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Piezoelectric Footstep Power Generation

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Abstract: Electrical energy is important and had been demand increasingly. A lot of energy resources have been wasted and exhausted. An alternative way to generate electricity by using a population of human had been discovered When walking, the vibration that generates between the surface and the footstep is wasted. By utilizing this wasted energy, the electrical energy can be generated and fulfill the demand. The transducer that uses to detect the vibration is a piezoelectric transducer. This transducer converts the mechanical energy into electrical energy. When the pressure from the footstep is applied to the piezoelectric transducer, it will convert the pressure or the force into the electrical energy. The piezoelectric transducer is connected in series-parallel connection. Then, it is placed on the tile that been made from wood as a model for footstep tile to give pressure to the piezoelectric transducers. This tile can be placed in the crowded area, walking pavement or exercise instruments. The electric energy that generates from this piezoelectric tile can be power up low power appliances.

Keywords*:* Footstep Power Generation, Piezoelectric Sensor, Rechargeable Battery, Electricity Generation

I. INTRODUCTION

In day today life the utilization of power turns to be necessary for each work .The power delivered in this paper will not contaminate the surroundings and it is also will not to rely upon the climate conditions. The paper proposes a novel technique for the creation of power utilizing piezoelectric sensors kept along the footpaths which can ready to charge the battery and ready to supply the force at whatever time of our prerequisite. The footstep power generation technique through piezoelectric sensors produces electrical force by changing mechanical energy of the development of individuals on the floor to electrical energy. The benefits of piezoelectric force generation framework is that it is sheltered and secure to utilize, it doesn't make any issue or distress for the general population strolling through footpath, and it is absolutely chance free strategy. Footstep power generation technique has mechanical part and in addition electrical part, however the electrical and mechanical losses are negligible. This framework additionally has the ability to store the electrical force away battery. The power produced by this technique can be utilized for helping up the road lights, additionally for activity reason, sign boards of streets. At long last the force which will be abandoned can be given to national grid for power reason.

Man has needed and used energy at an increasing rate for the sustenance and well-being since time immemorial. 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.

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II. LITERATURE SURVEY

Generally, there are different techniques in generating electrical energy that are received from the people movement or vehicles movement on roads. An unfamiliar method is used for the fluctuation of pressure in the ground that is formed by crossing of people or vehicles that are exposed and resulting fixedpressure amplitude [8]. For an example, in the Netherland, the electromagnetic generator is applying on the dance floor to generate electricity. However, a relatively larger deflection of floor up to 10mm is needed to generate noticeable electric energy. Additionally, its have a complex structure and demand in high assembling cost [9]. In Japan, the piezoelectric transducer had been installed in the floor of the subway ticket machine to generate electricity and only need piezoceramic without any complex mechanical structure [8-9]. In this method, the energy conversion is based on piezoelectric effect. There are two categories of piezoelectric effect which are direct piezoelectric effect and converse piezoelectric effect [10, 11]

The direct piezoelectric effect is the ability of the piezoelectric transducer to convert the mechanical energy to electrical energy [12-14]. When vibration or mechanical stress is appliedon the piezoelectric transducer, it will deform and produced electric charge. It is also known as generator or transducer effect [15]. the ability of the piezoelectric transducer to convert the electrical energy into the mechanical energy is known as converse piezoelectric effect [14, 15] The piezoelectric transducer will deformed when the piezoelectric transducer is subjected to the electric field or the electric field is applied to the electric field.

This also known as actuator or motor effect [13, 14, 16] Research has been done in generating the power energy by using piezoelectric transducer. Arvind et.al proposed a power generation through human locomotion [21]. It generatethe electricity by placing the circular piezoelectric transducer in the pedestrians and used it to light the street lights. Another research was done by Ghosh et al., and they proposed electrical power generation using footstep for urban area energy application [22]. In this research, they are using sources from human motion to press the gear and the shaft to

create electrical energy by rotational motion and using the faraday law concept [22]. Besides that piezoelectric transducer also can be used in medical purpose. For this study, Meirer et al., proposed a piezoelectric energy harvesting shoe system for podiatric sensing [23]. This study is implement the circular piezoelectric transducer in the heels of the shoes and it targeted to the athletes, physical therapy patients, amputees, and those with muscular or nervous system disorders [23]. Another research had been done by AkshatKamboj et.al, design of footstep power generator using piezoelectric sensors [24]. This study also used circular piezoelectric transducer to generate power by using footstep. The power generate is stored in two batteries which is 6 volt for each batteries before using to running the load such as light [24].

In Bangladesh, by using its population density, the electrical energy can begenerating by using the piezoelectric material that had been study by Nayan HR. In this study, 12 piezoelectric sensor is used in 1 square ft and by using 50kg weight pressure from single person, the minimum voltage per step is 1V [25].

