SMART SHOE

A Project Report Submitted to

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IN

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by

Name	USN
Ms. Precilda Irneaus Furtado	**4VM16EC062**
Ms. Sahana M S	**4VM16EC073**
Mr. Sandeep	**4VM16EC074**
Ms. Shilpa B N	**4VM17EC440**

Under the Guidance of

Prof. Lalitha N

Assistant Professor

Department of Electronics and Communication Engineering

VIDYA VIKAS EDUCATIONAL TRUST

VIDYA VIKAS INSTITUTE OF ENGINEERING AND TECHNOLOGY

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AFFILIATED TO VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

Certified that the project work entitled "**SMART SHOE**" is a bonafide work carried out by Ms. PRECILDA IRNEAUS FURTADO bearing USN **4VM16EC062,** Ms. SAHANA M S bearing USN **4VM16EC073,** Mr. SANDEEP bearing USN **4VM16EC074** and Ms. SHILPA B N bearing USN **4VM17EC440** in the department of Electronics and Communication Engineering from **VIDYA VIKAS INSTITUTE OF ENGINEERING AND TECHNOLOGY** submitted in partial fulfilment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** prescribed by the Visvesvaraya Technological University, Belagavi during the year 2019-2020. It is certified that all suggestions recommended for Internal Evaluation have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements with respect to Project work prescribed for the said Degree.

Signature of the Guide	Signature of the HOD	Signature of the Principal
Prof. Lalitha N	**Dr. Bindu A Thomas**	**Dr. M.Ravishankar**
Assistant Professor	Professor & Head	Principal
Dept. of ECE	Dept. of ECE	VVIET, Mysuru
VVIET, Mysuru	VVIET, Mysuru	

External Viva

Name of the Examiners — Signature with Date

1.

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ABSTRACT

Energy is important in our daily life especially in this era of information technology. For wearable and portable devices, energy storage and supply are always an issue. So, here come renewable energy technology, which can harvest renewable energy and apply it onelectronic devices. There is some energy which is commonly harvested from human body, for example, vibrational energy, thermal energy and so on and also with the development and awareness of social affairs concerning locating missing person and location detection services has been widely on demand. This explains the design of incorporating the GPS technology to deliver a location-based service for tracking and detecting human.

The proposed methodology focuses on harvesting energy by using piezoelectric material. Piezoelectric material used in this project is piezoelectric plate, it will be placed under shoe sole. When human apply pressure on the plate, electrical energy will be converted into DC and store into a battery. Therefore, whenever user walks or runs with the piezoelectric shoes, energy will be harvested and stored and can be used to charge the phone in emergency purposes. Second part is to build a GPS tracker which is useful to identify the location of a person in a public area and may benefit in monitoring and tracking the whereabouts of our loved ones.

ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of a task would be incomplete without the mention of the people who made it possible. We wish to express our sincere and heartfelt gratitude to those who guided us to accomplish the assigned Project work.

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Ms. Precilda Irneaus Furtado	4VM16EC062
Ms. Sahana M S	4VM16EC073
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Ms. Shilpa B N	4VM17EC440

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Ms. Precilda Irneaus Furtado

(4VM16EC062)

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Ms. Sahana M S

(4VM16EC073)

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Ms. Shilpa B N

(4VM17EC440)

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Chapter 1

INTRODUCTION

The world is getting smarter each day and each material can be made smart with the help of technology, just by making use of a sensor and collecting information and communicating via internet makes things smarter. And when you pair your wearable tech device with a compatible app, it's easy to log your progress. This been used for monitoring human activity, and they allowed not only to examine the state of body and the health of persons, but also to recover much information concerning different fields of application: human motion, geo localization security and many others. As the growing population increases there are millions of people who go for a walk. At an average every individual walk say for around 3.5miles a day, and we know that everyone uses a footwear while walking what if it is a shoe this shoe can be added with intelligence and made smart calling it to be a Smart Shoe

Many cases of missing person in a public area were reported and fast detection is highly demanded this situation is commonly seen in aged people , for their safety related problems most of the aged people suffer from memory related disease its seen that around 50000 millions of people in the world suffer from this problems people are so busy that they cannot give that care and safety to their aged parents they keep them away from the outside world from the fear of getting lost there is a solution to this by making use of GPS in the shoe, thus getting hold of one person. Almost every day, cases of missing person were reported. A gadget to prevent this is needed thus a person's location can be tracked and detected. In emergency cases where phone call is impossible, a device may save life. Many have been looking for solution as a service to inhibit situation. With this issue to solve, with the widely use existing GPS technology. The portable electronic devices and the concept of harvesting renewable energy in human surrounding arouses a renewed interest. Ambient energy harvesting is one of the methods to reduce and solve the energy issues. It contains several methods to harvest and recycle ambient waste energy. Energy is everywhere, these energies can be heat, radio frequency waves, vibration and so on. They are waste energy which we can recycle and convert into electrical energy, we store it into energy storage and use whenever we need. Harvesting ambient energy on human body is one of the fields of harvesting ambient energy, this field grow fast due to its In the current era which is witnessing high energy costs and an exponential decrease in the supply of fossil fuels, there

arise a need to develop methods from judicious use of energy which lay emphasis on protecting the environment as well Piezoelectric materials can be used as a means of transforming ambient vibrations into electrical energy that can then be stored and used to power other devices. There is a wasted energy everywhere a huge number of people walking, jogging and running everyday generate enormous energy that is just a waste. About wearable electronics devices, one of the most efficient systems for energy capturing are those that use Energy Harvesting systems inserted into the shoes. The compression and bending of the shoe sole represent a way for harvesting energy that could be put to useful applications. This system includes an integrated modular monitoring circuit that provides location information and also piezoelectric charging technique which also includes a step counter.

1.1 Motivation

The motivation of this project is that as we know abduction rates are increasing now a days and it's been a serious security issue for people, a lot of elder people suffer from memory disease one such is the Dementia or Alzheimer's it's difficult to keep watching or to take care of them wherever they go hence to keep a track of such patients and also the adults for the safety of our loved ones we can make use of Shoes instead of carrying any extra device they can just put it on. Distance walked by a typical human being per day is 3.5 miles. A huge amount of 3.4 trillion calories of energy is being burnt by people just while walking. This nasty number of calories of energy being burnt everyday this energy can be generated that can be used to power few electronic boards and mobile just while walking. The aim of Energy harvesting is to capture free energy, available without costs, from the environment. The advanced techniques allowed us to capture, store and to manage natural energy, transforming them into electrical energy. Thus, we in this project give a more general and simple approach where the voltage from the sensor can be stored as well as used whenever required.

1.2 Problem Statement

There are a huge number of missing cases recorded every day the reasons for this can be many. A gadget to prevent this is needed where phone call is impossible a device may save life also the dependency of Smart Phone has become a part of life and the power consumed for charging this device is of numerous amount ,one message or phone call can do a huge work if there is no charge in our phone then it causes lot of loss to our job and even

personally, the availability of the sockets or ports for charging are also less whenever we travel we don't have the availability to charge our phones.

1.3 Objective

The main objective of our project is to design a Smart Shoe that can be used for the safety purpose by Building a human tracking system using GPS module of all age groups and all people by monitoring their location at all time and also Build an energy harvester (using piezoelectric generator) and store the energy generated from body movement in battery piezoelectric power generation that can be a good alternative for fossil fuels its used to charge the phone via walk at emergency cases where u don't have direct access of charging unit. In order to check how much it charges based on the steps a Step counter is also used and to encourage people walking making a shoe Smart gadget.

1.4 Organization of the report

Report presents the detailed approach of technology used for Smart Shoe

Chapter 1 Consists of a brief introduction of the work. It also defines the problems faced in today's world and how the proposed design overcomes them.

Chapter 2 Includes the literature survey. It consists of the comparison between various components and technologies. It also includes the discussion done in few papers.

Chapter 3 Discusses about the components required for the project

Chapter 4 Detailed implementation of the project

Chapter 5 Discussion of results

Chapter 2

LITERATURE SURVEY

Literature survey is a crucial stage in project life cycle; therefore, its importance cannot be underestimated. The information collected through websites is properly analysed to clearly understand the requirements. The purpose of this literature survey is to derive a new solution by understanding the failing and inadequacies of the present system. The survey is carried out in the initial stages of the work and the need of this application is determined. This chapter contains the study of different previous technologies and draw backs of the previous technologies. Comparison between the previous technology and the technology adopted in the work, comparison between previous designs and proposed design is also included in this chapter.

