Foot Pressure Monitoring By Physiological Parameters And Early Detection Of Pvd

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Abstract
In today's demanding lifestyles, prolonged standing and sudden movements often lead to fatigue, affecting individuals, especially athletes, who rely on optimal foot performance. Additionally, conditions like Peripheral Vascular Disease (PVD) pose significant health risks, necessitating early detection for effective management. To address these concerns, we propose integrating foot pressure monitoring technology with physiological parameters such as heart rate, blood oxygen saturation (SpO2), and temperature. This holistic approach aims to develop a comprehensive monitoring system capable of early PVD detection. By embedding a GSM Module with a MAX30102 sensor into footwear, real-time foot pressure distribution can be monitored, providing insights into gait abnormalities and potential circulatory issues. Concurrently, monitoring physiological parameters offers additional indicators of vascular health and perfusion. This integrated system offers a proactive approach to foot health monitoring, empowering individuals, particularly athletes, to optimize performance and mitigate health risks associated with conditions like PVD. Early detection through this system can lead to timely interventions, enhancing overall well-being and quality of life.

Introduction
A foot analyzer system is designed to assess various aspects of a person's feet to provide insights into their biomechanics, structure, and potential issues. It can be used in medical settings, sports medicine, footwear design, and retail environments A user-friendly interface allows the operator or user to interact with the system, input necessary information, view results, and interpret findings. Foot Pressure Analysis: The system measures pressure exerted by different parts of the foot while standing, walking, or running. This analysis helps identify areas of high pressure, which can indicate potential foot problems or suggest appropriate footwear.For the detection of flat feet, a smart wearable device was used and prioritized qualitative assessment over quantitative gait monitoring. Here three sensors were incorporated and the method used was deep neural network based, and the device achieves an accuracy of about 87.1% in prescreening and monitoring of flat feet, which provides convenience for both the patients and clinicians [1]. For the assessment of various positioning systems of WirelesBody Area Networks (WBANs), by considering their advantages and disadvantages within tWBAN environment, the continuous monitoring of patients who are equipped witWBAN sensors and proposed Global System for Mobile Communication (GSM) technology because of its global infrastructure and dual functionality for communication and positioning [2]. The proposed system named the Foot Plantar pressure system, leverages highly linear pressure sensors to measure high-pressure distributions under the foot, without hysteresis with better accuracy and reliability [3]. To detect the gait phase, 174 sensing units with the force-sensitive film were used. To minimize crosstalk, a zero potential method was employed, while a tailored algorithm detects stance sub-phases [4]. To enhance diabetic foot ulcer prevention strategy, smart technology was integrated that underscores the significance of analyzing plantar pressure comprehensively, urging interventions to mitigate cumulative pressure over time [5]. To assess plantar pressure signals during walking, sensors were employed, and a piezoresistive-based gait monitoring method was used. Here the plantar surface was divided into eight areas, with time and force calculated for each area in a gait cycle [6]. The system addressed sensor drift issues using a zero-velocity update algorithm and implemented a complementary filter with a proportional integral controller which can reduce computational errors and support diagnosis and rehabilitation in hospitals [7]. For assisting paraplegic patients while standing, sitting, and walking, a CUHK-EXO wearable exoskeleton suit was introduced. To stabilize system balance during walking and to generate reference joint trajectories, Offline Design and Online Modification (ODOM) algorithms were proposed [8]. For the detection of impaired push-off and foot drop deficits in hemiparetic gait analog pressure sensors were used. This system offers a potential benefit for stroke rehabilitation with modular ankle exoskeletons like ankle bots and this result showed that the sensors provided more comprehensive data

than the foot switches [9]. Evaluation of Six algorithms for automatic classification of left and right footsteps from plantar pressure recordings and this methodology achieved the result with 99.4% accuracy [10]. In our proposed system,Peripheral Neuropathy is considered to be the most common complexities found in Diabetic patients caused by long term high sugar levels. This also makes an individual vulnerable to ulcers and severe amputation in extreme cases. The proposed model helps in providing cloud access to the real-time Foot pressure and Temperature of an individual with an SOS alert system to the hospital. The thresholds have been set using TCSS and based on increased forefoot to rear foot increased pressure ratio. There have been enough pieces of evidence developed till now based on thermal imaging analysis as well as multiple patient's data indicating that the patients with diabetic neuropathy had a higher foot temperature (32°C - 35°C) compared to patients without neuropathy (27°C - 30°C). For a patient with diabetic neuropathy, at mid-foot, the peak pressure was significantly different among all groups: control group (139.4±76.4 kPa), diabetic neuropathy (205.3±118.6 kPa) and DNU (290.7±151.5kPa) (p=0.008)

Fig 1. Schematic of Feet

TABLE I: THEORETICAL ANALYSIS OF FOOT

Foot Point	Marked Location	Pressure Sensitivity (kPa)	Temperature(°C)	Risk Factor
1	Big Toe	>212	32-35	Very High
2	Pointer Toe	>180	32-35	High
3	Middle Toe	>180	27-30	Medium
4	Index Toe	>173	27-30	Medium
5	Small Toe	>173	27-30	Medium
6	Ball	>230	32-35	High
7	sole	>154	32-35	High
8	Instep	<115	32-35	High
9	Heel	<135	27-30	High

