ISSN: 2348 - 2117

International Journal of Engineering Technology and Computer Research (IJETCR)

Available Online at www.ijetcr.org

Volume 11; Issue 03; May-June; 2023; Page No. 01-09

Enhancing Elderly Well-being: An Embedded Robust Fitness Tracker for Holistic Mental and Physical Health Monitoring

Saakshi Goswami

Jaipur Engineering College and Research Centre, Jaipur Urvashi Goswami, M.B.M. Engineering College, Jodhpur.

Conflicts of interest: Nil

Corresponding author: Saakshi Goswami

Abstract

Every person's health needs are unique and complicated, therefore they must be carefully monitored and attended to. This becomes more of a problem now because constant monitoring is required yet almost no one has the time to perform it. There is a critical need for health assessment tools and technologies to efficiently and affordably address these issues. While there are consumer-level health monitoring gadgets out now, the financial burden on the typical person still has to be addressed. The primary goal of this project is to create a low-cost wearable health monitoring band that can track vital signs such as temperature, heart rate, pulse, and even detect falls and sound an alarm for people with chronic conditions like Down syndrome.

Keywords: Health monitoring, Medical Instrumentation,Sensors, Wearable electronics, Wrist band.

Introduction

Hearing aids, pacemakers, and other forms of implantable medical equipment have been worn by the general public for decades. Wearable electronic devices have been more popular in recent years; they were not originally conceived of as such but have been modified to better meet consumer needs. Wearable technology with built-in GPS is now commercially accessible and widely hailed as a breakthrough in practical technology. Consumers may see pertinent information about themselves while using these devices. The patient's breathing, heart rate, temperature, and the possibility of a fall are all tracked by the band. A personal computer is linked to the signal collection module to show the findings of the signal processing analysis and provide precise user feedback. In this setup, several measurements may be taken using only one instrument. Importantly, none of the planned measures will be intrusive.

PROBLEM STATEMENT

Elderly people face a great difficulty of frequent visits and prolonged stay in the hospitals. Monitoring their unstable vitals is yet another challenge.

ROLE OF SENSORS

Wearable electronics rely heavily on sensors, which play an increasingly important role as they shrink and improve in sophistication. Wearable technology may make use of a wide variety of sensors. The speed and direction of a moving system may be tracked with the help of a DPS310 pressure sensor. Pressure, temperature, compass, GPS, gyroscope, and humidity sensors are also often used. Sensors in medical devices may track and record data on a wide variety of physiological parameters, including heart rate, blood pressure, blood oxygen levels, muscular activity, and even body composition and weight. Activity trackers for sports and fitness have become a popular healthcare wearable. The ability to monitor one's movement is a standard feature of most modern smartphones. A person's pulse rate may also be measured and shown graphically. Smart clothing and bands are effective for health monitoring since they are warmly received by the end users.

EASE OF USE

To ensure continuous monitoring data log is maintained and for safety an alarm has been set, that buzzes in case of any abnormalities in the measured parameters. The methods that we have introduced for the measurement of parameters are totally pain free and are easy to be handled by the patients and others. Since the biometric data is monitored continuously, frequent visits to the hospital can be avoided. The bed ridden people can be easily taken care even at home. Children who are prone to certain genital disorder require frequent monitoring. This can be totally reduced with the help of this device. They are cost efficient and reliable.

SOCIAL BENEFITS

The wearable health monitoring band is very useful for the patients who do not have stable health condition. When the people are bed ridden, the band is used to monitor and check their vitals without having the trouble of moving them to the hospital and better health management. Children who are bornwith certain genital disorder are very unstable with certain medical parameters like blood pressure which make them slow and prevent them from the society to avoid unexpected breakdown or collapse. These children can be left free wearing the band so that they can be monitored with the help of the data log anywhere. They reduce the medical expenditure to a great extent.

METHODOLOGY

This project has a great advantage over the availablecommercial product and is comparatively economical. They can be easily operated and are more comfortable to the user.

