CORTEX FEET PRESSURE BALANCING FOR DIABETIC PATIENT

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Abstract——-- Detection of foot pressure in diabetic patients is crucial due to irregular blood supply which can cause ulcers. An app has been developed to continuously monitor the foot pressure and prevent ulcers. The app utilizes a MEMS Accelerometer to create vibrations and a flexi force sensor to detect non-uniform pressure. The user can switch on the respective vibrators using the app when needed. Low pressure beyond the threshold triggers the vibrator, which helps circulate blood in the foot.

***Keywords—Cortex feet, Flexiforce sensor, Vibrator, MEMS, Mobile app** (prevent- diabetic- foot – ulcer)*

I. INTRODUCTION (*DIABETIC FOOT ULCER*)

The prevalence of diabetic ulcers in India is 4.54% among patients. Generally, those with type 2 diabetes mellitus are most affected by diabetic foot ulcers. Those who have diabetic ulcers may experience symptoms such as pain, redness, skin discoloration, and swelling. The body has difficulty healing wounds due to limited blood flow to the affected area. Regrettably, diabetic ulcers are chronic issues, and half of patients do not fully recover within a 12-week period.The goal of the Cortex Feet initiative is to improve treatment choices for individuals who suffer from diabetes. Cortex refers to the relationship between the skin and the brain, creating a signal pathway. The sole of the foot contains approximately 7,000 nerves. The foot is made up of fascia, tendons, and ligaments that are electrically charged and receive sensory signals that provide feedback to the brain. These factors are crucial for diabetic patients who may experience foot swelling, reduced activity, and depression..The app and device will monitor the pressure on the patient's foot and detect any pain or itching. Patients can utilize the app to control the device, which activates the vibrator based on the amount of pressure applied. This helps in the early healing of foot ulcers..