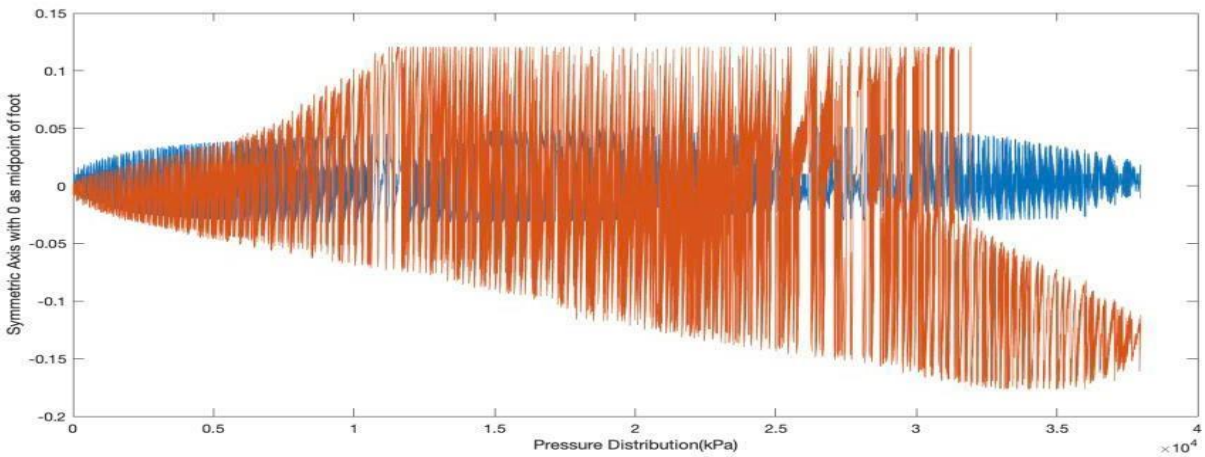
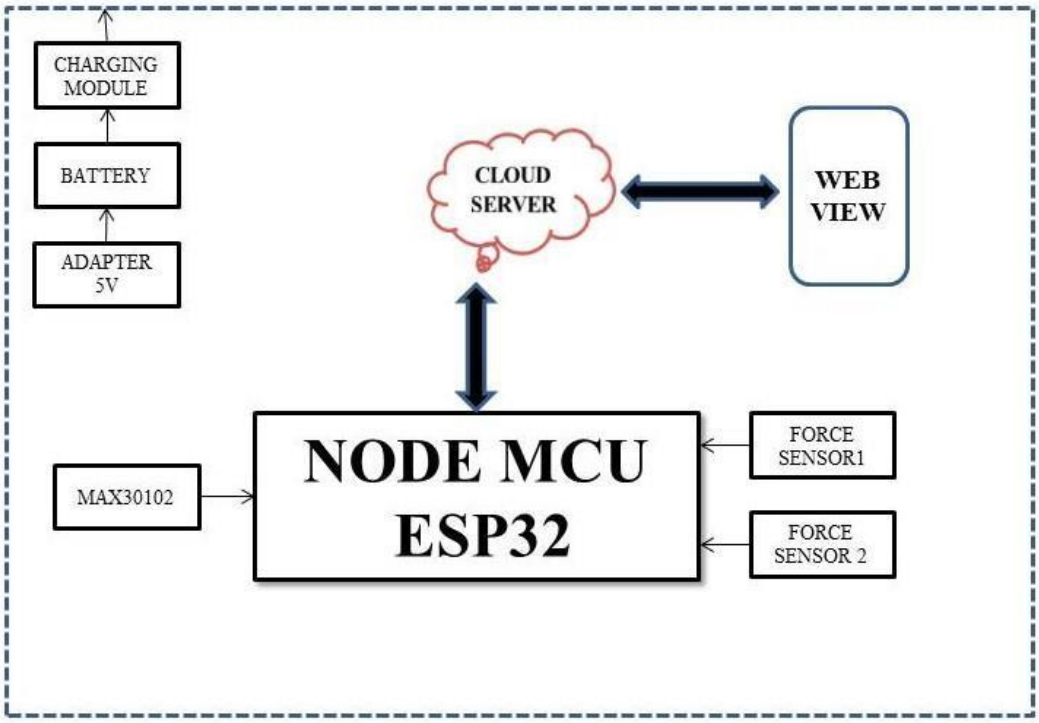


Fig2. Pressure Distribution Plot obtained while calibrating for Left foot for a normal person

Irregularity in pressure area leads to a range of obtained pressure data and the nominal pressure of all the points have been assessed and marked into the proposed system as a threshold. Table 1 has been designed according to the abnormality in foot temperature as well as in the pressure. Higher pressure and higher temperature over multiple positions are the most prominent factors to decide the severity level of the patient's diabetic peripheral neuropathy. The cloud system has settled threshold and responsive user interface to provide real-time SOS warning to health centers as well as patients. Figure 1 has been marked with point-wise distribution to examine pressure and temperature at each point. Figure 2 has been made using the serial plot obtained using the Flexi force pressure sensor at normal force to analyse the normal pressure distribution throughout the left foot considering point '0' as the back centre.

