Smart Shoes

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***Abstract*--The word 'smart' in the technological aspect refers to the systems which have till a certain extent quick-witted intelligence. Every day we come across the word 'smart' like Smart TV, Smart phones so why not think of making a Smart Shoe? Footwear is an essential and an irreplaceable part of the human life, which has the most important job of protecting our feet. This project aims at developing a Smart Shoe. The principal intention of this project is to establish a smart shoe setup which will function as a health tracker. This project aims towards fitness as it helps in counting the footsteps taken by a human and in turn calculates the calories burnt. The interesting part of this project is yet to come. Yes, the shoe itself generates the energy which is required to drive this system! Isn't it interesting? The piezo transducer does all the magic. This energy can even be used to charge a mobile phone.**

Keywords—Pedometer , ADXL335 , piezoelectric transducer.

I. INTRODUCTION TO THE SMART SHOE SYSTEM

The main objective of this project is to create an inexpensive smart shoe system which will count the number of steps taken and calculate the calories corresponding to those steps and also charge our mobile phone. Piezoelectricity is exhibited by certain type of materials. Some materials possess the ability to generate electrical energy after the application of sufficient amount of pressure. This procedure involves the conversion of mechanical energy to electrical energy.

This project takes into consideration this property of materials in order to charge a mobile phone with the help of the electricity generated by the piezo crystals while walking, mounted on the sole of a shoe. This energy will even be used to drive the
microcontroller and the other devices. Secondly, with the help of accelerometer and a mobile application, this device will also be able to assist the users in knowing how much distance they covered and how much calories they have burnt while walking or running.

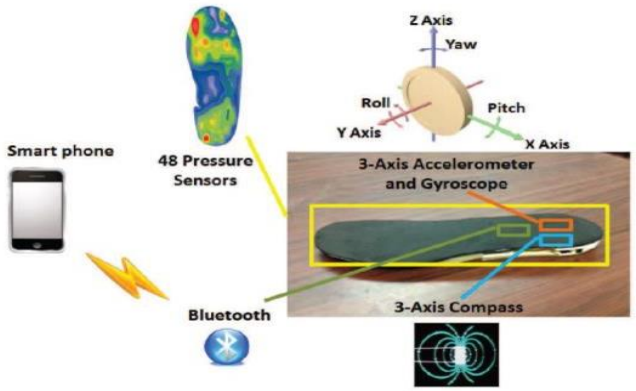

Figure 1: Overview of Smart Shoes [1]

II. PEDOMETER

With the increasing health risks arising due to sitting for a long time and not walking enough, it is decided to add the feature of a pedometer in these
shoes. A pedometer is a device which measures the steps taken by a human. This pedometer uses a accelerometer ADXL 335, Bluetooth module HC-05 & Arduino Nano, to count steps and gives the result on a mobile phone.

A. ADXL 335

The ADXL335 is a thin, small, low power complete 3-axis accelerometer with signal conditional signal outputs as shown in figure 2. In our project, the application of this device is calculating the calories from the number of steps walked. The accelerometer can be programmed in such a way that when a particular threshold value is reached it will count it as a step taken.

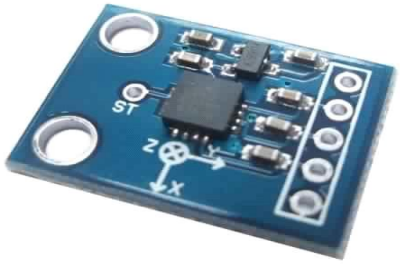

Figure 2. Accelerometer ADXL335 [2]

B. Bluetooth Module

As shown in figure 3, HC-05 is the Bluetooth module which is designed for wireless communications. It is used for sending & receiving data with the help of a 2.4Ghz wireless link. It has six pins:

1.Key/Enable: Used to bring Bluetooth module in AT commands mode.
2.VCC: Connect 3.3V or 5V to this pin.
3. GND: Ground pin.
4. TXD: Transmit Serial data.
5. RXD: Receive Serial data.
6. State: It tells whether module is connected or not.

Figure 3. HC-05 Bluetooth Module [3]

C. Arduino Nano

The Arduino Nano as shown in the figure 4 is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

Figure 4. Arduino Nano [4]

When ADXL 335 is connected to Arduino Nano and configured accordingly, it can give the no of steps walked in the Arduino IDE serial port. TABLE 1 shows the output in the Arduino Serial Monitor when there is a movement & Table 2 shows the output in the Arduino Serial Monitor when there is no movement. The number of steps can be converted into calories burnt and distance travelled so that user can meet his or her fitness goals.

TABLE I. ARDUINO SERIAL MONITOR READINGS WHEN THERE IS MOVEMENT

Y	Z
1	15
2	9
15	-8
12	28
26	15
43	-13
48	-15
40	-22
40	1

TABLE II. ARDUINO SERIAL MONITOR READINGS WHEN THERE IS NO MOVEMENT.

