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Hybrid Photovoltaic-Piezoelectric Energy Harvesting For Low-Power Wearable Systems

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ABSTRACT: Proposal for the harvesting energy of foot power with human locomotion is very much relevant and important for highly populated countries like India where the streets, public places etc., are overcrowded all round the clock. When the flooring is engineered with piezoelectric technology, the electrical energy produced by the pressure is captured by floor sensors and converted to an electrical charge by piezo transducers, then stored and used as a power source This paper is all about generating electricity when people walk on the Floor. Think about the forces you exert which is wasted when a person walks.. The idea is to convert the physical weight energy to electrical energy, by generating floor kinetic energy to the electrical power Due to this a lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India where the railway station, temples etc., are overcrowded all round the clock. When the flooring is engineered with piezo electric technology, the electrical energy produced by the pressure is captured by floor sensors and converted to an electrical charge by piezo transducers, then stored and used as a power source. And this power source has many applications as in agriculture, home application and street lighting and as energy source for sensors in remote locations. This paper is all about generating electricity when people walk on the Floor. Think about the forces you exert which is wasted when a person walks. The idea is to convert the weight energy to electrical energy The Power generating floor intends to trans- late the kinetic energy to the electrical power. Energy Crisis is the main issue of world these days. The motto of this research work is to face this crisis somehow. Though it won't meet the requirement of electricity but as a matter of fact if we are able to design a power generating floor that can produce 100W on just 12 steps, then for 120 steps we can produce 1000 Watt and if we install such type of 100 floors with this system then it can produce 1MegaWatt. Which itself is an achievement to make it significant

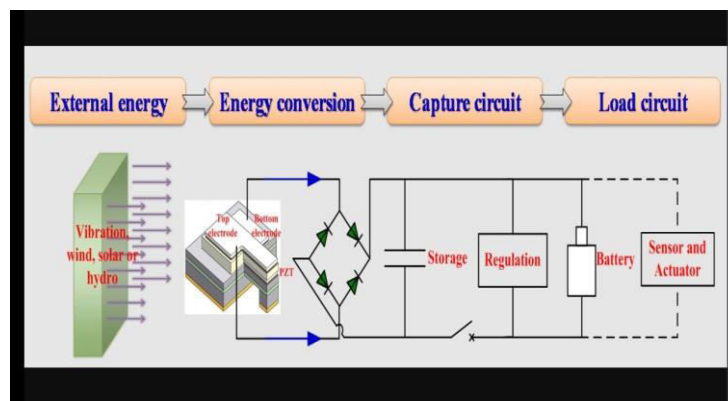
I. INTRODUCTION

The Day by day, the population of the country increased and the requirement of the power is also increased. At the same time the wastage of energy also increased in many ways. So reforming this energy back to usable form is the major solution. As technology is developed and the use of gadgets, electronic devices also increased. Power generation using conservative methods becoming deficient. There is a necessity arises for a different power generation method. At the same time the energy is wasted due to human locomotion and many ways. To overcome this problem, the energy wastage can be converted to usable form using the piezoelectric sensor As technology is developed and the use of gadgets, electronic devices also increased Power generation using conservative methods becoming deficient. There is a necessity arises for a different power generation method.

To overcome this problem, the energy wastage can be converted to usable form using the piezoelectric sensor, Solar and hydro power. This sensor converts the pressure on it to a voltage. So by using this energy saving method that is the footstep power generation system we are generating power. This project is used to generate voltage using footstep force. The proposed system works as a medium to generate power using force. This project is very useful in public places like bus stands, theaters, railway stations, shopping malls, etc. So, these systems are placed in public places where people walk and they have to travel on this system to get through the entrance or exists Using the ATM (Automatic Teller Machine) which provide customers with the convenient banknote trading is very common. However, the financial crime case rises repeatedly in recent years, a lot of criminals tamper with the ATM terminal and steal

user`s credit card and password by illegal means. Once user`s bank card is lost and the password is stolen, the criminal will draw all cash in the shortest time, which will bring enormous financial losses to customer. How to carry on the valid identity to the customer becomes the focus in current financial circle. Traditional ATM systems authenticate generally by using the credit card and the password, the method has some defects. Using credit card and password cannot verify the client`s identity exactly. In recent years, the algorithm that the fingerprint recognition continuously updated and sending the four digit code by the controller which has offered new verification means for us, the original password authentication method combined with the biometric identification technology verify the clients` identity better and achieve the purpose that use of ATM machines improve the safety effectively.