BLOCK DIAGRAM



SENSOR UNIT

Based monitoring guidelines, the monitoring parameters are monitored.

In this proposed system consists of Heartbeat sensor, Temperature sensor, spo2 sensor and a force sensor had been designed for use in-the-field in a remote location to measure spo2 flow rate, Bpm level, temperature and a foot pressure level these are the parameters monitor for an athlete and a patient. The sensor values are fed to Micro controller, which is 12 bit programmable micro controller. This project aims at developing an affordable. Foot pressure monitor by physiological parameters and early deduction of pvd. IOT principles and with appropriate analysis of sensor data, a smart system could be used that would provide real time information monitoring and reporting the data to the user who wear that module.

HARDWARE COMPONENTS

- MICROCONTROLLER- ESP-32 DEV Board
- Force Sensor
- IR Sensor
- MAX-30102 (Temp, Heart Rate, Spo2)
- Pull up Resistor
- Pull down Resistor
- Lithium-Ion Battery
- BMS Module
- Power Bank Module

SOFTWARE COMPONENTS

- Arduino ide
- Tina software
- Proteus software

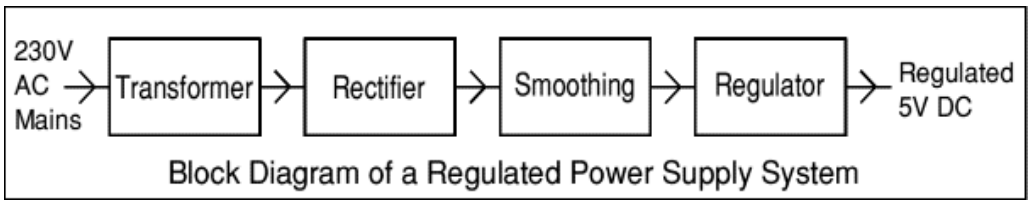
HARDWARE DESCRIPTION

POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. Power supplies for electronic devices can be broadly divided into linear and switching power supplies. The linear supply is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.

LINEAR POWER SUPPLY

An AC powered linear power supply usually uses a transformer to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage. If it is used to produce DC, a rectifier is used. A capacitor is used to smooth the pulsating current from the rectifier. Some small periodic deviations from smooth direct current will remain, which is known as ripple. These pulsations occur at a frequency related to the AC power frequency (for example, a multiple of 50 or 60 Hz). The voltage produced by an unregulated power supply will vary depending on the load and on variations in the AC supply voltage. For critical electronics applications a linear regulator will be used to stabilize and adjust the voltage. This regulator will also greatly reduce the ripple and noise in the output direct current. Linear regulators often provide current limiting, protecting the power supply and attached circuit from over current. Adjustable linear power supplies are common laboratory and service shop test equipment, allowing the output voltage to be set over a wide range. For example, a bench power supply used by circuit designers may be adjustable up to 30 volts and up to 5 amperes output. Some can be driven by an external signal, for example, for applications requiring a pulsed output.



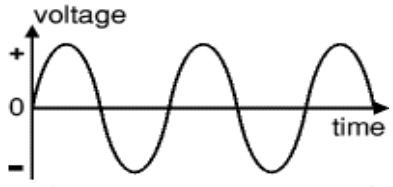
Block Diagram of a Regulated Power Supply System

TRANSFORMER:

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage. The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor. The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead, they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

Turns ratio=Vp/Vs=Nn/Ns and Power out=Power in Vs*Is=Vp * Ip

Transformer



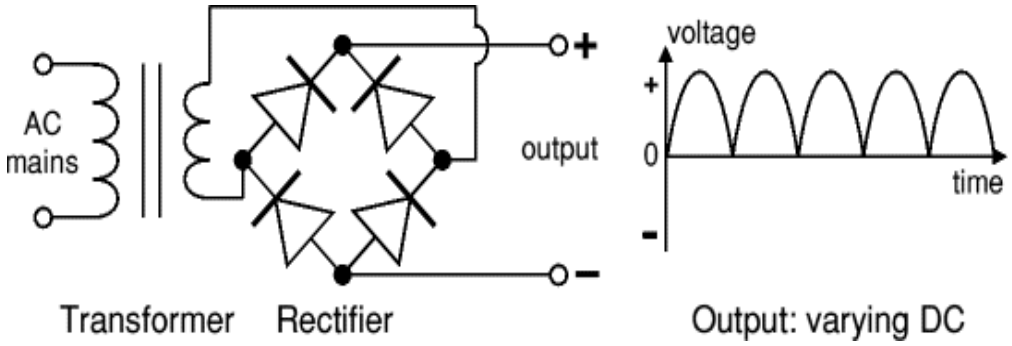
Output: low voltage AC

Vp = primary (input) voltage
Np = number of turns on primary coil
Ip = primary (input) current
Vs = secondary (output) voltage