Block Diagram

The suggested model's block diagram is seen in Fig. 1. Body temperature, respiration rate, heart rate, and pulse are all examples of parameters that will be monitored. In addition, the data log explains how the data will be gathered through the Internet of Things.

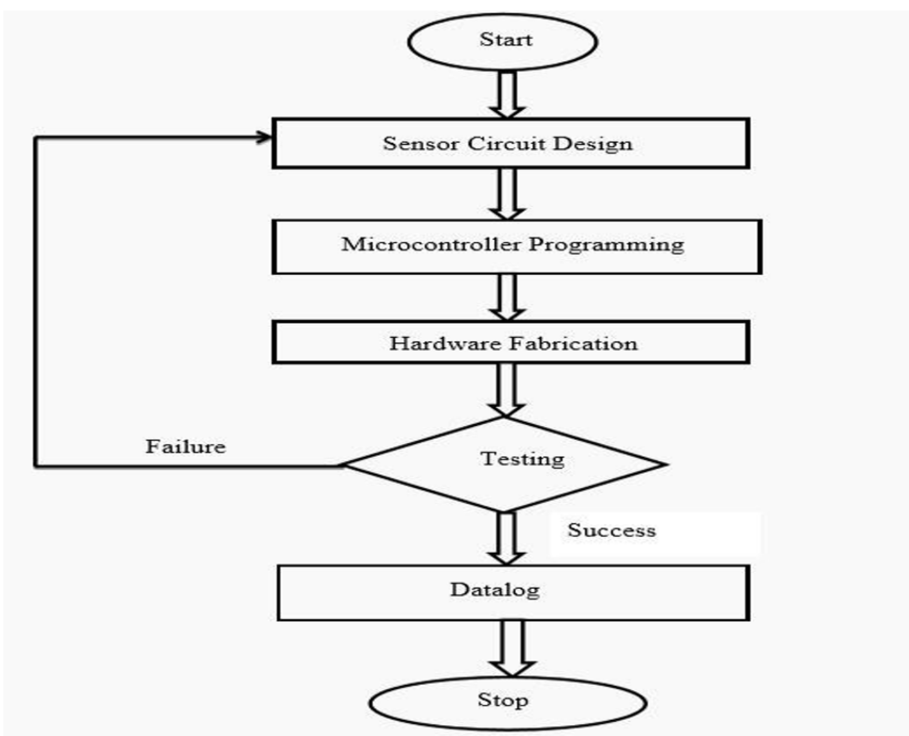


Figure 1. Flow Diagram of the Proposed Model

Flow Diagram

These flow diagram (Fig.2) gives the overall view of the working of the proposed system and the arrangements made inthe band for the data log.

Sensor Circuit design

A sensor PCB is designed to house the temperature sensor, Infineon DPS310 Pressure Sensor, pressure sensor, pulse wave sensor, pulse oximeter and optical sensor[12][21].

Microcontroller Programming

The microcontroller is programmed to collect the data from the individual sensors and feed them to the Wi-Fi module

Hardware Fabrication

The sensor and microcontroller unit are fabricated on a PCB. This setup is mounted on a band made up of a conducting fabric which can be worn by the patient.

Testing

This device is tested on a patient to check its functioning compared with other products in the market.

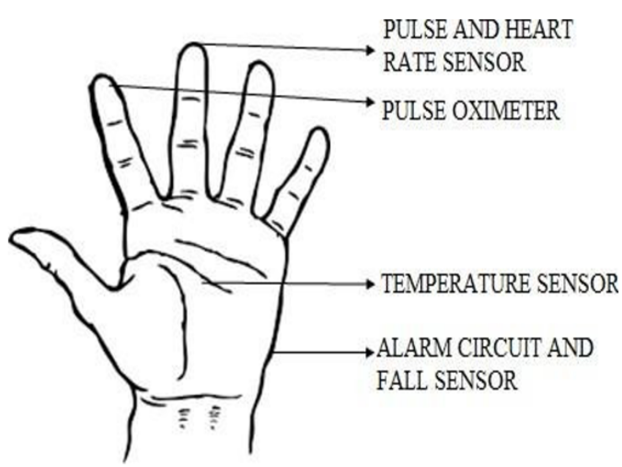
Data log

The physiological parameters are continuously monitored andstored into a database or cloud and are used at times of need.

