead acid battery is used to store electrical energy. It consists of electrochemical cells. In foot step power generation system lead acid battery is used to store electrical energy of sensors.

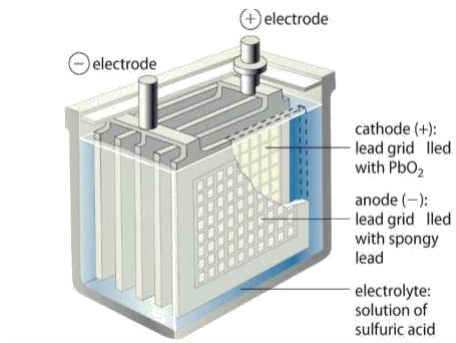


Fig. 2.1.4: LEAD ACID BATTERY

2.1.5 VOLTAGE SAMPLER

Voltage Sampler or sample and hold circuit is an essential analog building block and the applications of voltage sampler include switched capacitor filters and analog-to-digital converters. The main function of the sample and hold circuit is to sample an analog i/p signal and hold this value over a particular length of time for subsequent processing. Sample and hold circuit is designed using only one capacitor and one MOS transistor. The working of this circuit is straight forward. When CK is high, then the MOS switch will be ON, which in turn permits output voltage to track input voltage. When CK low, then the MOS switch will be OFF.

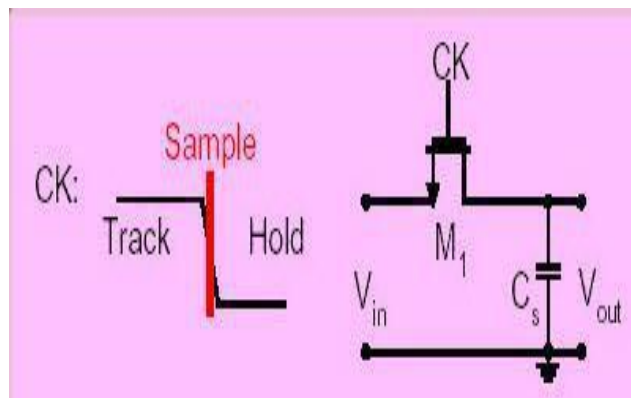


Fig. 2.1.5: VOLTAGE SAMPLER

2.1.6 AC RIPPLE NEUTRALIZER

AC ripple neutralizer is a voltage stabilizer. It is required to protect a high rating component like AC from damage. The circuit essentially involves capacitors as they act as good filters.

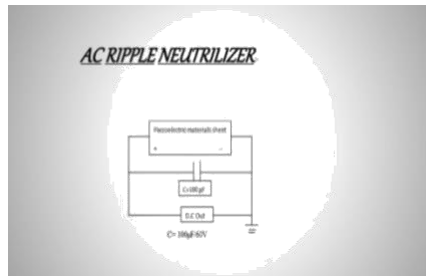


Fig. 2.1.6: AC RIPPLE NEUTRALIZER

2.1.7 16x2 LCD **16x2 DISPLAY EQUIVALENTS**

Dot Matrix LED Display, 7-Segment LED Display, OLED Display, TFT LCD Screen Display.



Fig. 2.1.7: 16x2 LCD

FEATURES OF 16x2 LCD **MODULES**

- Operating Voltage is 4.7V to 5.3V.
- Current consumption is 1mA without backlight.
- Alphanumeric LCD display module, meaning can display alphabets and numbers.
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5x8 pixel box.
- Can work on both 8-bit and 4-bit mode.
- It can also display any custom generated characters.
- Available in green and blue backlight

2.1.8 ADC (ANALOG TO DIGITAL CONVERTER)

A simple ADC consists of two parts. First is a voltage source. The voltage source can step voltage up from 0 to a specific maximum level in defined steps. Example: The ADC inside the ESP8266 can measure voltages between 0V to 1V.



Fig. 2.1.8: Analog to Digital Converter

Internally this is controlled by a 10-bit register. 10 Bits can count from 0. $2^{10}-1$ (1024 - 1). So the voltage is stepped up from 0 to 1 Volt in steps of $1/1024$ V.

2.1.9 Inverter

An inverter is an electrical device that converts direct current to alternating current; the converted alternating current can be at any required voltage & frequency with the use of applicable control circuits, transformers and switching.