Ns = number of turns on secondary coil
Is = secondary (output) current

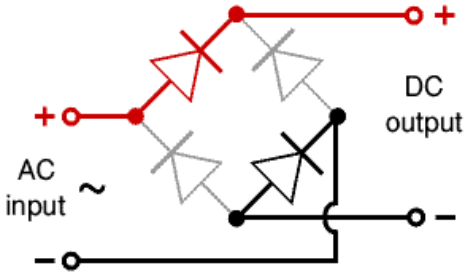
RECTIFIER

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The **bridge rectifier** is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A **single diode** can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC

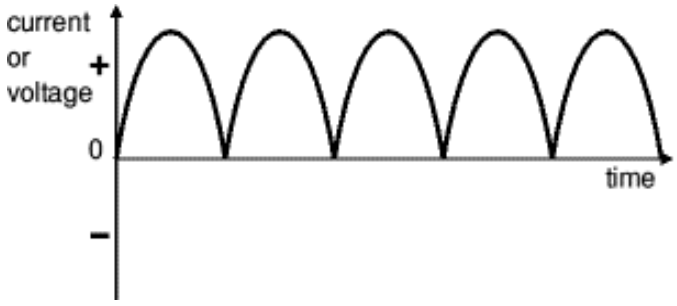


The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

BRIDGE RECTIFIER

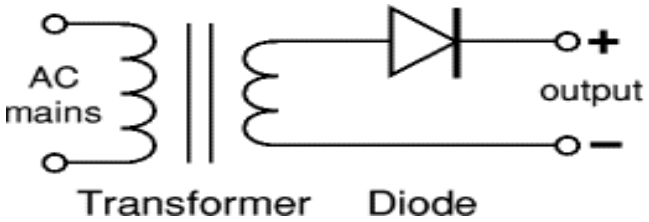


A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages).
Output: full-wave varying DC: (using the entire AC wave):

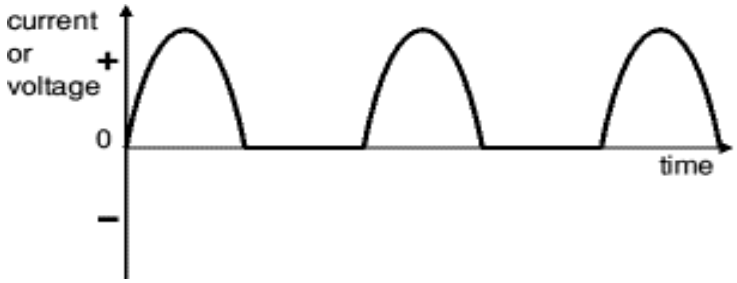


SINGLE DIODE RECTIFIER

A single diode can be used as a rectifier but this produces **half-wave** varying DC which has gaps when the AC is negative. It is hard to smooth this sufficiently well to supply electronic circuits unless they require a very small current so the smoothing capacitor does not significantly discharge during the gaps.

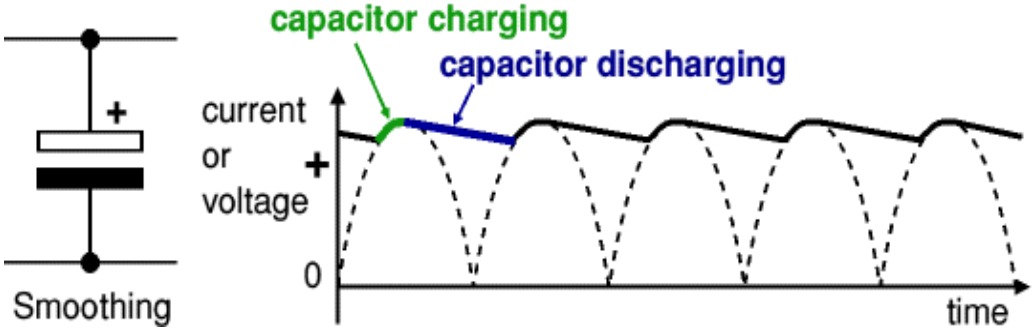


Output: half-wave varying DC (using only half the AC wave)



SMOOTHING

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.



Smoothing significantly increases the average DC voltage to almost the peak value (1.4 × R MS value). For example, 6V RMS AC is rectified to full wave DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving 1.4 × 4.6 = 6.4V smooth DC.

Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give fewer ripples. The capacitor value must be doubled whensmoothing half-wave DC.

