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Health Monitoring Using Fitness Band and IOT

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Abstract: *Currently wireless technology, fitness trackers and body sensor devices are creating great impact on the quality of living and healthcare system. The main aim of fitness bands is to keep you motivated during your regular workouts by providing necessary information regarding your fitness level over the entire day. This information can be obtained by using a fitness band or a smartphone app. The main objective of this study is to provide the necessary information regarding the electronic sensors used in these bands and also their working to determine step count, heart rate, quality of sleep, calories burnt etc.*

Keywords: *Fitness band, Healthcare system, Internet of things (IoT), Sensors.*

I. Introduction

1.1 History

The term "Fitness bands" mainly refers to the wearable devices that monitor and record a person's fitness activity. By late 20^{th} and early 21^{st} century, improvement in technology helped in automating the monitoring and recording of fitness activities and integrating them into more compatible wearable equipments.

In 1981, wearable devices to monitor heart rate for athletes were available. Then in early 1990's, wristband sized bicycle computer that monitors speed, distance travelled, duration etc were developed. The wearable fitness tracking devices including the wireless heart rate monitor were available in consumer grade electronics by the year 2000. These fitness bands are normally upgraded versions of pedometers for counting steps.

1.2 Fitness bands

Fitness bands were basically a step counter wear on the wrist but now due to the advanced electronic sensors placed within it, it can perform various functions, like measuring your heart rate, warning you to get out of sun's harmful radiations, everything can be done easily.

Fitness bands have positive effect on our health. These devices help an individual to measure their daily activity, sport parameters and sleep pattern as well as other physical parameters which is required to remain fit. The use of smartphones with fitness bands helps to record and monitor activities such as calories consumed, calories burnt, heart rate, oxygen level, steps taken and sleep pattern.

1.3 Introduction to IoT

Internet of Things (IoT) is described as a vast network of devices connected to the internet including smartphones, tablets and almost anything with a sensor on it like cars, wearable devices, machine in production plant. What it does actually is these "things" collect data and exchange it between the devices. IoT not only involves connection and integration of devices that monitor the physical world like temperature, sound, images, motion but also aggregation, relationship and analysis of information so that action can be taken depending on the situation.

II. Fitness Bands (Technical)

The sensors involved in the fitness bands which play an important role in tracking fitness activities are,

2.1 Accelerometer sensor

It is the most common and basic tracker included in fitness bands for counting steps. It measures orientation and acceleration force. Accelerometer sensor determines whether the band is horizontal or vertical and if its moving or not. Fitness bands comes with 3-axis accelerometer sensor so that it can track movement in all directions.[1]

The fig.[1] shows VLSI implementation of accelerometer sensor. It is basically a capacitor which consists of two plates (green and red) separated by some dielectric medium. A tiny weight made up of silicate is present at one end. This tiny weight is very sensitive to the movement force, which shifts the entire count finger structure so that the distance between finger structure changes, which inturn changes the capacitance. Then a circuitry and software converts this capacitive change into useful data or voltage.