2.1 Existing Systems

Chandana P, Roger O, Sheikh I "A Wireless Smart Shoe System for Gait Assistance" [1] This paper proposes smartphone based based system for analysing characteristics of gait by using a wireless smart shoe. The system employs four force sensitive resistors to measure the pressure distribution underneath a foot data is collected via a WIFI communication network between the smart shoe and smart phone

Dhananjay Kumar, Pradyuman Chaturvedi and Nupur Jejurikar "Piezoelectric Energy Harvester Design and Power Conditioning".[2] It describes that harnessing energy through piezoelectric material provide a cleaner way of powering lighting systems and other equipment's. It is a new approach to lead the world into implementing greener technologies that are aimed to protect the environment. Piezoelectric energy harvesting systems are a one time instalment and they are require less maintenance.

Qiani Xu, Tian Gan, Shue Ching Chia, Liyuan Li "Design and Evaluation of Vibrating Footwear for Navigation Assistance to Visually Impaired People" [3] In this paper a wearable system is designed to provide directional information to visually impaired people. It consists of mobile phone and haptic shoe. The former serves as the perceptual and control unit that generates directional instructions. Upon receiving the instructions, the shoes combine them with the user's walking status to produce unique vibration patterns. To enable effective

direction sensing, a few alternative configurations are proposed, whereby the position and strength of vibrations are modulated programmatically

Susmita Das, Sagar Patra, Mugdha Mondal and Sandipan Deb "Design of a Portable Charger with Energy Conservation" [4] In this paper an investigational design idea is presented on a power generator shoe with a specially structured piezoelectric transducer. The properties of the transducer are similar to the regular shoe filling and it is designed to collect energy from human walk without affecting the users own gait.

Salma Saidini, Rim Haddad, Neila Mezghani, Ridha Bouallegue "A survey on Smart Shoe insole Systems" [5] Here the foot pressure analysis using a wearable sensing system becomes innovative in clinical and research fields to enable real time care of patients and to accelerate the detection of diseases. The plantar pressure is measured using a smart shoe insole system with multisensors placed in different positions of the foot

Po-Yu Hwang, Chia -Ching Chou, Wai-Chi Fang, Ching-Ming Hwang "Smart shoe design with embedded monitoring with electronics system for healthcare and fitness applications"[6] In this paper , the system architecture and adherence method of a wearable medicare health fitness it gives the information including coordinate tracker, step counter, calorie counter as well as for biomedical information such as foot oxygen content

Inurina Ibrahim and Engku Mohammad Nazreen "Development of Location Detection and Human Tracking Application via GPS and GSM Service" [7] This paper, presented the methods adopted in developing of the initial prototype as a pilot study. The result of the evaluation discussed recommendations for further improvement in the prototype development. This shall be achieved by adding specific values for a better outcome. A detail result on the improvement will be discussed in the next paper. The purpose of this study is to share this information with other researcher and to foresee ways to improve the current processes hence the same study can be initiated and explored by others. A further enhancement of this service shall be proposed and another set of evaluation should be performed thus there be a potential for application commercialization

2.1 Outcome of Literature Survey

The main idea of how to make a smart shoe the various uses of the Smart Shoe in different applications as a fitness tracker in medical applications as well as energy generation can be

known from the various papers. How the smart shoe was used for the gait analysis based on how the person walks his posture for early detection of disease and the Piezoelectric power generation can be a good alternative for fossil fuel it is clean, non-hazardous easy implementable, inexpensive and eco-friendly source of energy, hence we are using this piezoelectric material to charge mobile phone. There are various kind of methods in harvesting vibrational energy from human body, for example, electromagnetic, electrostatic and piezoelectric generator proposed an energy harvester that harvests energy from human movement by using magnetic spring use a coil and a magnet to create an electromagnetic transducer. At some busy place full with people walking around, for example, airport terminal. There are a lot of motion energy that we can capture through piezoelectric technology. In order to harvest those walking energy, piezoelectric devices is installed underneath the floor of terminal. The efficient way of energy harvesting using the piezoelectric material and to design a shoe for charging how to implement it and not only use it for one application but to make it smart by adding features to it that can be used for multipurpose to find the location of the user if he is lost in some place with the help of his location data

Chapter 3

HARDWARE AND SOFTWARE SPECIFICATION

The current chapter describes about various hardware and software requirements needed to build the system and their specifications

3.1 Piezoelectric plate

Pierre Curie founded the piezoelectric effect in 1880, but it started to be used for industrial sensing application in 1950. **Piezoelectric sensor** is used to convert the mechanical stress into electric charge, it gives AC at output. Certain crystals such as quartz are piezoelectric. That means that when they are compressed or struck, they generate an electric charge. It works the other way as well. If you run an electric current through a piezoelectric crystal, the crystal changes shape slightly. This property makes piezoelectric crystals useful in many applications.

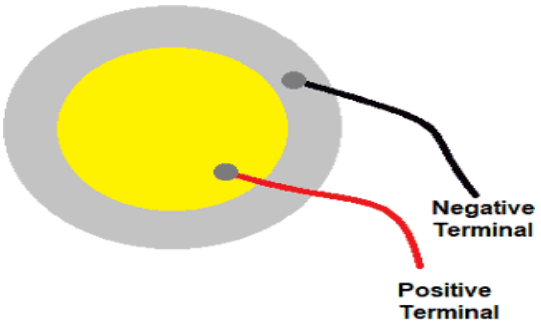

Figure 3.1: Piezoelectric plate

The most common type of force transducer is the piezoelectric type. In this device, force is applied to a piezoelectric crystal such as quartz. The ability of a piezoelectric material to convert a mechanical stress into electrical charge is called a **Piezoelectric Effect**. The word Piezoelectric derived from the Greek word ‘piezein’ which means to push, press and squeeze. Piezoelectric effect is reversible effect means when we applied mechanical stress to the piezoelectric material, we get some electrical charge at output. Same as when we feed electrical charge to the sensor it gets stretch or compresses.

3.1.1 Features and Specifications

- Impedance: ≤500Ω;

- Voltage: ≤30Vp-p;
- Operating temperature: -20°C~+60°C
- Storage temperature: -30°C~+70°C
- Low Soldering temperature
- Strain sensitivity: 5V/με
- Material: Quartz (mostly used)

3.2 Diode

A diode is a device which allows current flow through only one direction. That is the current should always flow from the Anode to cathode. The cathode terminal can be identified by using a grey bar as shown. A 1N4007 diode is electrically compatible with other rectifier diodes, and can be used as a replacement for any diode in the 1N400x family. Reverse Voltage Rating A diode allows electrical current to flow in one direction -- from the anode to the cathode.

Figure 3.2: Diode IN4007

3.3 Regulator

7805 is a three terminal linear voltage regulator IC with a fixed output voltage of 5V which is useful in a wide range of applications. Currently, the 7805 Voltage Regulator IC is manufactured by Texas Instruments, ON Semiconductor, STMicroelectronics, Diodes incorporated, Infineon Technologies, etc. They are available in several IC Packages like TO-220, SOT-223, TO-263 and TO-3. Out of these, the TO-220 Package is the most commonly used one (it is the one shown in the above image).

Some of the important features of the 7805 IC are as follows:

- It can deliver up to 1.5 A of current (with heat sink).
- Has both internal current limiting and thermal shutdown features.
- Requires very minimum external components to fully function.

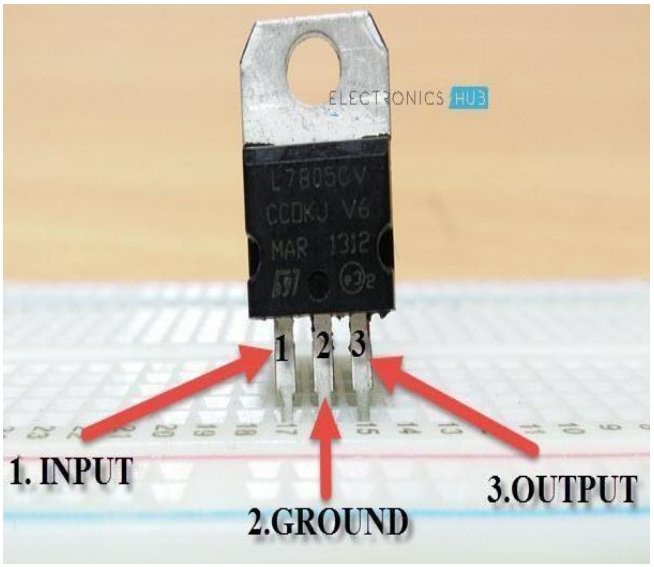

Figure 3.3: 7805 Voltage Regulator

3.4 Capacitor

Capacitor, device for storing electrical energy, consisting of two conductors in close proximity and insulated from each other. Capacitors have many important applications and are used in digital circuits and as filters that prevent damage to sensitive components and circuits caused by electric surges.

