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Smart Shoe

B.Ravichandra Rao
Assistant professor, Department of EEE
G. Narayanamma Institute of Technology & Science Autonomous (For women)
rao.ravichandra@gmail.com

K. Supraja[1], M. Keerthi[2], S. Anuhya[3], Ch. Sushma[4] and S. Harshini[5]
Department of EEE
G. Narayanamma Institute of Technology & Science Autonomous (For women)

Abstract

This paper aims to create a smart shoe that generates electricity while being worn, allowing users to charge their electronic devices as they walk. The shoe utilizes a piezoelectric transducer as a voltage source, which produces a varying output based on the pressure applied to the heel while walking. This work also incorporates safety features, including the ability to track the user's location and the number of steps taken.
To achieve this, the system utilizes GPS and GSM modems, as well as an Arduino microcontroller board. Using the programmed microcontroller, the GPS receiver locates the user and delivers latitude and longitude coordinates through SMS to a registered cellphone number. The system's core processing unit is the microcontroller. Additionally, a panic button can be used to activate an ALERT system, which sends information to the registered mobile number, with an SMS sent every two minutes.

Keywords: Arduino Nano, GPS tracker, GSM module, piezoelectric sensor

I. INTRODUCTION

The proposed paper introduces a cost-effective device called the "smart shoe" that can help users monitor their physical activity by tracking the distance traveled and calories burned during walks or runs. This device utilizes a force sensitivity resistor to measure the user's movement and calculate the overall distance and calorie count. The smart shoe is designed for universal wearability and offers easy maintenance. This work aims to create a low-cost solution that can benefit a broad range of users.

Statistics:

3.5 miles (7500 steps) is the average daily walking distance for an adult.

Humans typically weigh 179 lbs on average.
7500 * 0.063 = 472.5 calories are burned by each individual.
There are 7.4 billion people around the globe.
7.4 billion*472.5=3.4 trillion calories burned daily in total.

The objective of energy harvesting is to capture free energy from the surrounding environment, converting it into electrical energy that can be stored and managed. Wearable electronic devices benefit from advanced techniques that allow for efficient energy harvesting, with the use of SMART SHOES being the most effective system for capturing energy. These shoes can monitor an individual's health by tracking their travel time and calories burned, utilizing GPS technology to track their location. In case of an emergency, the SMART SHOES can send alarm SMS messages every two minutes to notify the individual's emergency contacts.

II. LITERATURE SURVEY

The objective is to make use of the energy generated by humans while walking or jogging and to enhance the safety of users who wear these smart shoes. The safety feature is particularly beneficial to women. In case of any emergency where the user does not have access to a mobile phone or other devices, they can press the panic button provided on the smart shoe. Once the button is pressed, an alert message is sent to the registered mobile number along with the user's location.
This Smart Shoe is also health-conscious as it regularly monitors the user's health profile, which includes the number of steps taken and calories burned. Therefore, this is useful for tracking not only humans but also animals, children, and the elderly.

III. ARDUINO NANO

The Arduino Nano is a compact, versatile, and breadboard-friendly board. Arduino.cc in Italy created an ATmega328p-based microcontroller board in 2008 that has 30 male I/O headers set up in a DIP30 fashion.

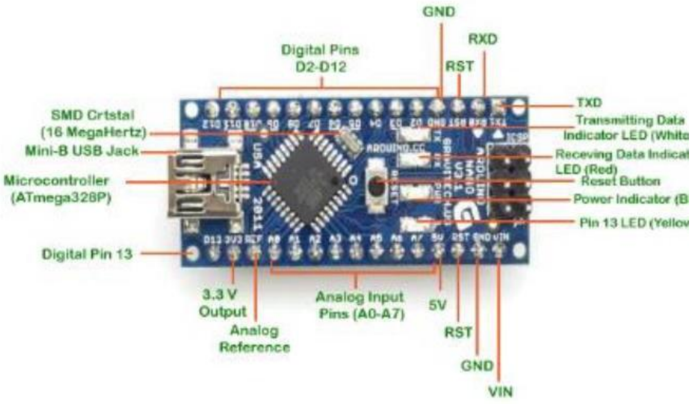

Figure 1: Arduino Nano

In 2008, Arduino.cc in Italy developed the Arduino Nano, a small and adaptable microcontroller board that is perfect for usage on breadboards. It has 30 male I/O headers in a DIP30 format and is based on the ATmega328p microcontroller. The board has 6 power pins, 2 reset pins, 8 analogue pins, and 14 digital pins. Although each pin can serve a variety of purposes, its main use is as an input/output port.

