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Development of Prototype Heart Pulse Rate Monitoring System

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***Abstract*: Heart rate measurement is a basic and essential for daily health monitoring. A heart rate monitoring system is a personal monitoring device that allows one to measure heart rate in real-time. If someone wants to record the data or use it to trigger events, there is a need to turn that mechanical pulsing action into an electrical signal and this can be done only through heart rate measuring system. The pulse rate helps to find out if the heart is pumping enough blood to the body and also helps to find the cause of various symptoms such as an irregular or rapid heartbeat, dizziness, fainting, chest pain or difficulty in breathing. More than million people are at high risk of having heart related diseases. It would be helpful if there was a way for these people to check the heart rate by sitting at home. In this paper focus have been made on realizing a portable, comfortable and low cost solution for long-term domestic heart rate monitoring. There are various methods or technologies to measure the domestic heart rate. We have mainly focused on IoT-based, polymer-based pressure sensors, optical sensors, plastic optical fiber sensor, smart phones, MEMS based piezoelectric pressure sensor. The most effective method will be considered as an efficient way of detecting the heart rate.**

***Keywords*: Heart rate, IoT, polymer based pressure sensor, optical sensor, fiber sensor, smart phone, piezoelectric sensor, MEMS.**

1. Introduction

One of the most important organ in the human body is heart. Circulating oxygen and blood throughout the body is done through heart acting as a pump, thus keeping the functionality of the body intact and healthy. A person to be healthy requires a healthy heart rate. A heartbeat can be defined as a pumping action of the heart two-part occurring for almost a second. Heart beat is produced mainly due to the contraction of the heart. Health issues related to heart are very common and mostly found in old aged people. Heart diseases are one of the most important causes of death among various people. Heart rate has been an essential factor in indicating patient's health condition for quite a long time. As people are paying more attention towards their health conditions, long-term heart rate monitoring is of more importance to everyone as it's a valuable indicator for early diagnosis of various diseases. Furthermore, heart rate monitoring is also essential for sports enthusiasts and professional athletes to keep them physically fit and mentally strong. According to all these requirements, it is necessary to design and fabricate a device which is suitable for long-term heart rate monitoring and that is easy to use and free from external disturbance. The portability, the reliability and the cost become three key issues for long-term heart rate monitoring for daily use. The main focus is to help old aged people to monitor their heart rate staying at home instead rushing to the hospital.

2. Literature Survey

[1] In this research paper they have described about the design of low cost heart rate monitoring device from fingertips based on the Bluetooth technology. Heart Rate (HR) is considered as one of the vital parameter for this device. The entire system is divided into several parts compromising of Heart Rate module, Android application and Bluetooth module. The Heart Rate (HR) module takes up heart rate signal by a non-invasive technique (Photoplethysmography) from the patients and sends the signal wirelessly to computer or android application using Bluetooth module. Their designed system can be embraced and combined as a part of telemedicine constituent. The received data from heart rate module using this technique can be saved and viewed for further medical usage. Bluetooth's signal can be transmitted between 15 to 20 meters radius, indeed the result from this device prototype can be utilized for various clinical investigations. Data is acquired using the capability of a heart pulse sensor. The microcontroller captures and process the data signals from the human's heartbeat. The IoT platform does the further analytics and visualization of the processed data. The proposed system is flexible, reliable and confidential for a heartbeat rate monitoring and control system using sensor network and IOT technology.

[2] In this paper they focused on realizing a portable, comfortable and low cost solution for long-term domestic heart rate monitoring. They proposed, manufactured and tested a tiny but efficient measurement system composed of a polymer-based flexible pressure sensor and an analog anti-interference readout circuit. The proposed polymer-based pressure sensor

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has a high sensitivity of 13.4 kPa^{-1} and a linear response. The heart rate monitoring becomes more realistic with the circuit's outstanding capability in removing interference caused by body movement. The sensor device is highly sensitive, flexible and comfortable. The proposed system has equivalent accuracy: <3% in heart rate measurement to the commercial product through comparative tests. A flexible, low-cost and small heart rate monitor comfortable enough for full-day wear is demonstrated. It is mainly based on the change in pressure on the skin caused by the artery pulse. To sense the pressure change a sensitive flexible pressure sensor is used and an effective ASP system is used to extract heart rate information from the signal. The results shows that this sensor is highly precise as it has been tested on several tastees. The ASP system also helps in reducing the noise. Their work showed that based on this novel flexible pressure sensor and ASP system, a new way for heart rate monitoring can be realized. A full-day long-term heart rate monitoring can be possible through this polymer based pressure sensor.

