A. Arthy et al. 2016, Volume 4 Issue 2
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Blood Flow Stimulator and Foot Neuropathy Analyzer Embedded in Smart Motion Sensing Shoes Designed For Diabetic Patients

[1]A. Arthy, [2]L. Balaji

Abstract

This paper is to design and build a low-cost foot pressure, foot movement analysis, blood flow stimulation and in addition heart rate monitoring system embedded within the smart footwear. The patient can wear the sensing shoes to monitor his or her foot pressure distribution and heart rate. The aged people who may not walk they monitor with the help of heart rate sensing unit if the patient's in abnormal condition means send an alert to the smart phone. Once the system detects an anomaly in the user's foot pressure distribution or foot motion, it issues an alert to the handheld device and diagnose foot neuropathy by stimulating the blood flow with the help of inbuilt vibrating motor in addition diagnose the Blood Pressure as early as possible.

Keywords: Microcontroller, flexi force sensor, TCRT1000Sensor, accelerometer, Vibrating motor, Smartphone.

Introduction

Diabetes is one of the major causes of ill health and early death in universal. Diabetes causes neurovascular difficulties, which result in the development of high pressure areas in the feet and hands. Diabetic neuropathy causes nerve damage which can ultimately lead to ulceration.

Middle vessels influence on ordinary nerve spot, and nerves depends on adequate blood flow. The people with diabetic neural dysfunction would also have Micro vascular dysfunction. As a therapy, sending imperceptible vibrations through the feet of the patients it significantly improves the damaged nerves and stimulates blood flow.

Related Work

[1] Subhas Chandra Mukhopadhyay, The paper titled as "Wearable Sensors for Human Activity Monitoring".

In our principles to control a superiors in world population get in the matter of a grand mature share is forcing rapid rises in healthcare costs. The healthcare system is going through a transformation in which continuous monitoring of inhabitants is possible even without hospitalization. The advancement of sensing technologies, embedded systems, wireless communication technologies, nano technologies, and miniaturization makes it possible to develop smart systems to monitor activities of human beings continuously.

Wearable sensors detect abnormal and/or unforeseen situations by monitoring physiological parameters along with other symptoms. Therefore, necessary help can be provided in times of dire need. This paper reviews the latest reported systems on activity monitoring of humans based on wearable sensors and issues to be addressed to tackle the challenges.

[2] Benoit Mariani∗, Mayt´e Castro Jim´enez, Franc¸ois J. G. Vingerhoets et al, The paper titled as" On-Shoe Wearable Sensors for Gait and Turning Assessment of Patients With Parkinson's Disease "In our goal of this paper is to present an advanced technology based on wearable sensors on-shoe and processing algorithm, which provides outcome measures describing PD motor symptoms during TUG and gait tests. Our results on ten PD patients and ten age-matched elderly subjects indicate an accuracy precision of 2.8±2.4 cm/s and 1.3 ±3.0 cm for stride velocity and stride length estimation compared to optical motion capture, with the advantage of being

practical to use in home or clinics without any discomfort for the subject. In addition, the use of novel spatio-temporal parameters, including turning, swing width, path length, and their intercycle variability, was also validated and showed interesting tendencies for discriminating patients in ON and OFF states and control subjects.

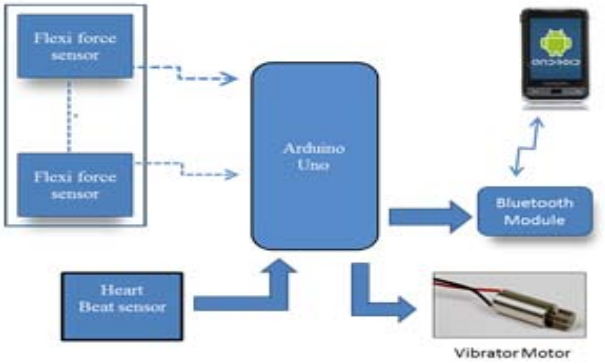
[3] Karandeep Malhi, Subhas Chandra Mukhopadhyay et al ,this paper titled as" A Zigbee-Based Wearable Physiological Parameters Monitoring System" In our system is to impact sensor has been used to detect falls. The device detects if a person is medically distressed and sends an alarm to a receiver unit that is connected to a computer. This sets off an alarm, allowing help to be provided to the user. The device is battery powered for use outdoors. The device can be easily adapted to monitor athletes and infants. The low cost of the device will help to lower the cost of home monitoring of patients recovering from illness. A prototype of the device has been fabricated and extensively tested with very good results.

