A Project Report
on
SMART SHOE FOR HEALTH FITNESS USING IoT

Submitted in partial fulfillment of the requirements

for the award of degree of

BACHELOR OF TECHNOLOGY

in

Information Technology

by

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(NAAC 'A' Grade & NBA Accredited- ECE, EEE, CSE IT)

June, 2023

DECLARATION

We hereby declare that the work presented in this project entitled **“SMART SHOE FOR HEALTH FITNESS USING IoT”** submitted towards completion of the Project in IV year I sem of B.Tech IT at “BVRIT HYDERABAD College of Engineering for Women”, Hyderabad is an authentic record of our original work carried out under the esteemed guidance of **Ms K . S. Niraja , Assistant Professor**, Department of Information Technology.

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CERTIFICATE

This is to certify that the Major-project report on **"SMART SHOE for HEALTH FITNESS USING IoT"** is a bonafide work carried out by **C. Neha Reddy (19WH1A1262), K. Deekshita (19WH1A1273), S. Sravani (19WH1A1280)** and **B. Sai Likhitha (19WH1A1298)** in the partial fulfillment for the award of B.Tech degree in **Information Technology, BVRIT HYDERABAD College of Engineering for Women, Bachupally, Hyderabad** affiliated to Jawaharlal Nehru Technological University, Hyderabad under my guidance and supervision.

The results embodied in the project work have not been submitted to any other university or institute for the award of any degree or diploma.

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ABSTRACT

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. An inexpensive device called smart shoe which is designed to assist user in knowing how many steps they have walked i.e; monitoring there daily exercise for health fitness. Proposed project is implementable for finding number of steps they have walked or runed by using force sensitivity sensor. Advantages of such shoes include extensibility and low maintenance. The idea was to develop shoes that anyone can wear. The shoes will be designed in such a way that anyone who does running or walking by wearing these uniquely designed shoe they will get to know how many steps they have walked and if the person sit ideal for sometime then he get a notification to warm up and if he do over exercise he get a notification to rest for a while with the help of GSM module. And there will be also a water remainder to help the user to avoid dehydration. And the proposed system also consists of GPS location tracking using GPS sensor so that if the user went for a walk or run then the concerned people can track him.

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1. INTRODUCTION

In today's generation many technological developments have been taking place. In that IoT technology are useful for many purposes which make the user's daily life more comfortable. Internet of Things is actually the combination of multiple technologies, real time analytics, machine learning, commodity sensors, and embedded systems. These physical devices are embedded with electronics, Internet connectivity, and other forms of hardware like sensors. These physical devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled.

The 21st century is the 5.0 era of the information society, because human society has begun to rely mainly on computers, using modern intelligent technology as the main means to work and live. Smart wearable fitness equipment is mainly used in road runners, so this article investigates and analyzes the applications of road runners and smart wearable fitness equipment [1, 2]. The survey results show that among road runners, the main considerations for purchasing and using smart wearable devices are product type, quality, functional effects, price, brand, etc. At present, there is not much investment in smart wearable devices and insufficient publicity in the market [3]. People do not know enough about the devices, and there are not many road runners buying smart wearable devices. The purchase of smart wearable devices is also related to the age and work status of road runners. Specific influencing factors include the consumption concept of road runners, the use experience of road runners, and the quality, function, appearance, and price of smart wearable devices [4]. Although the current sales of smart wearable devices are not impressive, with the development of the times and technological progress, road runners' acceptance of smart wearable devices will become higher, and the demand for devices will naturally change accordingly [5].

Since the current level of technological development cannot better support the application of smart wearable devices, the current application of devices also has some practical application problems [6]. If there are problems, companies can increase the promotion of equipment. For example, they can broadcast advertisements on TV, put up billboards in subway stations, and set up promotion points on running roads; relevant departments should also establish a complete system. The supervision system of smart wearable devices promotes the functional construction of smart wearable devices on the market and the improvement of supporting facilities [7]; the most important thing is to increase scientific research and accelerate the development of science and technology [8]. This article analyzes the application and research status of the Internet in sports and fitness at home and abroad and sorts out and analyzes the existing “Internet plus” related literature, and conducts research on the application of “Internet plus” in sports and fitness [9]. The development of this research conclusion will play a positive role.

Recent years have seen a rising in wearable sensors and today several devices are commercially available for personal health care and activity awareness. A recent health care system should give better health care services to people at any time anywhere in a friendly way. In the IoT environment, all objects in our daily life become part of the internet due to their communication and computing capabilities.

Internet of Things represents a general concept for the ability of network devices which sense and collects data from the world around us, and then share that data across the Internet where it can be processed and utilized for various interesting purposes.

The principal intention of this project is to establish a smart shoe setup which will function as a health tracker using IoT.

Designing a unique wearable device in order to help the people in there health fitness by monitoring step count, avoiding dehydration and helping them from over exercise (Through walking and running) and tracking there whereabouts.

Wearable technology is defined as any compact device, either in the form of a body sensor or head-mounted display, which provides a user information and allows user interaction as physical input.

The purpose of this wearable physical device is to create convenient, portable and hands-free access to computers, thus facilitating or enhancing everyday tasks.

Smart shoes have been revolutionizing the future of footwear with an assertive introduction of technology in product designing and development. Ranging from monitoring physical health attributes to evaluating health benefits, the smart shoes empower wearers to have personalized feedback. In a bid to improve the shoe-wearing experience, several shoe brands from across the globe have been incorporating technology to boost comfort, convenience, and good health.

The new smart wearable technologies and the health information technology provided by the internet of things would enable a comprehensive view of an individual's life. Mobility is of the utmost importance, as it defines the quality of life in healthy living and chronic diseases. In numerous neurological, musculoskeletal,cardio-pulmonary capacities, and thereby limit the independence and autonomy of individuals. Even though the disease-causing mechanisms and symptomatic patterns are specific to each disorder, impaired mobility is a typical consequence. This fact makes mobility an important surrogate marker for disease severity, progress, and responsiveness to the prescribed therapies, providing opportunities to assist therapeutic decision-making.

To enable the applications of smart devices for the purpose of mobility assessment for three reasons:

(i) smart shoes have a predefined, rigid sensor position on the foot, providing accurate and flexible biomechanical analysis.

(ii) smart shoes can be used to monitor gait, a highly stereotyped movement that enables the automated assessment of functional biomechanics.

(iii) Smart shoes enable non-obtrusive and non-stigmatizing integration of technology ultimately improving patient acceptance and long-term adherence. We also envision that the sporting goods industry will produce a growing number of sensor-equipped smart shoes that are capable of monitoring fitness and health conditions. The current limitations of this technology, namely restricted usability to patients, limited battery runtime, and especially restriction to only one shoe model due to a limited availability of instrumentation,will be overcome in the future once this mass-market availability is ensured. sequent analysis to support objective and clinically relevant gait analysis outside of conventional clinical environments.

The main three components in this project for sending GPS location to concerned people and notifications to user are GPS (Global Positioning System) module, GSM Module, and an Arduino Uno. Here we are sending the live coordinates received by the GPS receiver module to a mobile phone via SMS using the GSM module.

A GPS receiver module is a device that receives information from GPS satellites and obtains the geographical position of the device.

A GSM module is a device used to establish communication over a mobile network. GSM or GPRS Module requires a SIM card to operate or to register a connection with the network operator or service provider.

1.1 Problem Definition

Development of a prototype called “Smart Shoe for Health Fitness using IoT” which is designed in a unique wearable device to help the people in there health fitness by monitoring step count, avoiding dehydration and helping them from over exercise and tracking there whereabouts.

1.2 Aim of the project

Aim of the project is to help the people in there health fitness by finding number of steps they have walked or run. The shoes will be designed in such a way that anyone who does running or walking by wearing these uniquely designed Shoe they will get to know how many steps they have walked and if the person sit ideal for sometime then he get a notification to warm up and if he do over exercise he get a notification to rest for a while. And there will be also a water remainder to help the user to avoid dehydration. And the project also consists of GPS location tracking so that if the user went for a walk or run then the concerned people can track him.

