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DIABETIC NEUROPATHY PREDICTION BASED ON A DESIGNED WEARABLE SENSING SHOE

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ABSTRACT

Diabetic neuropathy is a type of nerve damage that occur with diabetes. The condition most often effects the legs and feet. New smart technologies and the internet of things increasingly play a key role in healthcare and wellness, contributing to the development of novel healthcare concepts. These technologies enable a comprehensive view of an individual's movement and mobility, potentially supporting healthy living as well as complementing medical diagnostics and the monitoring of therapeutic outcomes. In this overview article specifically addresses smart shoes, whichare becoming one such smart technology within the future internet of healththings, since the ability to walk defines large aspects of quality of life in a wide range of health and disease conditions.

1. INTRODUCTION

Diabetic neuropathy is a type of nerve damage that occur with diabetes. The condition most often effects the legs and feet. New smart technologies and the internet of things increasingly play a key role in healthcare and wellness,contributing to the development of novel healthcare concepts.

Technology developments towards novel healthcare concepts pave the way for the rising area of digital health, which, according to the U.S. Food and Drug Administration (FDA), includes categories such as mobile health (mHealth), health information technology, wearable devices, telehealth and telemedicine, and personalized medicine. Especially, new smart wearable technologies and the health information technology provided. Even though the disease-causing mechanismsand symptomatic patterns are specific to each disorder, impaired mobility can be the things would enable a comprehensive view of an individual's life. In this context, mobility isof the utmost importance, as it defines quality of life in healthy living and chronic diseases.

Numerous neurological, musculoskeletal, and cardiovascular disorders, distinct symptoms reduce motor function and/or cardio-pulmonary capacity, and thereby limit the independence and autonomy of individuals. Even though the disease-causing mechanisms and symptomatic patterns are specific to each disorder, impaired mobility is a typical consequence. This fact makes mobility an important surrogate marker for disease severity, progress, and responsiveness to prescribed therapies, providing opportunities to assist therapeutic decision making.

Technology developments towards novel healthcare concepts pave the wayfor the rising area of digital health, which, according to the U.S. Food and Drug Administration (FDA), includes categories such as mobile health (mHealth),humanbeings information technology,wearable devices, telehealth and telemedicine, and personalized medicine.Especially, new smart wearable technologies and the health information technology provided by the internet of things would enable a comprehensive view of an individual's life. In this context, mobility is of the utmost importance, as it defines quality of life in

healthy living and chronic diseases. In numerous neurological, musculoskeletal, and cardiovascular disorders, distinct symptoms reduce motor function and/or cardio- pulmonary capacity, and thereby limit the independence and autonomy of individuals. Even though the disease- causing mechanisms and symptomatic patterns are specific to each disorder, impaired mobility is a typical consequence. This fact makes mobility an important surrogate marker for disease severity, progress, and responsiveness to the prescribed therapies, providing opportunities to assist therapeutic decisionmaking.

Diabetic neuropathy is a type of nerve damage that occur with diabetes. The condition most often effects the legsand feet. New smart technologies and the internet of things increasingly playa key role in healthcare and wellness, contributing to the concept. The other end of the load returns.Transformer via the other parallel diode when the polarity changes the other to diodes conduct.These systems consist of pressure sensors for plantar pressure measurement, inertial sensors (accelerometer and/or gyroscope) for movement detection and a wired or wireless connection for data acquisition. The signal processing of this collected data varies depending on the application, can range from IOT methodologies running on a web page.

Several vital biomechanical parameters can be estimated using sensors placed in the footwear. For example, by placing pressure-sensitive elements in the footwear, foot plantar pressure can be measured. By utilizing pressure- sensitive elements along with inertial sensors, several gait parameters can be calculated. Additionally, by placing actuators in the footwear and measuring gaitpatterns, one can generate biofeedback to assist patients suffering from stroke. The same set of pressure sensors and inertial sensors can also be used in tracking posture and activity recognition and energy expenditure estimation.

