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Diabetic Level Detection Using Non-Invasive Method

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Abstract-*Measuring foot-shoe pressure is necessary for various medical diagnoses, including gait. Unusual pressure can be a sign of a number of health problems, including unstable walking, postural abnormalities, the possibility of calluses or ulcers, especially in diabetic feet, and many more biological analytical uses. Anomaly pressure may also be utilized for further diagnostic purposes.Foot pressure can only be distributed evenly with the proper orthotics [1].Neuropathy accounts for about 60% of diabetic foot ulcers. Therefore, early diagnosis of foot ulcers might be beneficial in lowering the risk of amputation, especially for those with diabetes. The strain gauge sensor with the NI data collecting interface is used in this study to create a plantar pressure sensor system that collects measurement data [2].Data is displayed and normalized using Labview.The strain on each insole sensor is shown in real time by the system software, which also logs the data into a file. This approach is economical and precise. This study tracks the distribution of foot pressure in different environments to evaluate both normal and abnormal foot function. While being monitored, the patient is free to stand, walk, or run. Additionally, it enables physicians to connect pressure distribution to health problems, allowing patients with diabetes and leprosy to receive customized footwear.Insole pressure gauge sensors on shoes are used in this investigation. The output voltage of these sensors is used to display pressure. There are eight little strain gauge sensor components in the system. Amplifiers then increase voltage.It is then received by the amplifier data acquisition section [1].*
Keywords- *gait, NI (National instruments) , strain gauge sensors, planter pressure, Labview .*

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I. INTRODUCTION

When endogenous insulin generated by pancreatic β-cells is able to control blood glucose levels, glucose homeostasis can be attained. However, diabetes mellitus will develop because the human body is unable to achieve glucose homeostasis [3,4]. A foot ulcer is characterized by the development of gangrenes and loss of feeling in the feet of diabetes individuals. People with diabetes often develop foot ulcers. An estimated 15% of diabetics globally are predicted to develop foot ulcers [5].A severe foot ulcer complication has the potential to be fatal. One common effect of diabetes is diabetic neuropathy, which is typically linked to a foot ulcer. Diabetic neuropathy is a disorder in which a diabetic may experience nerve damage in their feet and legs. Neuropathy accounts for about 60% of diabetic foot ulcers. Blisters or sores on the foot or lower limb are typically the first signs of diabetic foot ulcers [5]. Therefore, by using proper foot care, early detection of foot ulcers is crucial and helpful as an indicator to lower diabetes-related foot issues [6].Diabetic foot ulcers are among the deadliest effects of diabetes. The body's natural healing process is normally handled by the innate system, which functions effectively. Diabetes mellitus is one such metabolic disorder that slows down normal wound healing processes. Peripheral neuropathy is the most prevalent complication of diabetes, and problems related to diabetes-related feet can be less likely if detected early. Autonomic neuropathies and persistent sensory distal symmetric polyneuropathy are the two most prevalent forms of neuropathies. As a result, this study suggests an alternate method of using LabVIEW software to identify the plantar or foot pressure pattern in diabetic patients in order to spot an early indication of a foot ulcer. A positive result would show a distinct pattern in the patient's metabolic condition. Therefore, early detection of foot ulcers may aid in diagnosis and lessen impact and danger in the future.

II. LITERATURE REVIEW

Diabetes poses a risk to general health. 10% of the world's population, or 642 million people, will have diabetes by 2040 [7].Diabetes frequently results in fatal foot ulcers. Delays in receiving care could lead to infection, amputation, and even death [8].Prompt intervention, however, can prevent these consequences. Additionally, 1.13 billion pounds were spent by NHS England on diabetic foot ulcers (DFUs) in 2014–2015[9,10].In the US, treating diabetic feet comes at a cost of $9–13 billion annually. A common cause of DFUs is elevatedor irregular plantar pressure [11].This array's sensors measure 4.0 mm by 4.0 mm by 1.1 mm and can detect shear pressures of up to 31 kPa 250 kPa for pressure and stress. Different choices for the year 2015 because inductive sensors can withstand hostile environments, they are frequently employed to assess heel pressure surroundings. The bendable force gauge developed by Wattanasarn et al. in 2012 allowed for the measurement of forces in three dimensions [12]. For detecting and stimulating on each of its four layers, the sensor is equipped with four square planar coils. 2012 is considered to be the year of sensors. The sensor's restricted capacity to measure a broad range of temperatures was caused by its compact size. Du et al. created an inductive sensor with three coils [13].Two coils responded to both pressure and tension at the same time, but one coil only reacted to tension. The prototype sensor measured the amount of pressure being applied to each foot as the user walked routinely. dimensions of 76,2 x 76.2 x 22 mm restricted its ability to resolve spatial information. No commercial sensor that can measure plantar pressure and shear stress in several axes with high spatial resolution has been found by the authors. In order to detect DFU plantar loading, this inquiry aims to design a triaxial force detecting device, building on our previous work in inductive load sensing [14], [15].The sensor's coil and conductor can be separated by a substance with springy characteristics to change eddy current-based turning displacement sensors into force sensors. The elastomer deforms in response to an external force. This results in a change in the conductor's displacement, which is also referred to as the target. This in turn modifies the circuit's inductance. Even the influence of wires that are not even connected to the circuit can be hidden by sufficiently dense conduit [15]. The front panel of the gadget has a knob, an LED, and a buzzer to notify medical personnel of patients' foot pressure. The voltage array that shows unexpected areas of pressure. Patient data is connected to the lab view via a data logger. multiple-channel electrical apparatus. Twenty channels are needed for this process.