2. LITERATURE SURVEY

Smart shoe technology design with embedded monitoring electronics system for health fitness:

Hwang et al proposed a smart shoe technology design with embedded monitoring electronics system for health fitness applications. This system contains an integrated modern monitoring circuit that can provide fitness and health related information including coordinate tracker, step counter, calorie counter, and biomedical information such as foot oxygen concentration.[8]

Wireless technology of smart-shoe system for monitoring human Locomotion:

Donkrajang et al proposed a wireless technology of smart-shoe system for monitoring human Locomotion. The proposed smart shoes used zigBee wireless network with restricted scope of development, which are not connected with internet of things (IoT) functionality. As the new technology and requirement in wearable device are being increasing with respect to that the smart shoe, we would improvise the new IoT technology and integrated it into the smart shoe, which not only increase the efficiency of the shoe but also improve the tread of wearable devices. Smart shoe can calculate and analyze all the foot pressure that assists the elderly person to avoid from falling down. The entire smart shoe only checked on the pressure applied by foot on the shoe and these shoes are restricted to only few categories. It does not comes under daily wearable device so this device which not only wear by all age categories ofpeople but also provide them with the information about their health and fitness.[5]

Wearable Smart Shoe Technology for Health Fitness using IOT:

Sayali Meshram proposed a Wearable Smart Shoe Technology for Health Fitness using IOT which works with the help of IOT consists of embedded features like piezoelectric devices, Arduino, GPRS device (sends alert messages when tapped by foot when in danger). This paper focus on the use of Wearable Smart-Shoe technology for the health fitness purpose. Fitness ratio is calculated and transmitted from hardware component to android device and represented graphically.[2]

IOT Based Wireless Smart Shoe and Energy Harvesting System :

P. Vijayakumar, P. D. Selvam, N. Ashokkumar, Sharmila , R. Raj Priyadarshini , M. Tamilselvi Rajashree. R, Xiao-Zhi Gao proposed a prototype in this paper is to produce energy and at the same time give some additional information of the user's fitness through a mobile application. The energy harvesting is being done using piezoelectric sensors along with an IoT based pedometer app which will take the step counts in cloud as input and will display distance covered and calories burnt. The product developed is cost efficient and has widespread real time applications.[3]

An Iot Based Solution For Health Monitoring Using A Body-Worn Sensor Enabled Device:

Harika Devi Kotha, Manisha Gunturi, Sirisha Potluri A wearable IoT, is embedded with various kinds of sensors using which different human activities like movement , walking, pulse rate , calories burnt etc.. Information can be gathered. Wearable IoT allows two way communication. Using wearable IoT a patient record is extracted and analyzed. Data is generated from day to day activities and collected at regular intervals of time. This paper aims in explaining about IoT, wearable IoT, and its architecture and finally presents the analyzed results.[7]

A Shoe-Embedded Piezoelectric Energy Harvester for Wearable Sensors:

Zhao explains in their paper on how mechanical energy is being harvested from human motion for electrical energy to charge up wearable devices. This research paper talks about how a smart shoe made up of piezoelectric sensors can be used for producing energy from human activities. People would find it comfortable while wearing the shoe. The two layers of the insole are sandwiched with each other in a thin symmetric form layer and have better efficiency. The structure comprises of the form of a sandwich with very minimal thickness making it fit comfortably in the shoe. When the person wears the shoes and takes steps, the insole layer makes the negatively charged particles (electrons) to move with an AC output. Zhao and You have also researched on two types of harvester which are also described in this paper. The first prototype consists of polyvinylidene fluoride layer in multi parts and it is placed in the heel of the insole. The second prototype is also made up of insole layer which consists of a rubber made up of silicon material and polyvinylidene fluoride films. On comparison of both the prototypes, we find out that more power can be produced from the first one than the second, whereas the second model has an advantage of comfort ability. Many tests have been performed to check out the working of these prototypes.[9]

A Comparative Review of Footwear-Based Wearable Systems:

Nagraj discuss about their research on how a wearable system can be varied based on today's trending technologies. The footwear-based system discussed in the paper has variety of uses. It can vary from simple basic uses to highly technical uses for different kinds of people (differently abled). An insole developed for gait monitoring is described in this paper. There are various types of gait monitoring techniques. One is temporal and the other is spatial. In this field a lot of footwear – based systems are used. Force sensitive resistors which are one of those sensitive and delicate elements are used in the system to find out the parameters such as cadence, step time and other parameters. Another application includes measuring of pressure map at one phase. The support is provided by the ankle and the foot. It plays a vital role in analysis of patients who are having diabetes. It is also used in identifying the problems associated in neurological, muscular and skeletal parts of the body[10].

3. SYSTEM OVERVIEW

3.1 Arduino

Arduino is a microcontroller board based on the ATmega328P. It has 14 digital input and output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

Figure 3.1: Arduino

It contains everything need to support the microcontroller. Arduino Software (IDE) were the reference versions of Arduino, now evolved to new releases. The Uno board is the first in a series of USB Arduino board, and the reference model for the Arduino platform.

Arduino is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. Its hardware products are licensed under a CC BY-SA license, while the software is licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially from the official website or through authorized distributors.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino Programming Language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool developed in Go.

3.2 Ultrasonic sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation D = ½ T X C (where D is the distance, T is the time, and C is the speed of sound 343 meters/second). From this we get time which helps us to insert water remainder in our system and we also help the user from over exercise by reminding him to rest for while. Here we display rest for a while message by calculating step count and time, which is done by ultrasonic sensor.

Figure 3.2: Ultrasonic Senosor

Ultrasonic sensors are used primarily as proximity sensors. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology. In comparison to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are not as susceptible to interference of smoke, gas, and other airborne particles (though the physical components are still affected by variables such as heat).

Ultrasonic sensors are also used as level sensors to detect, monitor, and regulate liquid levels in closed containers (such as vats in chemical factories). Most notably, ultrasonic technology has enabled the medical industry to produce images of internal organs, identify tumors, and ensure the health of babies in the womb.

Ultrasonic Sensor Working Principle

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

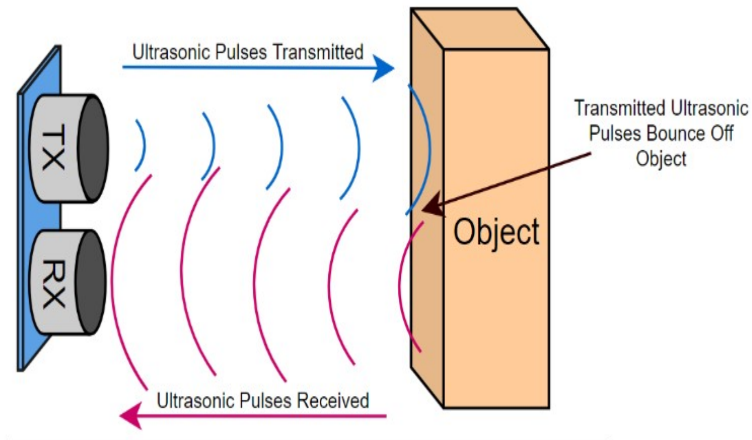

Figure 3.2.1: Working of Ultrasonic Senosor

3.3 MEMS Sensor (Micro Electro-Mechanical System)

MEMS, or Micro Electro-Mechanical System, is a chip-based technology where sensors are composed of a suspended mass between a pair of capacitive plates. When the sensor is tilted, a difference in electrical potential is created by this suspended mass. The created difference is then measured as a change in capacitance.

These are a set of devices, and the characterization of these devices can be done by their tiny size the designing mode. The designing of these sensors can be done with the 1- 100-micrometer components. These devices can differ from small structures to very difficult electromechanical systems with numerous moving elements beneath the control of incorporated micro-electronics. Usually, these

Figure 3.3: Mems Sensor

sensors include mechanical micro-actuators, micro-structures, micro-electronics, and micro-sensors in one package.