PROJECT IMPLEMENTATION

Positioning Of Sensors

The positioning of the sensors on the band is done as shownin Fig.3.The pulse and heart rate sensor is placed on the middle finger, pulse oximeter on the index finger, temperaturesensor behind the palm and alarm circuit and fall sensor on thewrist.



A. Temperature Sensor

The temperature of the body is measured by use of a temperature sensor. Thermistors are often used to measure temperature. A thermistor is a temperature-sensitive resistor. A thermistor is a kind of temperature sensing element made from sintered semiconductor material, which shows a considerable change in resistance in response to a relatively little change in temperature. The resistance of a thermistor often lowers as its temperature rises[12, 24]. This is because thermistors typically have a negative temperature coefficient. Two kinds of thermometers exist.

- ✓ In a Negative Temperature Coefficient (NTC) component, the resistance drops as the temperature rises. The temperature sensor and current limiter in one convenient package.
- ✓ PTC (Positive Temperature Coefficient) is a kind of over current protection in which an increase in temperature results in an increase in resistance.

An NTC 10K thermistor is used as temperature sensor.

Figure 4: A 10K Thermistor

A. *Heart Beat & Pulse Sensor*

A heart rate and pulse sensor detects and records each heartbeat and pulse. It is often attached to a finger or earlobe and communicates with Arduino via wires. It also comes preinstalled with an open-source app that can show your heart rate. A tiny circular hole with an LED on the opposite side of the sensor allows it to make touch with the skin on the side with the heart logo. A tiny square sits directly beneath the LED; this is an ambient light sensor, the same kind used in smartphones, tablets, and laptops to automatically alter screen brightness based on surrounding light. The rest of the sensor is installed behind this assembly.

A. *Fall Sensor*

DPS310XTSA1 is a highly accurate, very stable, and low-current-consumption digital barometric air pressure sensor. Pressure and temperature may be measured using the same sensor. The capacitive sensing concept on which the pressure sensor element is based ensures excellent stability over a wide range of temperatures. The DPS310 is well-suited for use in portable and wearable devices because to its convenient 8-pin LGA packaging. The pressure and temperature sensor components' output is converted to 24-bit values by the device's internal signal processor.

B. *Stress Sensor*

C. Electrodes must be sensitive to these variations in electrical (ionic) activity and send that information to the *recording device for a GSR measurement to be effective.*

D. *Hardware Setup*

E. *Fig.7 shows the whole hardware configuration.In addition to the arduino uno, the hardware configuration also consists of a Wi-Fi module and an alarm circuit.*

F. *Powerful Infineon DPS310 sensors may be paired with a mobile app through Bluetooth. The software creates real-time graphics that reflect the sensor's readings. It served a purpose, but it wasn't perfect for our idea. Because of this, we attached an Arduino Nano to the sensor's I2C interface in order to read its data. Because of this, we were able to process the information and draw conclusions about the patient's* potential situations. Once we had it figured out, we linked the Arduino to an ESP8266 WiFi module, allowing it to talk to a mobile app.