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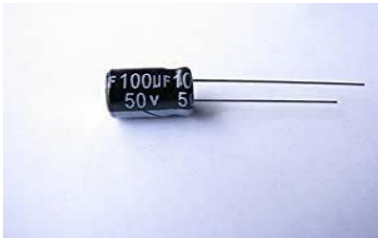


Figure 3.4: 100uF Capacitor

3.5 Lipo Battery

Lipo stands for the lithium polymer. These are the batteries which having high-performance rechargeable battery by using the lithium-ion battery. These batteries are used in making the vaping box mods. The lithium polymer batteries are the type of rechargeable battery and can be used again and again by charging them. These are the batteries which are highly used in the helicopters and planes. These batteries are prevalent because they are light in weight and easy to carry. These are more likely as that they are high capacity and high discharge rate. If these batteries are appropriately used as prescribed by the manufactures, then these batteries are long lasting. The analysis of lithium deep cycle battery involved the widely used because of increasing urbanization and industrialization and the rising usage of these batteries in vehicles.

Figure 3.5: Lipo Battery

3.6 Li -Ion TP4056

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion (Li-Ion) batteries.

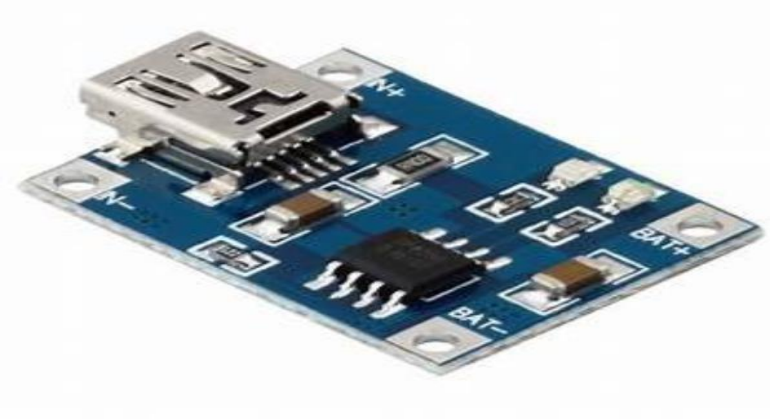


Figure 3.6: Li-Ion TP4056

Its SMD package and little external components make the TP4056 ideally suited for portable applications. This module is based on TP4056 IC. It is ideally suited for portable applications. The Li-Ion Battery Charger can work within a USB or wall/5V adapter. Other features include current monitor, under voltage lockout, automatic recharge, two status LEDs to indicate charge termination and the presence of an input voltage and also 2 digital pins, "CHG" and "STB" that you can use to monitor the charging process with a microcontroller.

No blocking diode is required due to the internal PMOSFET architecture and have prevent to negative Charge Current Circuit. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The TP4056 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached. TP4056 Other features include current monitor, under voltage lockout, automatic recharge and two status pin to indicate charge termination and the presence of an input voltage.

3.6.1 Features

- Programmable Charge Current Up to 1000mA
- No MOSFET, Sense Resistor or Blocking Diode Required
- Complete Linear Charger in SOP-8 Package for Single Cell Lithium-Ion Batteries
- Charges Single Cell Li-Ion Batteries Directly from USB Port
- Preset 4.2V Charge Voltage with 1.5% Accuracy
- Automatic Recharge ·two Charge Status Output Pins
- C/10 Charge Termination
- 2.9V Trickle Charge Threshold (TP4056)
- Soft-Start Limits Inrush Current
- Available Radiator in 8-Lead SOP Package, the Radiator need connect GND or impending

3.7 Mini Node MCU DI

ESP8266 is a very popular Wi-Fi enabled microcontroller. The NodeMCU is based on a ESP8266-12 but features a built in serial over USB interface and other amenities like 2 buttons and 2 leds. The board is compact and fits on a breadboard. The NodeMCU uses the

CH340 serial USB programmer, which requires the installation of a specific driver it is a highly integrated chip. It requires stable power supply, and sophisticated programming method. Wemos D1 mini solves all those inconveniences. Basically, it's very similar to Node MCU module. The main difference is size. Wemos D1 is smaller, and have newer version of Wi-Fi module - 12F. More stable and with a better range. D3 to G and reset button to enter bootloader mode. ESP8266EX offers a complete and self-contained WiFi networking solution; it can be used to host the application or to offload WiFi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications.

Figure 3.7: Mini Node MCU DI.

Alternately, serving as a WiFi adapter, wireless internet access can be added to any microcontroller-based design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated WiFi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receiver amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, besides the WiFi functionalities. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; sample codes for such applications are provided in the software development kit (SDK).

3.7.1 Why Node MCU

- The ESP8266 is a low-cost Wi-Fi enabled microchip with full TCP/IP stack and microcontroller capability
- Node MCU includes CPU core, faster Wi-Fi, more GPIOs, and supports Bluetooth 4.2 and low power Bluetooth
- Additionally, the board comes with touch sensitive pins and built in Hall effect sensor and temperature sensor
- Very cheap as compared to Arduino Uno

3.7.2 Features of NodeMCU

- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Integrated TR switch, LNA, power amplifier and matching network
- Supports antenna diversity
- Wi-Fi 2.4 GHz, support WPA/WPA2
- Support STA/AP/STA+AP operation modes
- Support Smart Link Function for both Android and iOS devices
- Operating temperature range -40C ~ 125C

3.7.3 Pin Definition

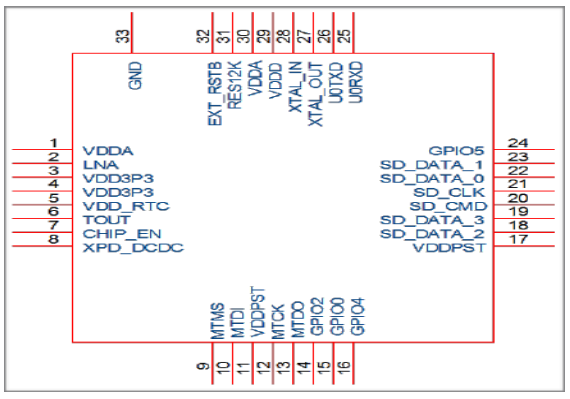


Fig 3.8: Pin Assignment

Pin	Name	Type	Function
1	VDDA	P	Analog Power 3.0~3.6V
2	LNA	I/O	RF Antenna Interface. Chip Output Impedance =500ohm No matching required but we recommend that the n-type matching network is retained.
3	VDD3P3	P	Amplifier Power 3.0~3.6V
4	VDD3P3	P	Amplifier Power 3.0~3.6V
5	VDD_RTC	P	NC (1.1V)
6	TOUT	I	ADC Pin (note: an internal pin of the chip) can be used to check the power voltage of VDD3P3 (Pin 3 and Pin4) or the input voltage of TOUT (Pin 6). These two functions cannot be used simultaneously.
7	CHIP_EN	I	Chip Enable. High: On, chip works properly; Low: Off, small current
8	XPD_DCDC	I/O	Deep-Sleep Wakeup ; GPIO16
9	MTMS	I/O	GPIO14; HSPI_CLK
10	MTDI	I/O	GPIO12; HSPI_MISO
11	VDDPST	P	Digital/IO Power Supply (1.8V~3.3V)
12	MTCK	I/O	GPIO13; HSPI_MOSI; UART0_CTS
13	MTDO	I/O	GPIO15; HSPI_CS; UART0_RTS
13	MTDO	I/O	GPIO15; HSPI_CS; UART0_RTS
14	GPIO2	I/O	UART Tx during flash programming; GPIO2
15	GPIO0	I/O	GPIO0; SPI_CS2
16	GPIO4	I/O	GPIO4
17	VDDPST	P	Digital/IO Power Supply (1.8V~3.3V)
18	SDIO_DATA_2	I/O	Connect to SD_D2 (Series R: 200Ω); SPIHD; HSPIHD; GPIO9
19	SDIO_DATA_3	I/O	Connect to SD_D3 (Series R: 200Ω); SPIWP; HSPIWP; GPIO10
20	SDIO_CMD	I/O	Connect to SD_CMD (Series R: 200Ω); SPI_CS0; GPIO11

21	SDIO_CLK	I/O	Connect to SD_CLK (Series R: 200Ω); SPI_CLK; GPIO6
22	SDIO_DATA_0	I/O	Connect to SD_D0 (Series R: 200Ω); SPI_MSIO; GPIO7
23	SDIO_DATA_1	I/O	Connect to SD_D1 (Series R: 200Ω); SPI_MOSI; GPIO8
24	GPIO5	I/O	GPIO5
25	U0RXD	I/O	UART Rx during flash programming; GPIO3
26	U0TXD	I/O	UART Tx during flash programming; GPIO1; SPI_CS1
27	XTAL_OUT	I/O	Connect to crystal oscillator output, can be used to provide BT clock input
28	XTAL_IN	I/O	Connect to crystal oscillator input
29	VDDD	P	Analog Power 3.0V~3.6V
30	VDDA	P	Analog Power 3.0V~3.6V
31	RES12K		Serial connection with a 12 kΩ resistor and connect to the Ground
32	EXT_RSTB	I	External reset signal (Low voltage level: Active)

Table 4.1: Pins of Node MCU module

3.8 Ublox Neo-6 module

The Neo-6 module series is a family of stand-alone GPS receivers featuring the high-performance u-blox 6 positioning engine. Their compact architecture and power and memory options make Neo-6 modules ideal for battery operated mobile devices with very strict cost and space constraints. GPS module is needed to collect location data such as longitude and latitude. GPS module supposed to be powered off by microcontroller when it is not used. The data received through GPS tracker will be forwarded to database by using GSM module through GPRS. The module used in the project need at least 5V of power supply, it communicates through digital pin serially with 9600 baud rate. The module come with voltage regulator, voltage more than 5V is acceptable but not exceed 7.4V. Power consumption of the GPS module is around 60mA.

