Wireless smart insole using combinational sensors for foot-ulcer detection and pressure distribution

Ms.D.Sudarvizhi AP (Sr. G) [1], Dr.M.Akila-Prof[2]

Mr.R.Anandkumar, AP(Sr.G)/MECH

Deebak P, Gowtham D, Meivel S

Electronics and Communication Engineering
KPR Institute of Engineering and Technology, Arasur, Coimbatore

Corresponding author : sudarvizhi.d@kpriet.ac.in, akila.m@kpriet.ac.in

ABSTRACT:
Diabetic foot ulcer brings many problems and challenges to patients, health care systems in all parts of the world. It causes illness and even death. Wounds cause nervous problems. This develops high pressure in legs. People with these problems will lose sensations in that area. Because the nerves are damaged by peripheral Neurotherapy. This must be treated correctly. Otherwise, it will cause injury in feet and this leads to the development of an ulcer. This will also lead to amputation. This technique provides a cheap instant resolution to each wear and records plantar foot at the same time. information acquisition used internal native memory to store pressure logs for offline information analysis. processing used the perpendicular slope to work out peak pressure and time of index. applied mathematics analysis will utilize to get foot deformity. The empirical leads to one subject showed a weak one-dimensionality between traditional and quick walk and a significant distinction in weight acceptance between traditional and slow walk. In shoe monitoring, systems can be implemented to avoid ulceration. This is used to measure the peak pressure

continuously. The main parameters are the number, location, and size of sensors. In this paper, the major idea is to build a low-cost pressure measurement and analysis of the pressure using cloud technology.

INTRODCTION:

Studies show regarding 5.1% of the U.S population suffers from the polygenic disease[1]. Up to 25% of diabetic people can develop foot ulceration throughout their life and lots of those patients eventually should bear amputations as a result of infection thanks to untreated foot ulcers [2]. Any reduction within the rate of diabetic foot complications would be vital to tending suppliers, and additional significantly would improve the standard of life for several people. Diabetic patients have issues within their feet in the main owing to poor blood flow, poor sensation(diabetic neuropathy), slashed wound healing rate, and bother fighting

off infection[3].With polygenic disease, even a wound as tiny as a blister, eg. Thanks to a decent shoe, will cause sizeable injury. In such patients, the injuries heal slowly owing to slashed blood flow. Once a wound isn't healing, it's in danger of infection. Moreover, diabetic patients with neuropathic feet lack the sensory feedback that indicates the necessity to vary gait patterns, rest, or take away a shoe to permit the traumatized foot to recover[4]. The first recommendations for preventing diabetic foot traumatized foot to recover. The first recommendations for preventing diabetic foot ulcers are daily foot inspections, temperature watching, and orthotic shoes[5]. Educating patients to perform rumination and properly take care of their feet is cheap and universally suggested. A promising variant of this is often daily mensuration of foot temperature. Finding elevated temperature within the foot could be vital early indicator ulceration. Correct diabetic footwear is effective in reducing the speed of neuropathic foot ulceration[6]. All preventive techniques need the patience to perform bound tasks frequently(foot care, temperature mensuration, or sporting shoes). By taking advantage of current technology, these devices may be placed as an innersole into traditional shoes. Also, considering aesthetics in their styles will result in perceive what style factors can increase patients' compliance. Many systems for activity region pressure within the foot are commercially offered, like Pedar[8] and F-scans[9] systems. These systems are very expensive and aim at athletic exercises and value tens of thousands of greenbacks per unit. For such systems to be reasonable to patients, it might be at a way higher value. This value purpose may be reached with some compromising: primarily the number of sensors within the shoe would be restricted. Many studies have examined such systems, that contain many resistive force sensors set out on an innersole. These studies checked out sensing element placement and established that such a system was attainable, though each system needed a computing device/gateway hooked up to the waist. Our system is equally a work example bindable to the shoe. The most contribution of our work is showing the importance of the field of study exchange.