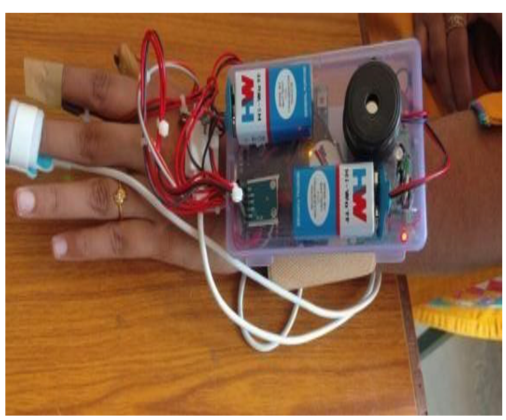


Figure 6. Hardware Setup

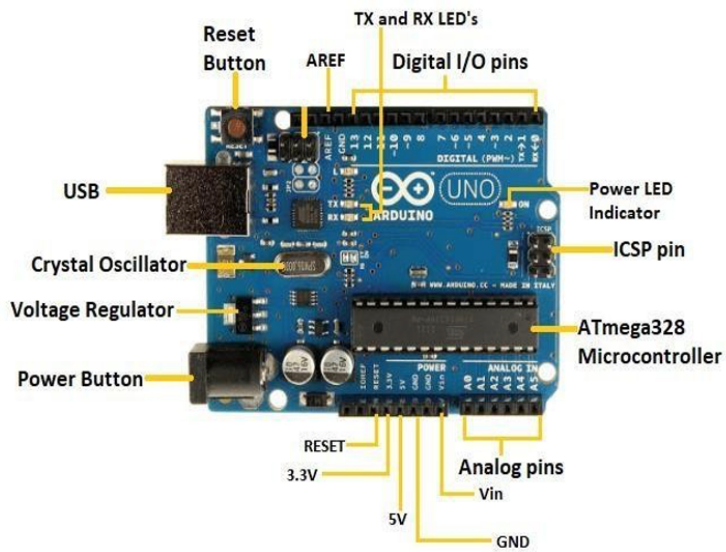


Figure 7. Arduino Uno

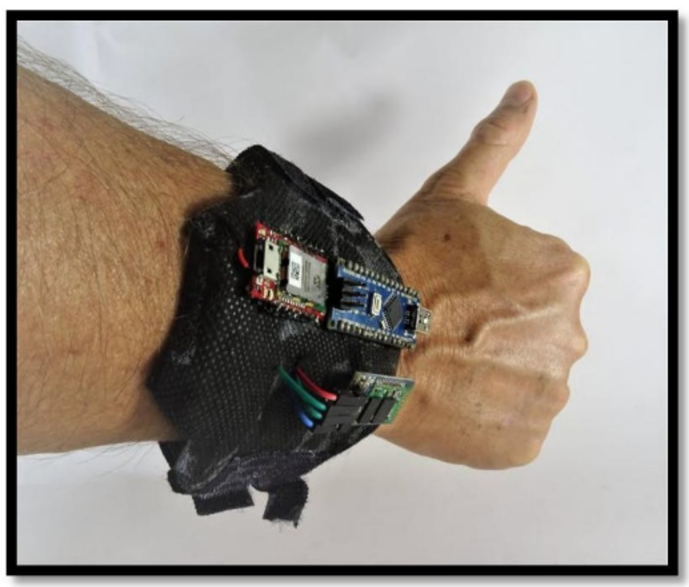


Figure 8. Entire Product on Band

The ATmega328P (datasheet) provides the foundation for the Arduino/Genuino Uno microcontroller board. It contains a USB port, a power connector, an ICSP header, a reset button, and 14 digital I/O pins (6 of which may be utilized as PWM outputs). It has everything you need to get started with the microcontroller; all you need to do is plug it into a computer through USB or provide power using an AC-to-DC converter or battery. There are 6 analog and 14 digital inputs on the Arduino UNO (software) header. The Integrated Development Environment (IDE) was used in the development of the software. It functions properly on both web-based and non-web environments. The following is a rundown of the Arduino UNO's technical specs: The Arduino UNO board has 20 input/output pins. There are 20 PIs total, consisting of 6 PWM pins, 6 analog pins, and 8 digital I/O pins with a Positive Temperature Coefficient (PTC). The UNO board accepts input voltage between 7V and 20V. The Arduino UNO may be powered directly from a wall outlet. It also has the ability to use USB power.

RESULTS AND DISCUSSION

The sensors are interfaced with the Arduino Uno and with the help of Arduino and Wi-Fi module the data from the sensors are monitored continuously through Internet oh Things (IoT). The sensor data is monitored continuously and the datalog is updated every minute.

The data is monitored through IoT in Blynk app.The various sensor data are displayed in the form of field charts. Each sensor data is displayed in a separate field chart.