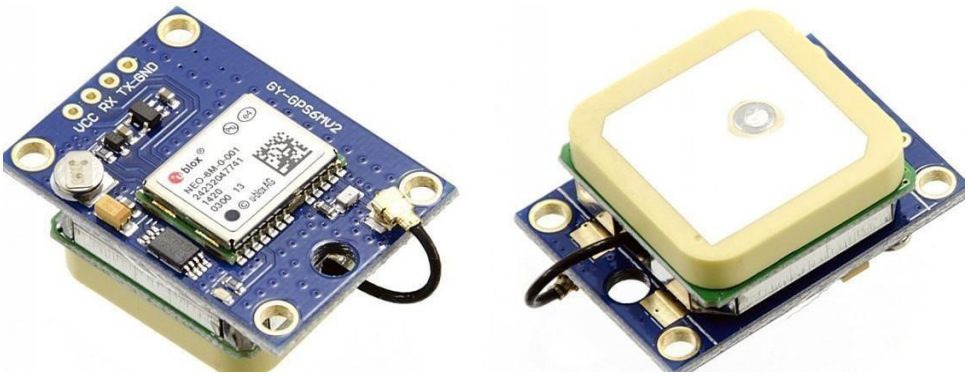


Figure 3.9: Ublox Neo-6 Module**.**

The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlates, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppress jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

3.8.1 Features of Ublox Neo-6 Module

- A complete GPS module with an active antenna integrated
- Built in 25*25*4mm ceramic active antenna provides strong satellite search capability
- Equipped with power and signal indicator lights and data backup battery
- Power supply 3-5V default baud rate 9600bps

3.8.2 Pin Definitions

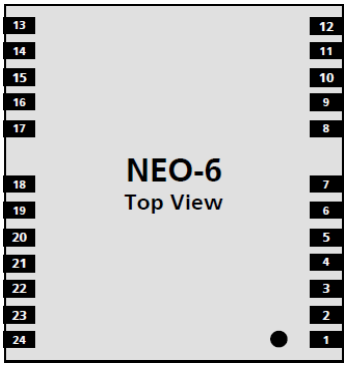


Figure 3.10: Pin Assignment

No	Module	Name	I/O	Description
1	All	Reserved	I	Reserved
2	All	SS_N	I	SPI Slave Select
3	All	TIMEPULSE	O	Time pulse (1PPS)
4	All	EXTINT0	I	External Interrupt Pin
5	All	USB_DM	I/O	USB Data
6	All	USB_DP	I/O	USB Data
7	All	VDDUSB	I	USB Supply
8	All	Reserved		See Hardware Integration Manual Pin 8 and 9 must be connected together
9	All	VCC_RF	O	Output Voltage RF section Pin 8 and 9 must be connected together.
10	All	GND	I	Ground
11	All	RF_IN	I	GPS signal input
12	All	GND	I	Ground
13	All	GND	I	Ground
14	All	MOSI/CFG_COM0	O/I	SPI MOSI / Configuration Pin. Leave open if not used.
15	All	MISO/CFG_COM1	I	SPI MISO / Configuration Pin. Leave open if not used.
16	All	CFG_GPS0/SCK	I	Power Mode Configuration Pin / SPI Clock. Leave open if not used.
17	All	Reserved	I	Reserved
18	All	SDA2	I/O	DDC Data
19	All	SCL2	I/O	DDC Clock
20	All	TxD1	O	Serial Port 1
21	All	RxD1	I	Serial Port 1
22	All	V_BCKP	I	Backup voltage supply
23	All	VCC	I	Supply voltage
24	All	GND	I	Ground

Table 4.2: Pins of GPS module

3.9 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

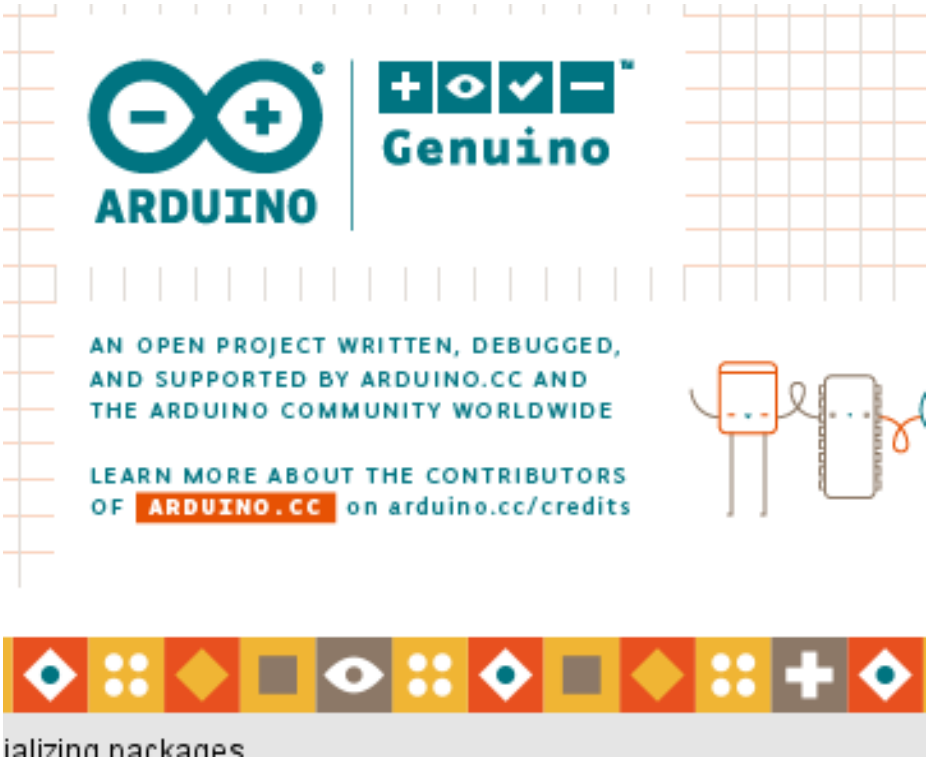


Figure 3.11: Arduino IDE

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main () into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers & tools (cores) that can build and upload sketches to other MCUs that are not supported by Arduino's official line of MCUs.

3.10 Programming using C++

C++ is a general-purpose programming language created by Bjarne Stroustrup as an extension of the C programming language, or "C with Classes". The language has expanded significantly over time, and modern C++ now has object-oriented, generic, and functional features in addition to facilities for low-level memory manipulation. is the language that is used everywhere but mainly in systems programming and embedded systems. C++ was designed with a bias toward system programming and embedded, resource-constrained software and large systems, with performance, efficiency, and flexibility of use as its design highlights. C++ has also been found useful in many other contexts, with key strengths being software infrastructure and resource-constrained applications, including desktop applications, video games, servers (e.g. e-commerce, Web search, or SQL servers), and performance-critical applications (e.g. telephone switches or space probes). Here system programming means for developing the operating systems or drivers that interface with hardware. The Arduino IDE accepts c++. In fact, many of the libraries are written in c++.

The Arduino programming language can be divided in three main parts; functions, values and structure.

- Functions: for controlling the Arduino board and performing computations, such as Digital I/O, Analog I/O, Zero, DUE &MKR family, Advanced I/O, Time, Math, Bits and Bytes etc

- Variables: Arduino data types and constants, Conversion, Data Types, Variable Scope & Qualifiers, Utilities.