The MEMS fabrication needs many techniques which are used to construct other semiconductor circuits like oxidation process, diffusion process, ion implantation process, low-pressure chemical vapor deposition process, sputtering, etc. Additionally, these sensors use a particular process like micromachining. This sensor is used to detect motion. In order to know whether the person wear shoe we need to detect motion, for that purpose we are using this MEMS sensor.

MEMS Sensor Working Principle

Whenever the tilt is applied to the MEMS sensor, then a balanced mass makes a difference within the electric potential. This can be measured like a change within capacitance. Then that signal can be changed to create a stable output signal in digital, 4-20mA or VDC.

These sensors are fine solutions to some applications which do not demand the maximum accuracy like industrial automation, position control, roll, and pitch measurement, and platform leveling.

Types of MEMS

The common types of MEMS sensors are obtainable within the market are

- MEMS accelerometers
- MEMS gyroscopes
- MEMS pressure sensors
- MEMS magnetic field sensors

3.4 GPS Module

The Global Positioning System (GPS) is a satellite based navigation system that provides location and time information. The system is freely accessible to anyone with a GPS receiver and unobstructed line of sight to at least four of GPS satellites. A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites.

Figure 3.4: GPS module

GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located. These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time.

A GPS tracker is a navigation device generally on a vehicle, asset, person, or animal that uses the Global Positioning System (GPS) to determine its movement and geographic position. GPS tracking devices send special satellite signals that are processed by a receiver. Locations are stored in the tracking unit or transmitted to an Internet-connected device using the cellular network or WiFi worldwide. GPS trackers connect to a series of satellites to determine location. The tracker uses a process called trilateration which uses the position of three or more satellites from the Global Navigation Satellite System GNSS) network and their distance from them to determine latitude, longitude, elevation, and time.

3.4.1 How GPS Receiver Calculates its Position and Time

GPS receiver receives information signals from GPS satellites and calculates its distance from satellites. This is done by measuring the time required for the signal to travel from satellite to the receiver.

$$\text{Distance} = \text{Speed x Time}$$

where,

Speed = Speed of Radio signal which is approximately equal to the speed of light i.e.

Time = Time required for a signal to travel from the satellite to the receiver.

By subtracting the sent time from the received time, we can determine the travel time.

3.5 LCD Display

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.

LCDs were a big leap in terms of the technology they replaced, which include light-emitting diode (LED) and gas-plasma displays. LCDs allowed displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it. Where an LED emits light, the liquid crystals in an LCD produces an image using a backlight. Here in our system we used 16x2 LCD which means 16 rows 2 columns.

Figure 3.5: LCD Display

How LCDs work

A display is made up of millions of pixels. The quality of a display commonly refers to the number of pixels; for example, a 4K display is made up of 3840 x2160 or 4096x2160 pixels. A pixel is made up of three subpixels; a red, blue and green—commonly called RGB. When the subpixels in a pixel change color combinations, a different color can be produced. With all the pixels on a display working together, the display can make millions of different colors. When the pixels are rapidly switched on and off, a picture is created.

The way a pixel is controlled is different in each type of display; CRT, LED, LCD and newer types of displays all control pixels differently. In short, LCDs are lit by a backlight, and pixels are switched on and off electronically while using liquid crystals to rotate polarized light. A polarizing glass filter is placed in front and behind all the pixels, the front filter is placed at 90 degrees. In between both filters are the liquid crystals, which can be electronically switched on and off.

LCDs are made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time.

Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology out of the two.

Types of LCDs

Types of LCDs include:

[1] Twisted Nematic (TN)- which are inexpensive while having high response times. However, TN displays have low contrast ratios, viewing angles and color contrasts.

[2] In Panel Switching displays (IPS Panels)- which boast much better contrast ratios, viewing angles and color contrast when compared to TN LCDs.

[3] Vertical Alignment Panels (VA Panels)- which are seen as a medium quality between TN and IPS displays.

[4] Advanced Fringe Field Switching (AFFS)- which is a top performer compared IPS displays in color reproduction range.

3.6 Power Supply

For power supply here we are using AC-DC power supply module 24V 6A switching power supply board. It consists of step down transformer which converts power from AC to DC and supply that DC power to system. This industry power module converts AC power to 24V 4A 100W DC. It has built-in over-voltage, over current and short circuit protection. Perfectly designed and well constructed, small and compact Size with an indicator.

Features:

1. Protection: over-voltage over current circuit protection
2. AC input: AC 85-265 V (Global common)
3. AC frequency: 50 HZ/60 HZ
4. Output voltage: DC 24
5. Output Current: 4 A-6 A
6.Output Power: 100 W
7.Modulation: Pulse width modulation

Figure 3.6: Power Supply

A power supply is an electrical device that supplies electric power to an electrical load. The main purpose of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. Examples of the latter include power supplies found in desktop computers and consumer electronics devices. Other functions that power supplies may perform include limiting the current drawn by the load to safe levels, shutting off the current in the event of an electrical fault, power conditioning to prevent electronic noise or voltage surges on the input from reaching the load, power-factor correction, and storing energy so it can continue to power the load in the event of a temporary interruption in the source power (uninterruptible power supply).

All power supplies have a power input connection, which receives energy in the form of electric current from a source, and one or more power output or rail connections that deliver current to the load. The source power may come from the electric power grid, such as an electrical outlet, energy storage devices such as batteries or fuel cells, generators or alternators, solar power converters, or another power supply. The input and output are usually hardwired circuit connections, though some power supplies employ wireless energy transfer to power their loads without wired connections. Some power supplies have other types of inputs and outputs as well, for functions such as external monitoring and control.

The main job of an AC/DC power supply is to transform the alternating current (AC) into a stable direct current (DC) voltage, which can then be used to power different electrical devices. Alternating current is used to transport electric power all across the electric grid, from generators to end users.

Switching AC/DC power supply

New design methodology has been developed to solve many of the problems associated with linear or traditional AC/DC power supply design, including transformer size and voltage regulation.

Switching power supplies are now possible thanks to the evolution of semiconductor technology, especially thanks to the creation of high-power MOSFET transistors, which can switch on and off very quickly and efficiently, even if large voltages and currents are present.

A switching AC/DC power supply enables the creation of more efficient power converters, which no longer dissipate the excess power.

AC/DC power supplies that are designed using switching power converters are called switched-mode power supplies. AC/DC switched-mode power supplies have a slightly more complex method for converting AC power to DC.

In switching AC power supplies, the input voltage is no longer reduced; rather, it is rectified and filtered at the input. Then the DC voltage goes through a chopper, which converts the voltage into a high-frequency pulse train. Finally, the wave goes through another rectifier and filter, which converts it back to direct current (DC) and eliminates any remaining alternating current (AC) component that may be present before reaching the output.

When operating at high frequencies, the transformer's inductor is able to transfer more power without reaching saturation, which means the core can become smaller and smaller. Therefore, the transformer used in switching AC/DC power supplies to reduce the voltage amplitude to the intended value can be a fraction of the size of the transformer needed for a linear AC/DC power supply.

Switching AC/DC power converters can generate a significant amount of noise in the system, which must be treated to ensure it is not present at the output. This creates a need for more complex control circuitry, which in turn adds complexity to the design. Nevertheless, these filters are made up of components that can be easily integrated, so it does not affect the size of the power supply significantly.

Smaller transformers and increased voltage regulator efficiency in switching AC/DC power supplies are the reason why we can now convert a 220V¬RMS AC voltage to a 5V DC voltage with a power converter that can fit in the palm of your hand.