II. LITERATURE SURVEY

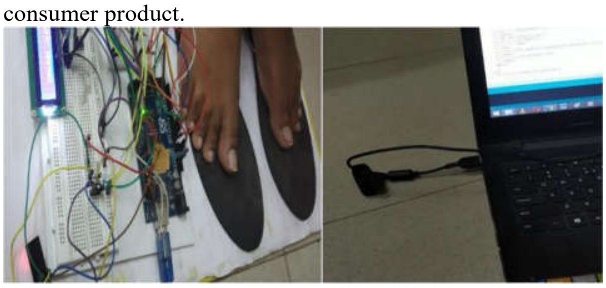
The medical industry relies on the Internet of Things (IoT) to address healthcare challenges in real-time. By utilizing advanced IoT Healthcare solutions, problems such as detecting diabetes, foot ulcers, and heart rate abnormalities can be resolved early. The Node MCU development board is essential in developing this model as it allows for the storage and tracking of patient medical records.[1].The study proposes a wearable shoe prototype that can detect foot ulcers in diabetic patients. The shoe includes temperature, vibration, and pressure sensors, which enable patients to assess their foot health on a daily basis. Timely detection of foot ulcers can prevent the need for amputation. [2] The proposed architecture deploys an Embedded GPU to implement a framework for classifying healthy and DFU classes from plantar thermograms. This is because thermos is a type of heat found in the infected area. The NVIDIA Jetson Nano device-package is used to showcase the suitability of embedded systems. [3]The input images will be classified by the system as having either no ulcer or an ulcer present. In case of the latter, the gadget is capable of outlining the surrounding area in the image as swelling typically appears in the leg. [4]. The primary objective of this device is to identify diabetic foot ulcers through thermal imaging using an unconventional technique called the Radon transformation. The images are analyzed and compared using the Hankel transform of photo processing. The data collected between 2015 and 2020 was obtained from an online database. [5] Ensuring adequate oxygen levels on the foot is crucial for the recovery of ulcer cells/tissues in individuals suffering from chronic DFU wounds. This paper presents the manufacturing process of the machine, information about PPG exams, and analysis of the results received as it pertains to this chronic disease. [6] It is a challenging task to manually identify the precise level of severity of an ulcer owing to the possibility of perception disparities, along with the tedious and time-consuming nature of the process. Consequently, the significance of an automated approach to determine the severity level cannot be overstated. Nevertheless, a comprehensive computer-assisted Wagner classification system for diabetic foot ulcers has yet to be published in literature.. [7] The advanced microwave sensor is built upon the concept of subwavelength complementary split-ring resonators (CSRRs), which is perfect for detecting changes in the electromagnetic properties of tissues located near the foot in the near-field zone. [8] To produce a potent and efficient deep learning model, we amassed a broad database containing 1775 pictures of diabetic foot ulcers (DFU). Medical experts utilized an annotator software to outline areas of interest within the DFU images, providing the ground truth of this dataset. The successful localization of DFU through deep learning methods demonstrates the potential for improving the model with a larger dataset..[9] The main aim of the research was to examine the link between temperature fluctuations in ulcers and three medical conditions related to wound healing - peripheral vascular disease, chronic kidney disease, and ischemic heart disease. The research analyzed thermal and RGB images of 23 ulcers in patients with diabetes during the initial 14 days of development. The findings revealed that temperature readings gleaned from thermal images of ulcers could be an effective predictive measure in evaluating their advancement.. [10] DFUs are a common issue for diabetes patients. They have a negative impact on healthcare resources and increase morbidity rates. Using machine learning (ML) can improve care for those at risk of DFUs by providing information on ML's current applications and accuracy in managing DFUs. ML can also guide future research in this area. Studies have shown that ML methods have at least a 90% accuracy rate when processing DFU data, regardless of the ML algorithm used. Examples of ML's positive impact on DFU data processing include image segmentation and classification, raw data analysis, and risk assessment. ML can also aid in collecting and analyzing data from DFU treatments in small sample sizes and research settings. [11] Diabetic foot is a common and challenging condition associated with diabetes. Peripheral neuropathy in diabetic patients can lead to foot ulcers, and in severe cases, amputation or death may occur. Although plantar pressure is a useful predictor for diabetic foot development, current measurement technologies are not suitable for long-term monitoring in daily life. This study presents an innovative and cost-effective shoe solution for daily plantar pressure monitoring in diabetic patients. The shoe has a pressure sensor insole that can track changes in plantar pressure dynamically and display them in real-time on a mobile device. [12] Chronic ulcers, specifically diabetic lower leg ulcers, are a severe problem that diminishes the quality of life for both patients and the healthcare system. Any injury that remains unhealed for a prolonged period due to reduced blood flow and oxygenation is considered a persistent injury. Hyperbaric oxygen therapy (HBOT) has been shown to enhance the healing of persistent diabetic foot ulcers, unlike traditional medical practices and treatments that have had poor outcomes. Our research included clinical trials involving 27 patients over ten months, resulting in a substantial decrease in wound size. [13]. The presence of infection (bacteria in the lesion) and inadequate blood flow, known as ischemia, in Diabetic Foot Ulcers (DFUs) can increase the risk of limb amputation. To address this, a deep learning-based image-based system was developed for identifying DFU infection and ischemia. The system utilized the Efficient Net deep learning network and an extensive collection of baselines for binary infection and ischemia classification. The DFU dataset was enhanced using geometric and color image processing. It also classified test images faster than the baseline. The prevalence of diabetes mellitus is increasing globally, leading to more cases of DFUs, which can have detrimental effects on a person's way of life. Diagnosis, monitoring, and treatment plans for DFU require interdisciplinary medical skills due to the large number of potential contributing variables. Healthcare personnel must inspect the feet of patients with active DFUs or those at high risk of getting one to avoid developing more serious issues. [14]The incidence of medical treatment is rapidly increasing in this population, primarily due to the growing risk of developing diabetes. The most common ailment, diabetic foot ulcer (DFU), is increasing. Foot ulcers are indicated by redness on the affected skin and surrounding area of the foot and can be caused by inflammation or bacteria in the feet. Diabetes patients have a 10%–23% chance of developing DFU, which, if not properly treated, may lead to amputation of the lower limb. This review aims to provide an overview of the pathological and causative factors of diabetes complications, while also distinguishing prediction frameworks and highlighting the current structure of this serious and untreated medical issue that offers a unique approach to addressing a technology firm. [15].

A. Abbreviations and Acronyms

The abbreviations MPLAB, MATLAB, PWM, I2C, SPI,SRC, and MEMS respectively stand for Microchip PIC Laboratory, Matrix Laboratory, Pulse Width Modulation, Inter Integrated Circuit, Serial Peripheral Interface, Source Code for file Computing, and Microelectromechanical Systems.

III. PROPOSED SYSTEM

The proposed system includes a shoe with a flexi force sensor that detects pressure. When the patient applies pressure to the shoe, the sensor reads the force, which determines the intensity of the vibrator. If there is an irregularity in the pressure value, the values are sent or bypassed to the mobile app. The vibrator values will automatically adjust accordingly. This system is not currently available as a consumer product.



Fig(a)

Fig(a) This figure denotes the previous existing systems in foot ulcer.

A. Algorithm

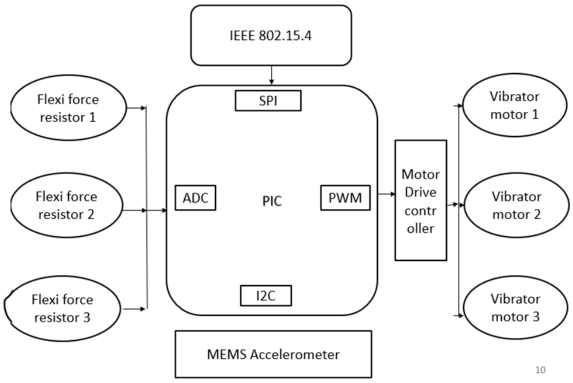
Start by creating an empty project in Android Studio. Create a List View that includes all discoverable Bluetooth devices. Obtain the name and MAC address of the HC-05 module. Connect to the HC-05 module. Send data to the module as bytes.

