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The Development Of Detection Walking Posture Abnormalities Patient In Human Gait Using Pressure Sensor

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Abstract

Nowdays, physiotherapy assistant needs to gain data and determine the rehabilitation process of every patient with a walking problem. This is because healthcare assistants don't have any tools that can come out with the precise data collecting.In order for gait rehabilitation treatments to be effective, a precise data analysis of a patient's gait is necessary. Supination, pronation, instability in the left foot, and instability in the right foot can all be detected through gait analysis. These abnormalities should be noticed immediately to correct our walking posture and avoid injury. However, the existing technology that has been applied to healthcare assistants only uses observation by perception without data for a user walking. Healthcare assistants could not get the exact data and analysis for the treatment progress besides hard to find in the market. Those techniques are still quite expensive for the consumer market due to technical reasons and the complicated instrument for measuring body movement. For this product, we've developed a home-based gait analysis shoe system. This paper aims to develop, record, and analyse the walking performance of users by collecting data from pressure sensors to determine whether the walking pattern is normal or abnormal.Families and healthcare assistants can keep a close eye on the person wearing the device by uploading and viewing an app-generated summary of their gait data. It is possible to monitor the wearer's gait by integrating sensors, wireless technology, and social ability with computer software.

Keywords: gait analysis, pressure sensor, abnormalities, shoe's insole, health monitoring, walking posture

1. Introduction

In daily life, walking always seems to be an essential activity. It's not something you usually think about, as the body will coordinate and manage the steps without controlling them. However, normal walking might be more challenging for persons who have trouble walking. When a person can't walk normally, it's called abnormal gait or walking abnormalities (Nmss, 2006). Walking fundamental trait will allow humans to go about their daily lives and contribute to society. The gait is a characteristic of walking. An average person's gait, also known as the

normal gait, is the optimal gait pattern in terms of power and gait velocity for a human to walk comfortably for a long time. According to the research, this abnormal walking behaviour will lead to many worst diseases either in the long term or short-term period such as leg pain, back pain, ankle problem and other serious bone injury (Sunarya et al., 2020). This device is developed for medical assistants in the healthcare sector for gaining the data analytic from patients. The main function is to detect the abnormal posture and gait which is opposite to the normal behaviour of human walking. The device that can gain the data by pressure sensor act by human while walking will be processed and transferred with interface application (Baker, 2018). This application will run the algorithm that will finalise either that human walk in normal or abnormal posture. The data gained will been monitor and utilized by healthcare assistant at hospitals nor patient itself at home as the product based on user friendly concept.

Nowadays, an increasing number of people suffer from gait disorders, and due to the diversity of patients' symptoms and causes, the treatment is performed manually and logically based on biomechanical, musculoskeletal, and neuromotor principles (Bae & Tomizuka, 2011). According to American Family Physician, gait disorders were detected in approximately 25 percent of persons 70 to 74 years of age, and nearly 60 percent of those 80 to 84 years of age (Salzman, 2011). According to the American Community Survey, about half of Americans ages 75 and older (49.8%) reported living with a disability in 2015, as did about a quarter (25.4%) of those 65 to 74. es with walking or independent living (Nilpanapan & Kerdcharoen, 2016). More than 20 million people ages 18 and older reported having serious difficulty walking in 2015, representing 7.1% of the civilian non-institutionalized population(Raknim & Lan, 2016).

2. Methodology

Designing and developing the mechanical part of the detection of walking posture abnormalities in patients in human gait using a pressure sensor, a block diagram of the operating system, and developing a flowchart of the operation device are all the stages of this research. The method is used to achieve the objective of the project that accomplishes a perfect result.

2.1 **Designing the mechanical part of the detection walking posture abnormalities patient in human gait using pressure sensor**

The detection of walking posture abnormalities in figure 1, has five points of detection and each point has five resistive pressure sensors. The components of the device in this research are, one (1) ESP 32 WI-FI module, one (1) power supply 6V,and five (5) resistive sensors.