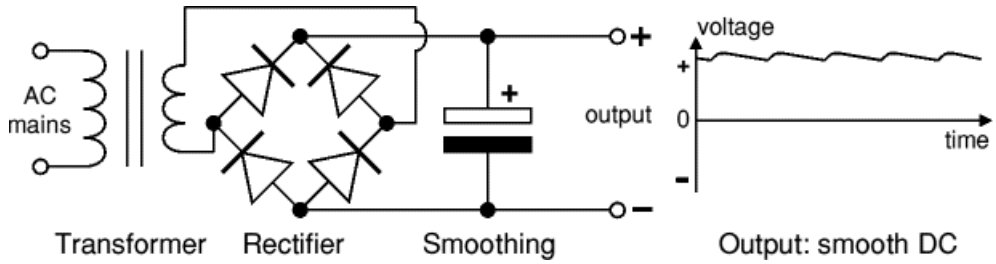
Smoothing Capacitor for 10% ripple, C=5*10/vs.*f

C = smoothing capacitance in farads (F)

Io = output current from the supply in amps (A)

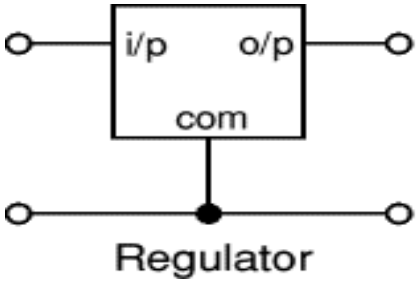
Vs = supply voltage in volts (V), this is the peak value of the unsmoothed DC.

f = frequency of the AC supply in hertz (Hz), 50Hz in the UK.



The smooth DC output has a small ripple. It is suitable for most electronic circuits.

REGULATOR



Voltage regulator is available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Althoughdesigned primarily asfixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a h eat sink if necessary.

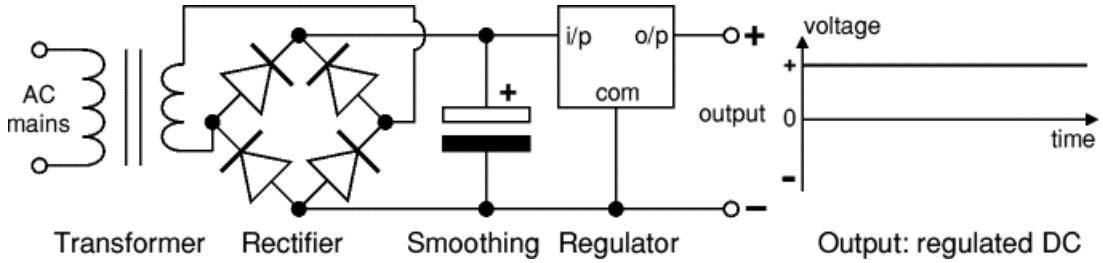
Positive regulator

1. input pin
2. Ground pin
3. Output pin

It regulates the positive voltage

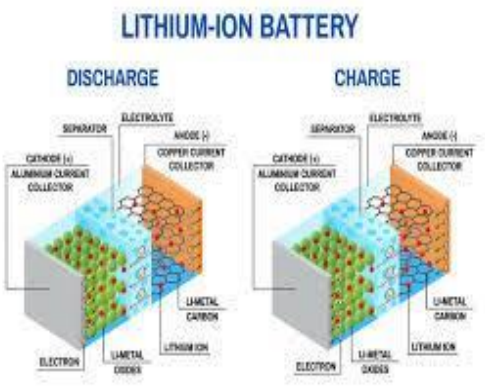
Negative regulator

1. Ground pin
2. Input pin
3. Output pin



The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

BATTERY



SPECIFICATIONS

- Working voltage: 5V
- Working Current: <20ma

- Interface: Analog
- Width of detection: 40mm×16mm
- Working Temperature: 100C~300C
- Output voltage signal: 0~4.2V

FEATURES

- Weight: 3g
- Size: 65mm×20mm×8mm
- Arduino compatible interface
- Low power consumption
- High sensitivity

APPLICATIONS

- Rainfall detecting
- Liquid leakage
- Tank overflow detector

FORCE SENSOR

A Force Sensing Resistor, also known as a Force Sensor, or simply an FSR, is a simple and inexpensive sensor designed to measure physical pressure, squeeze, and weight. It can befound in a variety of portable electronics, including electronic drums, handheld gaming devices, and mobile phones. This sensor is excellent at measuring pressure, but not so accurate at estimating how much weight is on it. So, if you just want to know "whether the sensor has been squeezed or pressed and how hard," it could be a good choice for your next force-sensing project.

FIG: FORCE SENSOR.

OVERVIEW

The patent for the technology used in FSRs is owned by Interlink Electronics, which has been in business since 1985. The most common types of FSR that you will encounter are Interlink FSR-402 and FSR-40

How Does FSR Work?

As previously stated, an FSR is basically a resistor whose resistive value varies based on the amount of pressure applied to it. In the absence of pressure, the sensor will read infinite resistance (larger than 1MΩ). Applying more pressure to the sensor's head reduces the resistance between its terminals, while releasing the pressure restores the resistance to its original value. The graph below shows the approximate resistance of the FSR-402 sensor at various applied forces. Here, logarithmic scales are used to plot the data. Observe that the graph is linear above 50g. This is due to the fact that these sensors have a turn-on threshold. We can use this equation to calculate the output voltage (Vo). In this configuration, the output voltage increases as the applied force increases. For example, with a 5V supply and a 10K pull-down resistor, when there is no pressure, the FSR resistance is extremely high (around 10M). This produces the following output voltage: If you apply significant force to the FSR, the resistance will drop to approximately 250 Ω. As a result, the output voltage becomes: As you can see, the output voltage varies from 0 to 5V depending on the amount of force applied to the sensor.