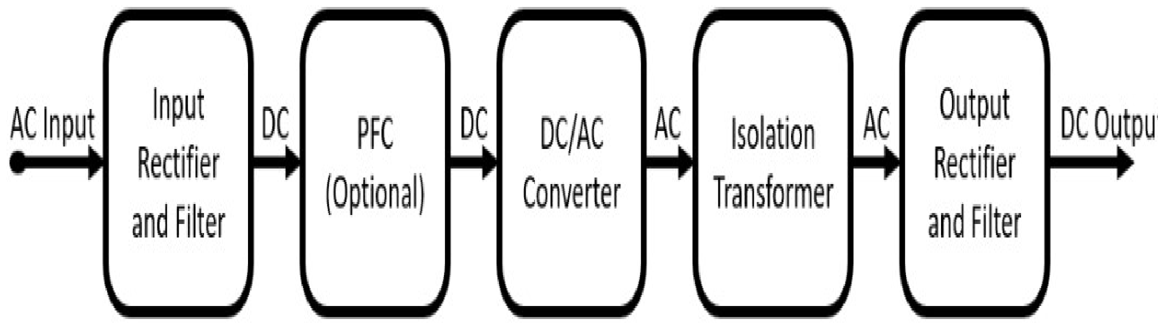

Figure 3.6.1: Switched-Mode AC/DC Power Supply Block Diagram

Higher frequencies allow for much smaller transformers, if needed. Transistors offer small switching losses, because they behave as small resistances. This enables efficient high-power applications. When transistors switch very quickly, they generate noise in the circuit. However, this can be either filtered out, or the switching frequency can be made extremely high, above the limit of human hearing, for audio applications The added noise generated by the transformers forces the addition of large, complex filters, as well as control and regulation circuitry for the converters.

3.7 GSM Module

A GSM modem or GSM module is a device that uses GSM mobile telephone technology to provide a wireless data link to a network. GSM modems are used in mobile telephones and other equipment that communicates with mobile telephone networks.

GSM (Global System for Mobile communications) modules are wireless communication modules that use cellular networks to send and receive data.
It was created to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones and is now the default global standard for mobile communications – with over 90 percent market share, operating in over 219 countries and territories.

Figure 3.7: GSM Module

A GSM module or a GPRS module is a chip or circuit that will be used to establish communication between a mobile device or a computing machine and a GSM or GPRS system. The modem (modulator-demodulator) is a critical part here.

These modules consist of a GSM module or GPRS modem powered by a power supply circuit and communication interfaces (like RS-232, USB 2.0, and others) for computers.

A GSM modem can be a dedicated modem device with a serial, USB, or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

A GSM module or GPRS modules are similar to modems, but there's one difference: A GSM/GPRS Modem is external equipment, whereas the GSM/GPRS module is a module that can be integrated within the equipment. It is an embedded piece of hardware.

A GSM mobile, on the other hand, is a complete system in itself with embedded processors that are dedicated to providing an interface between the user and the mobile network.

Wireless modems generate, transmit or decode data from a cellular network, in order to establish communication.

A GSM/GPRS modem is a class of wireless modems, designed for communication over the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also, they have IMEI (International Mobile Equipment Identity) numbers similar to mobile phones for their identification.

1. The MODEM needs AT commands, for interacting with the processor or controller, which are communicated through serial communication.
2. These commands are sent by the controller/processor.
3. The MODEM sends back a result after it receives a command.
4. Different AT commands supported by the MODEM can be sent by the processor/controller/computer to interact with the GSM and GPRS cellular network.

Its functions include:

• Read, write and delete SMS messages.

• Send SMS messages.

• Monitor the signal strength.

• Monitor the charging status and charge level of the battery.

• Read, write and search phone book entries.

What is Mobile Station?

A mobile phone and Subscriber Identity Module (SIM) together form a mobile station. It is the user equipment that communicates with the mobile network. A mobile phone comprises Mobile Termination, Terminal Equipment, and Terminal Adapter.

Mobile Termination is interfaced with the GSM mobile network and is controlled by a baseband processor. It handles access to SIM, speech encoding and decoding, signaling, and other network-related tasks.

Terminal Equipment is an application processor that deals with handling operations related to keypads, screens, phone memory, and other hardware and software services embedded into the handset.

The Terminal Adapter establishes communication between the Terminal Equipment and the Mobile Termination using AT commands. The communication with the network in a GSM/GPRS mobile is carried out by the baseband processor.

3.8 Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the

Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

The Arduino IDE will appear as:

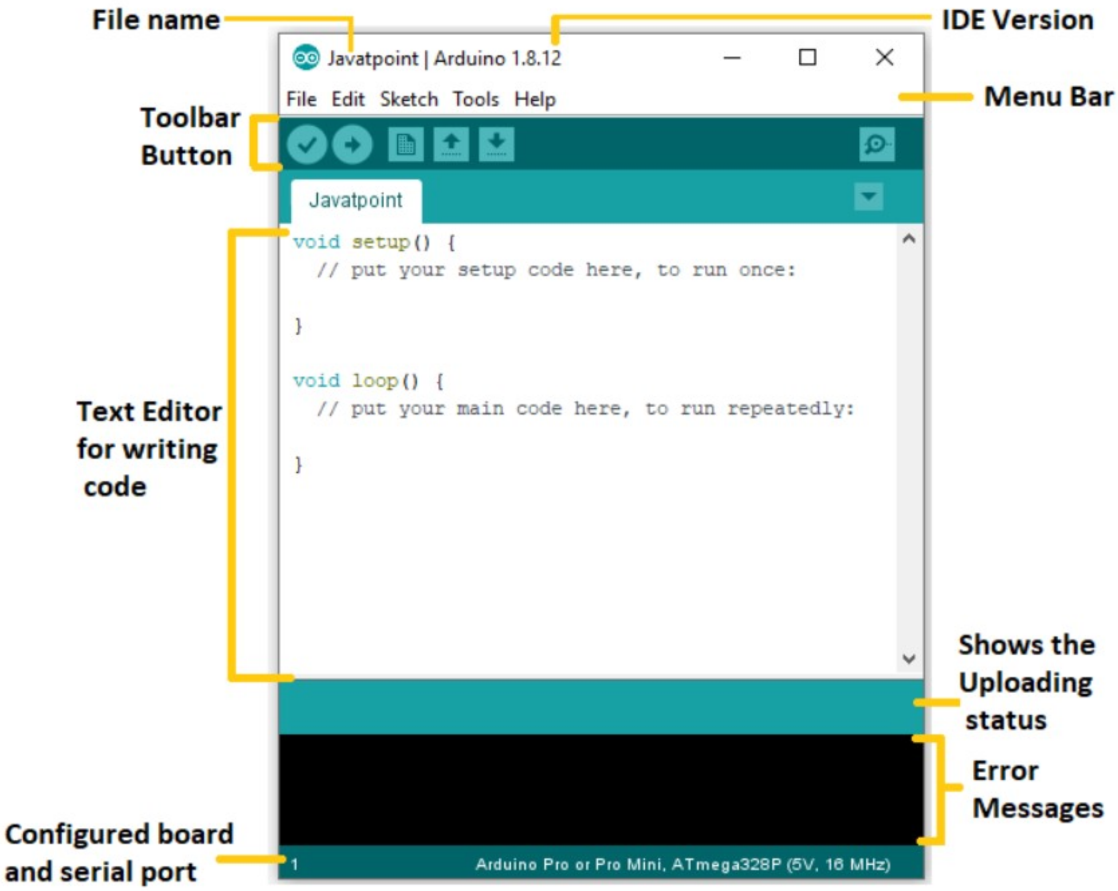

Figure 3.8: Arduino IDE

Toolbar Button

The icons displayed on the toolbar are New, Open, Save, Upload, and Verify.

It is shown below:

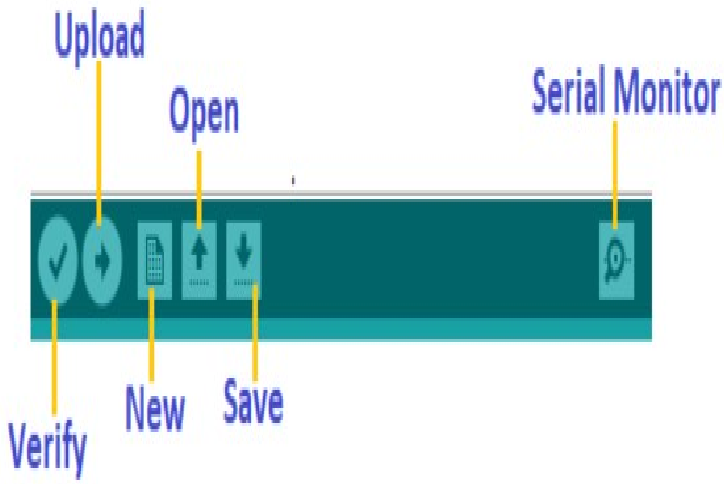

Figure 3.8.1: Toolbar icons

Upload

The Upload button compiles and runs our code written on the screen. It further uploads the code to the connected board. Before uploading the sketch, we need to make sure that the correct board and ports are selected.