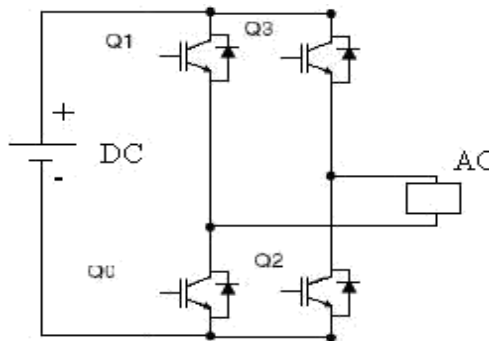


Fig. 2.1.9: Inverter

Solid state inverters are used in a wide range of applications because they have no moving parts from small switching power supplies to large electric utility high-voltage direct footstep power generation using piezoelectric material that transport bulk power. Inverters are used to supply AC power from DC sources like batteries or solar panels. These are classified into two types the modified sine wave inverter's o/p is similar to a square wave o/p excluding that the o/p goes to 0 V for a time before switching +ve or -ve. It is very simple and low cost and is well-suited with various electronic devices, except for sensitive or specialized equipment.

3. IMPACT TO SOCIETY

The system generates voltage using footstep force. The system serves as a medium to generate electricity using non-conventional sources (force) and /store/use it. The project is designed to be useful at public places like railway stations where a lot of people keep walking through all day. At such places these systems are to be placed at any entry points where people travel through entrance or exits and they have to step on this device to get through. These devices may then generate a voltage on every footstep and when mounted in series they will produce a sizeable amount of electricity. For this purpose we here use piezoelectric sensors that use piezoelectric effect in order to measure acceleration, force, and pressure by its conversion into electric signal.

4. NEED FOR THE SYSTEM

Proposal for the utilization of the waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like china and India where the roads, railway stations, bus stops, temples etc., are all over crowded and millions of people moves around the clock. This whole human being wasted if can be made for possible for it will be great invention and crowed energy farm will very useful energy sources in crowed countries. Walking across a crowed farm then will be a fun for ideal people who can improve their health by exercising in such farms with earning. The electrical energy generated at such farms will be useful for nearby application.

5. FUTURE INNOVATION

The main innovation for our project will be to change the piezoelectric sensor and replace it with Gear motor because the power formed by the system using piezoelectric sensor is low compared to gear motor. From a survey we came to know that from every 10kg of weight 0.012W power is produced if the project is made with piezoelectric sensor. Whereas if the project is made with gear motor every 12 steps will produce 100w of power. Gear motor will produce the desired amount of power that will help us in future with generation of power.

6. APPLICATION

- Foot step generated power can be used for agricultural, street lighting.
- Foot step power generation can be used in emergency power failure situation.
- Metros, rural application etc.

7. OBSERVATION

Since 1 piezoelectric produces 0.7V- 1V voltage on once fully press. There are 4 piezoelectric are connected parallel. Simultaneously when all are pressed, then their equivalent voltage is 2.7V-3V voltage.

POWER GENERATING SHOE USING PIEZOELECTRIC SENSOR (PROPOSE MODEL)

8. INTRODUCTION

In the recent years there has been an increasing interest in research and development of advanced smart phone technology. But as technology evolves so are the problems associated with it, and one among those is the fast draining of battery. Almost every smartphone user wishes he had more battery life. Now, imagine your phone getting charged where ever you go. This is possible by Piezo electric wireless power transfer (WPT) mobile charging technique. The keys to this technique are the piezoelectricity and wireless power transfer. Harvesting mechanical energy from human motion is an attractive approach for obtaining clean and sustainable electric energy. Piezoelectricity is electrical energy produced from mechanical pressure (such as walking, running) using shoe. When pressure is applied to the shoe, a negative charge is produced on the expanded side and a positive charge on the compressed side of the piezoelectric crystal. Once the pressure is relieved, electrical current flows across the material. Wireless power or wireless energy transmission is the transmission of electrical energy from a power source (piezoelectric Power) to a load (such as any electrical device) without any physical connector such as wires or conductors. Energy is harvested from the human movements and is transmitted wirelessly thorough wireless power transfer technique and is used to charge the mobile battery.