We use the IoT Node MCU development device in our concept. The Wi-Fi is utilized by this open-source Internet of Things platform. Espressif Systems produces wifi, bluetooth, and ESP-32 modules in addition to System-on-Chip (SOC) devices. The framework is made up of these elements. The tensilica 32-bit RISC Processor Xtensa LX106 in the NodeMCU ESP8266 operates at a clock frequency of 80–160 MHz, which is compatible with the realtime operating system (RTOS). To detect foot pressure, a non-polarized flexi sensor with two terminals is affixed to the patient's foot.

III. METHODOLOGY

To take part in this, volunteers were sought out. The participants ranged in age from 15 to 25. Out of four participants, one have been diagnosed with diabetes while the remaining three are in good health..The university lab is where the plantar pressure sensor prototype is being created and tested. The National Instruments (NI) system provided the data collection. The NI multifunction I/O device type of DAO hardware was used in this investigation [2].

Through a USB port, it communicates with the computer. The ease of use and simplicity of plugging into the computer slot led to the selection of this DAO module When selecting this sensor, a few factors were taken into account, including its high sensitivity, straightforward design, long-term stability, and linear response to applied pressure. The strain gauge sensor's active sensing region is located near its extremity. Given that these sensors are positioned at particular locations that may experience increased pressure, this feature is consistent with the foot's insole.Five strain gauge sensors are connected to a DAO device in this pilot research. Each sensor is positioned at a specific spot on the right foot's insole and is wired straight to the DAO. The heel, midfoot, forefoot, toe and fingers are the four areas of the foot. As seen in Fig- 1, the output voltage was then linked to the DAO analog input. Every sensor is linked together to form a circuit with a voltage divider.After that, the participant will be instructed to step on the plantar pressure setup with his or her right foot.

The voltage and pressure readings were noted. The LabVIEW system's front panel shows the outcomes of every location on the subject's right foot that was recognized.The user can view the results of each foot on the front panel, Also it can be predicted that whether they are or not at risk of developing a dangerous foot ulcer. Each of the five determined points on the plantar pressure is indicated by the light-emitting diode (LED) on the front panel. The dangerous foot ulcer LED will illuminate when the pressure rises above 625. In the event that the pressure is less than 625, the typical foot's LED will illuminate in the user interface[2].

Calibration is a technique used to determine the relationship between input and output with regard to the real unit. An experimental calibration is finished in this experiment since the input is pressure and the output is voltage [2].

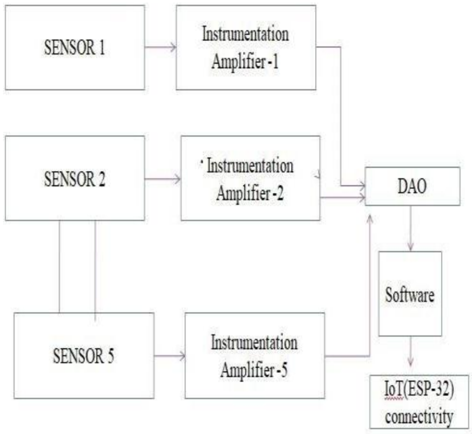


Fig-1

Strain Gauge Sensor: This is the sensor placed in the footwear to measure the pressure exerted by the foot. It detects changes in resistance due to mechanical stress.
Instrumentation: This stage involves signal conditioning and amplification of the strain gauge sensor output to make it suitable for processing. This may include amplifiers, filters, and analog-to-digital converters (ADCs) to convert the analog signal to digital.
Data Acquisition (DAQ): The digitized signal from the strain gauge sensor is sent to a Data Acquisition module. This module collects, samples, and processes the data from the sensor in real-time.