We also need a USB connection to connect the board and the computer. Once all the above measures are done, click on the Upload button present on the toolbar.

The latest Arduino boards can be reset automatically before beginning with Upload. In the older boards, we need to press the Reset button present on it. As soon as the uploading is done successfully, we can notice the blink of the Tx and Rx LED.

If the uploading is failed, it will display the message in the error window.

We do not require any additional hardware to upload our sketch using the Arduino Bootloader. A Bootloader is defined as a small program, which is loaded in the microcontroller present on the board. The LED will blink on PIN 13.

Open

The Open button is used to open the already created file. The selected file will be opened in the current window.

Save

The save button is used to save the current sketch or code.

Verify

The Verify button is used to check the compilation error of the sketch or the written code.

Serial Monitor

The serial monitor button is present on the right corner of the toolbar. It opens the serial monitor. When we connect the serial monitor, the board will reset on the operating system Windows, Linux, and Mac OS X. If we want to process the control characters in our sketch, we need to use an external terminal program. The terminal program should be connected to the COM port, which will be assigned when we connect the board to the computer.

4. SYSTEM ANALYSIS AND DESIGN

4.1 Proposed System

The Proposed system is used for finding number of steps they have walked or run by using ultrasonic sensor and mems sensor. The shoes will be designed in such a way that anyone who does running or walking by wearing these uniquely designed shoe they will get to know how many steps they have walked and if the person sit ideal for sometime then he get a notification to warm up and if he do over exercise he get a notification to rest for a while through LCD display. And there will be also a water remainder to help the user to avoid dehydration. And the proposed system also consists of GPS location tracking using GPS sensor so that if the user went for a walk or run then the concerned people can track him.

4.2 System Architecture

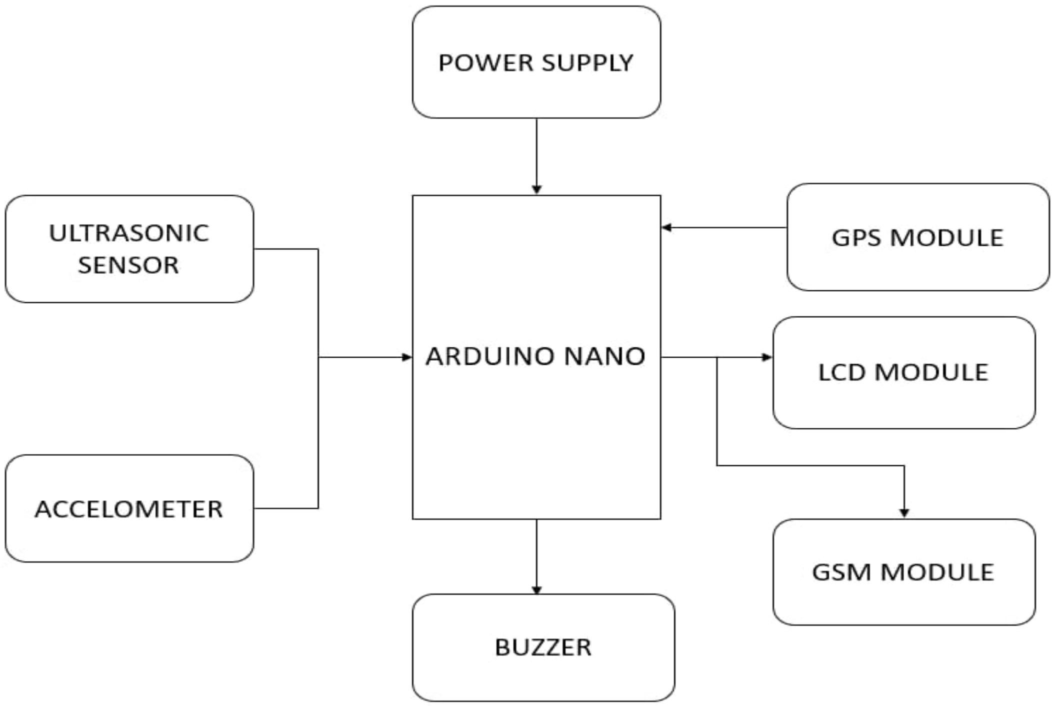

Figure 4.2: System Architecture

Firstly, power supply is given to IoT module and Arduino uno. Here in order to supply power we are using AC-DC power supply module 24V 6A switching power supply board. It consists of step down transformer which converts power from AC to DC and supply that DC power to system. And all the input devices and output devices are connected to the arduino. Arduino is the micro controller unit which controls the entire system. Based on the program we uploaded in Arduino uno, it knows how to control the system. Secondly, after giving power supply the Arduino takes the input from mems sensor. MEMS sensor detects the motion of the system and send it as input to Arduino. Once the moment is detected now ultrasonic sensor will calculate the number of steps the person walked. Ultrasonic sensor consists of two pins, trigger pin and echo pin. Trigger pin sends the radio wave. When the person lifted his leg to start walk the trigger pin get activated and calculates the distance and when the person keep his leg to ground after one step then the distance between ground and ultrasonic sensor decreses. When the distance become less than five then it will taken as step count one. So the trigger pin emits radio wave which travels and hit ground and sends echo which will be taken by echo pin and sends to Arduino. Lastly, GPS tracker will track the persons location and send it to the concerned people. The step count, moment detection, distance and time will be displayed as an output in LCD display. Number of steps person walked, water remainder, rest for a while message from stopping him from over exercise through walking or running and warm up message will be given as message notification to the user with the help of GSM module.

4.3 Use Case Diagram

A use case diagram is used to represent the dynamic behavior of a system. It encapsulates the system's functionality by incorporating use cases, actors, and their relationships.It models the tasks, services, and functions required by a system/subsystem of an application. It depicts the high-level functionality of a system and also tells how the user handles a system.