IV. Global system for Mobile Communication (GSM)

A common digital cellular communication standard for mobile devices all across the world is the Global System for Mobile Communications (GSM). Mobile devices look for nearby cell towers operated by a cell phone service provider to join a GSM network. A SIM800L GSM module, which has a total of 12 pins, is used to connect to the outside world. With a helical antenna for sending and receiving calls and messages, its main use is to make and receive calls and send messages. Operating voltage for the SIM800L is 3.4 to 4.4 volts. GSM is now well-established globally with over 450 million users and offers the benefits of Subscriber Identity Modules, which are smart cards that offer secure data encryption, as well as compatibility with Integrated Services Digital Network (ISDN) and other telephone company services. GSM is utilized to send the location information when the panic button is pressed (or) switched and the number of step travelled by user in regular and given interval of time, to the registered mobile number in GSM Module.

Figure 2: GSM Module

V. Global Positioning System(GPS)

The Global Positioning System (GPS) is a widely utilized technology that offers extremely precise and adaptable position data for navigational applications. It makes use of satellites to pinpoint one's location and the GPS NAVSTAR (Navigation Satellite Timing and Ranging Global Positioning System) system for positioning and timing. The GPS allows for continuous three-dimensional positioning around-the-clock, with the capacity to gather accurate data down to about 100 metres for navigation and even to the metre level for mapping. Numerous industries can benefit from this technology, including mapping, surveying, and the gathering of GIS data. The most advanced navigation satellite system in use today, GPS is a member of the GNSS (global navigation satellite systems) class. Point placement is the name given to the first type of positioning, whereas the second is relative positioning. Static positioning is used when the object being moved is already in place. Kinematics positioning describes the placement of an object while it is in motion.

In order to calculate a position in three dimensions four satellite observations are required. The positions are determined by the GPS using trigonometric calculations.

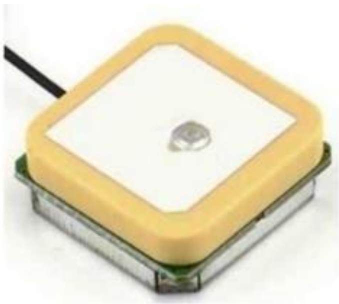

Figure 3: GPS tracker

A network of satellites that orbit the Earth and continuously send signal data makes up the GPS system. Ground-based GPS receivers pick up this signal data and utilise triangulation to determine the user's precise location. The GPS receiver can calculate how far away a satellite is by comparing the time at which a signal was emitted by the satellite to the time at which it was received. The GPS receiver can then use this distance measurement plus information from numerous satellites to pinpoint the user's precise location and show it on an onscreen map. The GPS system is a useful tool for mapping, surveying, and navigational purposes because of its accuracy.

VI. PIEZO SENSOR

Piezoelectric sensors have been used as tilt or pressure sensors in a variety of applications, including those in the medical, aerospace, nuclear instrumentation, and consumer electronics industries. Piezoelectric components are utilized in the automotive sector to monitor combustion when internal combustion engines are being developed. Through extra holes, the sensors can be installed directly into the cylinder head, or a tiny piezoelectric sensor can be integrated into the spark or glow plug.

Figure 4: Piezo sensor

The flexible piezoelectric technology can be used to measure a variety of physical quantities. Pressure and acceleration are the most commonly measured ones. The piezoelectric sensor is used to measure the pressure applied by the user's foot while walking or running, and the mechanical energy from the user's footsteps is converted into electrical energy, which generates a voltage output in millivolts. The voltage output from the sensor is directly proportional to the number of steps taken by the user or the distance traveled.

$$C_x = d_{xy} F_y b / a,$$

Charges are moved along the direction of (x), perpendicular to the line of force, when a force is applied along a neutral axis (y). The geometrical parameters of the relevant piezoelectric element affect the charge (cx).