METHODOLOGY:

This is the primary study to research the forefoot load of diabetic patients in an exceedingly lifestyle environment using foot motion data. Daily walk measurement employing a wearable combination of sensors appears feasible and safely induces no adverse events in patients with diabetes. The smallness and lightness of inertial wearable combinational sensors in soled customized shoes were considered to permit daily measurement of daily walks in diabetic patients. Daily walks of two diabetic patients were measured and consecutive steps not but 30 seconds were analyzed. The sum of all of the consecutive steps that were timed failed to occupy much of the recorded time of patient 1 because he was mainly traveling by buses and trains. Patient 1 had excessive Foot Loading (FL) at a rate of 1 per 5 steps on his way from his home to the stop. The daily walking data of patient 2 included the time strolling around for shopping downtown, and consecutive steps that took but 30 seconds were often observed.Therefore, excessive FL is assumed to possess seldom occurred

during walking when the aim of the consecutive steps wasn't to maneuver around [11]. Patient 2 had excessive FL most often when going home from downtown and therefore the rate was 1 of two steps. it had been observed that there was no excessive load when 30 steps were counted as having been walked on a corridor. Thus, a patient whose forefoot tends to receive excessive load couldn't be found unless the walking measurement is taken in an exceedingly lifestyle environment. The situations within which excessive FL occurred is also different from a laboratory setting in terms of the walking speed or properties of the paved surface in their lifestyle environment [10]. Therefore, these differences may suggest the occurrence of excessive FL. Future research must be conducted which estimates the daily forefoot load of diabetic patients with/without frequent excessive FL and investigate the association between the frequent excessive FL and calluses. Such a future study would offer insights into the screening of patients in danger for DFU.

EXISTING MODEL:

Load cell could be a transducer that's wont to convert a force into electrical signal.The signal is transmitted to SCU (Signal conditional unit) which in turn converts the one form of signal to other. The converted signal is given to node MCU which contains arduino and Wi-fi. The received information is transformed wirelessly to the display.The main components of the project are load cell sensors, signal conditioning unit ,node MCU, Raspberry-pi module and display. The proposed system is divided into two subsystems. They are

- Transmitter system
- Receiver system

Transmitter system consists of the following units. They are

- Load cell sensors
- Signal conditioning unit
- Node MCU

Receiver system consists of two modules. They are

- Raspberry-pi
- Display

LOAD CELL:

Load cell are physical elements, which also are referred to as transducers. Transducers can convert one from of energy into another from of energy ; if force is applied into a load cell, it may be transformed into an electrical signal. This signal will have a magnitude that's directly proportional to the force being applied, making it easier to live. There are various kinds of load cells. The three commonest ones are gauge, hydraulic and pneumatic load cells. this implies that there are three easy ways for a load cell to translate an applied force into a measurable reading. Michigan Scientific in both stock gauge load cells, and custom gauge load cells. And while three are other kinds of load cells, they're less commonly applied.

OPERATION:

Load cell could be a transducer that's accustomed converts a force into electrical signal. This conversion is indirect and happens in two stages. Through a mechanical arrangement, the force being sensed deforms a strain gage. The strain gage converts the deformation (strain) to electrical signals.

A load cell usually consists of 4 strain gage during a Wheatstone bridge configuration. Load cells of 1 strain gage (Quarter Bridge) or two strain gauges (half bridge) also are available. The electrical signal output is usually within the order of some mill volts and requires amplification by an instrumentation amplifier before it is used. The output of the transducer is plugged into an algorithm to calculate the force applied to the transducer.Although strain gage load cells are the foremost common, there are other sorts of load cells also. In industrial applications, hydraulic (or hydrostatic) is maybe the second commonest, and these are utilized to eliminate some problems with strain gage load cell devices. As an example, a hydraulic load cel is resistant to transient voltages (lightning) so can be a more practical device in outdoor environments. Other types include piezoelectric load cells (useful for dynamic measurements of force), and vibrating wire load cells, which are useful in geomechanical applications because of low amounts of drift.Every load cell is subject to "ringing" when subjected to abrupt load changes. This stems from the spring-like behavior of load cell. so as to live the hundreds, they need to deform. As such, a load cell of finite stiffness must have spring-like behavior, exhibiting vibrations at its natural frequency. An oscillating data pattern is the results of ringing figure 2 Ringing is suppressed during a limited fashion by passive means. Alternatively, a sway System can use an actuator to actively damp out the ringing of a load cell. This method offers better performance at a price of great increase in complexity.