The system is classified into two parts, viz. Hardware and software; whereas hardware units consists of microcontroller, inertial sensors (Accelerometer and Gyroscope), pressure sensors, flexible sensors and wearable sensors. ATmega-8 is basically an Advanced Virtual RISC (AVR) micro-controller. It supports the data up to eight (8) bits. ATmega-8 has 32KB internal built-in memory. This micro-controller has a lot of other characteristics. Here the microcontroller is connected with pressure sensor such as capacitive force sensor, optical force sensor, force sensitive sensor. The temperature sensors are connected with microcontroller for initiate the amountof temperature of its environment and converts the input data.

Sensing area: large area underestimates peak pressure where as too small area leads to inaccurate estimate of peak pressure. Sensor area should be minimum 5*5 mm to be a stand-alone sensor.

Temperature sensors are connected with microcontroller for initiate the amount of temperature of its environment and converts the input data into electronic data to record, which generate electrical voltage or resistance once it notices a change in temperature. They consist ofThermocouples, Resistor temperature detector, Thermistors. A pressure sensor is a device for pressure measurement of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. ATmega-8 is basically an Advanced Virtual RISC (AVR) micro- controller. It supports the data up toeight

(8) bits. ATmega-8 has 32KB internal built-in memory. This micro- controller has a lot of other characteristics. ATmega-8 iscommonly used in many projects and autonomous systems where asimple, low- powered, low-cost micro- controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino Uno developmentplatform, namely the Arduino Uno and Arduino Nano models. In addition, the ATmega-8 is designed with static logic for operation down to zero frequency

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and supports two software selectable power saving modes. The idle mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The accumulator is used as a generalregister to accumulate the results of the large number of instructions. It can hold an 8-bit (1-byte) value and is the most versatile register the 8051 has duethe shear number of instructions that make use of the accumulator. PCB of Microcontroller Board which has ATmega-8 IC shown in figure 4.1, calibration internal oscillator, regulators and power supply are included with CPU.
ADC stands for Analog to Digital Converter. ADC is an electronic circuit used to convert analog signals into digital signals. This digital representation of analog signals allows the processor (which is a digital device) to measure the analog signal and use it through its operation. Arduino Pins A0-A5 are capable of reading analog voltages. On Arduino the ADC has 10-bit resolution, meaning it can represent analog voltage by 1,024 digital levels. The ADC converts voltage into bits which the microprocessor can understand. One common example of an ADC is Voice over IP (VoIP). Every smartphone has a microphone that converts sound waves (voice) into analog voltage. This goes through the device's ADC, gets converted into digital data, which is transmitted to the receiving side over the internet. In addition, the ATmega-8 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The idle mode stops the CPU while allowing the RAM, timer/counters,serial port and interrupt system to continue functioning. The accumulator isused as a general register to accumulate the results of the large number of instructions. It can hold an 8-bit (1-byte) value and is the most versatile register the 8051 has due the shear number of instructions that make use of the accumulator. Common-mode rejection isthe ability of the differential amplifier (which sitsbetween the oscilloscope and probes as a signal- conditioning preamp) to eliminate the common-mode voltage from the output But as signal frequency.

2. MAIN CONTRIBUTIONS

- The pilot study demonstrates the efficaciousness of the physical activity on the psychological feature performances in frail older adults, whereas maintaining an occasional breakage level.
- We use the important dataset, collected during a semi-controlled setting, to judge the performances of a binary stress detection system supported completely different classification algorithms. It provides promising results compared with solutions utilized in fully controlled settings.

3. MONITORING

Foot Perfusion test is performed as part of clinical tests for diabetic patients. This test is per-formed to evaluate the effective blood circulation of the foot. To monitor blood perfusion, decision to add Heart-Rate Monitor is taken. Heart rate monitors can provide information about pulse and oxygen saturation (SpO2) of the blood which can help in extractingfootperfusion information. Thisinformation can be used to extract information about blood flow of the body such as pulse rate or oxygen saturation. When the blood flow changes due to physiologicalchanges such as blood pulserate or change in blood volume, light shown on the skin also changes in predictable manner. This information can be used to extract information aboutblood flow of the body such as pulse rate or oxygensaturation.

