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CORTEXFEETPRESSUREBALANCING FOR DIABETIC PATIENT

R.Sofia Assistant Professor DepartmentofECE ManakulaVinayagar Institute of Technology

Monica.V Departmentof ECE Manakula VinayagarInstitute of Technology

PUGAZHNANGAI.S Department of ECE ManakulaVinayagar Institute of Technology

JAYAPRIYA.B Departmentof ECE ManakulaVinayagar Institute of Technology

NIVEDHINI.C Departmentof ECE ManakulaVinayagar Institute of Technology

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 respectivevibratorsusing the app whenneeded. 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(*DIABETICFOOT ULCER*)

Theprevalenceofdiabeticulcersin Indiais4.54%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 affectedarea.Regrettably,diabeticulcersarechronicissues, 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,creatingasignalpathway.Thesoleofthefootcontains 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..Theappanddevicewillmonitorthepressureon thepatient's footanddetectanypainoritching.Patientscan utilize the app to control the device, which activates the vibratorbasedontheamountofpressure applied.Thishelps in the early healing of foot ulcers..

II. LITERATURESURVEY

ThemedicalindustryreliesontheInternetofThings(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 canberesolvedearly.TheNodeMCUdevelopmentboardis essentialindevelopingthismodelasitallowsforthestorage and tracking of patient medical records.[1].The study proposesawearableshoeprototypethatcandetectfootulcers in diabeticpatients. Theshoe 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 embeddedsystems.[3]Theinputimageswillbeclassifiedby 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.Theimagesareanalyzedandcomparedusing theHankeltransformofphotoprocessing.Thedatacollected between 2015 and 2020 was obtained from an online database. [5] Ensuringadequateoxygenlevelsonthefootis crucial for the recovery of ulcer cells/tissues in individuals sufferingfromchronicDFUwounds.Thispaperpresentsthe manufacturing process of the machine, information about PPGexams,andanalysisoftheresultsreceivedasitpertains tothischronicdisease.[6]Itisachallengingtasktomanually identifythepreciselevelofseverity ofanulcerowingtothe

possibility of perception disparities, along with the tedious andtime-consumingnatureoftheprocess.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]Theadvancedmicrowavesensorisbuiltupon the concept of subwavelength complementary split-ring resonators(CSRRs),which is perfectfordetecting changesin theelectromagneticpropertiesoftissueslocatednearthefoot 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 throughdeeplearningmethodsdemonstratesthepotentialfor improvingthemodelwithalargerdataset..[9]Themainaim oftheresearchwastoexaminethelinkbetweentemperature fluctuationsinulcersandthreemedicalconditionsrelatedto woundhealing - peripheral vascular disease, chronickidney 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 impactonhealthcareresourcesandincreasemorbidityrates.

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 footdevelopment,currentmeasurementtechnologiesarenot 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 ona 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. Anyinjurythatremainsunhealedforaprolongedperiod due to reduced blood flow and oxygenation is considered a persistent injury. Hyperbaric oxygen therapy (HBOT) has beenshowntoenhancethehealingofpersistentdiabeticfoot ulcers, unlike traditional medical practices and treatments thathavehadpooroutcomes. Our researchincludedclinical 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 increasetherisk oflimbamputation.To addressthis,a deep learning-based image-based system was developed for identifyingDFUinfectionandischemia.Thesystemutilized 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,whichcanhavedetrimentaleffectsonaperson'sway of life. Diagnosis, monitoring, and treatment plans for DFU require interdisciplinary medical skills due to the large number of potential contributing variables. Healthcare personnelmustinspectthefeetofpatientswithactiveDFUs orthoseathighriskofgettingonetoavoiddevelopingmore 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,diabeticfootulcer(DFU),isincreasing.Footulcers areindicatedbyrednessontheaffectedskinandsurrounding 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,ifnotproperlytreated, mayleadto amputationofthelowerlimb.Thisreviewaimstoprovidean overviewofthepathologicaland causative factorsofdiabetes 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].

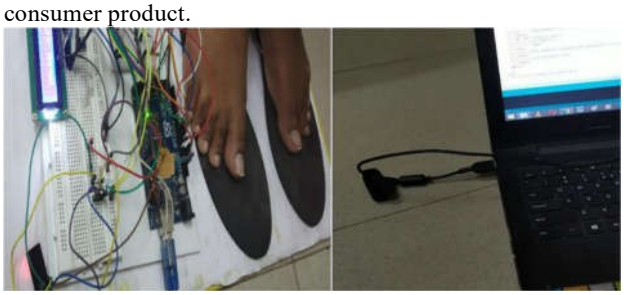
A.AbbreviationsandAcronyms

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 MicroelectromechanicalSystems.

