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Tracking System Using GPS and GSM Energized by Piezoelectric Crystal Embedded in Shoe Sole

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ABSTRACT: Nowadays, the usage of portable devices increases day by day, which necessitates portable power bank. The power bank also requires the periodic charging. To avoid this situation energy harvesting concept is introduced. This paper deals about the power generation which is harvested from the piezoelectric materials through the pressure given by human steps. Power generation is achieved with the aid of Lead Zirconate Titanate. The mechanical foot pressure is converted to the electrical energy (AC). This energy is transformed into pulsating DC using rectifier and filtered using capacitor. The rectified and filtered DC is stored in a rechargeable battery.This battery is further used to power up the portable devices like tracking system. The tracking system consists of a GSM modem, GPS receiver, LCD module and buzzer. In case of perilous situations, the person presses the buzzer while in turn signals the base camp by sending the message consists of latitudinal and longitudinal position of the person as well as the battery level. The LCD module displays the current position of the person. This can be a basic life guarding system for a person, which is implemented with low cost and high reliability.

KEYWORDS: Energy harvesting, Piezoelectric material, PZT, GPS and GSM.

I.INTRODUCTION

Current portable and wireless devices must be design to include electrochemical batteries as the power source. The use of batteries can be troublesome due to their limited life span, thus necessitating their periodic replacement. Energy scavenging devices are designed to capture the ambient energy surrounding the electronics and convert it into useable electrical energy. The concept of power harvesting works towards developing self- powered devices that do not require replaceable power supplies [1].

The power requirements for microelectronics continue decreasing, environmental energy sources can begin to replace batteries in certain wearable sub systems.The properties of the transducer match regular shoe filling and it is designed to harness energy from human walk without affecting the user's gait. The generated power is regulated with a self-powered dc/dc conversion circuit that achieves a high 65% efficiency for converting the high peizo electrically generated voltage (130 V) to a low voltage (4 V) suitable for portable electronic devices [2].

Harvesting mechanical energy from human motion is an attractive approach for obtaining clean and sustainable electric energy to power wearable sensors, which are widely used for health monitoring, activity recognition, gait analysis and so on. The harvester is based on a specially designed sandwich structure with a thin thickness, which makes readily compatible with a shoe. Besides, consideration is given to both high performance and excellent durability. The harvester provides an average output power of 1mW during a walk at a frequency of roughly 1Hz. Furthermore, a direct current (DC) power supply is built through integrating the harvester with a power management circuit[3].

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The Piezoelectric element (PZT) is capable in converting mechanical energy from the motion of human body, such as walking and running activities, into electrical energy. Piezoelectric disk-type sensor was installed inside a shoe of officer cadets to harvest the mechanical force from the walking motion. The experimental work was tested for five different weights (48 kg, 59 kg, 62 kg, 71 kg, and 85 kg) of officer cadets on the treadmill with a constant speed of 2 km/h. Before the piezoelectric device was tested on the cadets, the effects of single impact of different weights (1N, 2N, 3N, 4N, and 5N) on PZT piezo disk were tested and responses were analyzed [4].

GPS collar which is used as a new tiger tracking system in order to crack down on lazy wildlife guards. A GPRS device, along with the M-STRIPES software, will be used to track the movement of the tigers. This collars can be connected to domestic animals.This connected dog collar enables to track dog's location via GPS. Built-in LEDs light up at night and will automatically flash if your poor hound is lost. It claims to have the longest rechargeable battery life of any smart dog collar with this selection of feature [5].

The wrist watch used by mountaineer's displays position, direction, surrounding temperature and it also acts as an altimeter.It is sophisticated, smooth, well designed and one of the more attractive GPS watches. A hiking watch should have special features beyond those of a normal watch. The most important features every hiking watch should have are barometer, altimeter, thermometer and compass. A barometer will give you the data to predict the weather. Storms in the mountains can be very dangerous, so it's good to have a reliable device able to detect rapid changes in pressure. The compass is used for navigation and when used together with an altimeter it makes navigation significantly easier. Most hiking watches today are also equipped with a GPS receiver which is currently the best solution for navigation and tracking moves [6].

GPS based tracking system which keeps track of the location of a vehicle and its speed based on a mobile phone text messaging system. The system is able to provide real time text alerts for speed and location. Particularly, the present location can be locked and the system will alert the owner if the vehicle is moved from the present locked location. In addition, the speed can be locked and an alert texted if this speed is exceeded. It would also be useful for parents to monitor the speeds at which their children drive to reduce the high accident risk posed by drivers under the age of 25 years, usually from over speeding [7].