It takes 800 steps to increase 1V charge in battery, so to increase 12V in battery it needs 9600 steps. If in 1 second the average of footstep is 2 step, then it take 80 minutes to achieve 9600 steps [25].

In this study, the development of power generation by using piezoelectric tile has been studied. The piezoelectric transducer generates electrical energy by converting the pressure applied on it. The sources of pressure are from the weight of the people walking over it. The 6 cell of piezoelectric transducers is attached together in series-parallel connection. The output of this piezoelectric transducer is in AC voltage and not a steady output. So a full wave bridge rectifier is used to convert the AC voltage into DC voltage, then the voltage is filtered by the smoothing capacitor to filter out any fluctuations in the output. After being rectifier and filter the output is ready to be store in capacitor or used by low power appliances.

III. PROPOSED SYSTEM

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.

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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.

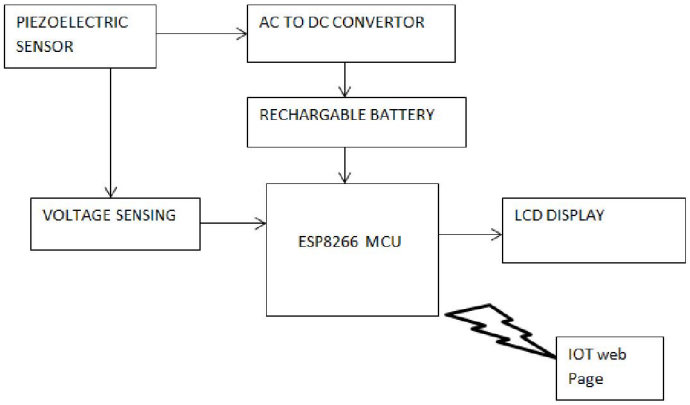

Fig.1. Block Diagram

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.

ESP8266 MCU

Espressif's ESP8266EX delivers highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design and reliable performance in the Internet of Things industry. With the complete and self-contained Wi-Fi networking capabilities, ESP8266EX can perform either as a standalone application or as the slave to a host MCU. When ESP8266EX hosts the application, it promptly boots up from the flash. The integrated high speed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any microcontroller design as a Wi-Fi adaptor through SPI/SDIO or UART interfaces. ESP8266EX integrates antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules. The compact design minimizes the PCB size and requires minimal external circuitries.

ESP8266 (also called ESP8266 Wireless Transceiver) is a cost-effective, easy-to-operate, compact-sized & low-powered WiFi module, designed by Espressif Systems, supports both TCP/IP and Serial Protocol.

It's normally used in IOT cloud based embedded projects and is considered the most widely used WiFi module beacuse of its low cost and small size.

It runs at operating voltage of 3V and can handle maximum voltage of around 3.6 V, so an external logic level converter is required if you are using 5V supply.

ESP8266 WiFi module can easily be interfaced with microcontrollers board (i.e. Arduino UNO) via Serial Port.

There are numerous breakout boards available based on ESP8266 WiFi Module (i.e. ESP8266 NodeMCU V3).

Because of its compact size, its mostly used in autonomyous projects (i.e. Robotics).

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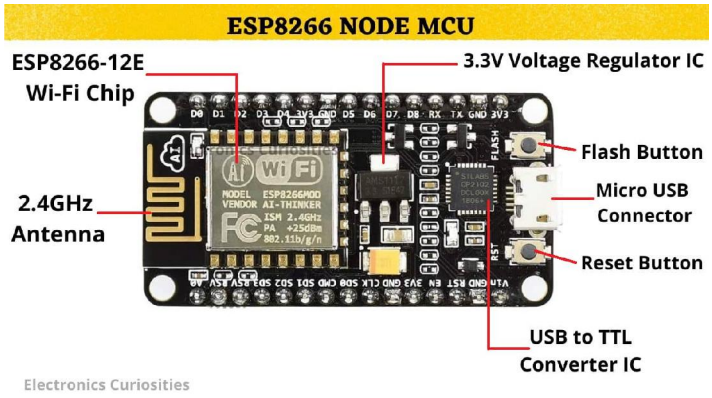

Fig. 2.ESP8266 MCU

Piezoelectric Sensor

Communication A sensor which works on the principle of **piezoelectricity** is known as a piezoelectric sensor. Where piezoelectricity is a phenomenon where electricity is generated if mechanical stress is applied to a material. Not all materials have piezoelectric characteristics. There are various types of piezoelectric materials. Examples of **piezoelectric materials** are natural available single crystal quartz, bone etc… Artificially manufactured like PZT ceramic etc…

Working of a Piezoelectric Sensor

The commonly measured physical quantities by a piezoelectric sensor are Acceleration and Pressure. Both pressure and acceleration sensors work on the same principle of piezoelectricity but the main difference between them is the way force is applied to their sensing element. In the pressure sensor, a thin membrane is placed on a massive base to transfer the applied force to the **piezoelectric element**. Upon application of pressure on this thin membrane, the piezoelectric material gets loaded and starts generating electrical voltages. The produced voltage is proportional to the amount of pressure applied. In **accelerometers, s**eismic mass is attached to the crystal element to transfer the applied force to piezoelectric materials. When motion is applied, seismic mass load's the piezoelectric material according to **Newton's second law** of motion. The piezoelectric material generates charge used for calibration of motion.