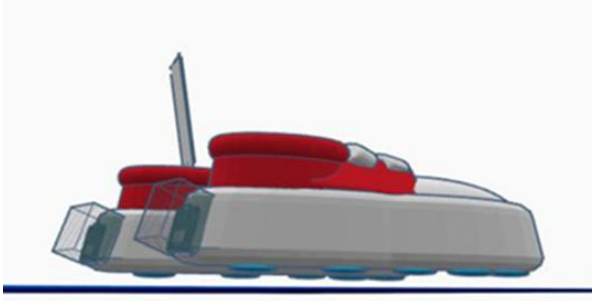

Figure 1: Mechanical Design Of The Detection Walking Posture Abnormalities Patient In Human Gait Using Pressure Sensor Using Tinkercad

The walking postures are detected by the resistive pressure sensor that has been placed at the insole which is when the patient starts walking the sensor will detect the abnormalities during the rehabilitation session. The device is a wearable device that comes with an on-off button so that the patient can save the device's power. The detection walking posture will detect the pressure of up to five-point during the human gait cycle as in the figure that shows the side view of the detection walking posture abnormalities device.

2.2 Developing The Hardware and IoT Implementation Of The Detection Walking Posture Abnormalities Patient In Human Gait Using Pressure Sensor

The figure 2 shows the system of circuit installation for the detection walking posture abnormalities in the patient in human gait using a pressure sensor. ESP32 Wi-Fi module works as a device controller which programs can be loaded onto it from the predefined Arduino IDE programming. The USB cable connection is used to upload the verified coding from the Arduino IDE to the circuit of the device.

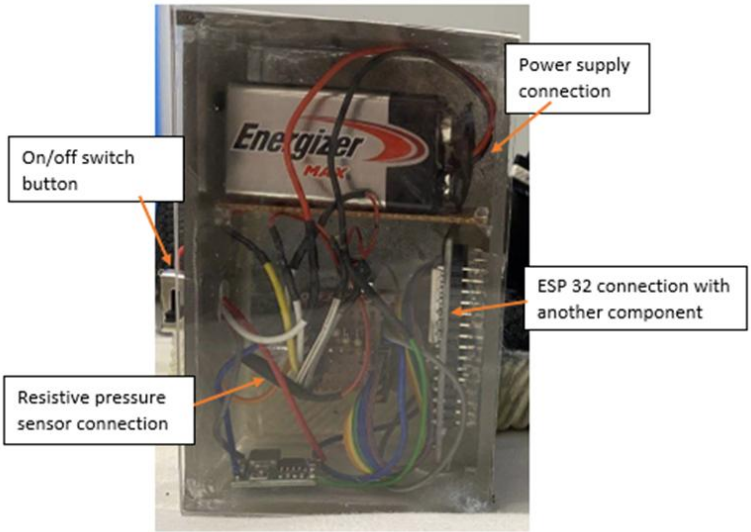

Figure 2: circuit installation of the Development of Detection Walking Posture Abnormalities Patient In Human Gait Using Pressure Sensor

Figure 3 shows the development of electronic and mechanical parts the wrist joint rehabilitation. The design of this data shoe is based on a home application that detects the wearer's gait behaviour in real-time. FSRs, or force-sensitive resistor sensors, are embedded in the shoe's insole to monitor gait. Five FSRs are embedded in four areas of the shoe: the bottom of the toes, the pad of the foot, the outer arch, and the heel of the foot, which is enough to collect gait pattern data. In addition, for the developer's convenience, the wireless data transfer device is installed in a small pocket at the anklebone.

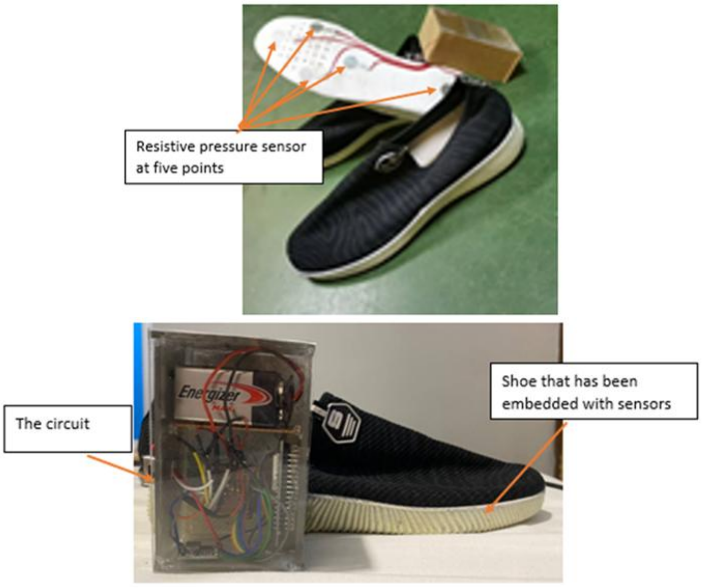

Figure 3: Development of electronic and mechanical part of The Detection Walking Posture Abnormalities Patient In Human Gait Using Pressure Sensor

Referring to Figure 4, the interface of IoT implementation using Blynk application for the live data pressure when patient walking and to give notification that the patient is in the abnormal condition and using Thingspeak application for the display and save the progress of the patient while using the device. The Blynk and Thingspeak applications are easy to download on the user's IOS system and android system which can make them easy to detect and see the progress of the abnormal pressure by walking even if the therapist is not around. Based on Table 1, shows the function of each button of the Blynk and Thingspeak application during using the device.