- Structure: the elements of Arduino (c++) code consists of Sketch, Control Structure, Further Syntax, Arithmetic Operators, Comparison Operators, Pointer Access operators etc

3.11 Blynk Application:

Figure 3.12: Blynk App

Blynk is an Internet of things (IoT) company which provides a platform for building mobile (IOS and Android) applications that can connect electronic devices to the Internet and remotely monitor and control these devices. Blynk was founded by Pavel Bayborodin, a user experience (UX) expert mobile and automotive space. Blynk application is responsible for all the communications between your mobile device that's running the Blynk app and the hardware. Blynk is a platform with IOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. Blynk is used as the user interface. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. Blynk IoT mobile app is a toolset for all who would love to use their smartphones to control electronics like Arduino, Raspberry Pi and similar ones by establishing an internet connection, building an app and writing hardware code in an easy way.

This chapter map out all the features of software and hardware used in this work along with their specifications. Upcoming chapter will depict the details about implementation carried to accomplish the results.

Chapter 4

METHODOLGY AND IMPLEMENTATION

The flavor of technology inherited in the work along with the hardware and software details is painted in chapter 4, map out the design and implementation part which involves how different modules of the system interfaced with each other and working methodology of the system.

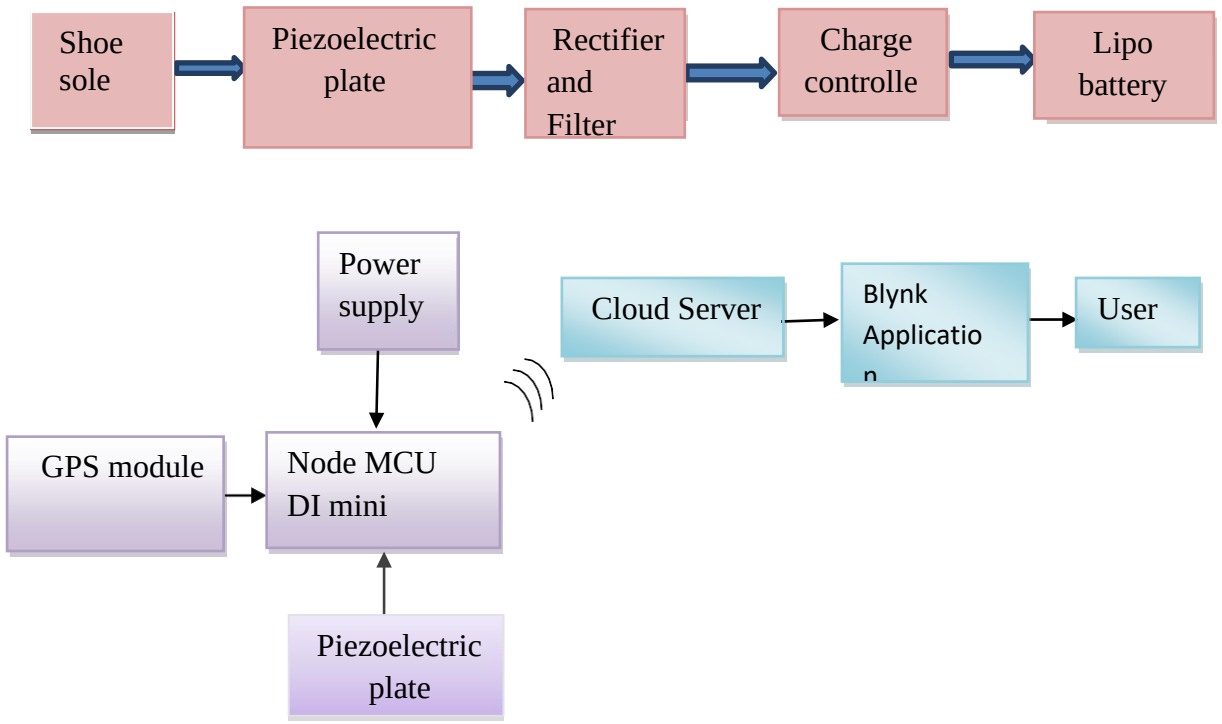


Figure 4.1: Block diagram of the System

4.1 Working

This project presents a prototype model and a system concept to provide a Smart Shoe. This system is intended to provide overall measures such as charging a cell phone, real-time Assistance via Global Positioning System, acts as pedometer which gives the step count. The system consists of Node MCU, GSM Module, piezoelectric crystals, rectifier circuit etc. This project aims at the development of a Smart Shoe. Piezoelectric transducers are comprised of materials such as crystals and certain ceramics that have a special property which allows them to convert physical energy into electrical. This piezoelectric element is put underneath the sole of the shoe converts that energy to electrical energy

Node MCU DI Mini is a WIFI enabled chip to this the various other components such as the Ublox Neo 6 module is connected which acts as a GPS receiver which gives the location of the shoe wherein you are walking ,since we are making use of the piezo plates it will give you the number of steps walked it acts as a pedometer which gives the step count. The block diagram describes the proposed system

4.2 Design of Piezoelectric Charging Circuit

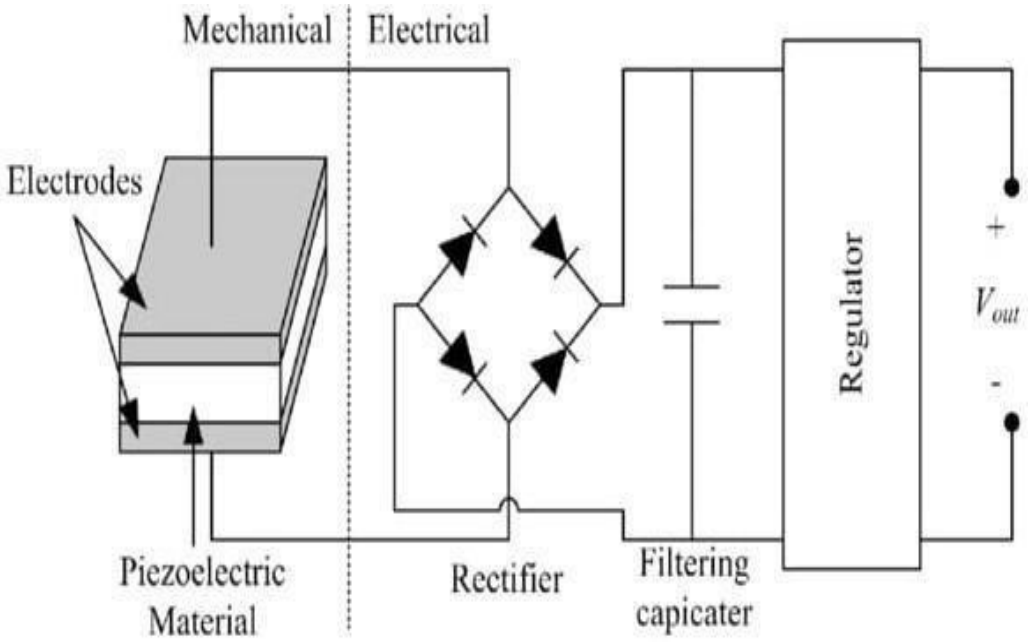


Figure 4.2: Generator Circuit

For the very first part of this project, it aims at developing a wearable technology. It revolutionizes the present shoe technology with smart applications piezoelectric sensor received force and pressure from body motion, then it converts the force into electrical energy. The voltage generated is linear with the force applied during human movements when the legs press on the ground there is a sudden peak of positive amplitude pulse of energy generated and as the stress is removed a negative peak of voltage is generated so

forming a oscillating AC voltage now in order to convert the generated AC voltage to DC we use a bridge rectifier hence the Piezoelectric sensor connects to full wave bridge rectifier. Then, the next part is full wave bridge rectifier which is built by 4 diodes. The rectifier circuit may be either a full wave or a half wave rectification circuit based on the combination of diodes. We need bridge rectifier because piezoelectric sensor will only generate AC but we need DC to store energy into battery. Electric charge in AC change direction periodically, so the voltage is also periodically reversed.