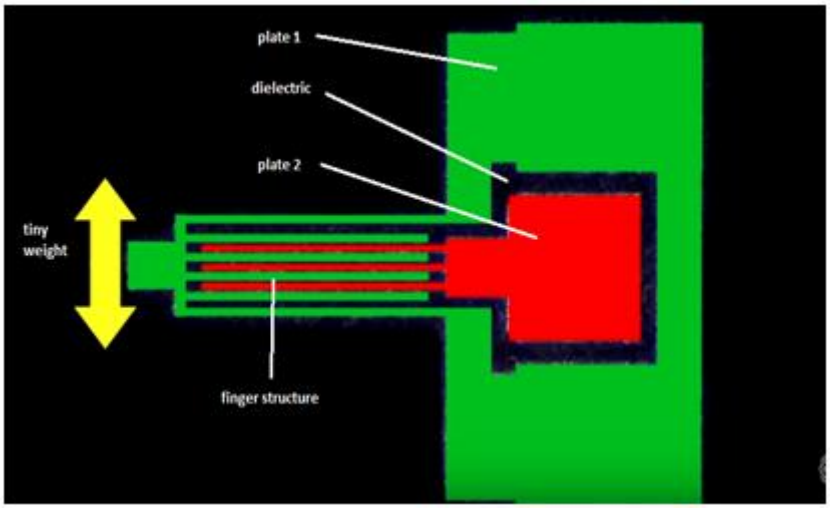


Figure 1. Accelerometer sensor VLSI view

2.2 Global Positioning system(GPS)

GPS works with total 29 satellites orbiting around the earth. A person has to be in a range of atleast 4 satellites to pin his location.GPS receives high frequency, low power radio signal sent by the satellite and measures time taken to reach the signal at wrist and translates it to distance from satellite which can be translated into precise coordinates. GPS is power hungry, but it allows runners, walkers and cyclists to point their location.[2]

2.3 Optical heart rate monitor

Optical heart rate sensors uses the method called "Photoplethysmography" (PPG) to measure the heart rate through shining light into skin and measures the amount of light scattered by blood flow as shown in fig. [2].PPG uses 3 technical components.[3]

1. Optical emitter-consists of 2 LED's that sends light waves into skin. Due to variety of difference in tone, thickness, morphology of skin the OHRM's in fitness bands uses multiple light wavelength.
2. Digital signal processor-DSP captures light refracted from the skin and converts it into 0 and 1 to calculate heart rate data.
3. Accelerometer-It measures the motion and combined with DSP signal, it is used as input to provide motion-tolerance PPG Algorithm.

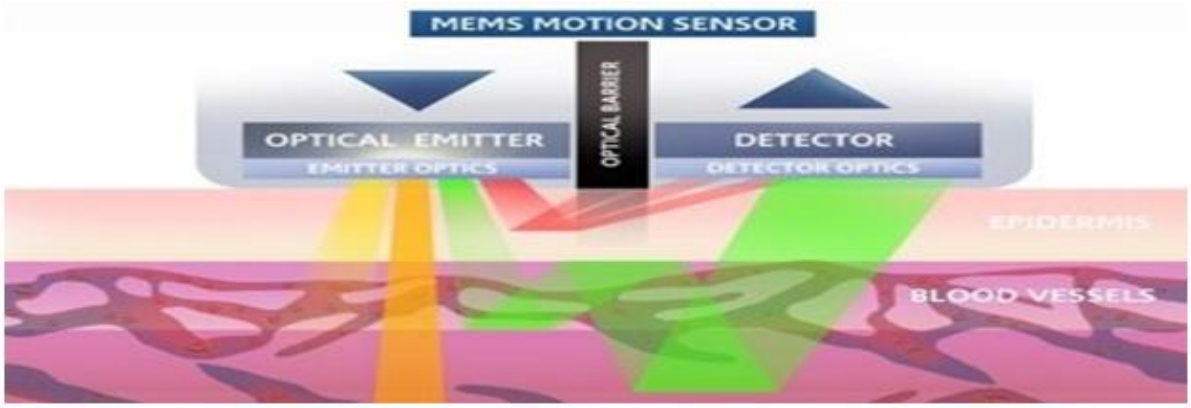


Figure 2. Heart rate monitor working

2.4 Galvanic skin response sensor

GSR sensors are used to measure electrical conductivity of skin using electrodes. Electrical conductivity is connected to change the moisture level of the skin when sweat glands are active. When you sweat more, the electrical conductance changes and that is detected by the sensor. The fig. [3] shows the location of GSR sensor in fitness band.[4]

Figure 3. GSR position in band

2.5 Ultra violet sensor

UV sensors informs when you absorb harmful UV radiation from sun. The software compares absorbed data to the values recognized by the scientists as harmful and then warns you to get away from the sunlight. UV sensor uses Beer-Lambert law, as shown in fig. [4] ,which determines the linear relationship between absorbance and concentration of absorbing species.