Figure 4: Interface of IoT implementation using Blynk and Thingspeak application for detecting the pressure of resistive pressure sensor

Table 1: function of the button of Blynk application

NO.	BUTTON BLYNK APPLICATION
1.	DETECT THE LIVE DATA OF FIVE PLACEMENT SENSOR
2.	THE AVERAGE AMOUNT FOR TO FIVE SENSORS

Table 2: function of the button of Thingspeak application

NO.	BUTTON THINGSPEAK APPLICATION
1.	THE DATA OF SENSOR 1
2.	THE DATA OF SENSOR 2
3.	THE DATA OF SENSOR 3
4.	THE DATA OF SENSOR 4
5.	THE DATA OF SENSOR 5
6.	THE AMOUNT OF AVERAGE OF FIVE SENSOR

2.3 Block Diagram of the Operating System

Block has a specific purpose, and the block diagram illustrates in Figure 5 shows how each process is connected. The information on the device is sensors such as a resistive pressure sensor to detect the pressure of the ground contact surface while the patient is walking. NedeMCU ESP32 microcontroller act to process the data gain while transmitter and receiver being a part in transmitting/receiving process than display by monitoring systems. The application will notify users in certain conditions whenever the data gain is out of the normal walking pattern range. The data has also been stored in a cloud data server for data references. Lastly, the user's walking pattern data will be displayed on the smartphone.

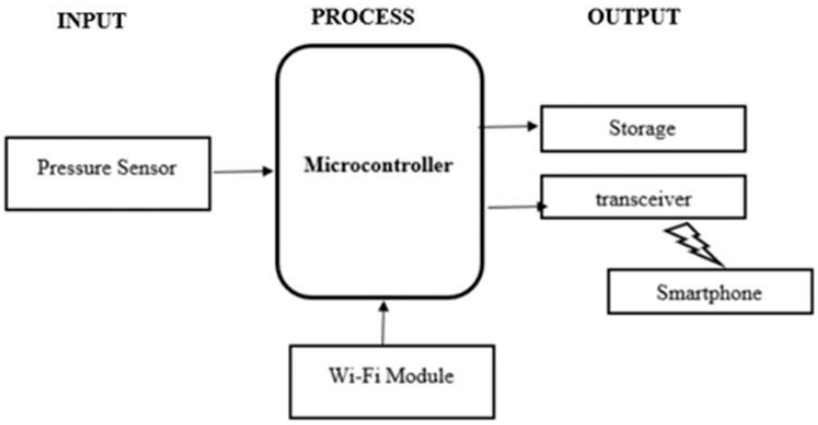

FIGURE 5: BLOCK DIAGRAM OF THE DETECTION WALKING POSTURE ABNORMALITIES

2.4 Flow Chart of the Operation Device

Figure 6 below shows a flowchart of the whole process of the system within the data collecting, transferring data, and monitoring system. First, the patient walks, and the pressure sensor at the insole will count every pressure in the gait walking phase. Next, the data collected transfer will be processed and transmitted for the monitoring process. This process will become out into two possible outcomes, either in the normal range or abnormal gait analysis. If the data is in an abnormal range, the application will notify the users about their walking gait pattern. Lastly, the data will be sent to the user's smartphoneand stored in the cloud storage.

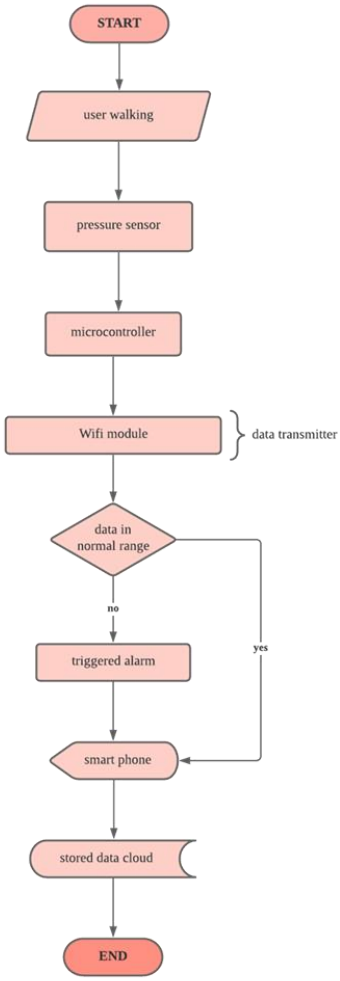

FIGURE 6: Flowchart of The Whole Process of System Within Data Collecting, Transferring Data and Monitoring System