III. PROPOSEDSYSTEM

Theproposedsystemincludesashoewithaflexiforcesensor thatdetectspressure.Whenthepatientappliespressuretothe shoe, the sensor reads the force, which determines the intensity of the vibrator. If there is an irregularity in the pressurevalue,thevaluesaresentorbypassed tothemobile app.Thevibratorvalueswillautomaticallyadjust

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

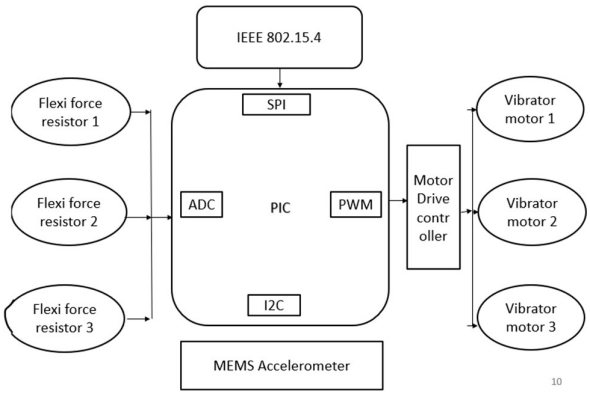
StartbycreatinganemptyprojectinAndroidStudio.Create aListViewthatincludesalldiscoverableBluetoothdevices. Obtain the name and MAC address of the HC-05 module. Connect to the HC-05 module. Send data to the module as bytes.

B. BlockDiagram

The mobile app is connected via IEEE 802.154 that is BluetoothSocket. TheHardwareforsimulationandcoding to function the project by using the MPLABXIDC for the hardware. By using the ANDRIODSTUDIO the developed coding for Cortex Feet connects

ThisistheConnectionforappandtheHardwareparts.

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,andthePWMisconnectedtovibrators1,2,and 3. The vibration of the vibratorsdepends on the value given bytheusertotheapp.ThreeFlexiForcesensors(1,2,and3) arelinkedtoananalog-to-digitalconverter,whiletheIEEE 802.154 is connected to a serial peripheral interface. A MEMS accelerometer combines mechanical and electrical components. The analog-to-digital converter converts the analogsignalfromtheFlexiForcesensorintoadigitalsignal, 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.ThePWMisconnectedtovibrators1,2,and3, and the vibrator that turns on depends on the user's input value in the app.

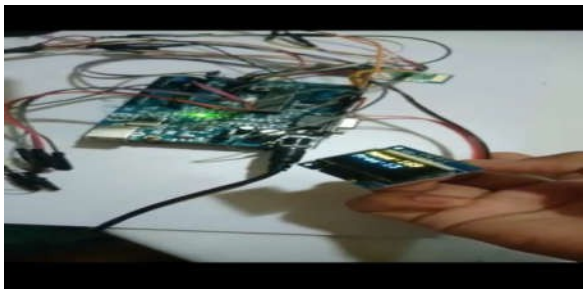


C. Resultand Discussion

The Cortex app and consumer product are cost-effective solutionsfordiabeticpatientswithfootulcers,aidingintheir speedy recovery.

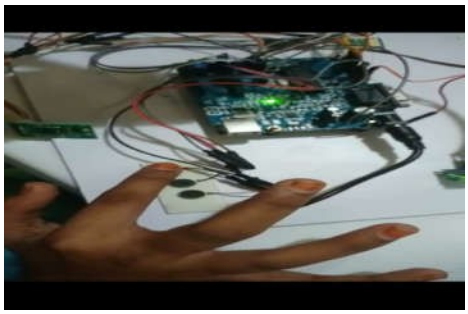
Fig(b)

(b) Thehardwaredevicewhichisconnectedtothemobile apptoaccessthevibratorandtopreventthefootulcerthis figure represents.



Fig(c)

(c) Thisrepresentsthewhilethemobileappconnectedthen 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 pressureonthefootfortheuserwearingtheshoe.

Fig(e)

(e) This figure denotes the whole consumer product for thediabeticpatientthosewhoaresufferingfromthediabetic foot ulcer.

D. Advantages

- This project offers thecapability to detectand treat Diabetic Neuropathy, a severe medical disorder. However, owning equipment to measure foot pressure distribution is either too costly or too cumbersome to transport.
- Theproject'ssystemdesignenablesthesensorsand 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 easilyaccessibleinunderdevelopedcountrieswhere therearealargenumberofcommunitieswithahigh incidencerateofdiabetes.Additionally,thisproject 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 deeplearningisnecessarytoaccessit.Thedeviceis user-friendly,allowingtheusertooperateitand activate the vibrator as desired.

E. Conclusion

Footpressuredistributionmeasuringequipmentcanbeeither costlyorimpracticaltotransport.Ourproject'ssystemdesign solvesthisissuebyintegratingsensorsandactuatorsintothe 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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