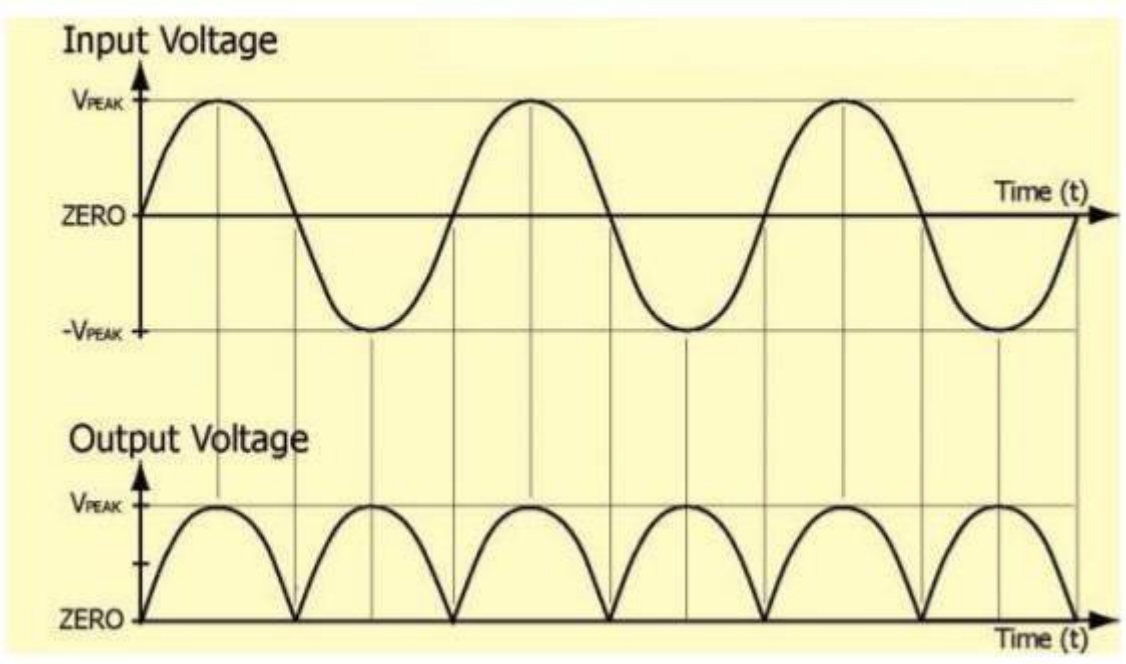


Figure 4.3: Rectifier output

By using bridge rectifier, AC is converted to DC just like figure 4.2 although it is DC but it is still ripple DC. So, we need a capacitor filter to solve the ripple DC problem. The output signal produced by the full wave rectifier is a DC voltage, but it pulsates. To be use full, this signal must be smoothed out to produced constant voltage at the output. A simple circuit for filtering the signal is one in which a capacitor is in parallel with the output. The generated voltage can be regulated to a positive 5 volts to which can be used for many different applications. the output is given to the charge controller which prevents overcharging of the battery and can be used to charge the phone.

Figure 4.4: Charging circuit

The output from the regulator is given to the IN+ and IN- It supports a constant current constant voltage charging mechanism for single cell Li-Ion Battery

4.3 Design of GPS Tracking System

There are some requirement for the GPS tracking system. Firstly, it can collect location data (longitude and latitude). Secondly, it should upload data into online database. Lastly, the system needs a user interface for user to observe the data. For the first requirement, GPS module can be used to get location data. When it gets data, a microcontroller is a must to manage those data. At here, NodeMCU was used to control the whole system due to its low power consumption. Then, the system has to upload data to online database, this step needs internet access. User who wish to know the location can check for the data through an application connected to database or straightly through database.

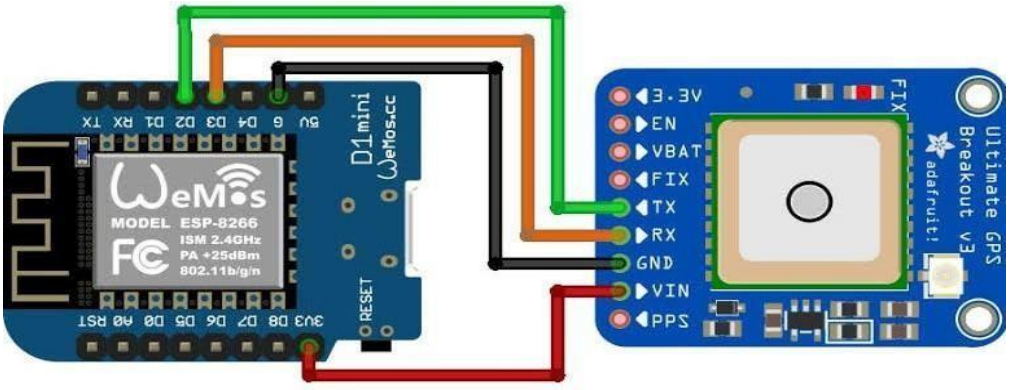


Figure 4.5: GPS with NodeMCU

GPS module has to communicate with NodeMCU by using serial data transfer. 2 digital pins of NodeMCU were set up as serial communication pin. The Pin D3 of the node mcu is connected to the RX reception of GPS, the D2 pin of node mcu is connected to the TX pin of GPS. Then both the ground connections are done along with the VIN pin of the GPS is given to 3V3 can be found in figure 4.4.

In the sketch of Node MCU, TinyGPS++.h library was used to decode GPS data. TinyGPS++.h is an open sources library which contain function to read and extract data from u-blox NEO 6M GPS module. Whenever serial data come from GPS module can be encoded by TinyGPS++ library encode () function, location (), time () and date () function were used to obtain data.

4.4 Design of Step Counter

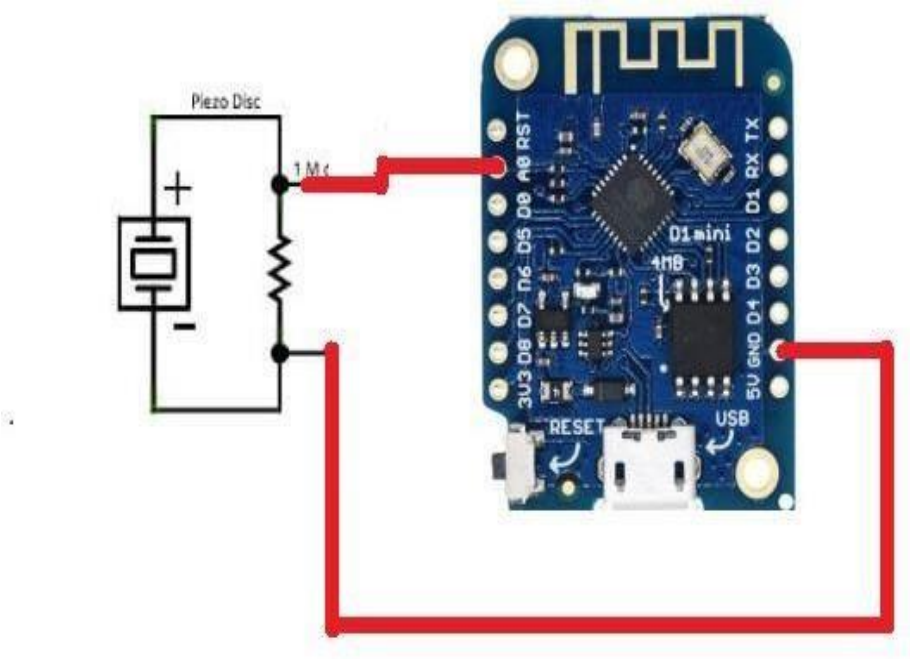


Figure 4.6: NodeMCU with Piezo disc

The step counter in the health application uses the sensors to detect if you are walking. When you walk, the sensor suite collects datapoints based on how the device is moving by its position in space, and the velocity it senses as your body moves. Which gives the step count. The A0 pin of the node mcu is connected to the positive part of the disc and the GND pin of the node mcu to negative part

4.5 Blynk for NodeMCU

The ESP8266 NodeMCU is a complex device which combines some features of the ordinary Arduino board with the possibility of connecting to the internet. The communication through the internet is very easy if Blynk application is used. With this application the board can be controlled by a smartphone in both directions, sending and receiving data between the device and the smartphone. Even the ESP8266 Node MCU Arduino IDE compatible, not all the codes can run on this board, some modifications are sometimes needed.

In this work we present simple counter realized with switches attached to the ESP8266 NodeMCU board and receive the data on the smartphone. With additional modifications the project could conduct to the possibility of using ordinary rotary encoder to send data to the smartphone.

Download the Blynk app and register with the email id which will be used for further process

Create a Blynk Project

Click the “Create New Project” in the app to create a new Blynk app. Give it any name. Blynk works with hundreds of hardware models and connection types. Select the Hardware type. After this, select connection type. In this project we have select WiFi connectivity.