2.5 Data analysis method

Testing of the hardware and software was done to examine the usefulness of Detection Walking Posture Abnormalities Patient In Human Gait Employed Pressure Sensor undergo the by following the gait phase that has been used by the patient. As indicated in Figure 9, the gadget has been tested by the subject. The assessed data are crucial in assessing the usefulness of the Detection Walking Posture Abnormalities Patient In Human Gait Employed Pressure Sensor by observing the gait phase that has been used by the patient and collecting comments from experts and the public.

Figure 7: Testing of the hardware and software of the device

3. Result And Discussion

This device must be able to detect the abnormalities of pressure when patients walk. By comparing the average pressure achieved by each sensor of the device and the normal pressure of each sensor, it can figure out the usability of the detection walking posture abnormalities patient in human gait using a pressure sensor by observing the gait phase that has been using by the patient

Table 3 : Comparison between average pressure achieved each sensor and normal pressure each sensor.

Movement	*Average Achieved (Pa)*	*Normal (Pa)*	*Comparison (%)*
step 1	25.896	20	-5.896
Step 2	22.984	20	-2.984
Step 3	20.464	20	-0.464
Step 4	16.392	20	3.608
Step 5	19.128	20	0.872

As shown in Table 3, the range of the average achieved each pressure of every movement of the device comfortably exceeds the normal range pressure of each sensor. All the human normal pressure is completely different due to the size, sex, weight, and height of every single patient that wears the shoes. As we can see here the difference of movement between the step 1 average achieved and normal pressure is about -5.896% which means the patient has exceeded the normal walking range. These modifications represent the replacement of the resistive sensor and the condition patient while using the device. The design of the prototype has proven to be sensible and comprised based on the normal range pressure for each sensor according to patients' conditions. Referring to the figure shows the Comparison between the average pressure achieved by each sensor and the normal pressure of each sensor.

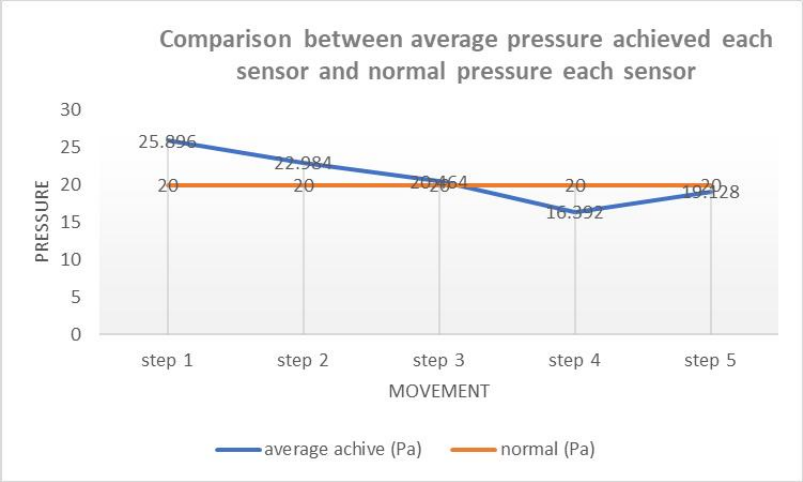

Figure 8: Comparison between average pressure achieved each sensor and normal pressure each sensor.

4. Acknowledgment

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5. Conclusion

The Detection Walking Posture Abnormalities Patient in Human Gait Using Pressure Sensor was designed and developed according to the patient foot size. To drive the resistive pressure sensor to function and detect the abnormal pressure range when patient walking may be altered according to the patient's demand in Arduino IDE program (UNO program) (UNO program). IoT is successfully applied to the device by utilizing the Blynk and Thingspeak application so that the patient may perform the walking therapy by themselves at home cause the application will alert when the walking is in the abnormal range. Next, this project aids irregular walking patterns patients to conduct the treatment session at home without supervision from the therapist at the facility.

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