Recently in the US and Australia, some of the Indian students were forced to have a Radio collars strapped to their ankles, so that their movements can be tracked by the officials.This can be fixed to a belt or placed in a pocket and pre-set so that should the wearer leave a given location or go missing then the unit reports this event back to the carer via text or e-mail. The wearer can then be tracked via the internet web-panel or a mobile phone if necessary. All tracking devices have panic buttons that will transmit an alert and current location to any pre-defined mobile phones, and can be set to issue automatic alerts when certain events take place, such as leaving a safe area or entering an area that is considered dangerous. A similar technology which will display the soldier's current location on a map at the base station [8].

Bio-sensors systems gives different types of small physiological sensors, biomedical sensor, transmission modules and processing capabilities and can thus facilitate low cost wearable unobtrusive solutions for health monitoring. GPS used to log the longitude and latitude so that direction can be known easily. These devices are being added to weapons, firearms, and militaries such as the Israeli an army which are exploring the possibility of embedding GPS devices into soldiers vests and uniforms so that field commanders can track their soldier's movements in real time. GSM module can be used for effective range of high speed transmission, short range and soldier to soldier wireless communications that will be required to relay information on situational awareness and other missions [9].

GSM and GPS based tracking system will inform where your vehicle is and where it has been, how long it has been. The system fetches the geographic location and time information from the Global Positioning Satellites. During vehicle motion, its real-time parameters such as location are reported by SMS message. The system takes advantage of wireless technology in providing powerful management transportation engine. Vehicle information can be viewed and located on the electronic Google maps via the internet or specialized software [10].

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II.PROPOSED MODEL

The mechanical pressure which is obtained from the pressing of foot against the sole of the shoe is used for the harvesting of energy. The pressure is converted into electrical energy with the help of piezoelectric sheets. The electrical energy obtained is in analog form. To convert it in to digital, the voltage produced is passed in to a rectifier and a filter. The output of this block is a pure direct current. The voltage is then stored in a lithium ion battery. The stored current is used to power up the ARM processor. The ARM processor is an integral part of the tracking system.
The tracking system consists of a GPS receiver, a GSM modem, an LCD and a buzzer. The current position of the soldier can be determined with the help of the GPS. In case of a panic situation, the soldier presses the buzzer which in triggers the ARM to obtained the information about the position of the soldier. This latitudinal and longitudinal position of the soldier is messaged to the base camp by the aid of the GSM modem. Here, the process of serial communication is used. To facilitate it, UART (Universal Asynchronous Receiver Transmitter) protocol comes in to effect. MAX 232 is an IC which helps to implement the UART protocol. Fig 2.1 shows overall block diagram.