At last, designing for the power generation of such types are very useful as compare to the demand of energy all over the world. Question that every time comes before every country i.e. the need of non-conventional energy sources or systems. Why we need these systems and the answers are the growing consumption of energy has resulted in the country becoming increasingly dependent on fossil fuels such as coal, oil & gas. Rising prices of oil and gases and their potential shortages have raised uncertainties about the security of energy supply in future, which has serious repercussions on the growth of the national economy. The main factor is increasing use of fossil fuels also causes serious environmental problems. Hence there is primary need to use renewable energy sources like solar, wind, tidal, biomass and energy from waste material. Now let us come to its some working principle, this device if embedded in footsteps of railway platforms, city malls, city footpaths etc. can convert the weight impact of people into electrical energy.

(We were planning to make the proposed model but due to the lockdown we were unable to complete our model. Here we have given the report of our proposed model which is the innovation part of our foot step power generation system. We have completed our report with the help of references that we have mentioned with details in the reference section).

8.1 BLOCK DIAGRAM OF FOOTSTEP POWER GENERATION SYSTEM USING SHOE

The design consists of two units. Generation –transmission unit and receiver-charger unit. The generation transmission unit side consists of the piezoelectric generator, capacitance bank, oscillator, and transmitter TX unit. This unit is integrated inside the shoe. Fig. 8.1 shows the design of the system.