FEATURES

High sensitivity
Simple drive circuit

APPLICATION

They are used in pressure detecting equipment's in family and medical industry, are suitable for detecting of weight of an object.

MAX30102 SENSOR

The MAX30102 is sensor used to measure temperature spo2 and heartrate in a single module an I2C protocol -based low-power plug-and-play biometric sensor. It can be used by students, hobbyists, engineers, manufacturers, and game & mobile developers who want to incorporate live heart-rate data into their projects.

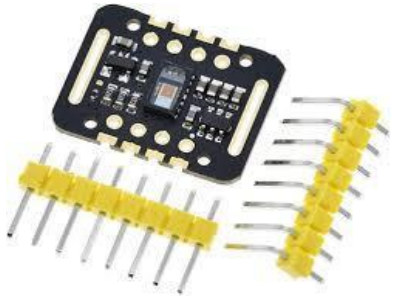


FIG: MAX30102 SENSOR

The MAX30102 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn't too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector. This method of pulse detection through light is called Photoplethysmogram. The working of MAX30102 can be divided into two parts: Heart Rate Measurement and Pulse Oximetry (measuring the oxygen level of the blood). Heart Rate Measurement The oxygenated haemoglobin (HbO2) in the arterial blood has the characteristic of absorbing IR light.The redder the blood (the higher the haemoglobin), the more IR light is absorbed. As the blood is pumped through the finger with each heartbeat, the amount of reflected light changes, creating a changing waveform at the output of the photodetector. As you continue to shine light and take photodetector readings, you quickly start to get a heart-beat (HR) pulse reading.

TECHNICAL SPECIFICATIONS
Power supply 3.3V to 5.5V
Current draw ~600μA (during measurements) ~0.7μA (during standby mode)
Red LED Wavelength 660nm
IR LED Wavelength 880nm
Temperature Range -40˚C to +85˚C
Temperature Accuracy ±1˚C

FEATURES
Fast response.
Stable and long life
Simple drive circuit

APPLICATION
They are used in measure heartrate, spo2 and temperature in a single module used in medical industries.

ESP 8266- 12E NODE MCU (IOT MODULE)
Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many opensource projects, such as lua-cjson, and spiffs. The *Internet of things* (IoT) is the network of everyday objects — physical things embedded with electronics, software, sensors, and connectivity enabling data exchange. Basically, a little networked computer is attached to a thing, allowing information exchange to and from that thing. Be it lightbulbs, toasters, refrigerators, flower pots, watches, fans, planes, trains, automobiles, or anything else around you, a little networked computer can be combined with it to accept input (especially object control) or to gather and generate informational output (typically object status or other sensory data). This means computers will be permeating everything around us — ubiquitous embedded computing devices,uniquely identifiable, interconnected across the Internet. Because of low-cost, networkable microcontroller modules, the Internet of things is really starting to take off.
Node MCU was created shortly after the ESP8266 came out. On December 30, 2013, Espress if Systems began production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications. NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub.Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform, and committed to Node MCU project, then Node MCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Dev ported the u8glib to Node MCU project, enabling Node MCU to easily drive LCD, Screen, OLED, even VGA displays.

MICROCONTROLLER
ESP32 ARDUINO CORE
Arduino began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino ide, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support

alternate tool chains to allow Arduino C/C++ to be compiled down to these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file down to the target MCU's machine language. Some creative ESP8266 enthusiasts have developed an Arduino core for the ESP8266 Wi-Fi SoC that is available at the GitHub ESP8266 Core webpage. This is what is popularly called the "ESP8266 Core for the Arduino IDE" and it has become one of the leading software development platforms for the various ESP8266 based modules and development boards, including Node MCUs. The Button is a Wi-Fi connected push button designed by Peter R Jennings. The Button is designed for single-purpose, internet-enabled functions. When the button is pressed, a connection is made to a web server which will perform the desired task. Applications include a doorbell or panic button.

NODE USB

Node USB is an open IoT platform about the size of a standard USB stick. It was designed to leverage Node MCU (Lua) for easy programming and has the extra feature of USB capability. It is ideal for Plug-n-Play solutions, allowing easy prototyping for developers Node MCU provides access to the GPIO (General Purpose Input/Output) and for developing purposes below pin mapping table should be referenced.

IO index	ESP8266 Pin	IO index	ESP32 Pin
0[*]	GPIO16	7	GPIO13
1	GPIO5	5	GPIO15
2	GPIO4	9	GPIO3
3	GPIO0	10	GPIO1
4	GPIO2	11	GPIO9
5	GPIO14	12	GPI010

Node MCU is an open source IoT platform based on the ESP-12E module. The version 1.0 is the 5th design of NodeMCU devkit. This uses CP2102 as UART bridge, and can flash firmware automatically by using nodemcu-flasher. also, it has a voltage regulator to convert from 5v to 3.3v which is the required by the esp21 module.