LabVIEW Interface: Lab VIEW acts as the interface between the DAQ module and the user. It provides a graphical programming environment for designing the user interface, data analysis, and visualization. LabVIEW communicates with the DAQ module to receive sensor data.
DAO (Data Access Object): DAO handles the storage and retrieval of data from a database. It stores the foot pressure data along with other relevant information such as timestamps, patient ID, and sensor readings.
ESP32 (microcontroller): This component enables wireless communication for remote monitoring and control. It receives data from LabVIEW via a communication protocol (e.g., Wi-Fi, Bluetooth), and it can also send alerts or notifications based on predefined thresholds or conditions.

IV. RESULT

The peak pressure of an average person is 625 KPa, however the peak pressure of an unusual person is higher. The NPP number is calculated using the individual's weight and pressure. Arduino facilitates the sending of the messages to the PC. Peak pressure in normal individuals is 625 KPa, however in unusual individuals, it is higher. The NPP number is determined by taking into account the individual's weight and pressure. The messages are transmitted to the PC via Arduino.

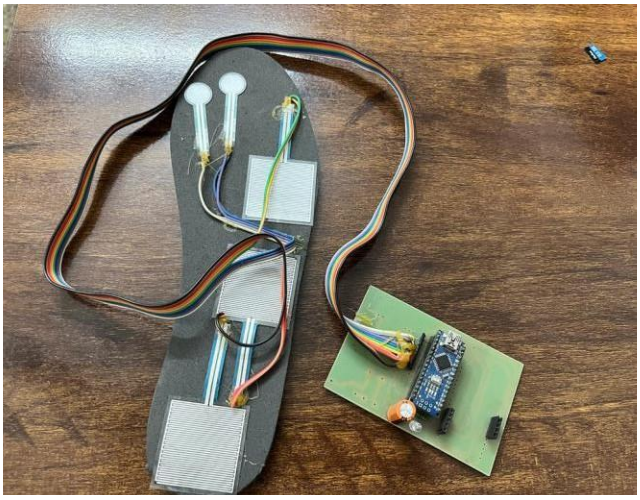
Fig-2

The foot pressure parameter NPP was examined in a variety of diabetes groups through experiments, and the mean values for normal and abnormal foot pressure were compared. Typically, pressure is measured four times. The areas most susceptible to foot ulcers will receive more weight. Thus, it's crucial to notice any shift in foot pressure that could indicate the early detection of a foot ulcer. This lessens the likelihood that the patient may require foot amputation because it is much simpler for the physician to identify a foot ulcer at an early stage [1].

Names	Senor 1(kpa)	Senor2(kpa)	Diabetic and non- diabetic acc to actual data	Diabetic and non- diabetic acc to our device
Test case 1	2356	2235	Non-diabetic	Non-diabetic
Test case2	2125	2095	Non-diabetic	Non-diabetic
Test case3	2465	2575	Non-diabetic	Non-diabetic
Test case4	1065	1185	Low-diabetic	Low-diabetic
Test case5	2100	2267	Low-diabetic	Non-diabetic
Test case6	2065	2239	Low-diabetic	Non-diabetic

Table 1- The pressure reading obtained by sensors

Table 1 displays the interquartile value that was computed from the two sites at which both groups were present. It is hypothesized that individuals with diabetes mellitus have greater blood pressure than healthy individuals at the measurement site located on the foot insole. The results also indicate that, in comparison to the normal group, the diabetes mellitus group had increased toe pressure.



V. FUTURE SCOPE

The scope of measuring foot pressure using strain gauge sensors is broad and encompasses various applications in healthcare, sports science, biomechanics, and wearable technology. Strain gauge sensors are devices that measure the deformation or strain in an object, making them valuable tools for assessing forces and pressures, including those exerted on the feet. Here are some key areas where measuring foot pressure with strain gauge sensors proves beneficial:

1. Clinical Assessment: Strain gauge sensors aid in clinical assessments of gait and foot mechanics. They provide quantitative data on pressuredistribution, helping healthcare professionals identify abnormalities and design personalized treatment plans for individuals with conditions such as diabetes, arthritis, or musculoskeletal disorders.
2. Orthopedics and Rehabilitation: In orthopedics, strain gauge sensors assist in evaluating the effectiveness of orthotic devices and rehabilitation programs. They offer insights into how forces are distributed during movement, guiding the development of interventions to improve gait and reduce the risk of injuries.
3. Wearable Technology: Wearable devices equipped with strain gauge sensors provide real-time feedback on foot pressure. This technology is useful for monitoring daily activities, promoting healthy habits, and preventing overexertion or improper weight distribution.
4. Research and Development: Strain gauge sensors play a vital role in research related to ergonomics, human movement, and the development of medical devices. Researchers use this data to enhance our understanding of biomechanics and contribute to the advancement of medical technologies.