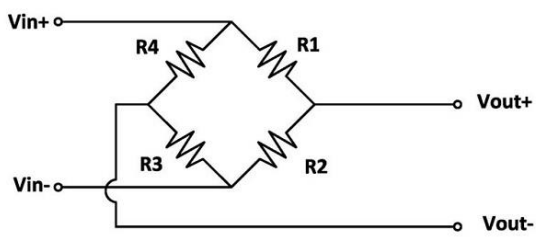
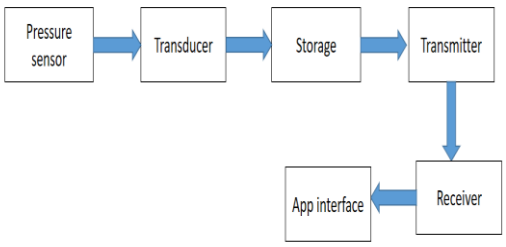


Figure Circuit diagram of load cell sensor

Load cell contains a spring element , which experiences elastic and linear deformation as a results of the force being measured, and a tool for measuring this deformation. There are various ways of measuring small deformations. the aim is usually to map the mechanical parameter "deformation" onto the electrical parameter "voltage" compressive.

PROPOSED MODEL:

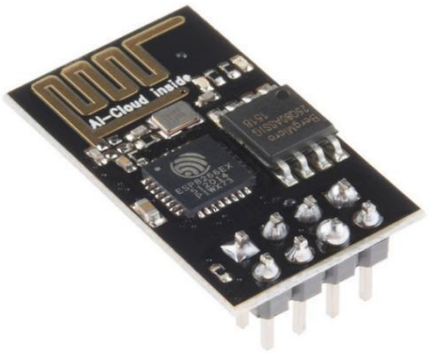


Sensors used will provide the gait analysis. The output of the sensors (piezo-electric,flexi-force,capacitive and resistive) is given as input to the transducer. The transducer produces the output in the form of voltage. This voltage is used to store the data in RAM. The RAM used is of 500 MB. Then the output is given to the transmitter. The transmitter used here is bluetooth transmitter of frequency 2.4 GHz and it covers a range of 100m. This

transmitter signal is received in the mobile which has the same bluetooth receiver of frequency 2.4 GHz and range of 100m. This output is viewed in application interface. Hence the output is obtained.

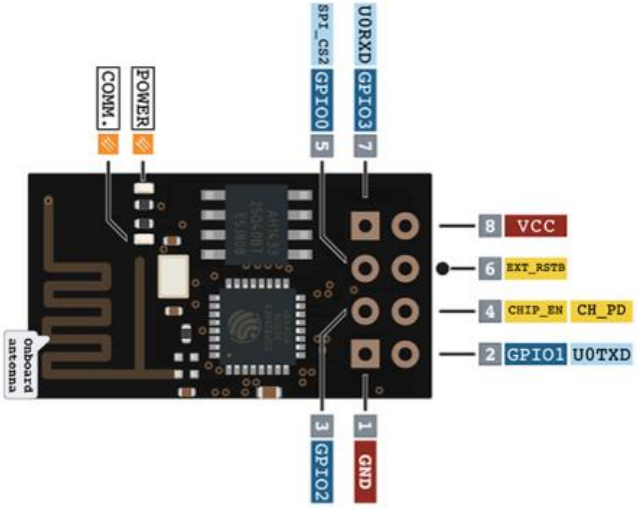
WIFI-MODULE:

The ESP8266 may be a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.The chip first came to the eye of western makers in August 2014 with the ESP -01 module, made by a 3rd party manufacturer, Ai-Thinker. This small module allows micro controllers to attach to a Wi-Fi network and make simple. TCP/IP connections using Hayes-style commands. However, at the time there was almost on West Germanic documentation on the chip and therefore the commands is accepted.They are at very low cost and therefore the indisputable fact that there have been only a few external components on the module which suggested that it could eventually by very inexpensive in volume, attracted many hackers to explore the module, chip and therefore the software on
that, additionally on translate the Chinese documentation.The ESP8285 is an ESP8266 with 1 MB of built-in flash, with single -chip devices capable of connecting to Wi-Fi .The successor to those microcontroller chips is that the ESP32.A Wi-Fi enabled devices, like a private coputer, computer game console, smartphone or digital audio player, can connect with the net when within range of a wireless network connected to the net.



One may also connect Wi-Fi devices in ad-hoc mode for client-to-client connections without a router. Wi-Fi also connects places normally without network access, like kitchens and garden sheds.