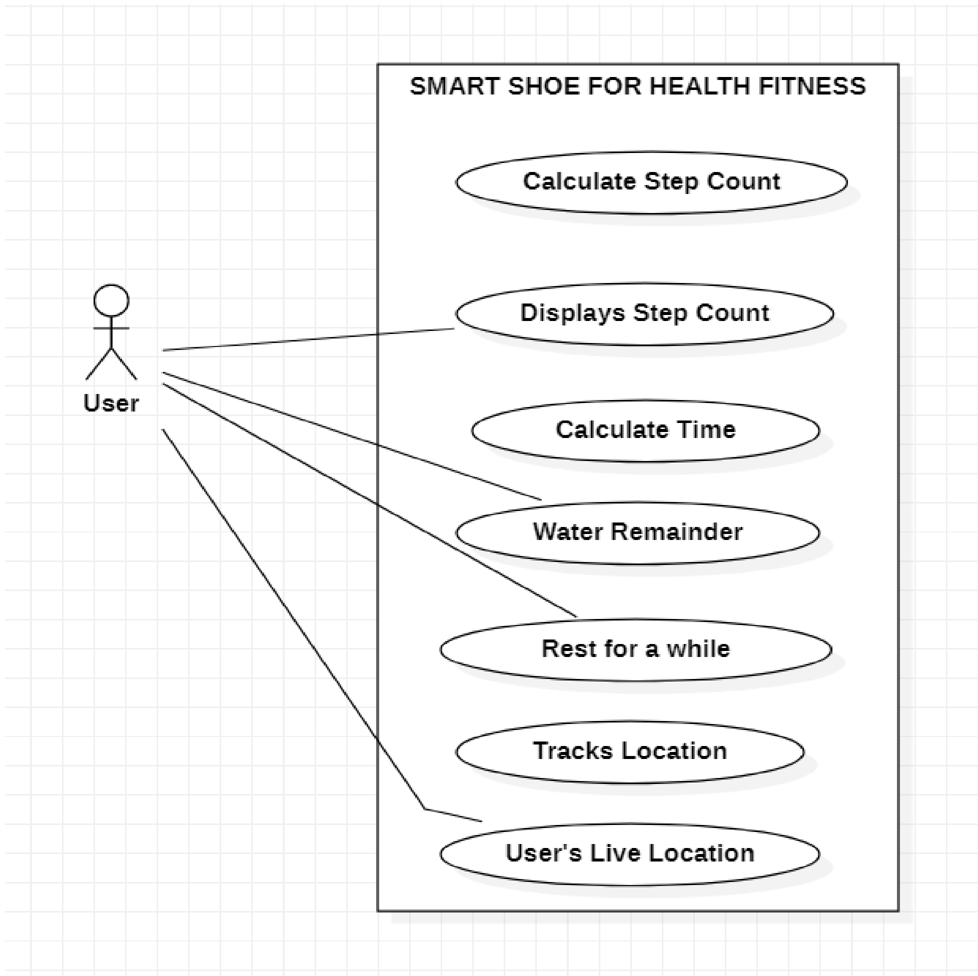

Figure 4.3: Use case Diagram

4.4 Sequence Diagram

A sequence diagram is a Unified Modeling Language (UML) diagram that illustrates the sequence of messages between objects in an interaction. A sequence diagram consists of a group of objects that are represented by lifelines, and the messages that they exchange over time during the interaction.

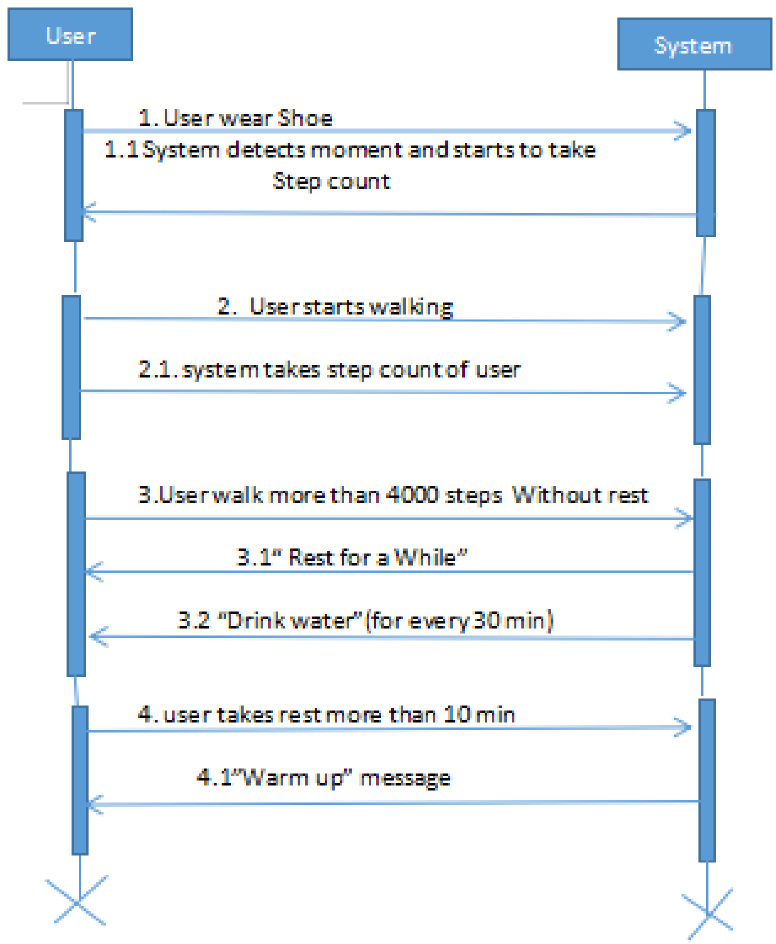

Figure 4.4: Sequence Diagram

4.5 Flow Diagram

Flow diagram is a graphic representation of the physical route or flow of people, materials, paper-works, vehicles, or communication associated with a process, procedure plan, or investigation. In the second definition the meaning is limited to the representation of the physical route or flow.

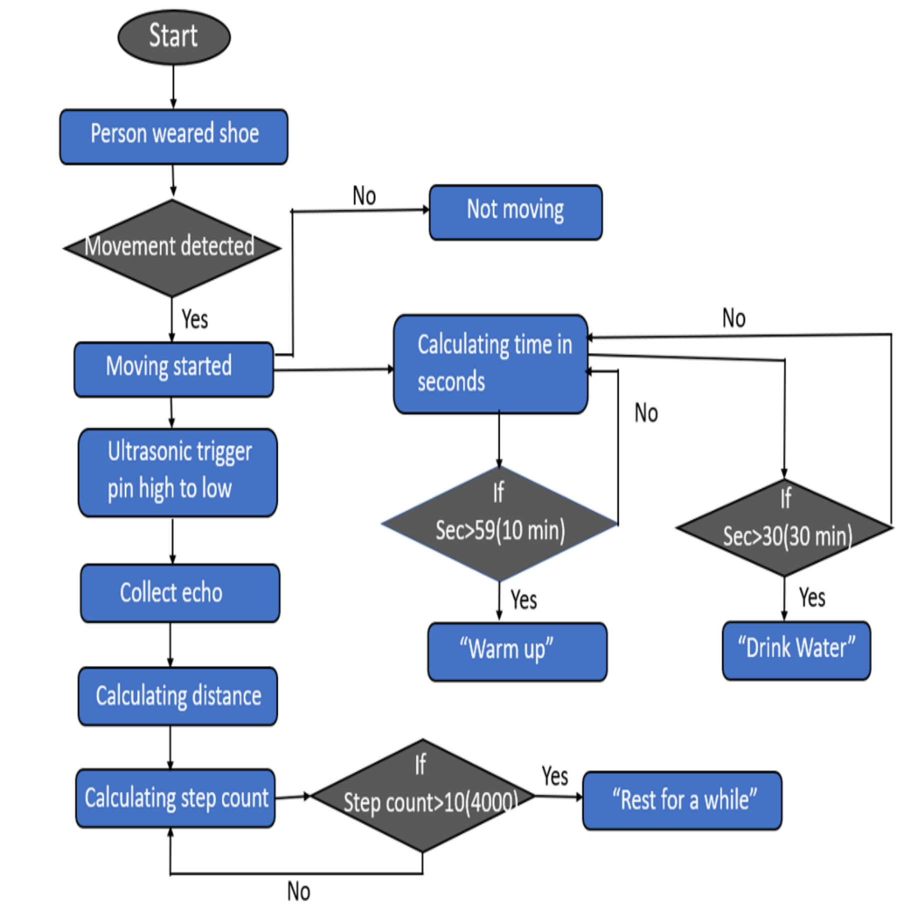

Figure 4.5: Flow Diagram

5. MODULES

5.1 Module Names

5.1.1 Movement Detection The movement of the shoe is detected using mems sensor. MEMS, or Micro Electro-Mechanical System, is a chip-based technology where sensors are composed of a suspended mass between a pair of capacitive plates. When the sensor is tilted, a difference in electrical potential is created by this suspended mass. The created difference is then measured as a change in capacitance. So, whenever the person wears these shoes, the movement is detected.

5.1.2 Calculating Steps Whenever the person wears these shoes and go for walking or running, then the following steps of the person are calculated. This step count is done using ultrasonic sensor. An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e., the sound that humans can hear. Trigger pin which is the output of the ultrasonic sensor and echo pin that collects the echo and counts the steps.