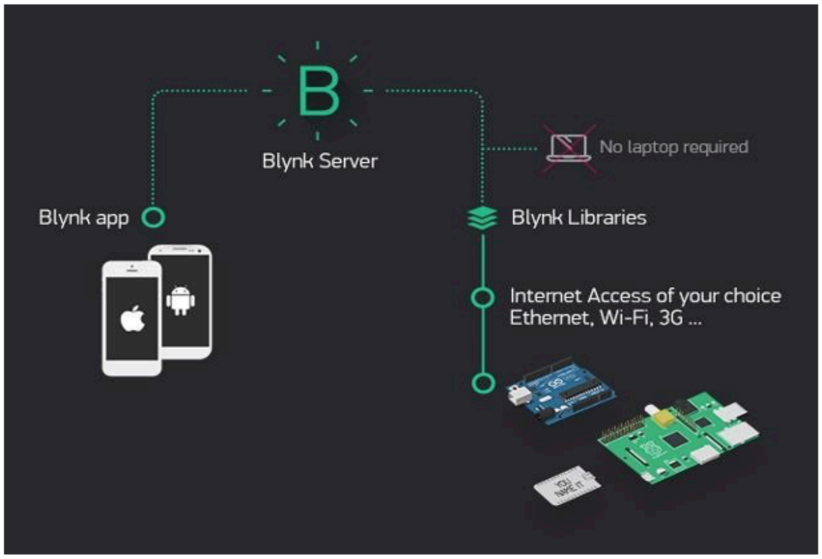


Figure 9. Data Monitor via IoT

There are totally four field charts. The four field charts show temperature, heart rate, respiratory rate and fall.The various field charts are shown below.

The normal human body temperature would range between 92.7–99.5 °F in an average. The temperature is normal and updated in the log continuously.

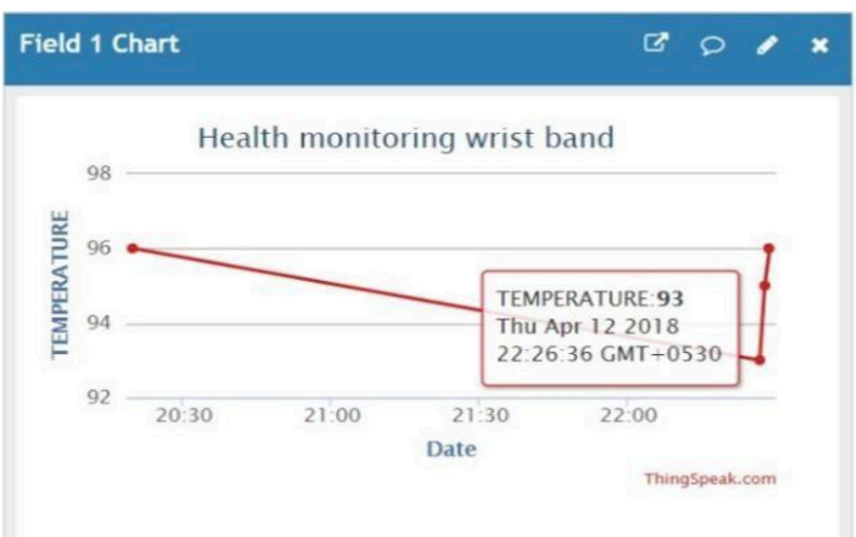


Figure 10. Temperature viewed using IoT

The normal heart rate of a person varies from 50-90 bpm as In case of adults it may vary from 60-100 bpm. The heart rateshown in Fig.9 is normal.