Beer-Lambert law written as,

$A = a(\lambda) * b * c;$

Where, A is measured absorbance.

a(λ) is wavelength dependent absorptivity coefficient.

b is path length and c is analytic concentration.

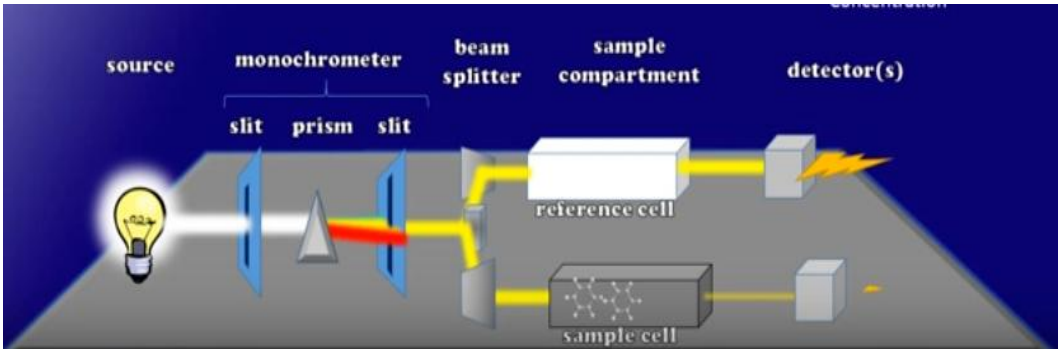
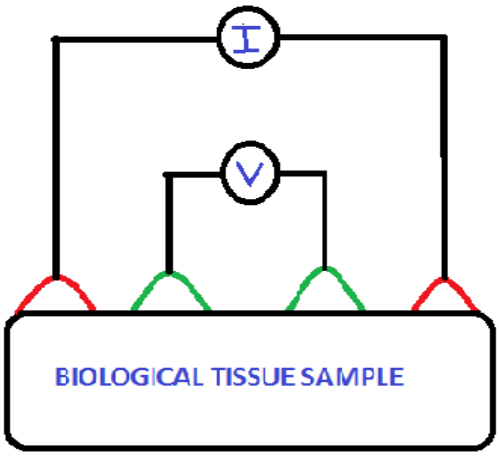


Figure 4 Beer-Lambert law working principle

2.6 Bioimpedence sensor



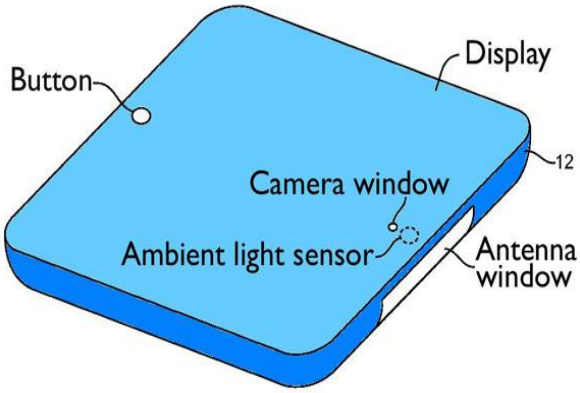
Fitness bands use a single bioimpedence sensor to cover heart rate, respiration rate and galvanic skin response. It sends very small electrical current and then measures the small impedance change within the body as shown in fig [5].

To measure heart rate, it measures the impedance change created by the volume of blood flowing through ulnar and radial arteries. It also informs about respiration and hydration of oxygen in blood. It uses four electrodes that drives tiny bit of electrical energy from each other to measure the result.[5]

Figure 5. Bioimpedence sensor

2.7 Ambient light sensor (ALS)

This sensor is basically present in smartphones but now it is implemented in smartwatches and fitness bands as shown in fig [6]. This works as and when we set brightness level to auto state depending on the available light intensity in the surrounding medium, the brightness level of screen changes. i.e. it dims the screen at night and brightenss in presence of sunlight, based on the intensity of light.



