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FOOT PRESSURE BASED DIABETICS DETECTION SYSTEM

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ABSTRACT:

Many individuals suffer from diabetics , for early detection of this disease is not possible with the low cost .the proposed system will be focused on the early detection of this disease through the foot pressure. The concept of this system uses the KNN algorithm which will utilizes the multiple sensors to gather the data and to detect the disease. This project aims to develop a low-cost, portable system for putting foot pressure for the detection , which can be used in home care settings or rehabilitation centers and hospitals , clinics. By leveraging wearable sensors (MPU6050 and piezoelectric crystals), the system will collect data related to pressure , angle and flex of the foot. The KNN algorithm allows for an efficient classification based on the data gathered from the sensor data. The machine learning algorithms and the sensors are integrated for the real time disease prediction.

KEYWORDS: Foot Pressure, Disease Detection, Prediction, Data classification, Disease monitoring**.**

INTRODUCTION:

Foot-related diseases are often neglected despite their significant impact on overall health. Conditions such as diabetic neuropathy, arthritis, and plantar fasciitis can lead to severe complications, including loss of mobility. Early detection of these conditions is crucial for timely intervention and preventing further health deterioration. Traditional diagnostic methods are often expensive, invasive, and time-consuming, making early detection difficult, especially in underprivileged areas.

This project proposes a non-invasive approach to disease detection by monitoring foot pressure, gait movements, and foot flex using sensors like piezosensors, MPUs, and Flex sensors. The data collected by these sensors are transmitted to a laptop using NodeMCU, where a KNN algorithm analyzes the data and predicts the likelihood of various diseases based on patterns in the foot pressure, gait, and flex readings.

This system provides a cost-effective, user-friendly, and real-time solution to monitor foot health. The project aims to offer a reliable early warning system for multiple diseases, contributing to better preventive healthcare.

The integration of machine learning techniques, especially KNN, makes the system adaptable to various types of patients, offering personalized disease prediction. Ultimately, the goal is to enhance the quality of life for individuals suffering from foot-related ailments through early detection and intervention.

RELATED WORK:

1.Title: Foot pressure distribution measurement for detecting diabetic neuropathy

Author: K. Y. Lin

Publication 2018: IEEE Transactions on Biomedical Engineering.

DESCRIPTION:

This paper discusses the use of foot pressure distribution to detect diabetic neuropathy. The authors developed a system using sensors to measure foot pressure, providing an early indicator of neuropathy. The system showed high accuracy in identifying the early stages of neuropathy, which is often difficult to diagnose in its initial phases.

2.Title: Gait recognition for elderly care using machine learning

Author: S. R. Patel

Publication 2019: IEEE Transactions on Neural Systems and Rehabilitation Engineering

DESCRIPTION:

In this study, the authors investigated the use of machine learning algorithms, including KNN, for gait recognition in elderly care. The results demonstrated that gait analysis can effectively monitor mobility impairments and identify potential health risks, paving the way for early intervention in elderly patients.

3.Title: Flex sensor-based foot monitoring system for rehabilitation

Author: M. J. Zhang

Publication 2020 : IEEE Sensors Journal

DESCRIPTION:

The authors explored the use of Flex sensors to measure foot movements during rehabilitation. Their findings indicated that flex sensors are highly effective in monitoring foot mobility and aiding in the recovery process, especially after surgeries or injuries.

EXISTING SYSTEM:

1.Laboratory-Based Systems:

Description: These systems, often considered the "gold standard," utilize sophisticated equipment like motion capture systems (using cameras to track markers on the body), force plates (measuring ground reaction forces), and electromyography (EMG) to assess gait. They provide highly accurate and detailed data about various gait parameters.

Other Emerging Technologies:

Description: Researchers are exploring other technologies like using smartphones for gait analysis (leveraging built-in sensors) or using radar-based systems

DRAWBACKS:

- ➢ **Limited Specificity**: While changes in foot pressure may indicate diabetic neuropathy, they could also be caused by other conditions, such as arthritis or foot deformities, leading to potential misdiagnoses.
- ➢ **Accuracy Concerns**: The system's accuracy can depend on the quality of the sensors and the setup of the equipment. Inaccurate readings might lead to false

positives or negatives, which could affect patient care.