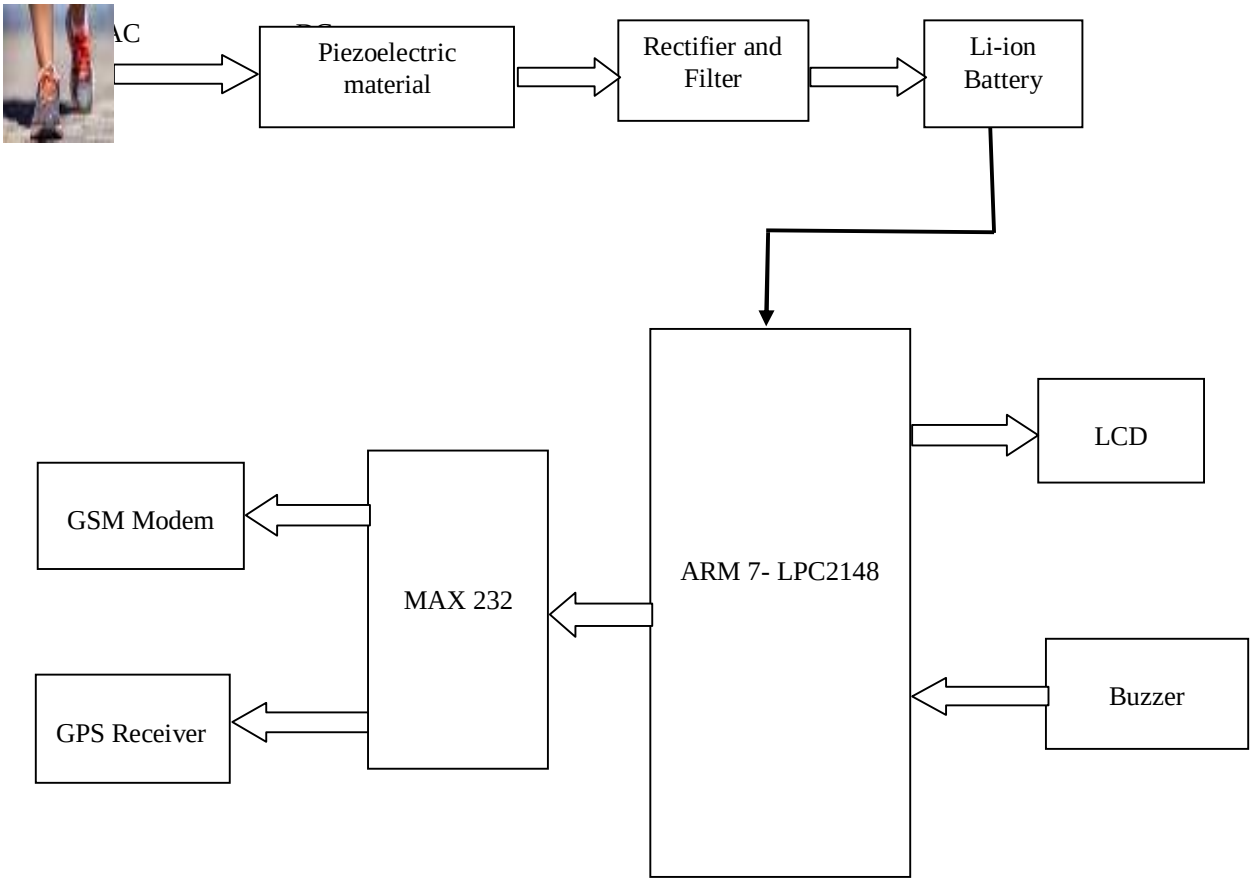

FIG 2.1: POWER GENERATION UNIT WITH TRACKING SYSTEM

The system has been divided in to two modules. First module is power generation unit. The energy is harvested from mechanical pressure with the help of piezoelectric sheets. The piezoelectric material that is used here is PZT (Lead Zirconate Titanate). Lead Zirconate Titanate (PZT)'s attributes of producing an electrical charge when mechanically compressed or vibrating when an electrical charge is applied, make it very conducive for passive sensing, active transmitting and mechanical displacement applications.

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The voltage produced is given to rectifier.A rectifier is an electrical device composed of one or more diodes that converts alternating current (AC) to direct current (DC). A diode is like a one-way valve that allows an electrical current to flow in only one direction. The voltage produced is stored in a lithium ion battery. The reason for choosing lithium ion is that they are generally much lighter than other types of rechargeable batteries of the same size and the electrodes of a lithium-ion battery are made of lightweight lithium and carbon. Fig 2.2 shows the block diagram for power generation unit.

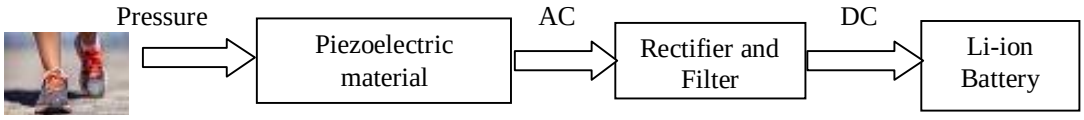

FIG2.2: POWER GENERATION UNIT

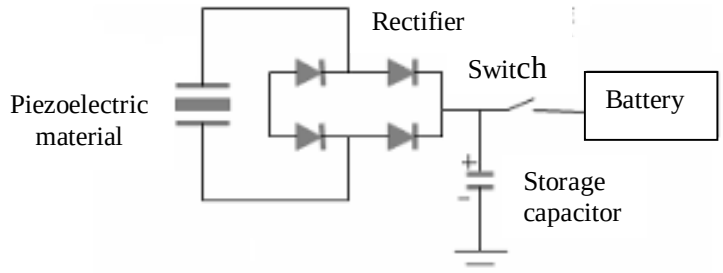

FIG 2.3: BASIC CIRCUIT DIAGRAM FOR ENERGY HARVESTING

Fig 2.3 shows the basic circuit diagram for energy harvesting module. It consists of four 1N4007 diodes forms the bridge rectifier. It converts the AC signal which is generated from the pressure given by footstep on piezoelectric crystal (PZT) into pulsating DC. The output from the rectifier is given as input to the filter. Here, storage capacitor (22µ) act as a filter and convert the pulsating DC into pure DC. The pure DC is passed through the voltage sensing switch and stored in the rechargeable battery. This battery is further used for other application.

The energy generated from the power generation unit is given as a power supply to the ARM processor used in tracking system. The tracking system consists of GPS receiver, GSM modem, LCD display, Buzzer, ARM processor. Whenever the soldier presses the buzzer, the latitudinal and longitudinal position of the person as well as voltage level of the battery is sent to the concerned mobile as a message through GSM modem. Fig 2.4 shows block diagram for tracking system.