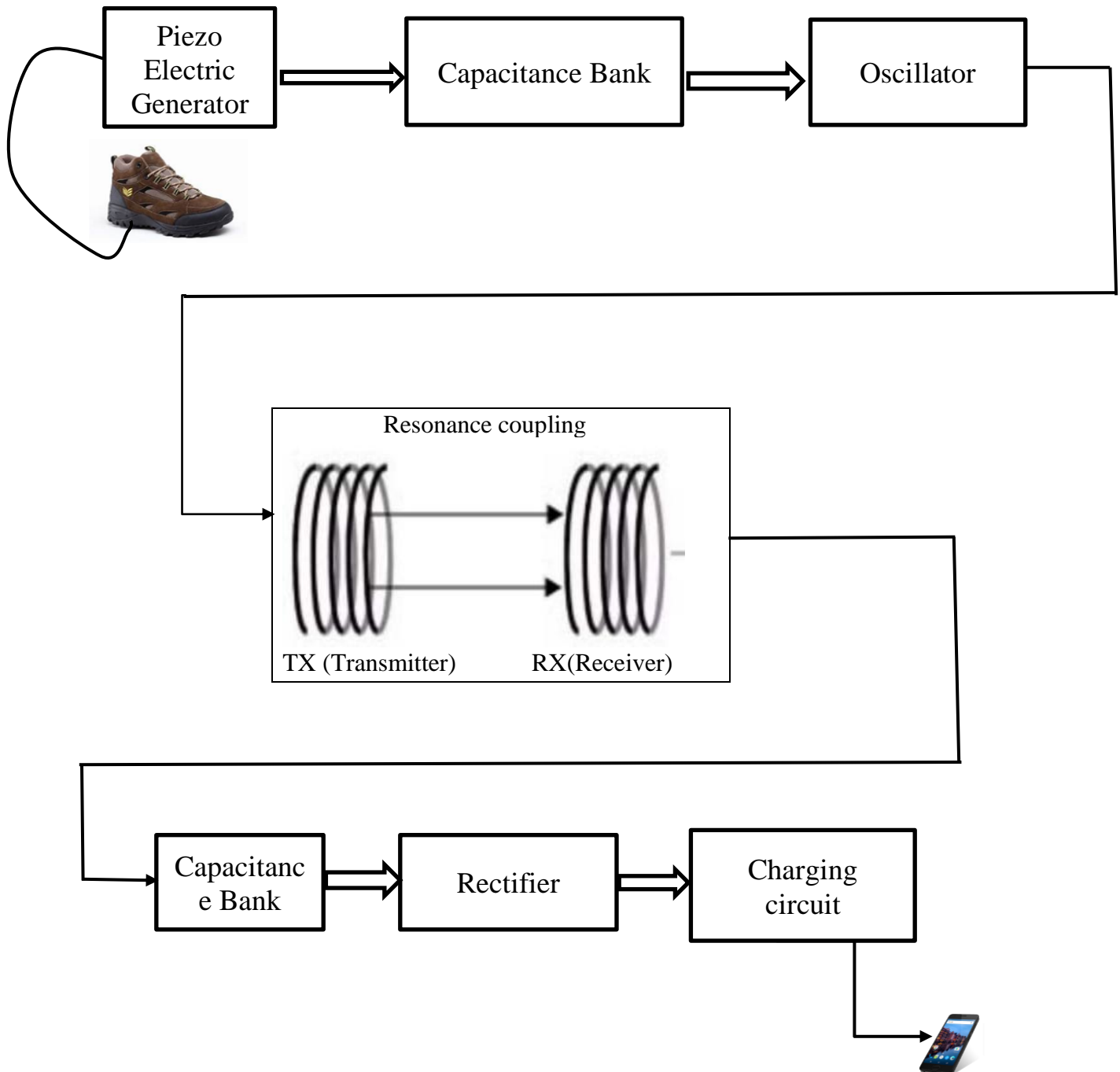


Fig 8.1: Block Diagram of Piezo Electric Wireless Power Transfer Mobile Charging Technique

8.2 DESCRIPTION

Receiver and charging unit consist of capacitance bank, rectification circuit and charging circuit. This can be either designed mobile independent or embedded inside the mobile. The receiver receives the power and this power is converted to DC supply using a rectification process and the output is fed to a battery of a device (mobile) through the charging circuit.

8.2.1 PIEZO ELECTRIC GENERATOR DESIGN:

The Piezo electric generator is placed inside a Shoe. A shoe has two points where the pressure exerted in maximum and they are the heel and the toe, and this is the exact place where the piezo electric unit is placed. The arrangement of the piezoelectric generator inside a shoe. Arrangement of piezoelectric generator inside a shoe. The design consists of a pair of array of piezo electric generator units connected in series. The front panel has the array of piezo electric generator in a linear arrangement and the rear panel with a circular arrangement. The receiving and charging side collects intermittent or continuous energy input from the piezo generator and efficiently stores their energy in the capacitor bank. During the charging process, the capacitor voltage is continuously monitored. When it reaches 5.2V the module output is enabled to supply power to a rectifier and charging unit.

8.2.2 WIRELESS POWER TRANSFER (WPT):

In the early 20th century, before the electrical- wire grid, Nikola Tesla devoted much effort towards transferring power wirelessly. However, typical embodiments (e.g., Tesla coils) involved undesirably large electric fields. The past decade has witnessed a surge in the use of autonomous electronic devices. As a result of this development, interest in wireless power has reemerged. In recent years, there has been increasing interest in research and development of wireless power technology to eliminate the “last cable” after Wi-Fi becoming widely accepted. Wireless electricity technique used here is based on strong coupling between electromagnetic resonant coils to transfer energy wirelessly between them. This differs from other methods like simple induction, microwaves, or air ionization. The system consists of transmitters and receivers that contain magnetic loop antennas critically tuned to the same frequency. The principle of evanescent wave coupling extends the principle of electromagnetic induction. Electromagnetic induction works on the principle of a primary coil generating a predominant magnetic field and a secondary coil being within that field so a current is induced within its coils. This causes a relatively shorter range due to the amount of power required to produce an electromagnetic field. Over greater distances the non-resonant induction method is inefficient and wastes much of the transmitted energy just to increase range. This is where the resonance comes in and helps the efficiency dramatically by “tunnelling” the magnetic field to a receiver coil that resonates at the same frequency. Theoretical analysis shows that by sending electromagnetic waves around in a highly angular waveguide, evanescent waves are produced which carry no energy. If a proper resonant waveguide is brought near the transmitter, the evanescent waves can allow the energy to tunnel to the power drawing waveguide, where they can be rectified into DC power. Since the electromagnetic waves would tunnel, they would not propagate through the air to be absorbed or be dissipated, and would not disrupt electronic devices or cause physical injury.