Pinconfiguration

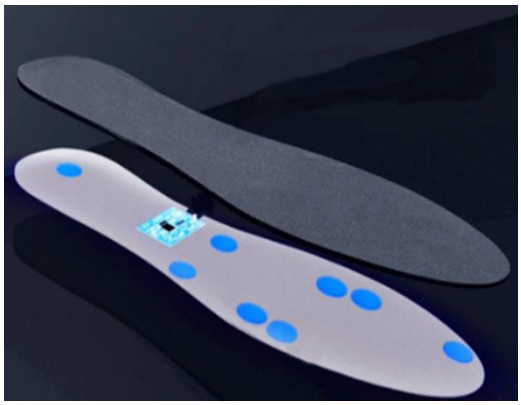


	ɔn
	3.0 ~ 3.6V
	d
Γ	al reset signal (Low voltage level: Active)
ΓOUT)	⁾in Analog Input 0 ~ 1V
Ɔ	:nable.Low: Off, small current; High: On, chip works properly;
)(FLASH)	ıl purpose IO, If low while reset/power on takes chip into serial programming mode
.(TX)	TXd and General purpose IO
;(RX)	RXd and General purpose IO
¦	ıl purpose InputOutput
;	ıl purpose InputOutput
.2	ıl purpose InputOutput
.3	ıl purpose InputOutput
.4	ıl purpose InputOutput
.5(HSPI_CS)	purpose IO, Connect this pin to ground through 1KOhm resistor else from internal flash.

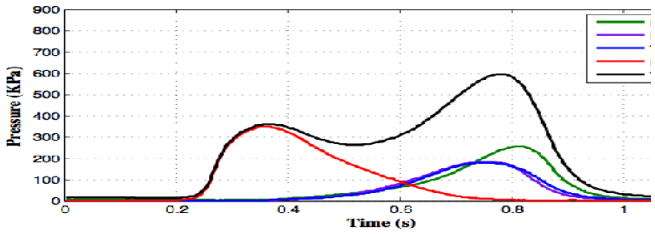
HARDWARE MODULE:

In this module,the sensor are piezo-resistive force sensor and 6-axis inertial motion sensor are used.The sensing of the insole is 10Hz and the thickness of the insole is 3mm.The pressure range of the insole is 30 to1200Kpa.The battery used in this insole is Lithium ion(Li^+) recharagable battery.The analog to digital module power of the insole is 1 to 5VThe operating temperature of the insole is 20 to 60°C.The operating humidity is 10 to 90%RH.The minimal bending radius of the insole is 50mm.The life of the battery used in this is 20 hrs of continuous usage.The charging mechanism

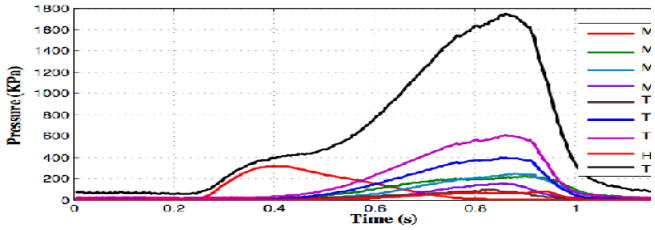
implemented in this insole is micro USB charging.The weight of the insole is 50g per pair and sizes of the insole is 20cm to 31cm which will customizable as per preference.The material used in the insole is patented variation of Processing Unit and Anti-bacterial,breathable and shock absorbing.



RESULTS:



(a) 4 large sensors



(b) 6 small and 2 large sensors

CONCLUSION:

We can prevent the patients from losing their leg. Even Non-diabetic patients can also use this efficiently. It reshapes itself according to the patient's comfort and dynamically monitor the condition and activity of patient and maintains the uniform pressure which in turn prevents the foot ulcer simultaneously. The foot pressure analysis plays a crucial role in determining the wound depth assessment. Hence sensor grid is fabricated in such a way that it senses the perpetual plantar foot pressure and in turn detected pressure automatize the sole pressure distribution through solenoid valves. In future the customized smart shoe will be interfaved via IoT app in order to connect the doctor and the patient for real time monitoring and control. The experiment results that the insole system provides accuracy in reasonable values. This model prevents high tensions or pressure under the feet. Adding more FSR sensors provides more accuracy. This method is quite reliable with low drift and hysteresis effect.

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