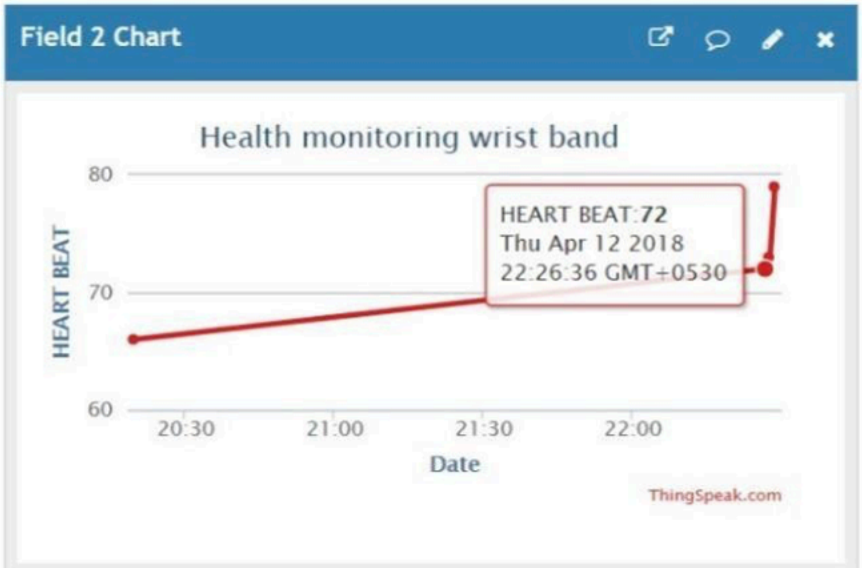
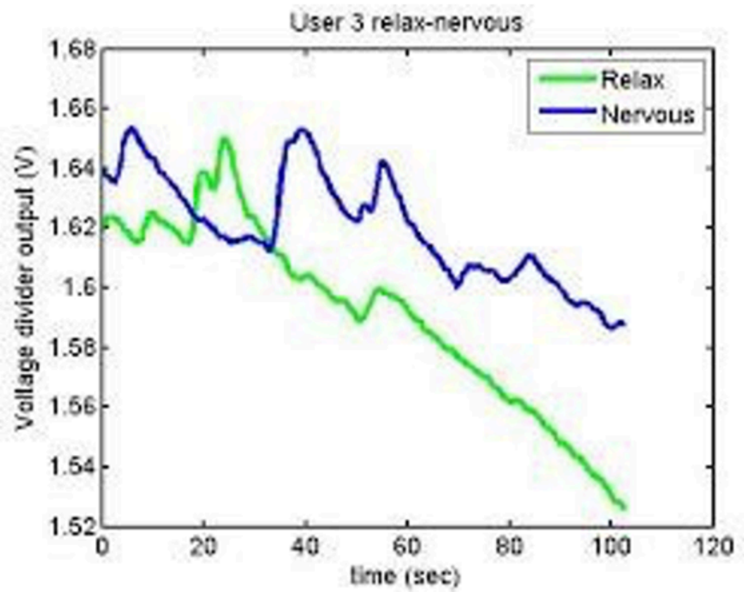


Figure 11. Heart rate viewed using IoT

Based on the axis of the DPS310 pressure sensor, fall is detected and is monitored using IoT. In Fig.10, no fall isdetected, hence the value is displayed as zero. When a fall is detected, the value isincremented accordingly anda buzzer buzzes to indicate the onset of fall.

Figure 12. Fall detection viewed using IoT

The Fig.13 shows the stress readings viewed using IoT. Theabove viewed result is found to be normal. The above obtained results are normal and if the values areabnormal, the alarm buzzes as a way of alerting the caretaker.



CONCLUSION

The project presented is a low-cost easy to wear device which effectively measured different physiologicaland mental health parameters of the individual such as sudden fall, heart rate, temperature and stress. Thewearable also notified the family members by any serious irregularity observed in the readings.It is also giving regular readings of the health parameters on their phones. It is also giving regular readings of the health parameters on their phones

SCOPE OF FUTURE APPLICATION

Future plans may include personalized wellness, which might individualize eating patterns, exercise routines, and stress-reduction strategies.In time, it will have guidance on healthy eating and exercise.

Additional sensors, such as UV, GPS, compass, and a gesture sensor, are also possible. The establishment of a new assessment paradigm for the impact of physical activity and exercise on health-related outcomes in the aged. Concurrently, the development of the Internet-of-Things (IoT), a network of WDs and other technological devices with interconnected autonomous communication, will undoubtedly create the necessary interface to a more permanent, objective, and holistic monitoring, boosting the efficacy of the various active aging strategies, and assisting elders, researchers, and caregivers in effectively intervening

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