It works when the visible light is translated into digital signal and then fed to the processor inside the band. This sensor helps to extend battery life of the band.[6]

Figure 6. ALS position in band

III. IOT Communication Model

This technology includes a wide spectrum of networked products, systems and sensors which take advantage of advancements in computing power, electronics miniaturization, and network interconnections to offer new capability in medical field. IoT involves 4 communication models to establish a connection with other devices [7].

1. Device to Device Communications: Here two or more devices connect each other directly without any intermediate application layer. For this device-to-device interconnection protocols such as Bluetooth, Z-wave or Zig-bee are used. Fitness band and smartphones are connected to each other by this communication model, which helps for shorter distance data transmission.
2. Device to Cloud Communications: In this communication model, the IoT device connects directly to an Internet cloud service like an application service provider to exchange data and control message traffic. This approach uses existing communications mechanisms like traditional wired Ethernet or Wi-Fi connections to establish a connection between the device and the IP network, which connects it to the cloud service.
3. Device to Gateway Model: In this model, the IoT device connects to the application-layer gateway which acts as an intermediary between the device and the cloud service and provides security and other functionality such as data or protocol translation. This model is found in many consumer devices. The personal fitness trackers do not have the ability to connect directly to a cloud service, so they usually rely on smartphone app software to serve as an intermediary gateway to connect the fitness device to the cloud.
4. Back End Data Sharing Model: The back-end data-sharing model refers to a communication architecture that enables users to export and analyze smart object data from a cloud service in combination with data from other sources. In this the user allows the third parties to access the uploaded sensor data. This approach is an extension of the single device-to-cloud communication model.

IV. IOT and Fitness band system s

The use of IoT in health care application is increasing day by day due to the sensors involved in it, that allows remote health monitoring, elderly care and many physical programs. The small, powerful, improved sensors and their capability in fitness band connected via IoT , helps the monitoring system approach the patient instead of the patients approaching the doctor for monitoring their health.[8]

The health care system with fitness bands and IoT can be explained using fig. [7].It consists of fitness band, smartphone and server system to control and manage the information. The sensors inside fitness bands sense health data such as heart rate, weight, calories burnt, step count, oxygen level, sleep pattern etc. and send this data to the server using smartphones. Further this data is sent to doctor's smartphone for analyzing patient's health status and to inform the necessary action to be taken. The data is also saved in medical database for any further reference .