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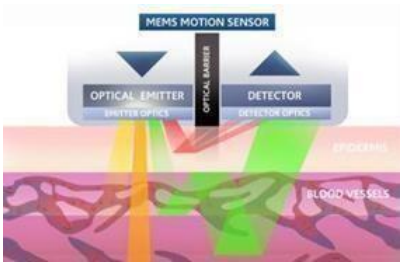

As a result, so as to prevent and minimise the danger of frailty failure, personal interventions should be developed, each in terms of health observance solutions and psychological feature and motor rehabilitation, as counseled by gerontologists. Personalisation, on the opposite hand, ought to take into consideration the degree of stress that these styles of programmes will cause in every subject, with the goal of determinant the optimum coaching condition in terms of each progress and private compliance. In fact, despite the very fact that correctcoaching has been shown to assist within themaintenance of economical psychological feature and motor skills, the connection between frailty standing and also the execution of specific coaching sessions has however to be examined, significantly in terms of connected stress. For the testing of heart rate monitor feasibility, MAX30102, a low power heart- rate and SpO2 monitor was selected. Manufacturer of the sensor (Maxim Integrated) also provided sample implementation of heart-rate algorithm to facilitate sensor integration and adoption. There are two areas of the foot where pulse can be detected. Heart-Rate sensor is placed at both sites to test the feasibility of the sensor integration. However it is found that sensor provided inconsistent results.

This influences variety of physiological processes, as well as pulse, respiration, pressure level, pupil dilation, and lots of others. As a result, in recent years, variety of methodologies and instruments (both intrusive and non- intrusive) are accustomed outline and classify physiological stress markers. Heart- Rate sensor is very sensitive to any movement of the sensor from the skin surface. If there is disturbance, it directly affect scattered and received signal at the detector. This results in erroneous readings.

4. PROPOSED SOFTWARE

EEPROM

Almost all AVR microcontrollers have internal EEPROM for semi- permanent data storage. Like flash memory, EEPROM can maintain its contents when electrical power is removed. In most variants of the AVR architecture, this internal EEPROM memory isnot mapped into the MCU's addressable memory space. It can only be accessedthe same way an external peripheral device is, using special pointer registers and read/write instructions which makes EEPROM access much slower than other internal RAM.

However, some devices in the SecureAVR (AT90SC) family use a specialEEPROM mapping to the data or program memory depending on the configuration. The XMEGA family also allows the EEPROM to be mapped into the data address space. Since the number of writes to EEPROM is not unlimited — Atmel specifies100,000 write cycles in their datasheets — a well designed EEPROM write routine should compare the contents of an EEPROM address with desired contents and only perform an actual write if contents need to be changed. Atmel's AVRs have a two stage, single level pipeline design. This means the next machine instruction is fetched as the current one is executing. Most instructions take just one or two clock cycles, making AVRs relatively fast among the eight- bit microcontrollers. The AVR family of processors were Atmel's AVRs have a two stage, single level pipeline design. This means the next machine instruction is

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fetched as the current one is executing. Most instructions take just one or two clock cycles, making AVRs relatively fast among the eight- bit microcontrollers. The AVR family of processors were can only be accessed the same way an external peripheral device The AVR Instruction Set is more orthogonal than those of most eight-bit microcontrollers, in particular the 8051 clones and PIC microcontrollers with which AVR competes today. Additionally, some chip-specific differences affect code generation. Code pointers (including return addresses on the stack) are two bytes long on chips with up to 128 kBytes of flash memory, but three bytes long on larger chips; not all chips have hardware multipliers; chips with over 8 kBytes of flash havebranch and call instructions with longer ranges; and so forth.