[4] Pietro Salvo, Fabio Di Francesco, Daniele Costanzo, Carlo Ferrari et al,This paper titled as" A Wearable Sensor for Measuring Sweat Rate "In our system Wearable sensors present a new frontier in the development of monitoring techniques. They are of great importance in sectors such as sport and healthcare as they enable physiological signals and biological fluids, such as human sweat, to be continuously monitored. Until recently this could only be carried out in specialized laboratories using cumbersome and often expensive devices. Sweat monitoring sensors integrated onto textile substrates are not only innovative but they also represent the first attempt to use such an idea in a system that will be worn directly on the body. This study outlines the development of a wearable sweat-rate sensor integrated onto a textile.

Methodology

The system consists of three units namely foot unit, heart rate sensing and hand held unit. In the foot unit will take abnormal foot pressure of patient .For the aged patients who may not walk they monitor with the help of heart rate sensor. Both the unit sending imperceptible data to hand held unit. Hand held unit is for receiving data form foot unit and heart rate sensing unit .The handheld touch screen unit communicates wirelessly with the foot attached unit and collects real-time data, stores it in the memory card for analysis by a doctor at afterward. The device monitors the user foot progress using a 3-axis MEMS Accelerometer and actively looks for situations leading to foot injuries. Once the system detects an abnormality in the user's foot pressure distribution or foot motion, it issues an alert to the handheld touch screen device. To improve the blood flow the smart footwear has a set of miniature Vibrating Motors that excite the nerves by vibrating in different amplitude that can be configured individually, started and stopped by the user using the handheld touch screen unit. The smart footwear will collect data from foot pressure sensors and foot motion sensor and periodically transfer this data to the handheld unit where it will be stored in a 2GB Micro SD memory card for future reference or for an analysis by a doctor.

Block Diagram



Hardware Component

Arduino Uno

The Development Tool is used here is Arduino 1.6.7 (ide) and the Programming Language isEmbedded c. The Protocol used here is USART.

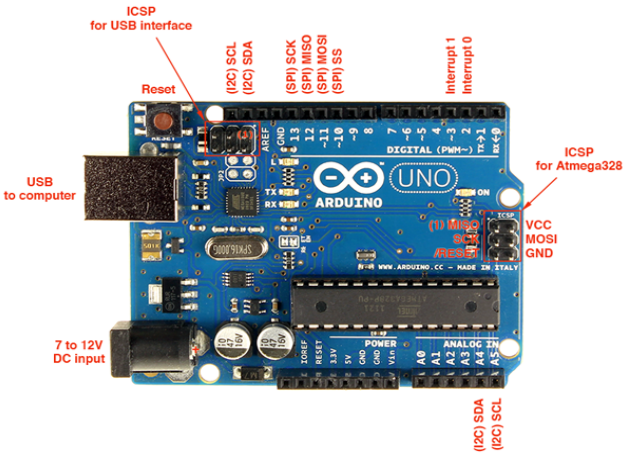


Fig: 1 Arduinouno Microcontroller

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter."Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM.

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode (), digital Write (),and functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50k ohms.

Serial: 0 (RX) and 1 (TX): Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

External Interrupts: 2 and 3: These pins can be configured to trigger an interrupt on a lowvalue, a rising or falling edge, or a change in value. See the attach Interrupt ()function for details.

***PWM: 3, 5, 6, 9, 10, and 11*:** Provide 8-bit PWM output with the analog Write ()function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK): These pins support SPI communication using the SPI library.

LED 13: There is a built-in LED connected to digital pin 13. When the pin is HIGH value, theLED is on, when the pin is LOW, it's off.

TWI: A4 or SDA pin and A5 or SCL pin: Support TWI communication using the Wire library. There are a couple of other pins on the board.

AREF: Reference voltage for the analog inputs. Used with analog Reference.

Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board

Heart Beat Sensor

The TCRT1000 are reflective sensors which include an infrared emitter and phototransistor in a leaded package which blocks visible light. The Principle of PhotoPlethysmoGraphy (PPG) is used in heart beat sensors. Measuring the variation in blood volume in tissues using a light source and a detector.

Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH Adaptive Frequency Hopping Feature.

Flexi Force Sensor

This is a force sensitive resistor with a round, 0.5" diameter, sensing area. This FSR will vary its resistance depending on how much pressure is being applied to the sensing area. The harder the force, the lower the resistance. When no pressure is being applied to the FSR its resistance will be larger than 1MΩ. This FSR can sense applied force anywhere in

the range of 100g-10kg. Two pins extend from the bottom of the sensor with 0.1" pitch making it bread board friendly. There is a peel-and-stick rubber backing on the other side of the sensing area to mount the FSR. Just Connect a resistor to form a voltage divider and measure the voltage at the junction to find the force applied. These sensors are simple to set up and great for sensing pressure, but they aren't incredibly accurate. Use them to sense if it's being squeezed, but you may not want to use it as a scale. This sensor can be easily interfaced with Microcontrollers, Arduino Boards.

MEMS Accelerometer

An accelerometer is an electromechanical device that is used to measure acceleration and the force producing it. Many types of accelerometers are available in the market today. They can be divided according to the force (static or dynamic) that is to be measured. Even today, one of the most commonly used one is the piezoelectric accelerometer. But, since they are bulky and cannot be used for all operations, a smaller and highly functional device like the MEMS accelerometer was developed. Though the first of its kind was developed 25 years ago, it was not accepted until lately, when there was need for large volume industrial applications. Due to its small size and robust sensing feature, they are further developed to obtain multi-axis sensing.

Working Principle

One of the most commonly used MEMS accelerometer is the capacitive type. The capacitive MEMS accelerometer is famous for its high sensitivity and its accuracy at high temperatures. The device does not change values depending on the base materials used and depends only on the capacitive value that occurs due to the change in distance between the plates.

Vibration Motor

A vibrator is a mechanical device to generate vibrations. The vibration is often generated by an electric motor with an unbalanced masson its driveshaft. Vibration motor is a compact size coreless DC motor used to Informs the users of receiving the signal by vibrating, no sound. Vibration motors are widely used in a variety of applications including cell phones, handsets, pagers, and so on. The main features of vibration motor is the magnet coreless DC motor are permanent, which means it will always have its magnetic properties (unlike an electromagnet, which only behaves like a magnet when an electric current runs through it); another main feature is the size of the motor itself is small, and thus light weight. Moreover, the noise and the power consumption that the motor produce while using are low. Based on those features, the performance of the motor is highly reliable.

Software Implementation

Android

Android is an open source and Linux-based Operating System for mobile devices such as smart phones among many ways, Bluetooth is a way to send or receive data between two different devices. Android platform includes support for the Bluetooth framework that allows a device to wirelessly exchange data with other Bluetooth devices. Scan for other Bluetooth devices and get a list of paired devices then Connect to other devices through service discovery.

Output

Conclusion

Diabetic Neuropathy is a serious medical disorder and can be prevented by the early detection of abnormal pressure patterns under the foot. Although equipment to measure foot pressure distribution is available in India and elsewhere, these are still not readily accessible for a large segment of the population, are too expensive to own, and are too bulky to be portable. This paper is to design a low-cost foot pressure, foot movement analysis, blood flow stimulation and heart rate monitoring system to diagnose the foot neuropathy and BP as early as possible.

References

[1] Subhas Chandra Mukhopadhyay, Fellow, "Wearable Sensors for Human Activity Monitoring IEEE SENSORS JOURNAL", VOL. 15, NO. 3, MARCH 2015

[2] Benoit Mariani∗, Mayt´e Castro Jim´enez, Franc¸ois J. G. Vingerhoets, and KamiarAminian, Member, IEEE "On-Shoe Wearable Sensors for Gait and Turning Assessment of Patients With Parkinson's Disease" IEEE transactions on biomedical engineering, vol. 60, no. 1, january 2013.