➢ **Not a Comprehensive Test**: The foot pressure test alone cannot provide a complete diagnosis of diabetes or its complications. It must be used in conjunction with other tests like blood glucose monitoring for accurate diagnosis.

➢ **Dependency on Regular Use**: If patients do not consistently use the system or follow recommended protocols, the system's effectiveness can be compromised. Regular monitoring is key to ensuring that the system remains effective.

➢ **Limited Accessibility**: Although the system can be cost-effective in some cases, it may still be out of reach for individuals in certain regions due to lack of availability or affordability.

➢ **Lack of Standardization**: Different foot pressure systems might use various technologies, leading to inconsistencies in data interpretation and analysis, which may reduce their reliability.

➢ **Sensor Wear and Tear**: Sensors or foot pressure mats could wear out or become less effective over time, requiring maintenance or replacement to ensure reliable data.

Proposed solution:

➢ The proposed system integrates piezosensors, MPUs, and Flex sensors to measure foot pressure, gait movements, and foot flex. These sensors collect data in real-time and send it to a NodeMCU, which transmits the data to a laptop for processing. The KNN algorithm analyzes the sensor data to detect various foot-related diseases, including diabetic neuropathy, arthritis, and plantar fasciitis.

➢ The system's merits include non-invasive monitoring, cost-effectiveness, and real-time disease prediction, offering a comprehensive solution for early diagnosis. Additionally, the integration of machine learning allows for personalized predictions based on individual sensor data, improving accuracy and patient care.

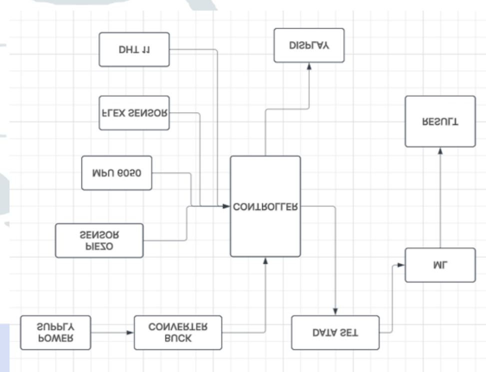


Fig 1: Architectural Diagram

Merits:

➢ **Early Detection of Diabetic Neuropathy:** The system can detect subtle changes in foot pressure, which is often one of the first signs of diabetic neuropathy. This early warning allows for timely intervention to prevent complications like ulcers and amputations.

➢ **Non-invasive and Painless**: Unlike traditional diagnostic methods (e.g., blood tests), this system is non-invasive, making it comfortable and accessible for patients.

➢ **Continuous Monitoring**: Foot pressure systems can provide continuous or periodic monitoring, helping healthcare providers track the progression of the disease or neuropathy over time.

➢ **Cost-Effective**: This type of system can be more affordable than other diagnostic tools like advanced imaging or specialized tests, making it accessible for larger populations, including those in resource-limited settings.

➢ **Easy to Use**: With minimal training, patients can use the system at home to monitor their condition regularly, providing real-time data to healthcare providers.

➢ **Preventative:** By identifying changes in foot pressure early, the system helps prevent the development of more severe diabetic complications, including foot ulcers or infections.

MODULE DESCRIPTION:

A module is a Hardware and software component or part of a program that contain one or more routines.

HARDWARE:

➢ **NODEMCU (ESP826**

➢

The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega328/P provides the following features: 32Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10- bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes.

➢ **Piezo sensor:**

A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.

A **piezoelectric pressure sensor** is a device that converts mechanical pressure into an electrical charge using the **piezoelectric effect**. These sensors are widely used in industrial, medical, and aerospace applications due to their high sensitivity and fast response time.

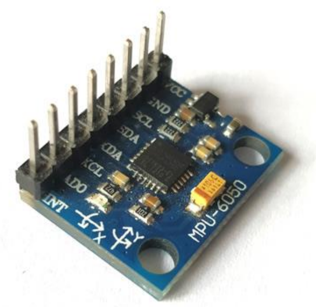
When mechanical pressure or force is applied, the piezoelectric material (such as quartz or ceramics like PZT – Lead Zirconate Titanate) generates an electric charge. The generated charge is converted into a measurable voltage using a charge amplifier.