Specification:

- These sensors contain as Impedance value ≤500Ω.
- These sensors generally operate in a temperature range of approximately -20°C to +60°C.
- These sensors are to be kept at a temperature between -30°C to +70°C to prevent them from degradation.
- These sensors have very low **Soldering** temperature.
- Strain sensitivity of a piezoelectric sensor is 5V/με.
- Due to its high flexibility Quartz is the most preferred material as a piezoelectric sensor.

Fig.3. Piezoelectric Sensor

LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over

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seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

.A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD.

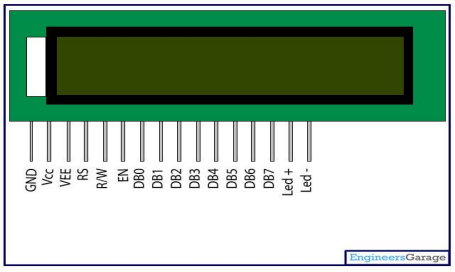

Fig. 4. LCD Display

Voltage Sensor

This sensor is used to monitor, calculate and determine the voltage supply. This sensor can determine the AC or DC voltage level. The input of this sensor can be the voltage whereas the output is the switches, analog voltage signal, a current signal, an audible signal, etc. Some sensors provide sine waveforms or pulse waveforms like output & others can generate outputs like AM (Amplitude Modulation), PWM (Pulse Width Modulation) or FM (Frequency Modulation). The measurement of these sensors can depend on the voltage divider.

This sensor includes input and output. The input side mainly includes two pins namely positive and negative pins. The two pins of the device can be connected to the positive & negative pins of the sensor. The device positive & negative pins can be connected to the positive & negative pins of the sensor. The output of this sensor mainly includes supply voltage (Vcc), ground (GND), analog o/p data

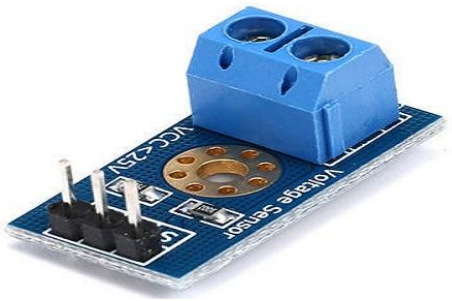

Fig.5. Voltage sensor

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Flow Diagram

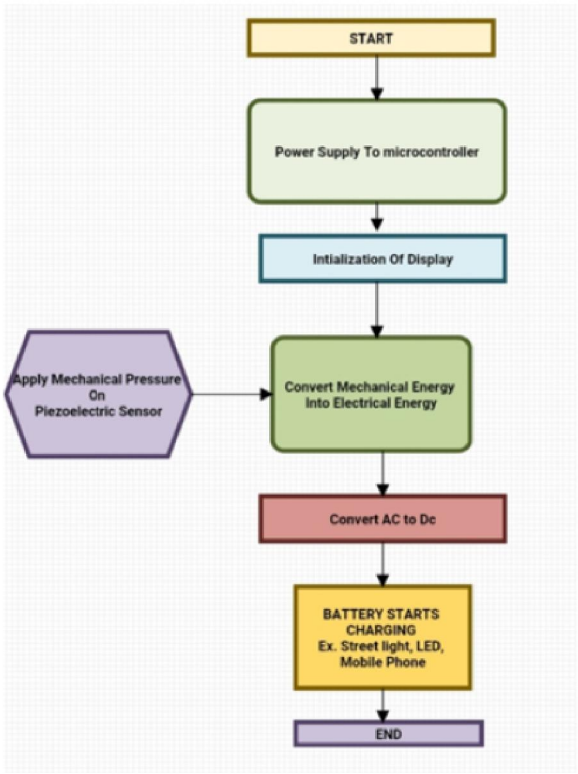

Fig.6. Flow Diagram

IV. CONCLUSION

A piezoelectric tile is capable of generating more voltage when longer the time taken. The longer the time taken means more footstep/force are applied on the tile. The linear relation is found between the voltage generated and the time taken. This piezoelectric are specifically suitable for the implementation in the crowded area such as pavement street, train ticket counter, stairs and dance floor. The piezoelectric tile is also suited for the exercise tile such as for skipping or on the treadmill. The power that is generated from this piezoelectric tile can be used to power up the light street, light along the stairs and also low power appliances.

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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