MCU Speed

The AVR line can normally support clock speeds from 0-20 MHz, with some devices reaching 32 MHz. Lower powered operation usually requires areduced clock speed. All recent (Tiny, Mega, and Xmega, but not 90S) AVRs feature an on-chip oscillator, removing the need for external clocks or resonator circuitry. Some AVRs also have a system clock prescaler that can divide down the system clock by up to 1024. This prescaler can be reconfigured by software during run-time, allowing the clock speed to be optimized. Since all operations (excluding literals) on registers R0 - R31 are single cycle, the AVR can achieve up to 1 MIPS per MHz, i.e. an 8 MHz processorcan achieve up to 8 MIPS. Loads and stores to/from memory take 2cycles, branching takes 2 cycles. Branches in the latest "3- byte PC" parts such as ATmega2560 are one cycle slower than on previous devices. Since all operations (excluding literals) on registers R0 - R31 are single cycle, the AVR can achieve up to 1 MIPS per MHz, i.e. an 8 MHz processorcan achieve up to 8 MIPS. Loads and stores to/from memory take 2 cycles, branching takes 2 cycles. Branches in the latest "3-byte PC" parts such as ATmega2560 are one cycle slower than on previous devices.

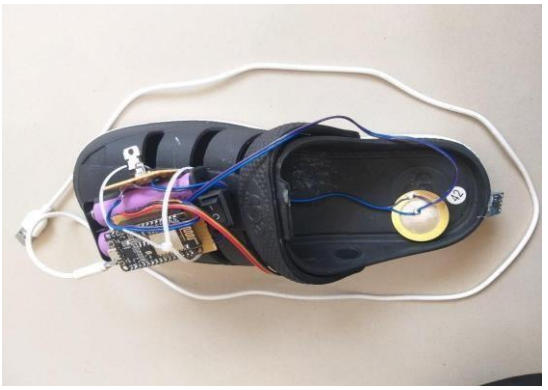
ISP

The In-system programming (ISP) programming method is functionally performed through SPI, plus some twiddling of the Reset line. As long as the SPI pins of the AVR aren't connected to anything disruptive, the AVR chip can stay soldered on a PCB while reprogramming. All that's needed is a 6-pin connector and programming adapter. This is the most common wayto develop with an AVR.

The Atmel AVR ISP II device connects to a computer's USB port and performs in-system programming using Atmel's software. AVRDUDE (AVR Downloder UploadEr) runs on Linux, FreeBSD, Windows, and Mac OS X, and supports a variety of in-system programming hardware, including Atmel AVR ISP mkII, Atmel JTAG ICE, older Atmel serial-port based programmers, and various third-party and "do-it-yourself"programmers.

5. RESULTS AND DISCUSSION

In our project we are using the **µVision3 Debugger window** software to set the commands. The output from the sensor is matched with the present commands in the microcontroller to obtain the desired output. pressure sensor is monitors the diabetic neuropathy and the display shows the rangescontinuously.
Diabetic neuropathy is a type of nerve damage that occur withdiabetes. The condition most often effects the available systems for pressure measurements are expensive and do not provide any information apart from pressure. Recent research trend shows inclination towards sock-based wearable systems however, there is a research gap for use of multiple parameters in sock system. Few such socks are commercially available. These systems only target one parameter and does not provide any information about the measurement system.



Hence, sock based wearable design incorporating multiple diabetic foot indicators has better prospects and offers several advantages of platform or shoe-based systems.

CONCLUSION

This project mainly focused on designing and developing of wearable sensing sock-shoe which can predict the diabetic neuropathy. In addition to the existing footwear-based solutions from academic research as well as commercial ones in the areas of gait monitoring, plantar pressure measurement, posture and activity classification, body weight and energy expenditure estimation, biofeedback, fall risk applications, navigation, along with footwear-based energy harvesting solutions were detailed.

The article also discussed sensor technology, data acquisition, signal processing techniques of different footwear-based systems along with critical discussion on their merits and demerits**.**

FUTURE SCPOE

Our existing system have drawbacks and high cost sensors are used. We proposed the system to overcome all the drawbacks by using low cost sensors and additionally attempted to shine a light on recent trends and future technological pathways for footwear-based solutions.

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