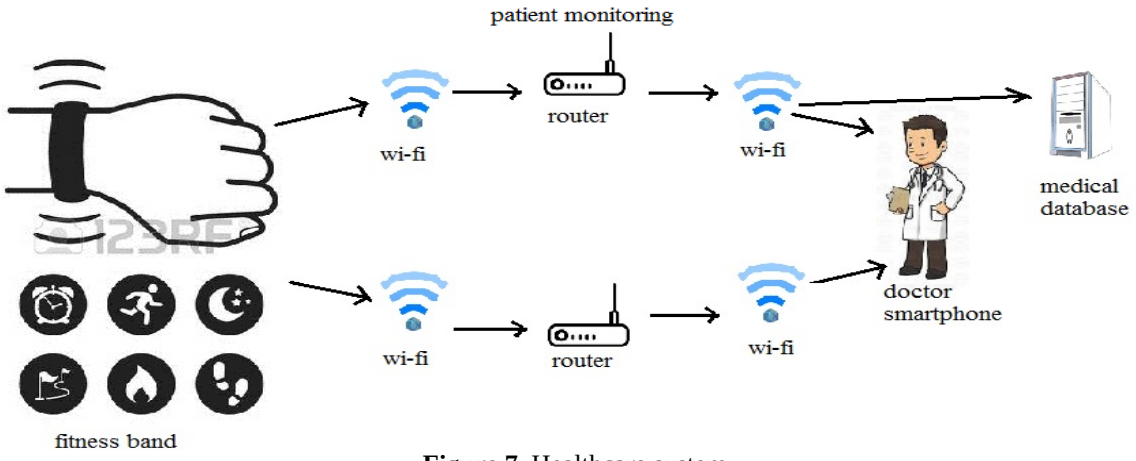


Figure 7. Healthcare system

In case of emergency the wearable devices can remotely report the health condition of patient to his doctors and family members. In such cases doctors and hospitals will try to provide immediate service such as ambulance or provide any necessary facility to help the patient.[9]

The actual use of IOT in fitness band can be easily analysed by the following fig. [8],

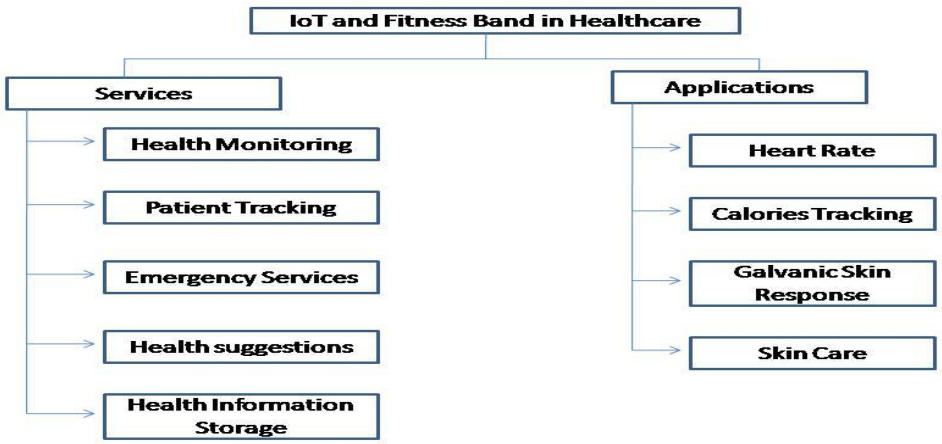


Figure 8. IoT and fitness band services and applications

V. Conclusion

The internet of things (IoT) gathers all the necessary information, shares that information with other connected devices so it is possible to collect, analyze and store data more accurately. IoT in fitness band will be the future for monitoring the patient's health, as the combination of IoT and wearable devices like fitness band helps for monitoring and providing services to the patient. Thus, IoT based health care system provides service in quick manner which would help to save millions of lives. Hence, this paper is mainly focused on the working of sensors in the fitness band and healthcare system model with the use of fitness band and IoT.

References

[1]. Tyler Hayes, *What's inside fitness tracker, anyway?* — November 29, 2014 1:00 PM
[2]. Fatemma El-Amraww, *Are currently available wearable devices for activity tracking and heart rate monitoring accurate, precise, medically Benefitial?*
[3]. Inna vishi, Mover of mirrors ,*How do optical heart rate sensor work?*, written Jun 20,2015
[4]. Michael sawh , *Sensors explored: galvanic skin response sensor*, Wednesday August 24,2016 (https:\\www.wearable.com/author/m.sawh)
[5]. A.Yufera,GHueras, A Olm, *A microscopic technique based on bioimpedence sensor*.
[6]. http://ams.com/eng/products/light sensors/ambient light sensors Proximity detection.

[7]. Anupama Kaushik, *IoT- An Overview*, Assistant professor,Dept. of IT, Maharaja Surajamal Institute of Technology, Delhi, India.
[8]. Sreekant K U ,PG scholar and Nitha K P, *A study on health care in Internet of Things* , Vidhya academy of science and Technology.
[9]. S.M.Riazul Islam, *The internet of things for health care: A comprehensive survey*, (member IEEE).