5.1.3 Calculating Time Time is calculated using preloaded timer which is the standard form that written in the program to calculate the time. The time is calculated in order to give water reminder message and workout message to a person.

5.1.4 Calculating Distance Distance is calculated with the help of ultrasonic sensor. Ultrasonic sensor have two pins which called trigger pin and echo pin. When trigger pin released radio waves they touch the ground and emit back in the form of echo and that echo will be collected by echo pin. The duration between this process, with the help of this duration distance will be calculated.

5.1.5 Tracking location with GPS A GPS receiver module is a device that receives information from GPS satellites and obtains the geographical position of the device.
The GPS receiver obtains the data as a whole NMEA format text. Only the latitude and longitude

coordinates are taken from it; using the Arduino TinyGPS library.

5.1.6 Sending SMS A GSM module is a device used to establish communication over a mobile network. GSM or GPRS Module requires a SIM card to operate or to register a connection with the network operator or service provider.

The GSM module sends SMS to the number specified in the code.

6. IMPLEMENTATION AND RESULTS

6.1 Circuit

Figure 6.1: Circuit

6.2 Program

```
// LCD Pins 8,9,10,11,12,13
//17.52700808337808, 78.3713754683256
// Mems  SCL:19 SDA:18
// Ultrasonic Trig:6, Echo:7
// IOT Serial 2,3
// GPS Serila 4,5
int buzzer = A0;
int f=1;
String numbers[3] = {"","",""};
String message,number;
#include <SoftwareSerial.h>
#include<LiquidCrystal.h>
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_ADXL345_U.h>
SoftwareSerial gsm(11,12);//rx,tx
Adafruit_ADXL345_Unified accel = Adafruit_ADXL345_Unified(12345);
LiquidCrystal lcd(10,9,8,7,6,5);
//GPS Variables...
char str[70];
String gpsString="";
//char *test="$GPGGA";
String gps1="";
String gps2="";
String GPS_RData="";
```

```
char *test="$GNGGA";
String latitude="No Range      ";
String longitude="No Range     ";
boolean gps_status=0;
//String gpsString="";
//char *test="$GPGGA";
//char *test="$GNGGA";
//String latitude="No Range      ";
//String longitude="No Range     ";
//boolean gps_status=0;
boolean wflag =0; // flag for fan
boolean flag = 0;
int Steps = 0;
int trigPin = 4;
int echoPin = 3;
int Count,i;
long duration, distance;
int restcount;
float value1 = 49910;
int seconds;
void setup()
{
 /* noInterrupts();                          // disable all interrupts
  TCCR1A = 0;
  TCCR1B = 0;
  TCNT1 = value1;                          // preload timer
```

```
  TCCR1B |= (1 << CS10)|(1 << CS12);    // 1024 prescaler
  TIMSK1 |= (1 << TOIE1);     */          // enable timer overflow interrupt ISR
   Serial.begin(9600);

  lcd.setCursor(0, 0);
  gsm.begin(9600);
  pinMode(echoPin, INPUT);
  pinMode(trigPin, OUTPUT);
  pinMode(buzzer, OUTPUT);
  //IOTSerial.begin(9600);
  lcd.begin(16,2);
  lcd.print("  SMART SHOE ");
//  lcd.setCursor(0,1);
//  lcd.print("COUNT MONITPRING");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0,1);
  lcd.print("Mems Init...");
  delay(1000);
  if(!accel.begin())
  {
  lcd.setCursor(0,0);
  lcd.print("Mems Not Found");
  delay(3000);
  }
  else
  {
```

```
  lcd.setCursor(0,0);
  lcd.print("Mems OK");
  delay(1000);
  }
  lcd.clear();
  digitalWrite(buzzer,HIGH);
  delay(300);
 digitalWrite(buzzer,LOW);
}
void  SendMessage(String num,String message)
{

  gsm.println("AT+CMGF=1");
  delay(1000);
  gsm.println("AT+CMGS=\"" +num + "\"\r");
  delay(1000);
  gsm.println(message);
  delay(1000);
  gsm.println((char)26);
  delay(1000);
  Serial.println("MESSAGE SENT ");
//  digitalWrite(BUZZER,HIGH);
//  delay(100);
//  digitalWrite(BUZZER,LOW);

}
void loop()
```

```
{
  Get_GPS_Data();
  sensors_event_t event;
  accel.getEvent(&event);
  lcd.setCursor(0,1);
  lcd.print("X:");
  lcd.print(event.acceleration.x);
  lcd.setCursor(9,1);
  lcd.print("Y:");
  lcd.print(event.acceleration.y);
  delay(300);
  if(event.acceleration.x>3)
  {
  lcd.setCursor(0,1);
  lcd.print("Moving Started");
  wflag = 1;
  }
  else if(event.acceleration.x<-3)
  {
  lcd.setCursor(0,1);
  wflag = 1;
  }
  else if(event.acceleration.y>3)
  {
  lcd.setCursor(0,1);
  lcd.print("Moving Started");
  wflag = 1;
```

```
  }
  else if(event.acceleration.y<-3)
  {
  lcd.setCursor(0,1);
  lcd.print("Moving Started");
  wflag = 1;
  }
  else
  {
  lcd.setCursor(0,0);
  lcd.print("Not Moving");
  }
  lcd.clear();
  flag = 1;
  if(wflag == 1)
  {
//    accel.stop();
    noInterrupts();
    TCCR1A = 0;
    TCCR1B = 0;
    TCNT1 = value1;                        // preload timer
    TCCR1B |= (1 << CS10)|(1 << CS12);    // 1024 prescaler
    TIMSK1 |= (1 << TOIE1);
    interrupts();
  }
  while(wflag==1)  //wflag for movement detection-> mems.
  {
```

```
    digitalWrite(trigPin,HIGH);
    delayMicroseconds(1000);
    digitalWrite(trigPin,LOW);
    duration=pulseIn(echoPin,HIGH);
    distance =(duration/2)/29.1;
    Serial.println(distance);
    lcd.setCursor(0,1);
    lcd.print("Dist:");
    lcd.print(distance);
    lcd.print("  ");
    if(Count==1){
      if(f==1){
        f=0;
 String message = "My locationn is http://maps.google.com/maps?q=17.52700808337808

SendMessage(numbers[i],message);
      }


    }


      if(Count>10)
      {
        Count = 0 ;
          digitalWrite(buzzer,HIGH);
          delay(100);
         digitalWrite(buzzer,LOW);
```

```
   // IOTSerial.print("<h2 style=\"color:blue;text-align:center\">!!REST FOR A
    for(int i=0;i<3;i++){
        SendMessage(numbers[i],"REST FOR WHILE");
    }
  }
  if(seconds==30)
  {
      digitalWrite(buzzer,HIGH);
      delay(500);
     digitalWrite(buzzer,LOW);

     for(int i=0;i<3;i++){
        SendMessage(numbers[i],"TAKE SOME WATER!");
    }
  }
  if(seconds>=59)
  {
     seconds = 0;
    for(int i=0;i<3;i++){
        SendMessage(numbers[i],"TAKE WARMUP");
    }
  }
if(flag==1) //Leg movement
{
  if(flag==1 && ((distance < 5) && (distance!=0)))
  {
  Count = Count+1;
```

```
            lcd.setCursor(0,0);
            lcd.print("Step Count:");
            lcd.print(Count); //Step count printing on LCD.
            flag=0;
            }
          }
        if(distance>5 && flag==0)
        {
          flag = 1;
          if(distance > 5)
          {
            seconds = 0;

          }
        }
  }
}

ISR(TIMER1_OVF_vect)                    // interrupt service routine for overflow
{
  TCNT1 = value1;                                 // preload timer
 // digitalWrite(ledPin, digitalRead(ledPin) ^ 1);  //Turns LED ON and OFF
 seconds = seconds + 1;
lcd.setCursor(12,1);
lcd.print("T:");
lcd.print(seconds);
lcd.print("   ");
```

```
}
void Get_GPS_Data()
{

Serial.read();
while (Serial.available()>0)
{
 // "$GNRMC"
if(Serial.find("$GNRMC"))
{
Serial.println("Got GNRMC");
for(i=0;i<40;i++)
{
delay(1);
GPS_RData = (char) Serial.read();
}
break;
}
}
Serial.println(GPS_RData[12]);
//gps1="Lat:";
//gps2="Lon:";
//Serial.println(GPS_RData);
if(GPS_RData[12]=='V')
{
gps1="Not Fixed";
gps2="Not Fixed";
```

```
}
else
{
gps1 = GPS_RData.substring(14, 23);
gps2 = GPS_RData.substring(27, 37);
Serial.println(gps1);
Serial.println(gps2);
GPS_RData="";
}
}
```