VII. BLOCK DIAGRAM

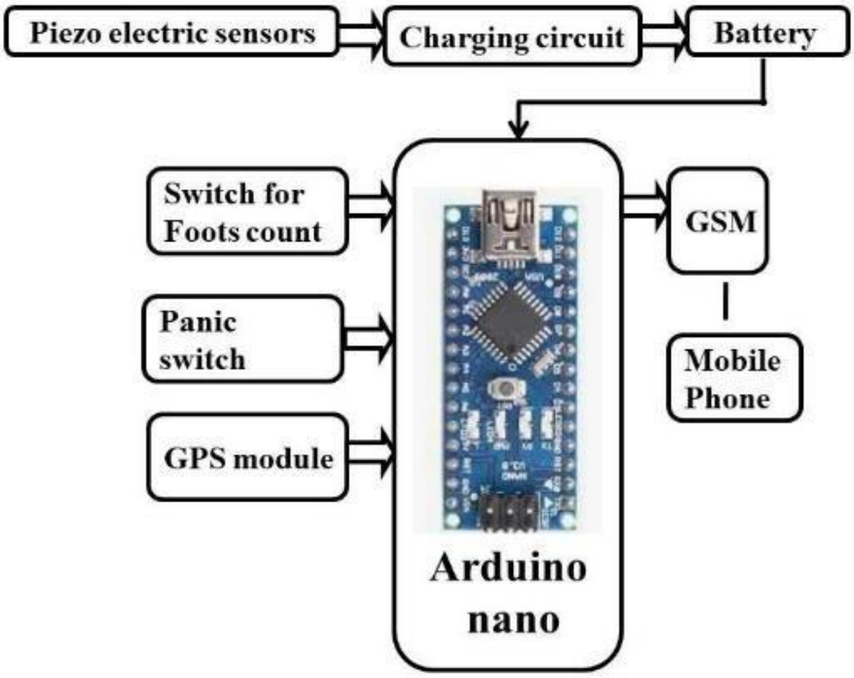

Figure 5: Block diagram

VIII. Working principle

This device utilizes piezoelectric sensors to generate power while walking, which is then stored in a 3.7V 2600mAh Lithium-ion battery through a charging circuit. The gadget is powered by an electrical charge created when the piezoelectric plate converts pressure, acceleration, strain, or force into an electrical charge. The device is equipped

with a GPS module to track the user's location and a GSM module for sending SMS messages in both regular and emergency situations. A push button is used to count the user's footsteps, while a panic button sends emergency alerts.
The main controlling device is an Arduino Nano programmed in embedded C language, which continuously reads data from the panic switch, switch, and GPS. The Arduino sends the user's foot count and health tracking information (calories burnt, distance covered) through SMS every 2 minutes via the GSM module. In the event of an emergency, the system sends an alert message with the user's location to a predefined mobile number through the GSM module