8.3 PROPOSE MODEL

(PICTURE REFERENCE TAKEN FROM PIEZOELECTRIC SHOE MADE BY ABEL HAYNES)

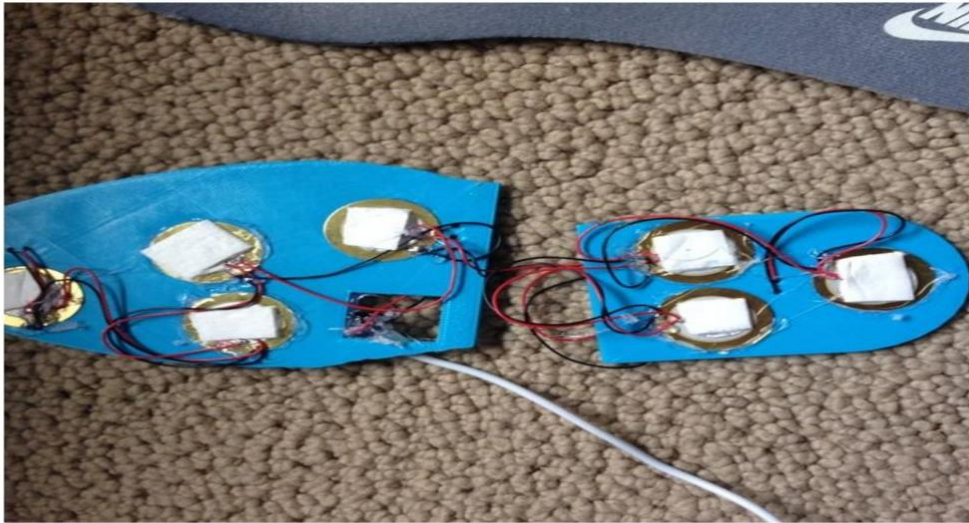


Fig 8.3: Connecting the Circuit with the Shoe Sole



Fig 8.4: Picture of Sole with the Circuit inside the Shoe

8.5 CIRCUIT DIAGRAM OF PROPOSED MODEL

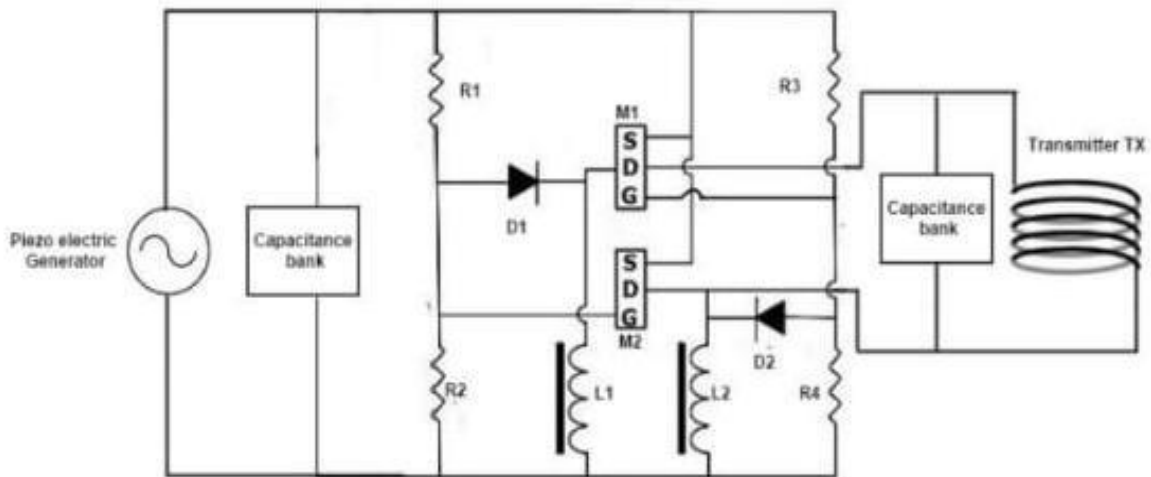


Fig 8.5: Circuit Diagram of Propose Model

9. COMPONENTS REQUIRED

- SHOES
- PIEZO ELECTRIC ELEMENTS
- RECHARGEABLE BATTERY
- HOT GLUE GUN
- SOLDERING IRON
- FOAM/CARDBOARD
- 1n4001-1N4007 DIODES

9.1 ABOUT THE COMPONENTS

9.1.1 HOT GLUE GUN



Fig 9.1.1: HOT GLUE GUN

Uses

Hot Glue Gun use continuous heating elements to melt the adhesive. In industrial settings, industrial hot glue and industrial hot glue guns give many advantages over solvent-based adhesives or other fasteners. Industrial hot glue can dry strong and quickly, reducing the time delay before the product is ready.