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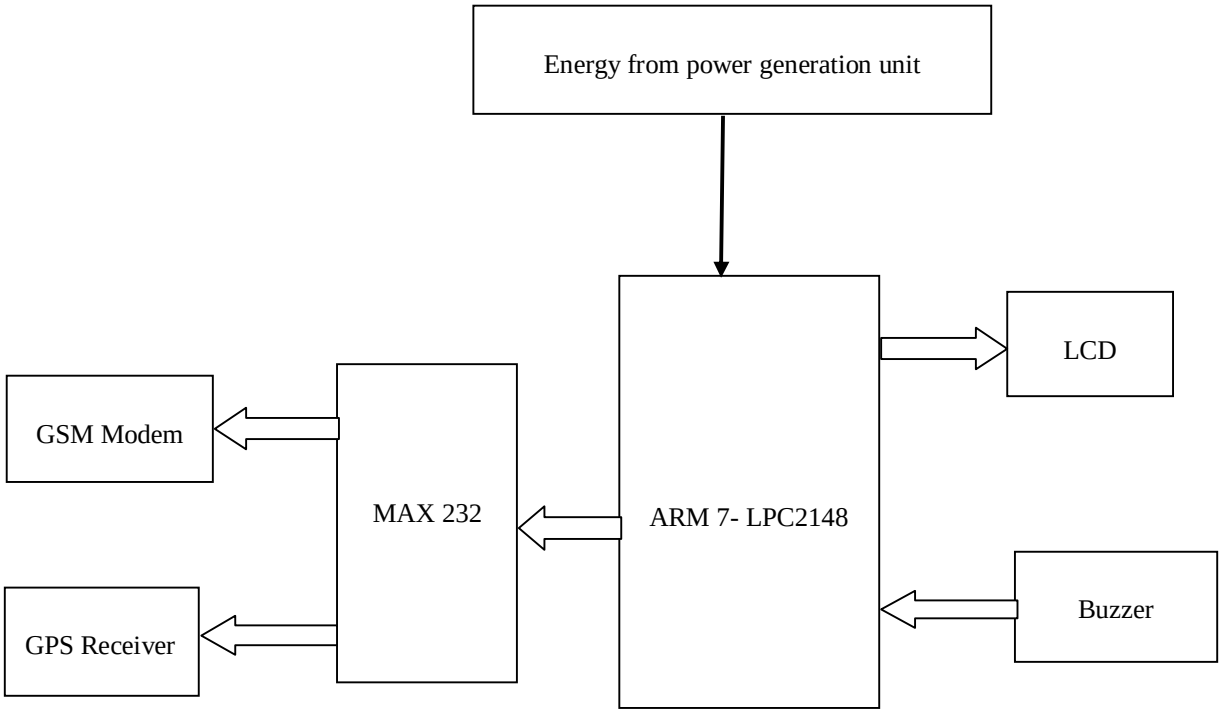

FIG 2.4: TRACKING SYSTEM

III. RESULT AND DISCUSSION

POWER GENERATION OUTPUT:

For power generation, three piezoelectric sheets are taken and are connected parallel to form a single layer. By this formation, three layers are formed which suggests that a total of nine piezoelectric sheets are used. It is to be noted that uniform pressure should be applied in all the three layers. Voltage of about 24V is obtained as maximum range and fig 3.1 shows the same.

FIG 3.1: POWER GENERATION UNIT OUTPUT

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TRACKING SYSTEM OUTPUT:

In tracking system, the buzzer is pressed in order to trigger the ARM processor. The processor in turn collects the location information from the GPS receiver. The location information consists of the latitudinal and the longitudinal position. Now, this location is displayed in the LCD module along with the information regarding the amount of voltage in the battery. The same is sent as an SMS to the concerned mobile. Fig 3.2 shows the output for the tracking system.

FIG 3.2: TRACKING SYSTEM OUTPUT

IV.CONCLUSION

This is an effective security system for soldiers. It provides a way for tracking each and every soldier who is stationed along the borders where the terrain is usually mountainous. It helps the base camp to keep track of each and every soldier's status so that we can ensure the security of the defence line. Also, the employment of energy harvesting technology has paved the way for utilisation of a new form of renewable energy which is mechanical pressure applied to the sole of the shoe converted in to electric current. With this energy, the tracking system can be powered up and also the soldiers can power up their own portable electronic gadgets.

V.FUTURE SCOPE

In future, the larger size of the circuit can be minimized to a greater extent with the help of VLSI technology where the entire circuit can be fabricated on to a single chip. The current piezoelectric material used is PZT which produces a voltage of about 3V. But by using the PVDF, voltage greater than 3V can be produced which can be used to charge multiple devices at the same time.

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