BLOCK DIAGRAM



HARDWARE REQUIRED

- Piezoelectric Sensor
- Solar panel
- Wind or Dynamo
- Boost Converter
- LCD display
- Battery
- Microcontroller
- Battery management system
- Arduino uno

SOFTWARE REQUIRED

- Arduino IDE
- Embedded C
- Simulink .

II. LITERATURE SURVEY

Earlier developments in the piezo electric circuitry involved concentration on small vibrations and hence small strains. Also, few of them required external voltage supply and there were number of losses in the system which amounts to low voltage output. In December 1929, scientists in U.S Navy performed various researches on piezoelectric crystals. Their focus was primary on the dimensions of crystals

This research proved that by changing the dimension and orientation of crystal the output. considerably changed. They designed the crystal named "Curie cut" or "Zero Cut" based on the changes made in the angles of the crystal. Thus, this proves that the crystals designed with such dimensions are effective in controlling oscillations of a 50watt vacuum tube. So, they act as a voltage controlling device too. In 1985, the concept of using handwriting dynamics for electronic

identification was performed in Sandia Laboratories A piezoelectric sensor pen for obtaining the pen point dynamics during writing was studied. Design equations were derived and details of an operating device were studied. Typical output waveforms obtained from the operation of the pen and showed the dissimilarities between dynamics of a genuine signature and an attempted forgery. So, this also shows high sensitivity of Piezo material towards marginal pressure change. In 2000, various applications of piezoelectric in wireless sensing was studied and experimented. Numerous industrial and military applications require remote sensing of various machine and equipment operating parameters in locations where traditional power sources may not be available and long periods of unattended operation are required. Quite often, however, some source of Vibrating energy may be present in operation of the machine in question. Hence a piezoelectric source is efficiently utilized to generate power for the operation of a microcontroller and radio transmitter acquire sampled machine data. Various techniques for the efficient conversion, use and storage of piezoelectric power are discovered and used in a general energy harvesting data transmitter design In 2005. United States Defense Advance Research Project Agency (DARPA) initiated an innovative project on Energy harvesting which attempts to power battlefield equipment by piezoelectric generators embedded in soldiers' boots. However, these energy harvesting sources put an impact on the body. DARPA's effort to harness 1-2 watts from continuous shoe impact while walking was abandoned due to the discomfort from the additional energy expended by a person wearing the shoes.

III. HARDWARE DESCRIPTION

PIEZOELECTRIC SENSOR

The A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge

When a force is applied to a piezoelectric material, an electric charge is generated across the faces of the crystal. This can be measured as a voltage proportional to the pressure (see diagram to the right).A given static force results in a corresponding charge across the sensor. Flex motions, touch, vibrations, and shock measurement all use piezoelectric sensors. They are used in sectors such as healthcare, aerospace, consumer electronics, and nuclear A piezoelectric sensor converts physical parameters - for example, acceleration, strain or pressure into an electrical charge which can then be measured. They are highly sensitive and very small in size making them well suited to everyday objects.

SOLAR PANEL

A Solar panel (also known as "PV panels") is a device that converts light from the sun, which is composed of particles of energy called "**photons**", into electricity that can be used as backup power for electrical loads.

It can be used for a wide variety of applications including **remote power systems** for **cabins, telecommunications equipment, remote sensing**, and particularly for wearable devices.

WIND ENERGY

Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore). Wind energy has been used for millennia, but onshore and offshore wind energy technologies have evolved over the last few years to maximize the electricity produced - with taller turbines and larger rotor diameters.

Though average wind speeds vary considerably by location, the world's technical potential for wind energy exceeds global electricity production, and ample potential exists in most regions of the world to enable significant wind energy deployment.

Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones. Offshore wind power offers tremendous potential.