6.3 LCD Display

Figure 6.3: LCD Display of Output

6.4 Message Notifications

6.4.1 GPS Notification

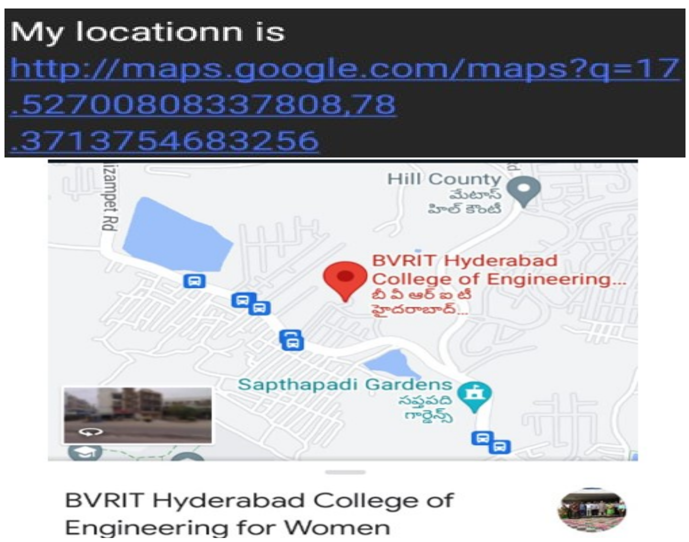

Figure 6.4.1: Message sent to concerned person

6.4.2 Notifications sent to user

Figure 6.4.2: SMS received by user

6.5 Applications

- Medical applications
- Personal health fitness

6.6 Advantages and Disadvantages

6.6.1 Advantages

- Smart shoes are very useful for GPS tracking
- The person can keep a track on his fitness with help of total step count
- Water reminder feature helps the person from dehydration
- Workout reminder helps the person to stay focused on his workout
- Saves time

• We can stay connected to our friends and families

6.6.2 Disadvantages

• They can be expensive

• They might not be comfortable for everyone

• We might have to charge them often

• They might not be very stylish

• Not everyone needs or wants all the features that smart shoes offer

• At time this system is working with only one user

• Not supporting multi user at time

7. CONCLUSION and FUTURE WORK

The Wearable device Smart-Shoe technology is in higher demand by the consumer market with its no of various features embedded in it. The proposed system consists of embedded features as: Step Count, helping from over exercise through walking and running by remaindering user to take some rest through Rest for a while”message, helping user from dehydration by giving him water remainder message, if the user sat ideal for some time then remaindering him to do some exercise by giving ”Warm up”message and also tracks the user’s location with the help of GPS device. This whole process is done by sending SMS to our mobile phones with the help of GSM module.
In future, our device can also helps parents in tracking children location when they went for playing or when they lost. Extending multi-functional Smart Shoe related applications can be created.

REFERENCES

[1] Baumgaertner M and kendoff D Ïnternet of Things Based Smart Shoe Using ESP32 — IoT project", IJMET, Year 2021.

[2] Sayali Meshram, T.," Wearable Smart Shoe Technology for Health Fitness using IOT" Proc. IEEE International Conf. on Biomedical Engineering, IRJET, Year 2020.

[3] P. Vijay Kumar and Selvam P D ÏOT Based Wireless Smart Shoe and Energy Harvesting System", IRJET, Year 2019

[4] John Singh. K, Sagar G. V, Sushmita Lenka, "FITNESS MONITOR WITH SMART SAFETY SHOE AND IOT", IJMET 2019.

[5] Donkrajang, W., Watthanawisuth, N., Mensing, J. P., Kerdcharoen, T., A wireless device smart-shoe system for monitoring human locomotions, Proc. IEEE International Conf. on Biomedical Engineering, Year 2019

[6] Vaishnavi Nayak, Sneha Prabhu, Sanket Madival, Vaishnavi Kulkarni,Vaishnavi. M. Kulkarni,"Smart Shoe,"in International Journal of Latest Engineering Research and Applications , IRJET, 2018

[7] Harika Devi Kotha, Manisha Gunturi, Sirisha Potluri .An Iot Based Solution For Health Monitoring Using A Body-Worn Sensor Enabled Device", Year 2018.

[8] Hwang, Po-Yu., Chia-Ching Chou, Wai-Chi Fang, ChingMing Hwang, Smart shoes design with embedded monitoring electronic system for healthcare and fitness applications, Proc. IEEE International Conf. on Consumer Electronics, Year 2016, 1-2.

[9] Zhao, Jingjing You, Zheng. A Shoe-Embedded Piezoelectric Energy Harvester for Wearable Sensors (Basel, Switzerland). year 2018.

[10] MDPI and ACS Style Hegde, N.; Bries, M.; Sazonov, E. A Comparative Review of Footwear-Based Wearable Systems. Electronics year 2019.

[11] B. Durga Sri, K. Nirosha, P. Priyanka and B. Dhanalaxmi,GSM Based Fish Monitoring System Using IOT, InternationalJournal of Mechanical Engineering and Technology 8(7), year2017

[12] S. S. Banerjee, T. Hemphill, and P. Longstreet, "Wearable devices and healthcare: data sharing and privacy," The Information Society, vol. 34, no. 1, pp. 49–57, 2017.

[13] J. Casselman, N. Onopa, and L. Khansa, "Wearable healthcare: lessons from the past and a peek into the future," Telematics and Informatics, vol. 34, no. 7, pp. 1011–1023, 2017.

[14] P. Forbrig, F. Paternó, and A. M. Pejtersen, "Human-computer interaction," Encyclopedia of Creativity Invention Innovation Entrepreneurship, vol. 19, no. 2, pp. 43–50, 2017.

[15] E. Morgulev, O. H. Azar, and R. Lidor, "Sports analytics and the big-data era," International Journal of Data Science and Analytics, vol. 5, no. 4, pp. 213–222, 2018.

[16] B. Yu, Q. Zeng, and G. Huang, "Advances in the application of headset virtual reality system in sports rehabilitation therapy," China Journal of Rehabilitation Medicine, vol. 33, no. 6, pp. 734–737, 2018.

[17] W. R. Thompson, "Worldwide survey of fitness trends for 2018," ACSM's Health Fitness Journal, vol. 21, no. 6, pp. 10–19, 2017.

[18] Lee, S.I.; Campion, A.; Huang, A.; Park, E.; Garst, J.H.; Jahanforouz, N.; Espinal, M.; Siero, T.; Pollack, S.; Afridi, M.; et al. Identifying predictors for postoperative clinical outcome in lumbar spinal stenosis patients using smart-shoe technology. J. Neuroeng. Rehabil. 2017.

[19] Hariharr C Punjabi, Sanket Agarwal, Vivek Khithani,Venkatesh Muddaliar and Mrugendra Vasmatkar, SmartFarming Using IoT, International Journal of Electronics andCommunication Engineering and Technology, 8(1), year 2018

[20] S. Nithya, Lalitha Shree, Kiruthika and Krishnaveni,Solar Based Smart Garbage Monitoring System Using IOT,International Journal of Electronics and CommunicationEngineering and Technology, 8(2), year 2017

[21] V. Uma Maheswari, S. Shoba Rani, D. Divakara Reddy, B.Lakshmi, E-Bazaar Innovation Using Iot Device in CloudSubscription Management. International Journal of CivilEngineering and Technology, 8(8), year 2017