B. Block Diagram

The mobile app is connected via IEEE 802.154 that is Bluetooth Socket. The Hardware for simulation and coding to function the project by using the MPLABXIDC for the hardware. By using the ANDRIODSTUDIO the developed coding for Cortex Feet connects

This is the Connection for app and the Hardware parts.

Three Flexi Force sensors (1, 2, and 3) are connected to an analog-to-digital converter, while the IEEE 802.154 is connected to the serial peripheral interface. The MEMS accelerometer combines mechanical and electrical components, and the PWM is connected to vibrators 1, 2, and 3. The vibration of the vibrators depends on the value given by the user to the app. Three Flexi Force sensors (1, 2, and 3) are linked to an analog-to-digital converter, while the IEEE 802.154 is connected to a serial peripheral interface. A MEMS accelerometer combines mechanical and electrical components. The analog-to-digital converter converts the analog signal from the Flexi Force sensor into a digital signal, allowing the controller and Arduino kit to comprehend it.PWM modulation increases the signal's width, while the MEMS accelerometer links electrical and mechanical components. The PWM is connected to vibrators 1, 2, and 3, and the vibrator that turns on depends on the user's input value in the app.

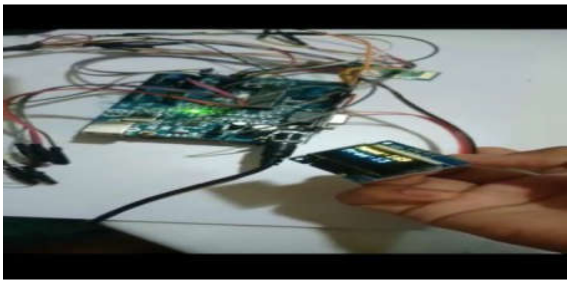


C. Result and Discussion

The Cortex app and consumer product are cost-effective solutions for diabetic patients with foot ulcers, aiding in their speedy recovery.

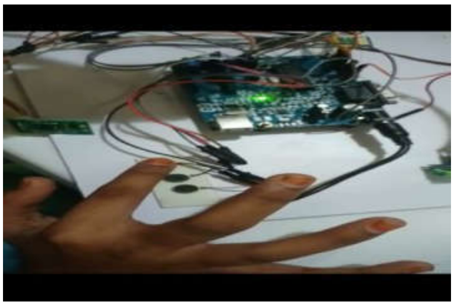
Fig(b)

(b) The hardware device which is connected to the mobile app to access the vibrator and to prevent the foot ulcer this figure represents.



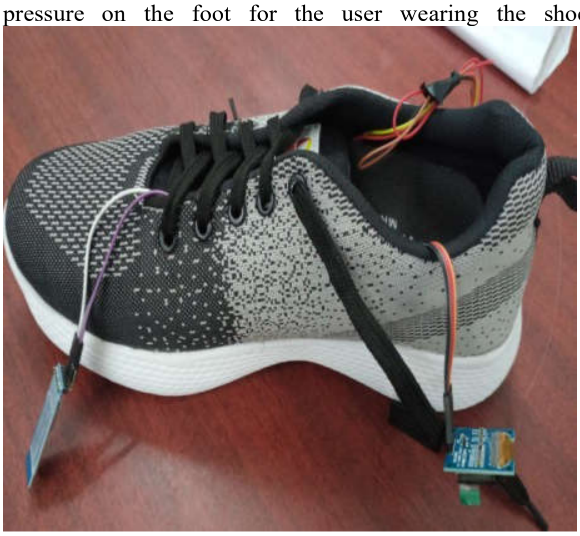
Fig(c)

(c) This represents the while the mobile app connected then the MEMS will show the pressure value of patient.



Fig(d)

(d) The statement conveys the activation of the vibrator through the mobile app and the corresponding sensation of pressure on the foot for the user wearing the shoe.



Fig(e)

(e) This figure denotes the whole consumer product for the diabetic patient those who are suffering from the diabetic foot ulcer.

D. Advantages

- This project offers the capability to detect and treat Diabetic Neuropathy, a severe medical disorder. However, owning equipment to measure foot pressure distribution is either too costly or too cumbersome to transport.
- The project's system design enables the sensors and actuators to fit inside the shoe unit, while the monitoring unit is a basic handheld device. This overcomes the previous limitation.
- The cost of this project will be lower and it will be easily accessible in underdeveloped countries where there are a large number of communities with a high incidence rate of diabetes. Additionally, this project does not necessitate the usage of ultrasonic or infrared light.

  The project can be easily completed at a low cost requiring additional investment.No knowledge of deep learning is necessary to access it. The device is user-friendly, allowing the user to operate it and activate the vibrator as desired.

E. Conclusion

Foot pressure distribution measuring equipment can be either costly or impractical to transport. Our project's system design solves this issue by integrating sensors and actuators into the shoe unit and using a handheld device for monitoring. This approach is less expensive and more accessible, making it particularly useful for communities in underdeveloped countries with high rates of diabetes.

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