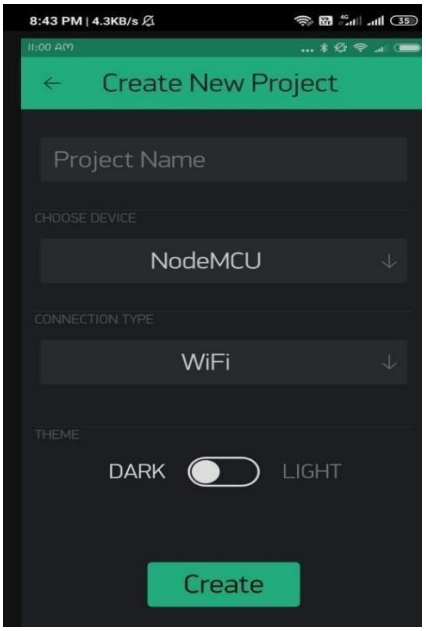


Figure 4.7: Create project

The **Auth Token** will be generated its very important – you'll need to stick it into your ESP8266's firmware

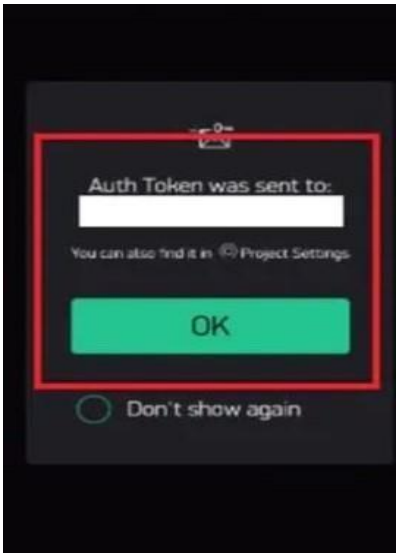


Figure 4.8: Authentication Token

Add Widgets to The Project

Then you'll be presented with a blank new project. To open the widget box, click in the project window to open. Then select Map From the widget box and select it as virtual pin. In the similar way from the widget add few more pins u can label it as latitude, longitude, Satellites and step which will give you the required data related to this information and select this with the respective type of pins

Figure 4.9: Widget option

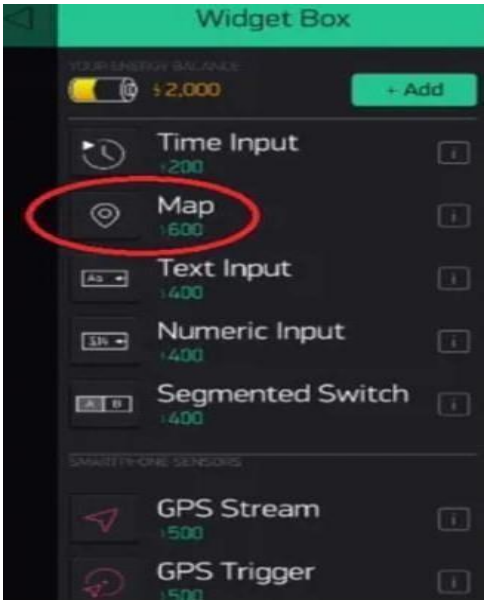


Figure 4.10: Adding widgets

Upload the Firmware and Code

Now that your Blynk project is set-up, open Arduino and navigate to the ESP8266_Standalone example in the File > Examples > Blynk > Boards_WiFi> ESP8266_Standalone menu. Before uploading, make sure to paste your authorization token into the auth [] variable. Also make sure to load your Wi-Fi network settings into the Blynk.begin(auth, “ssid”, “pass”) function, and upload the code and see the output on the user’s smartphone

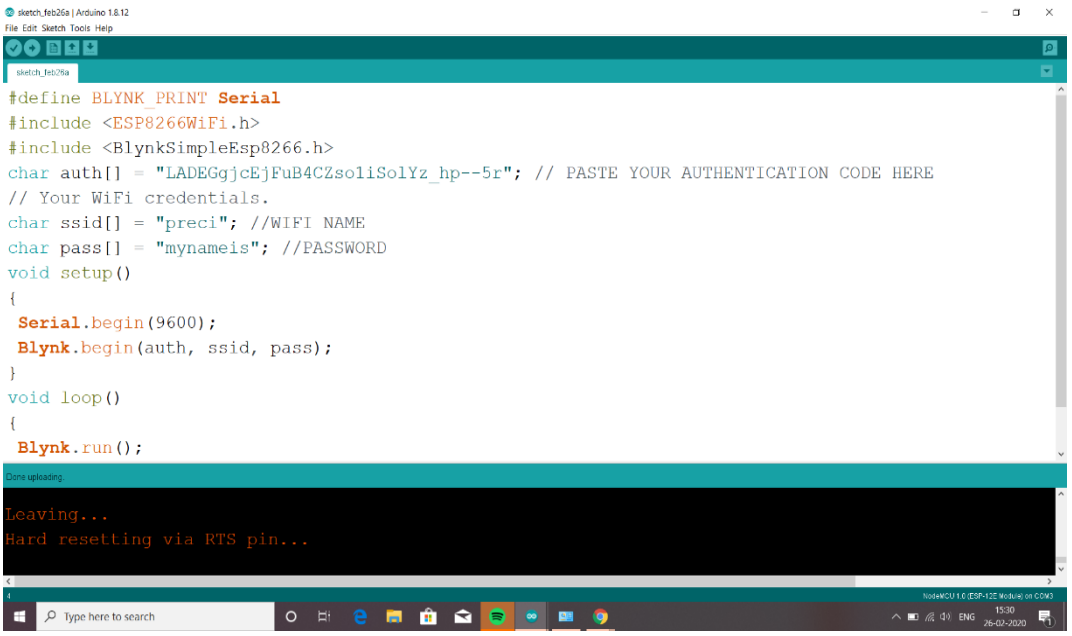
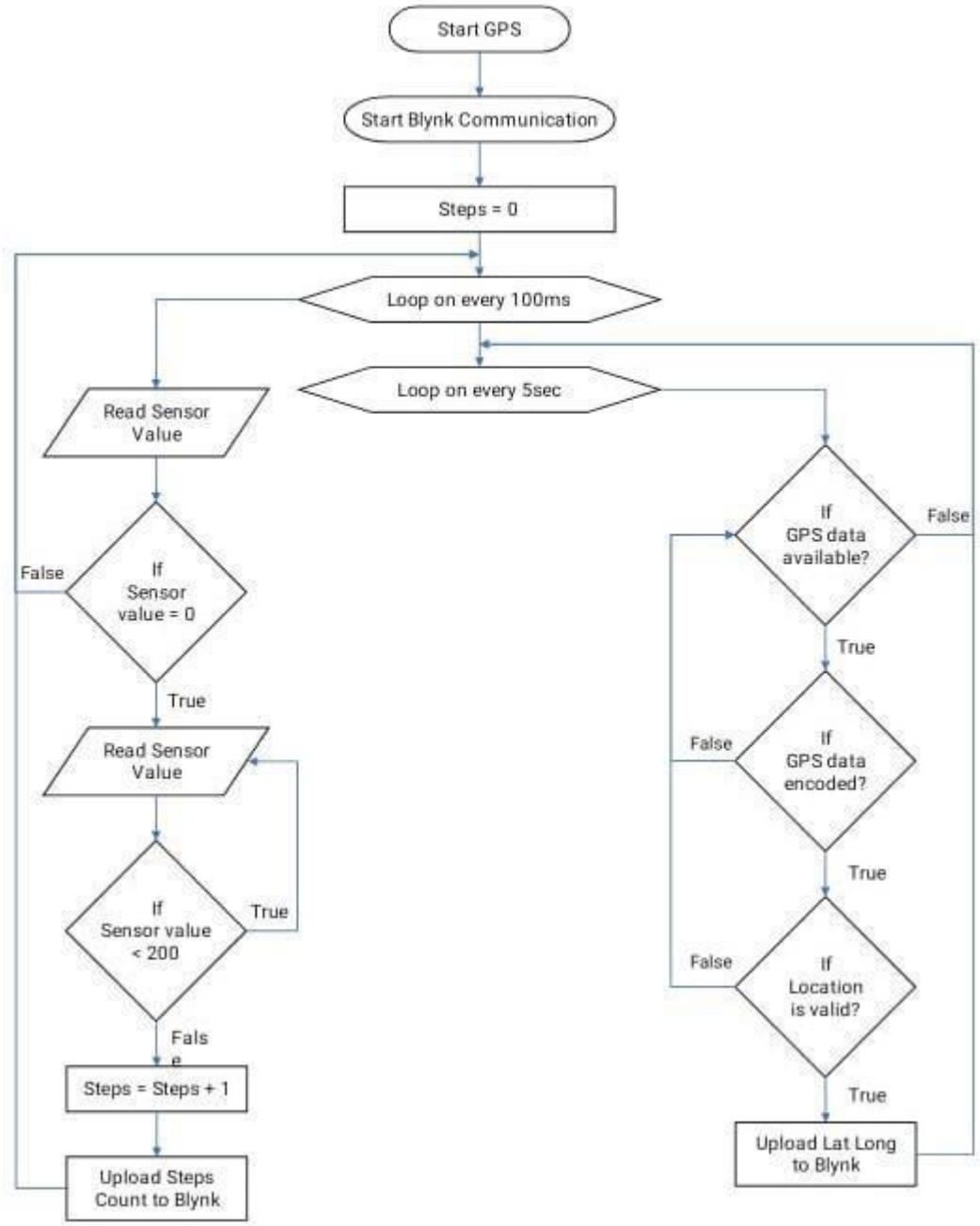