Y	Z
0	5
1	7
2	8
2	7
1	7
0	5
1	8
-1	6
0	7

The readings will also be displayed on mobile phone using Ardutooth app as shown in Figure 5. Ardutooth application is a kind of terminal emulator. It is used to communicate with any serial device using a Bluetooth serial adapter.

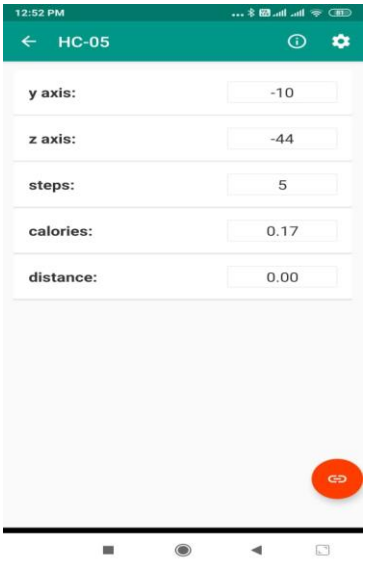

Figure 5. Ardutooth App Readings.

III. PIEZOELECTRICITY

In order to charge the mobile phone.is is necessary to convert the mechanical energy generated during walking into electrical energy. The key to achieve this is

Piezoelectric Effect. Piezoelectricity is an electrical energy that is generated from mechanical pressure such as walking, running, etc. On the application of pressure to an object, the expanded side develops negative charge and positive charge is developed on the compressed side of the piezoelectric sensor. Once the pressure is relieved, energy is developed that can be stored in batteries or power bank .They can be used to charge the mobile phone. The block diagram, Figure 6 shows the steps followed in energy conversion.

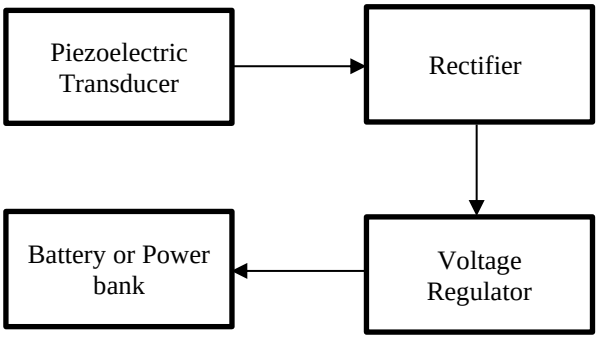

Figure 6: Block Diagram

A. Piezoelectric Sensors

The piezoelectric sensors are devices that measures any change in the pressure, strain, stress, acceleration and force and converting them to equivalent electric charge as shown in Figure 7 . They uses piezoelectric effect which can be seen as a transfer between mechanical and electrical energy.

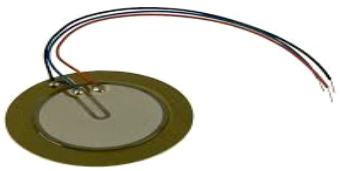

Figure 7: Piezo Transducer [6]

The piezoelectric effect is of two type's viz. direct piezoelectric effect and indirect piezoelectric effect. Direct piezoelectric takes place when the piezoelectric materials are stressed leading to the mechanical deformation; creating an electric field & finally voltage difference across the material takes place. Conversely, because of the electric field, deformations are induced in the piezoelectric materials. This effect is called as inverse piezoelectric effect.

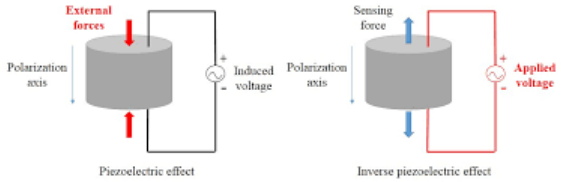

Figure 8 . Direct and Indirect Piezoelectric Effect.[7]

The sole of the shoes will be fitted with piezoelectric sensors. The piezo sensors will be placed on the pressure points of the sole. These sensors will convert the pressure applied while walking into electric energy. These sensors will be connected in series and parallel to increase the power produced by them. The center part of sensor is considered as positive while the outer part is considered to be negative. The output of these sensors will be in form of alternating current (AC). However we need DC supply to charge mobile phone. Around 6 to 7 piezo sensors will be required in order to charge the phone.

This AC current is then given to a rectifier. As shown in Figure 9 , this rectifier along with capacitor filter converts AC to DC. The acquired output will be given to a battery which will store the power. This battery will be enough to charge the mobile phone in case of emergency.

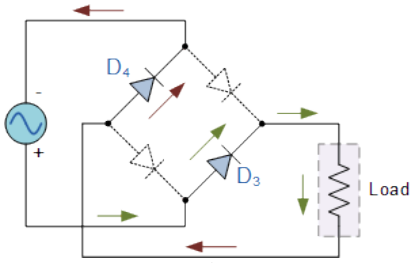

Figure 9.Rectifier Circuit [5]

CONCLUSION

Thus in this project ,a health tracker and mobile phone charging feature was incorporated in the unique design of the smart shoe with the help of diverse components and applications. Also, the proper functioning of our system will be taken care of.

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