BOOST CONVERTER

It is a DC to DC converter and output voltage greater than the input voltage. The device has at least to semiconductors and one energy storage element. It is a class of switched mode power supply. Anyone that ever worked with electronics

knows how wide the range of rated voltages in the market is. For example, inside a computer there are at least three different voltage supply lines: 12 V, 5V and 3.3 V. They are needed because the rated voltages of different components, such as processors, fans and hard disks, are inherently different: they vary with the application, brand and model. In this scenario, voltage converting systems are fundamental. Their job is to convert an input voltage (for instance, the main line) to a DC value that can be used by the component. Changing the supply level is 1-3 V to 35-40V the easy part; the problem is doing it in an efficient way, which is why there are so many topologies of power converters. In this article, we will discuss the voltage booster, or boost for short. This circuit is a switched-mode power supply (SMPS) able to output a voltage higher than its input, with the actual value being defined by the duty-cycle of the control signal. We will present the voltage booster basic concepts, the operation modes and some design guidelines, without going too deep into the mathematics of the circuit.

LCD DISPLAY

The term **LCD stands for liquid crystal display**. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment **light-emitting diodes** and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

The LCD which is interfaced with the microcontroller to display the amount of charge stored by the battery.

BATTERY

A battery is a source of electric power consisting of one or more electrochemical cells with external connections^[1] for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode.^[2] The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells; however, the usage has evolved to include devices composed of a single cell.^[3]

Primary (single-use or "disposable") batteries are used once and discarded, as the electrode materials are irreversibly changed during discharge; a common example is the alkaline battery used for flashlights and a multitude of portable electronic devices. Secondary (rechargeable) batteries can be discharged and recharged multiple times using an applied electric current; the original composition of the electrodes can be restored by reverse current. Examples include the lead-acid batteries used in vehicles and lithium-ion batteries used for portable electronics such as laptops and mobile phones.

MICROCONTROLLER

The main controlling unit of the entire system is a microcontroller. The input of the microcontroller is the output from the voltage generator. For the project PIC8F4520 is used. The filter used removes the AC components from the output voltage of the sensor. It acts like a short circuit for AC voltage and open circuit for DC voltage. A LCD display is interfaced with the microcontroller. This stage contains a battery backup which is a 3.7V 6600mAh and can power the circuit for almost 7 hours when it is fully charged. It can be charged through USB adapters, PC or power banks. Due to the fact that the battery is 3.7V and the voltage that powers the circuit is 5V, a DC to DC boost converter is employed to convert the 3.7V or even as low as 2V to 5V to power the circuits.

BATTERY MANAGEMENT SYSTEM

Voltage converting systems are fundamental and play a major part in energy harvesting for boosting the voltage. Their job is to convert an input voltage to a high level DC 1-3 V to 35-40V, the problem is doing it in an efficient way, which is why there are so many topologies of power converters. Our circuit is able to output a voltage higher than its input, with the actual value being defined by the duty-cycle of the control signal.

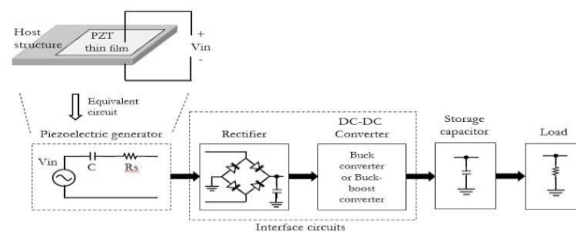
ARDUINO UNO

Arduino Uno is one type of microcontroller board, and it is designed by Arduino.cc. It can be built with a microcontroller like Atmega328. This microcontroller is also used in Arduino UNO. It is a small size board and also flexible with a wide variety of applications. Other Arduino boards mainly include Arduino Mega, Arduino Pro Mini, Arduino UNO, Arduino YUN, Arduino Lilypad, Arduino Leonardo, and Arduino Due. And other development boards are AVR Development Board, PIC Development Board, Raspberry Pi, Intel Edison, MSP430 Launchpad, and ESP32 board