[3] Karandeep Malhi, Subhas Chandra Mukhopadhyay, Fellow, IEEE, Julia Schnepper, Mathias Haefke, and Hartmut Ewald "A Zigbee-Based Wearable Physiological Parameters Monitoring System." IEEE sensors journal, vol. 12, no. 3, march 2012.

[4] Pietro Salvo, Fabio Di Francesco, Daniele Costanzo, Carlo Ferrari, Maria Giovanna Trivella, and Danilo De Rossi. "A Wearable Sensor for Measuring Sweat Rate." IEEE sensors journal, vol. 10, no. 10, october 2010.

[5] M. Z. Poh, K. Kim, A. Goessling, N. Swenson, and R. Picard,"Cardiovascular monitoring using earphones and a mobile device,"IEEE Pervasive Comput., vol. 11, no. 4, pp. 18–26, Oct./Dec. 2012.

[6] P. Salvo, F. Di Francesco, D. Costanzo, C. Ferrari, M. G. Trivella, and D. De Rossi, "A wearable sensor for measuring sweat rate," IEEE Sensors J., vol. 10, no. 10, pp. 1557–1558, Oct. 2010.

[7] C. Strohrmann, H. Harms, C. Kappeler-Setz, and G. Tröster, "Monitoring kinematic changes with fatigue in running using body worn sensors," IEEE Trans. Inf. Technol. Biomed., vol. 16, no. 5, pp. 983–990, Sep. 2012.

[8] M. Ermes, J. Pärkkä, J. Mäntyjärvi, and I. Korhonen, "Detection of daily activities and sports with wearable sensors in controlled and uncontrolled conditions," IEEE Trans. Inf. Technol. Biomed., vol. 12, no. 1, pp. 20–26, Jan. 2008.

[9] B. Mariani, M. C. Jiménez, F. J. G. Vingerhoets, and K. Aminian, "On-shoe wearable sensors for gait and turning assessment of patients with Parkinson's disease," IEEE Trans. Biomed. Eng., vol. 60, no. 1, pp. 155–158, Jan. 2013.

[10] B.-R. Chen et al., "A web-based system for home monitoring of patients with Parkinson's disease using wearable sensors," IEEE Trans. Biomed. Eng., vol. 58, no. 3, pp. 831–836, Mar. 2011.

[11] S. Patel et al., "Monitoring motor fluctuations in patients with Parkinson's disease using wearable sensors," IEEE Trans. Inf. Technol. Biomed., vol. 13, no. 6, pp. 864–873, Nov. 2009.

[12] P. Castillejo, J. F. Martínez, J. Rodríguez-Molina, and A. Cuerva, "Integration of wearable devices in a wireless sensor network for an E-health application," IEEE Wireless Commun., vol. 20, no. 4, pp. 38–49, Aug. 2013.

[13] O. Aziz and S. N. Robinovitch, "An analysis of the accuracy of wearable sensors for classifying the causes of falls in humans," IEEE Trans. Neural Syst. Rehabil. Eng., vol. 19, no. 6, pp. 670–676, Dec. 2011.

[14] C. Ranhotigmage, "Human activities and posture recognition: Innovative algorithm for highly accurate detection rate," Dept. Eng. Electron.Comput. Syst. Eng., M.S. thesis, Massey Univ., Palmerston, New Zealand, 2013.[Online]. Available: http://mro.massey.ac.nz/handle/10179/4339

[15] T. Shany, S. J. Redmond, M. R. Narayanan, and N. H. Lovell, "Sensors based wearable systems for monitoring of human movement and falls," IEEE Sensors J., vol. 12, no. 3, pp. 658–670, Mar. 2012.

Author's details

[1]UG Student, Department of ECE, IFET College Of Engineering, Villupuram, India, Email: arthyifetece@gmail.com

[2]Assistant Professor, Department of ECE, IFET College Of Engineering, Villupuram, India, Email: balaji87.ram@gmail.com

Copy for Cite this Article- A. Arthy and L. Balaji, "Blood Flow Stimulator And Foot Neuropathy Analyzer Embedded In Smart Motion Sensing Shoes Designed For Diabetic Patients", *International Journal of Science, Engineering and Technology,* Volume 4 Issue 2: 2016, pp. 409- 413.