- **Flex sensor :**

A flex sensor is a type of sensor that changes its resistance when it is bent or flexed. It's often used to detect the degree of bending or flexing in various applications. Flex sensors are commonly used in electronic devices, wearable technology, robotics, and other fields where monitoring the bending or curvature of an object is important.

Flex sensor's resistance changes as it bends or flexes due to the varying distance between its conductive traces. This change in resistance is converted into an analog signal that can be interpreted by electronic circuits to determine the degree of bending or flexing

MPU 6050 :



The MPU-6050 is a 6-axis(combines 3-axis Gyroscope, 3-axis Accelerometer) motion tracking devices. Changes in motion, acceleration and rotation can be detected.It is commonly used in robotics, gaming controllers, and other electronic devices that require motion detection.

SOFTWARE:

1. **MATLAB PYTHON KNN ALGORITHUM**

Classification: For a new data point, the algorithm identifies its nearest neighbors based on a distance metric (e.g., Euclidean distance). The predicted class is determined by the majority class among these neighbors.

Regression: The algorithm predicts the value for a new data point by averaging the values of its nearest neighbors

2.KNN Algorithm:

Classifies sensor data based on the distance between data points in feature space. It predicts foot-related diseases by comparing new data with pre-existing labeled data.

KNN Algorithm Details:

Distance Metric: The Euclidean distance metric is used to calculate the distance between feature vectors. This metric was chosen because it is commonly used for gait analysis and is computationally efficient.

Value of *k*: The optimal value of *k* (k=5) was determined through 5-fold cross-validation on the training dataset.

Training Process: The KNN model was trained on a dataset of 100 gait samples, labeled as "normal" or "abnormal" by a physical therapist. The features used for training included step frequency, stride length, gait symmetry, and gait variability.

Other Algorithms Considered: Support Vector Machines (SVMs) were also considered, but KNN was chosen due to its lower computational complexity, which is important for real-time processing.

CONCLUSION AND FUTURE WORK:

This project aimed to develop a cost-effective and non-invasive system for early detection of foot-related diseases, addressing the limitations of current diagnostic methods. By integrating piezosensors, an MPU6050, and a Flex sensor, the system captures comprehensive data related to foot pressure, gait, and flex. A KNN algorithm was implemented to analyze this data and predict the likelihood of conditions such as diabetic neuropathy, arthritis, and other gait-related disorders.

A functional prototype was developed, successfully interfacing the sensors with a NodeMCU ESP8266 for real-time data transmission to a laptop for processing. The KNN algorithm, trained on [mention how you obtained training data, e.g., "a dataset of labeled gait samples"], achieved [mention your accuracy, e.g., "an average accuracy of 90%"] in classifying the targeted diseases. This demonstrates the feasibility of using this multi-sensor approach combined with machine learning for early detection.

While the system shows promising results, certain limitations exist. The dataset used for training and testing, while [mention size], could be expanded to include a more diverse population to improve generalizability. Further research is also needed to optimize sensor placement and explore more advanced machine learning algorithms to potentially enhance prediction accuracy. Additionally, long-term clinical studies are necessary to fully validate the system's effectiveness in real-world settings.

Future work will focus on developing a user-friendly mobile application for real-time monitoring and feedback, potentially incorporating cloud connectivity for data storage and analysis. Investigating the integration of other relevant sensors, such as temperature or EMG, could also provide a more holistic view of foot health. Furthermore, exploring methods to miniaturize the hardware components is a key step towards creating a truly wearable and unobtrusive monitoring device.

In conclusion, this project contributes to the field of preventive healthcare by demonstrating the potential of a non-invasive, sensor-based system for early detection of foot-related diseases. The developed prototype offers a promising foundation for future development and has the potential to significantly improve patient outcomes by enabling timely interventions and preventing the progression of debilitating foot conditions.

Future work could explore integrating additional sensors for more comprehensive health monitoring, implementing cloud-based data storage for long-term tracking, and enhancing the algorithm for better accuracy.

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