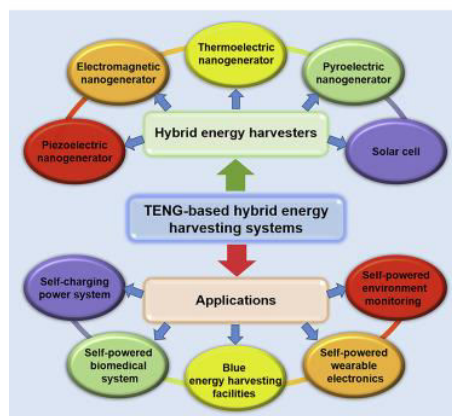
FEATURES

- The piezoelectric crystals have being start better use with the positive result. In china and Japan, maximum public movement is observed in railway station, airports and shopping malls.
- Hence this place can be used for piezoelectric crystals for generation of electric power. Apart from all the above places attempts are made to develop energy from our daily life by initialing piezoelectric in shoes thus in each step piezoelectric crystal can be compressed which can turned enough power to charge a cell phone.mp3 player
- Through this we can generate electric power and used that for small electronic gadgets.Application development is simple: developers can provide control instructions, self-fingerprint application product development, without the need for professional knowledge of fingerprinting.
- Adjustable security level: suitable for different applications, security levels can be set by the user to adjust.
- Finger touch sensing signal output, low effective, sensing circuit standby current is very low, less than 5uA.

CIRCUIT DIAGRAM



HARVESTERS



WORKING

The main components of the system include piezoelectric sensors, voltage boosters, voltage regulator, PIC microcontroller, battery, LCD display, LDR and a socket for mobile charging. Here in this this system, at first, the

output from an array of piezoelectric sensors is fed into voltage booster. In the system, two voltage boosters are used to boost the voltage to get the desired output. The output from piezoelectric sensor is in the range of 3 V to 4 V. It has to be boosted to a range of 9 V to 12V with the help of voltage boosters.

A constant output voltage irrespective of fluctuations will be maintained by a voltage regulator. This regulated voltage is stored in the battery and is fed to the microcontroller. The LCD which is interfaced with the microcontroller in turn displays the amount of charge stored by the battery. In this system the power generated has been used for two applications such as lighting a street light and charging a mobile phone. A LDR is used to indicate the street light application.

A buzzer is used to alert when the battery voltage falls below the required voltage for charging the microcontroller. For PIC microcontroller 5 V is required for its working. The mobile charging socket also requires 5 V for its operation. A pull down resistor is used in the socket to pull down the voltage to 5 V. The power is generated by simply walking over a step. The system does not need any fuel input for its functioning this is a non-conventional system in which battery is used to store the generated power. Even though the force is used to generate power, the system is applicable to particular places. Mechanical moving parts used in the system are large there by increasing the cost. The power generation using footsteps can be implemented effectively in schools, colleges, cinema theaters, shopping complexes, temples and many other buildings.

PROBLEM FORMULATION & SOLVING

- A. As technology is developed use of electronics equipment also increased
- B. Conventional methods of power generation becoming insufficient.
- C. It introduced a new problem, lack of power.
- D. There is a need arises for an alternative power generation method
- E. At the same time energy is wasted in many form and one of them is due to the human locomotion

DISAVANTAGES

- A. Only applicable for the particular place
- B. Intial cost of the arrangement is high
- C. Output affected by temperature variations
- D. Crystal is prone to crack if overstressed

IV. CONCLUSION

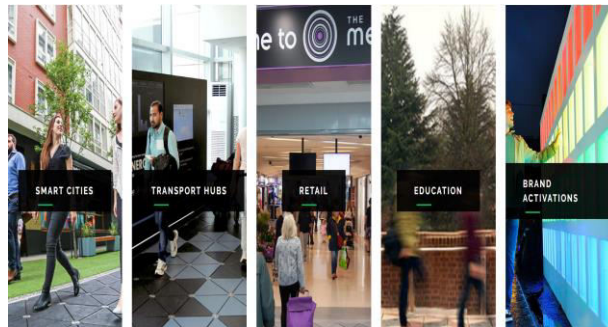
In this project, we are generating electrical power as non-conventional method by simply walking or running on the foot step. Non-conventional energy system is very essential at this time to our nation. Non-conventional energy using foot step is converting mechanical energy into the electrical energy. By using this energy conservation theorem and Piezo sensor we are proposing a new method for power generation. Proposal for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India and China where the roads, railway stations, bus stands, temples, etc. are all over crowded and millions of people move around the clock

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APPLICATIONS





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