REFERENCES

[1]. IoT and LABVIEW-based screening for diabetic foot ulcers using flexibleforce sensors, Anusha M Dept. of ECE, T. P. Kausalya Nandan Dept. of ECE,B V Raju Institute of Technology.

[2]. A Development of Plantar Pressure Sensor for Foot Ulcer Detection in Diabetic Neuropathy Individuals – A Pilot Study Nor Salwa Damanhuri, Nor Azlan Othman*, Wan Fatimah Azzahra WanZaidi, Samihah Abdullah Faculty of Electrical Engineering, Universitiy Teknologi MARA, Cawangan Pulau Pinang, Malaysia ICoSeMT 2019 Journal of Physics: Conference Series.

[3]. Alberti K G M M and Zimmet P F 1998 Provisional report of a WHO consultation, Diabetic medicine 15 539-53

[4]. American Diabetes Association 2014 Diagnosis and Classification of Diabetes Mellitus Diabetes Care 37 S81-S90.

[5]. Farzamfar B, Nazari R and Bayanolhagh S 2013 Diabetic foot ulcer Gangrene management-New advancements and current trends ed A Vitin (London: InTech).

[6]. Priya S K, Nithyaa A and PremKumar R 2014 Int. J. Sci. Eng. Res. 5 87-92.

[7]. S. Amendola, R. Lodato, S. Manzari, C. Occhiuzzi and G. Marrocco, "RFID Technology for IoT-Based Personal Healthcare in Smart Spaces," in IEEE Internet of Things Journal, vol. 1, no. 2, pp. 144- 152, April 2014.

[8]. A. Ukil, S. Bandyopadhyay, C. Puri and A. Pal, "IoT Healthcare Analytics: The Importance of Anomaly Detection," 2016 IEEE 30th International Conference onAdvanced Information Networking and Applications (AINA), Crans-Montana, 2016, pp. 994-997.

[9]. S. Tyagi, A. Agarwal and P. Maheshwari, "A conceptual framework for IoT-based healthcare system using cloud computing," 2016 6th International Conference - Cloud System and Big Data Engineering (Confluence), Noida, 2016, pp. 503-

[10]. 507.

[11]. Mahmud, R., Koch, F. L., & Buyya, R. (2018, January). Cloud-fog interoperability in IoTenabled healthcare solutions. In Proceedings of the 19th international conference on distributed computing and networking (pp. 1-10).

[12]. Kim, Suwon, and Seongcheol Kim. "User preference for an IoT healthcare application for lifestyle disease management." Telecommunications Policy 42.4 (2018): 304- 314

[13]. Xiaoyou Lin and Boon-Chong Seet. 2016. Battery-free smart sock for abnormal relative plantar pressure monitoring. IEEE transactions on biomedical circuits and systems 11, 2

[14]. (2016), 464–473.

[15]. Chanjuan Liu, Ferdi van der Heijden, Marvin E. Klein, Je! G. van Baal, Sicco A. Bus, and Jaap J. van Netten. 2013. Infrared dermal thermography on diabetic feet soles to predict ulcerations: a case study. In Advanced Biomedical and Clinical Diagnostic Systems XI (Proceedings of SPIE), Anita MahadevanJansen, Tuan VoDinh, and Warren S. Grundfest (Eds.). SPIE. https://doi.org/10.1117/12.2001807

[16]. Chanjuan Liu, Jaap J van Netten, Je! G Van Baal, Sicco A Bus, and Ferdi van Der Heijden. 2015. Automatic detection of diabetic foot complications with infrared thermography by asymmetric analysis. Journal of biomedical optics 20, 2 (2015), 026003.

[17]. Bijan Naja", Hooman Mohseni, Gurtej S Grewal, Talal K Talal, Robert A Menzies, and David G Armstrong. 2017. An optical-berbased smart textile (smart socks) to manage biomechanical risk factors associated with diabetic foot amputation. Journal of diabetes science and technology 11, 4 (2017), 668–677.