9.1.2 SOLDERING IRON



Fig 9.1.2: SOLDERING IRON

Uses

A Soldering iron is a hand tool used in soldering. It supplies heat to melt solder so that it can flow into the joint between two work pieces.

9.1.3 1n4001-1N4007 DIODES

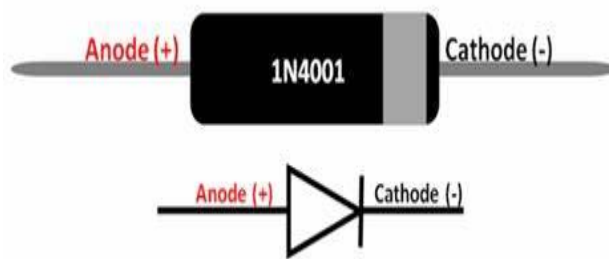


Fig 9.1.3: 1n4001-1N4007 DIODES

Features

- Diffused junction
- High current capability & low forward voltage drop
- Surges overload rating to 30A peak
- Low reverse leakage current

10. EQUATION

Voltage developed

$$\text{Voltage} = P_{app} \cdot T_p \cdot C \quad (1)$$

Where P_{app} = Pressure applied on piezo, T_p = Thickness of the piezo and C = piezo rating.

AMPLIFICATION MODEL

The voltage gain depends on the impedances connected

Across the pnp transistor in the Darlington pair.

$$\text{gain} = \frac{r_f + 1}{r_i}$$

Here, r_f = resistance in parallel, r_i = resistance in series

11. RESULT

We could not find the accurate result as due to lockdown we were unable to make the proposed model of our project. The pictures of the proposed model are taken from the reference that helped us to complete the project report.

12. FUTURE SCOPE

Utilization of wasted energy is very much relevant and important for highly populated countries in future.

12.1. Flooring Tiles-

Japan has already started experimenting the use of piezoelectric effect for energy generation. They implement piezoelectric effect on the stairs of the bus. Thus every time passenger steps on the tiles; they trigger a small vibration that can be stored as energy. The flooring tiles are made up of rubber which can absorb the vibration. This vibration generates when running or walking on it. Under these tiles piezoelectric material are placed. When the movement is felt by the material they can generate the electricity. This generated energy is simultaneously stored into the battery. Generated electricity we can use the lightning of lamp or street light. Energy is generated by step of one human being is too less but if number of steps increases ultimately energy production also increases.

12.2. Dance floors-

Europe is another one of the country which started experimenting use of piezoelectric crystal for energy Generation in night clubs. Floor is compressed by the dancer's feet and piezoelectric materials makes contact and generate electricity. Generated electricity is nothing but 2-20 watt. It depends on impact of the dancer's feet. If constant compression of piezoelectric crystal causes a huge amount of energy.

13. CONCLUSION

Project work based on the idea of electric power generation without polluting the environment. The waste energy in form of human walking is utilized in the system. it is very useful at crowded places to install this system to produce electricity. This system is smoother and less noisy in operation and provide flexibility in working. This system plays a important role for producing electricity at places where there are no sources of electricity like village areas. This energy source is renewable and continuous. In the innovation part of the project we have illustrated the design of system which can harness the power generated by the human movements and transfer the power to a device wirelessly. We believe that this research holds the key to an uninterrupted way of using smart phones. This system can also be built shoe independent and as a compact version that can strap on to any shoe. This humanitarian project holds the solution to the problem almost every smartphone used faces. Around 1.8 Billion people use Smartphone, and almost every smartphone user wishes he had more battery and a way to charge it anytime. This research project holds the key to an uninterrupted way of using smart phones. Harvesting energy from human motions is an attractive approach for obtaining clean and sustainable energy. This project has its root in all the areas of consumer electronics. This project also extends Future work includes designing authentication and monitoring systems for this project.

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