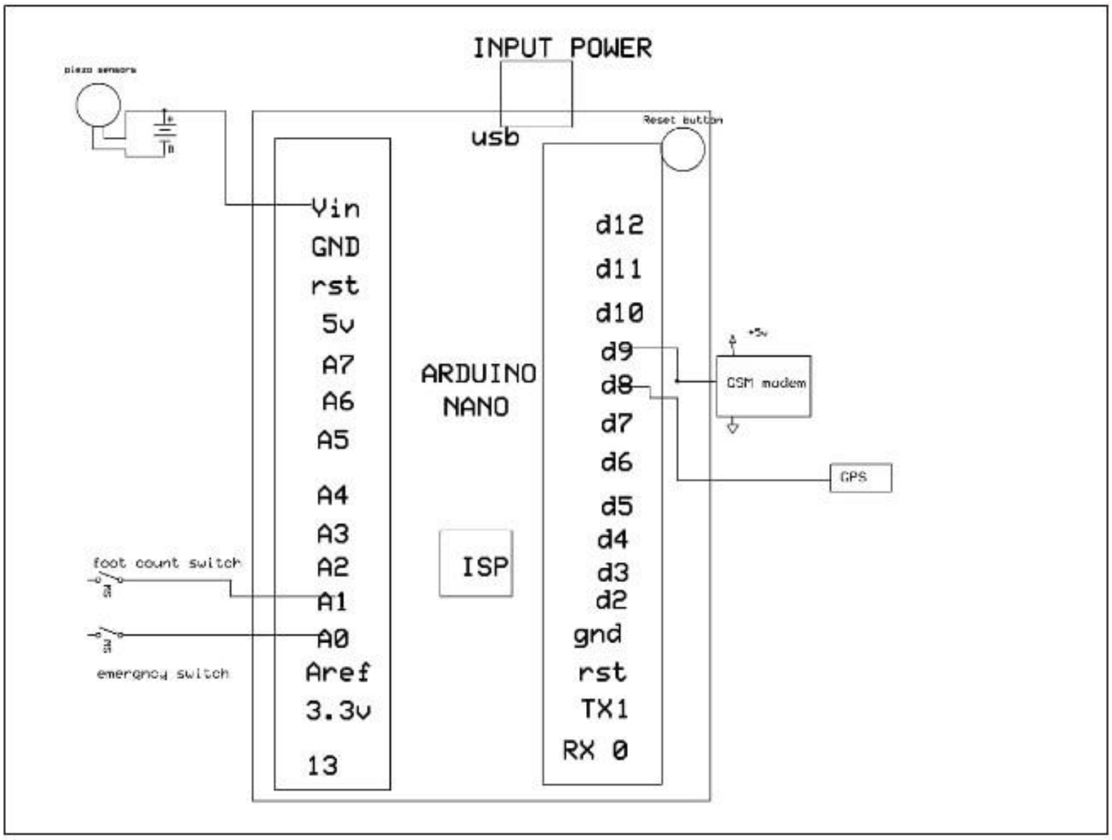

Figure 6: Circuit diagram

A charging circuit can be utilized to charge the battery from the piezo. Firstly, the output of the piezo sensor is connected to the rectifier to eliminate any spikes in the signal. A capacitor is also incorporated to aid in this process. The output terminal provides a steady 3V DC, which can be detected by the glowing LED. This 3V DC power is then utilized to charge the battery.

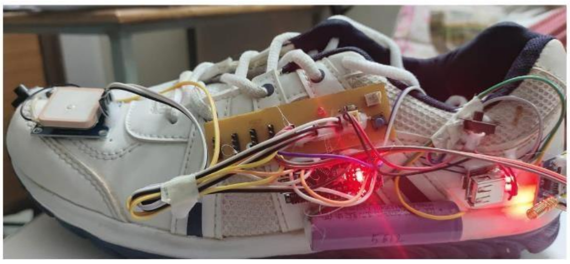

Figure 7: Smart shoe in function

IX. SOFTWARE USED

These softwares are used to carry out this work:

a. Express PCB is used to create circuits.

b. Arduino IDE Studio Compiler is used to compile code.

X. RESULTS

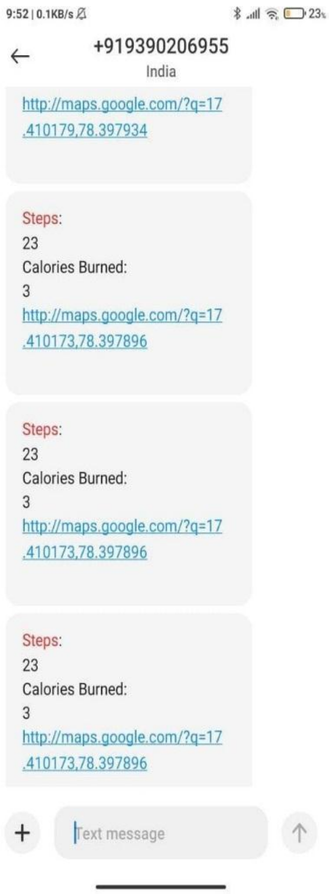

Figure 8: No. of steps travelled and calories burnt

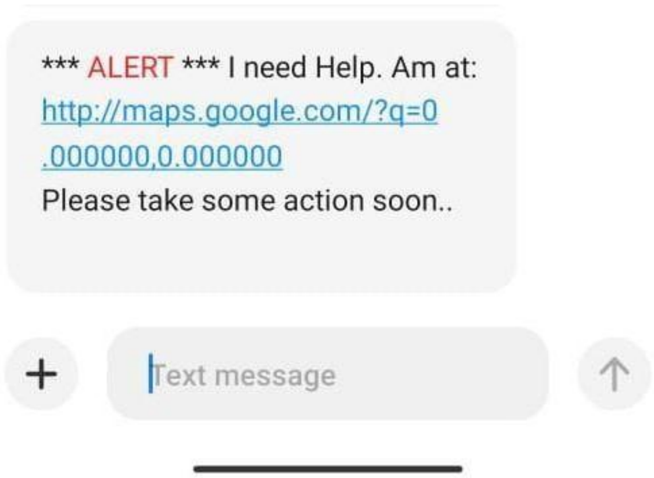

Figure 9: Alert message when panic button is pressed

XI. CONCLUSION

The controlling unit is the Arduino Nano, which runs a program coded in embedded C. Arduino continuously reads data from the panic switch, switch, and GPS. Using a GSM module, Arduino sends the person's foot count and health tracking (calculated through mathematical computations) via SMS every two minutes. In case of emergency, the panic button triggers the system to send an alert message and location to a pre-defined mobile number via GSM. The design of the smart shoe has been carefully planned to integrate the hardware modules and enhance the performance. The work was successfully finished with the aid of cutting-edge ICs and emerging technologies.

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