	NodeMCU v1.0	Arduino MKR1000
Microcontroller	ESP-12E module, with Espressif ESP32 32bits	ARM Cortex M0+ 32bits
Clock speed	80/160MHz	48MHz
Board power supply	5V	5V
Circuit operating voltage	3.3V	3.3V
Flash memory	4 MB	256 KB
SRAM	64KB	32KB
EEPROM	NO	NO
Digital I/O Pins	10	8
PWM Pins	10	12
Analog input pins	1(ADC 10 Bit)	7 (ADC 8/10/12 Bit)
Analog Output pins		1(DAC 10 Bit)
Connectivity	IEEE 802.11 b/g/n Wi Fi	IEEE 802.11 b/g/n Wi Fi

	NodeMCU v1.0	**Arduino MKR1000**
Antenna type	PCB	PCB
Supported Battery	No	Li-Po single cell, 3.7V, 700mAh minimum
UART	1 (+ TX only on pin GPIO2)	1
SPI	2	1
12C	1	1
LED Builtin	**D0 / GPIO 16 Node MCUv1.0**	GPIO 6 **Arduino MKR1000**
Programming Languages	C++ / Python / Lua/Javascript	C++
Flashing	Locally / OTA	Locally / OTA

CHIP

The ESP32 series, or family, of Wi-Fi chips is produced by Espress if Systems, a fabless semiconductor company operating out of Shanghai, China. The ESP8266 series presently includes the ESP32 and ESP8285 chips. **NODEMCU** (simply referred to as ESP32) is a system-on-chip (SoC) which integrates a 32-bit Tensilica microcontroller, standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules into a small package. It provides capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I²C), analogto-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I²S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). The processor core, called "L106" by Espressif, is based on Tensilica's Diamond Standard 106Micro 32-bit processor controller core and runs at 80 MHz (or overclocked to 160 MHz). It has a 64 KiB boot ROM, 32 KiB instruction RAM, and 80 KiB user data RAM. (Also, 32 KiB instruction cache RAM and 16 KiB ETS system data RAM.) External flash memory can be accessed through SPI. The silicon chip itself is housed within a 5 mm × 5 mm Quad Flat No-Leads package with 33 connection pads — 8 pads along each side and one large thermal/ground pad in the centre.

PIN CONFIGURATION

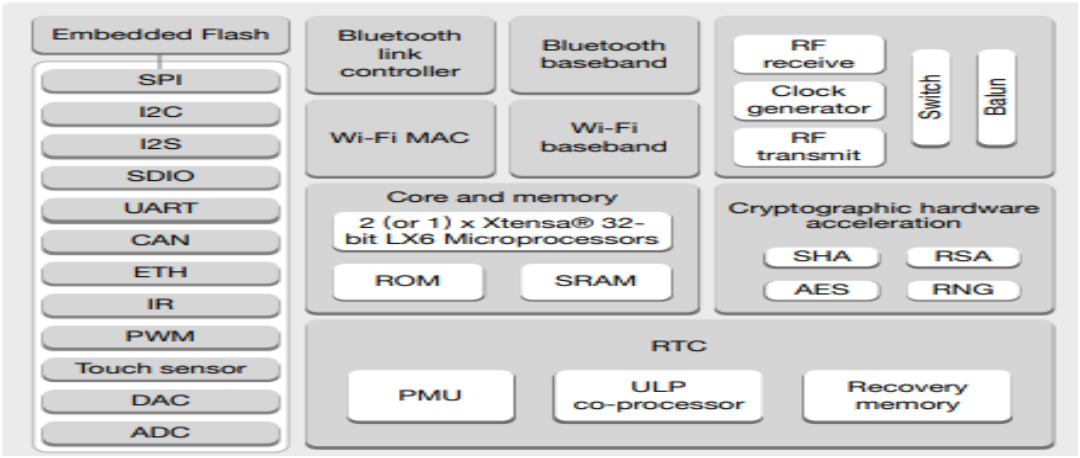
FIG: PIN DIAGRAM

The ESP32 microcontroller has a variety of pins, each with specific functionalities. Here's a brief overview of the pin configuration of the ESP32:

1. GPIO Pins: The ESP32 has a large number of General-Purpose Input/Output (GPIO) pins, typically labeled GPIO0 through GPIO39. These pins can be configured as digital inputs or outputs and can also support functions like PWM, I2C, SPI, UART, and more.
2. Analog Pins: The ESP32 features multiple analog input pins, typically labeled as ADC1_CH0 through ADC1_CH7, which can be used to measure analog voltages. These pins can also support functions like touch sensors and Hall effect sensors.