Figure 4.11: Uploading Code

4.6 Flow Chart for the tracking system



A flow chart shows sequential steps in a task or process. Here it shows how the tracking and the step count is done and after how much time it goes on updating the values to the server this shows the overall process that takes place in the tracking system as well as step count

CODE

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// Define Pin Numbers:
#define RX_Pin 4      // GPIO 4 = D2 in NodeMCU, Connect to TX of GPS Module
#define TX_Pin 5      // GPIO 5 = D1 in NodeMCU, Connect to RX of GPS Module
#define Sensor_Pin A0

// Software Serial Port:
SoftwareSerial SerialGPS(RX_Pin, TX_Pin);

// Objects:
TinyGPSPlus gps;
BlynkTimer timer;
WidgetMap myMap(V0);  // V0 for virtual pin of Map Widget
WidgetLED gpsStatusLED(V1);

// Blynk Authentication and WiFi credentials
char auth[] = "ll8paShDOF1ylzGFANiWc_lhj_gSwwu8";           //Your Project authentication key
char ssid[] = "preci";                          // Name of your network (HotSpot or Router name)
char pass[] = "preci.321";                              // Corresponding Password

unsigned int gpsLoc_index = 1;
unsigned int steps = 0;
void setup() {
  //Begin serial communication with Arduino and Arduino IDE (Serial Monitor)
  Serial.begin(9600);

  //Begin serial communication with Arduino and GPS Module
  SerialGPS.begin(9600);
```

```
  //Begin Blynk
  Blynk.begin(auth, ssid, pass);

  gpsStatusLED.off();
  Blynk.virtualWrite(V2, 0);          // Latitude
  Blynk.virtualWrite(V3, 0);          // Longitude
  Blynk.virtualWrite(V4, 0);          // Steps
  timer.setInterval(100L, countSteps);
  timer.setInterval(5000L, getGPSData);
}

void loop() {
  Blynk.run();
  timer.run();
}

void countSteps() {
  if (analogRead(Sensor_Pin) == 0) {
    while (analogRead(Sensor_Pin) < 200) {
      yield();
    }
    steps++;
    Blynk.virtualWrite(V4, steps);
    Serial.print("Steps : "); Serial.println(steps);
  }
}

void getGPSData() {
  while (SerialGPS.available()) {
    if (gps.encode(SerialGPS.read())) {
      if (gps.location.isValid()) {
        gpsStatusLED.on()
        float latitude = gps.location.lat();
        float longitude = gps.location.lng();
```

```
        Serial.print("Latitude : "); Serial.println(latitude, 6);
        Serial.print("Longitude: "); Serial.println(longitude, 6);

        Blynk.virtualWrite(V2, String(latitude, 6));
        Blynk.virtualWrite(V3, String(longitude, 6));
        myMap.location(gpsLoc_index, latitude, longitude, "GPS_Location");
      }
    }
  }
  gpsStatusLED.off();
}
```

CHAPTER 5

RESULT AND DISCUSSION

The practical implementation is done using the hardware and the software figure 5.1 shows the circuit required for piezoelectric energy generation and location tracking figure 5.2 shows the overall model of our project figure 5.3 shows how the model communicates through the internet and gives the data related to the location of the shoe as well as the number of steps walked by the user through the Blynk app via the Smart Phone figure 5.4 shows the Smart Shoe charging the Smart Phone.

Figure 5.1: Circuit design of Smart Shoe

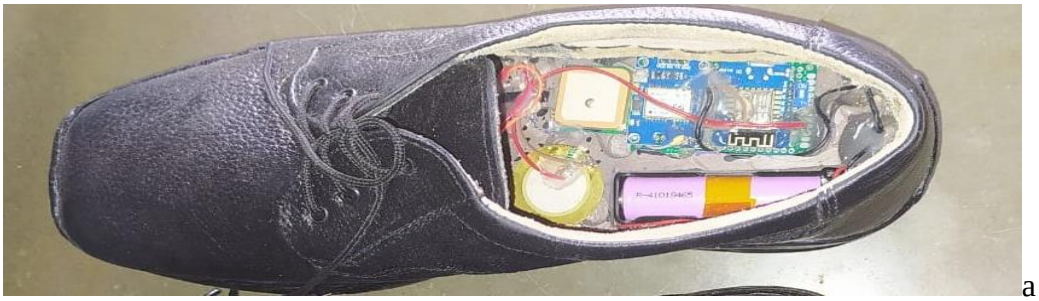


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Figure 5.2: Model of Smart Shoe

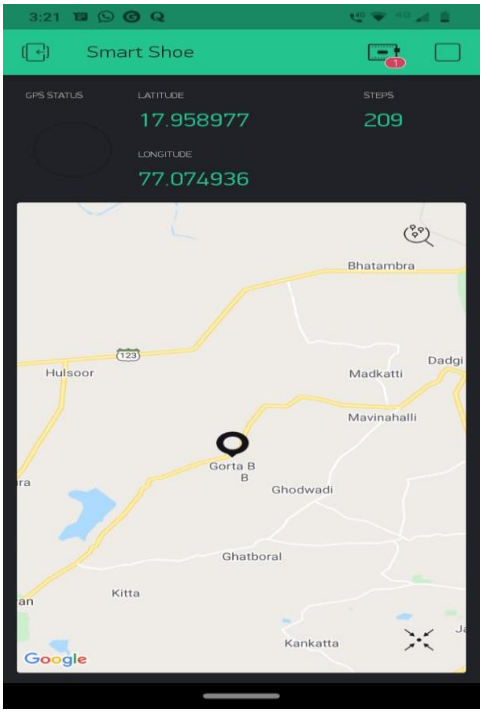

Figure 5.3: Result displayed on Smart Phone

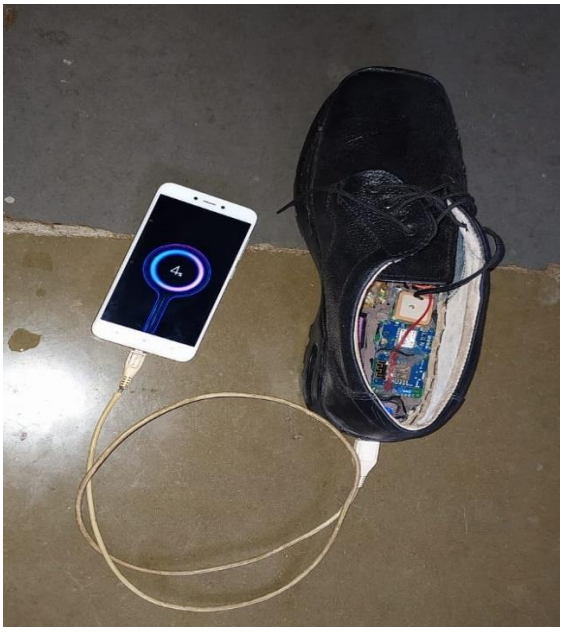

Figure 5.4: Smart Shoe charging the Smart Phone

CONCLUSION AND FUTURE SCOPE

In this project, piezoelectric energy harvesting method is not that hard to implement and all the materials to build the circuit is low cost. The challenging part of this project is the improvement. We only need piezoelectric sensor, diodes and capacitor to build the circuit, but it is hard to maximize the current output. From the calculation result in the energy harvested is not that much and the efficiency is considered low. However, it still can extend battery life time or power up low power devices. To apply it in a formal application, the circuit design needs to be improved in order to maximize the energy that we can harvest. Furthermore, the size of the GPS tracking system needs to shrink down to make it suit into the sole of a shoe more comfortably and give the location more accurately and quickly as soon as possible. Especially for the weight of the Shoe must be reduced and made more compact

For the future work, there are some improvement can be done. Firstly, piezoelectric material can be stacked with more pieces to increase the energy output. Besides that, diode with higher efficiency can improve the amount of energy harvesting. In addition, microcontroller and modules used in this project are all for development purpose. So, there are a lot of unwanted load which will consume power, for example, voltage regulator. Self-implemented circuit board with necessary component for GPS and Node MCU will definitely decrease a lot of power consumption and the size of device. For the selection of battery, prevent using lower or higher voltage that the system wanted because voltage regulator or converter cause energy loss too. In a nutshell, this project technology is possible and worth to develop due to the factors stated above

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