3.Power Pins: The ESP32 includes power-related pins such as VCC (supply voltage), GND (ground), and EN (enable pin). Additionally, there may be separate power pins for supplying power to specific components or peripherals.
4.Serial Communication Pins: The ESP32 supports various serial communication protocols such as UART, SPI, and I2C. It includes dedicated pins for these interfaces, such as TX (transmit) and RX (receive) pins for UART communication, as well as pins for SPI and I2C communication.
5. Special Function Pins: The ESP32 includes special function pins for specific purposes such as bootstrapping, reset, and programming. These pins may have specific functions during boot-up or when programming the microcontroller.
6. LED Pins: Some ESP32 development boards may include built-in LEDs connected to specific pins for visual feedback or indication.

BLOCK DIAGRAM OF ESP-32



SOFTWARE DESCRIPTION
ARDUINO IDE
• The Arduino Integrated Development Environment - or Arduino Software (IDE) - an open-source software contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.
PROJECT CREATION
• The toolbar buttons allow you to verify and upload programs, create, open, and save A Toolbar with buttons for common functions and a series of menus. The sketches, and open the serial monitor.
UPDATING SOURCE CODE
• The text editor for writing your code.
• The text console displays text output by he Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port.
UPLOADING CODE
• To upload it to your board, simply click on the arrow in the top left corner. This process takes a few seconds, and it is important to not disconnect the board during this process. If the upload is successful, the message "Done uploading" will appear in the bottom output area
ADVANTAGES AND APPLICATIONS
Advantages:
1. Cost Savings: Reduces inspection costs by providing real-time data, allowing targeted and cost-efficient maintenance.
2. Early Warning: Alerts authorities immediately about toxic effluents, preventing environmental hazards and public health risks.
3.Budget Optimization: Optimizes budget allocation for sewer maintenance through proactive planning based on real-time data**.**
4. Research and Analysis: Provides long-term data for researchers to analyze sewer system dynamics and urbanization impacts on drainage systems.

RESULT AND CONCLUSION
The development of a real-time cloud monitoring system with the foot Heartrate, Spo2, temperature and pressure measurement to avoid chances of ulceration and fatalities due to peripheral neuropathy which is extremely common among the type 2 diabetes patients. This system will help in maintaining an individual a healthy lifestyle with physical activities and a nutritious diet to avoid chances of any severe health conditions. SOS warning system and real-time tracking can help in providing remote access to the health condition of an individual especially helping for old age and extreme fatal patients. In the future, the system can be further advanced by the addition of extra features and a more precise and accurate system.

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REFERENCE

1. Kolb, H. and Mandrup-Poulsen, T., 2010. The global diabetes epidemic as a consequence of lifestyle-induced low-grade inflammation. *Diabetologia*, *53*(1), pp.10-20.
2. G. Jiang Wild, S., Roglic, G.,Green, A., Sicree, R. and King, H., 2004. Globalprevalence of diabetes: estimates for the year 2000 and projections for2030. Diabetes care, 27(5), pp.1047-1053.
3. Saeedi, P., Salpea, P., Karuranga, S., Petersohn, I., Malanda, B., Gregg, E.W., Unwin, N., Wild, S.H. and Williams, R., 2020. Mortality attributable to diabetes in 20–79 years old adults, 2019 estimates: Resultsfrom
4. the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice*, p.108086.
5. Meijer, J.W.G., Smit, A.J., Sonderen, E.V., Groothoff, J.W., Eisma, W.H. and Links, T.P., 2002. Symptom scoring systems to diagnose distal polyneuropathy in diabetes: The Diabetic Neuropathy Symptom score. *Diabetic Medicine*, *19*(11), pp.962-965.
6. Davies, M., Brophy, S., Williams, R. and Taylor, A., 2006. The prevalence, severity, and impact of painful diabetic peripheral neuropathy in type 2 diabetes. *Diabetes care*, *29*(7), pp.1518-1522.
7. Priya, S.K., Nithyaa, A.N. and PremKumar, R., 2014. Screening of foot ulceration in diabetic neuropathy patients using flexi force sensor platform. *International Journal of Scientific Engineering and Research*,*5*(4), pp.87-93.
8. Nguyen, H.H., Mirza, F., Naeem, M.A. and Nguyen, M., 2017, April. A review on IoT healthcare monitoring applications and a vision for transforming sensor data into real- time clinical feedback. In *2017 IEEE 21st International Conference on Computer Supported Cooperative Work in Design (CSCWD)* (pp. 257-262). IEEE.
9. Tyagi, S., Agarwal, A. and Maheshwari, P., 2016, January. A conceptual framework for IoT-based healthcare system using cloud computing. In *2016 6th International Conference-Cloud System and Big Data Engineering (Confluence)* (pp. 503-507). IEEE.
10. Ahmed, A.I.A., Gani, A., Ab Hamid, S.H., Abdelmaboud, A., Syed, H.J., Mohamed, R.A.A.H. and Ali, I., 2019. Service management for IoT: requirements, taxonomy, recent advances and open research challenges. *IEEE Access*, *7*, pp.155472-155488.
11. Roihan, A., Sudarto, F. and Putro, T.C., 2018, September. Internet of Things on Monitoring and Control System in Server Area. In *2018 International Seminar on Application for Technology of Information and Communication* (pp. 116-120). IEEE.