[3] In this paper they presented a heart rate measuring device, which first infrared light is transmitted by the infrared sensor (IR LED TX) to the fingertip and then reflects light on a Photodiode RX sensor and converted to a suitable signal by the Signal Conditioning, and suitable signal sent to the microcontroller, finally, the heart rate is measured by processing and analysis. On the device, when the power button is pressed, the user places his fingertip on the sensors then the microcontroller key is pressed and then the heart rate is measured in 15 seconds and displayed on the LCD screen. Using this device, it can be measured easily and in a short time, heart rate with a non-invasive method without harm to the human body. In this paper which can be measured at any time when needed. The main elements of this device include a low-cost microcontroller, which is the overall function of the device. The advantages of this device are low cost, easy to use, high speed, high precision and easy transportation.

[4] In this research, they measured heart rate by using sensors based on plastic optical fiber. The sensors are made from fiber optic material. Three configurations include straight, sinusoidal, and spiral. Each sensor configuration was tested and each was paired in three positions of the human body, i.e., hand, chest, and the neck. The intensity of light in optical fiber will be disrupted and effecting loss of power so the light intensity will be smaller, it can be detected by the phototransistor and then converted into an electric voltage, if the sensor detects the heart rates. In spiral configuration mounted on the neck in a slow heart rate condition with a sensitivity value 0.00231 $V.s^{-1}$ and a resolution 0.43203 s, the best measurement will be obtained. The advantage of this sensor is that easy fabrication, low cost, real-time measurement, high sensitivity, easy to operate and can be monitored via computer.

[5] In this research paper they developed Prototype for measuring heart rate. Providing easier measurement with no age limits. This paper mainly noticed the Sudden Infant Death Syndrome (SIDS) is a phenomenon in which new-born infant's die, often during sleeping, and no cause of death is identified after the autopsy and examination. Main objective was that is to perform a study on practical issues that may arise when one is contemplating to build a mobile application for monitoring the heart rate of individuals. This issue includes the level of accuracy and the best room conditions. Secondary objective with this work is to present a heart rate monitor prototype application at a conceptual level. They conducted a literature review and an analysis of the current available technology, approaches and applications for smart-phones. They conducted experiments on a controlled environment by taking heart rate measurements and comparing results obtained from one smart phone application with results obtained with one standard electrocardiogram tool. After gathering the outputs of the experiments, they analyzed the patterns with the ultimate goal to identify the best set of parameters for the application to work. Although related this work with SIDS, they collected data from adults. The procedures for obtaining the Heart Rate with this application is to analyze the skin of an individual and, thus it does not matter if it is an infant or adult. They identified relevant parameters that affect directly the performance of the application, leading it to malfunction. Finally, they proposed a prototype of a mobile heart rate monitoring, that we named The Mobile Heart Rate Monitoring System (MHRMS) at a conceptual level, including the outlining the best conditions and positioning for it to work correctly and also functionality to the existing technology. The main conclusion that they reached is that it is reasonable to make use of the current technology that are available in today's smart phones for having a trustworthy heart rate monitoring tool.

[6] In this research paper a Piezoelectric high pressure sensor is composed such that, the sensor that can produces electric potential for pressure extending from 1 Pascal to 100 kilo Pascal. The primary intention of this paper is to plan a piezoelectric high pressure sensor with various materials and simulate it to explore the energy generation capability as well as to check the sensitivity of the sensor using COMSOL Multiphysics tool and compare the results of designed models. Model 2 utilizes silicon as a diaphragm and Model 1 utilizes material stainless steel as diaphragm. It gives the outcomes as stress, displacement and electric potential. It is extremely useful in real time applications, touch screen devices, auto industry, bio-restorative instrumentation, current uses, flight and marine industry.

3. Conclusion

The heartbeat rate is one of the indispensable boundaries in each human's body, which by realizing it can distinguish coronary illness and forestall more major issues. IOT based heart rate monitoring system have many challenges and threats. Mainly includes security and privacy, risk of failure, cost of its implementation in hospitals and staff training is quite high, integration that is lack of uniformity preventing full-scale integration of IoT, therefore limiting its working potential. Polymer based pressure sensors due to its high sensitivity, noises may be induced by the wearer's skin and the device. When heart rate is counting such noises can easily make the monitor fail. On the otherhand problems faced while using heart rate monitoring based on optical sensors is that optical noise,

sensor location on the body, skin tone, the crossover problem and low perfusion. Plastic optical fiber sensor have low power since light emitting sources are limited to low power. Although high power emitters are available to improve the power supply, it would add extra cost and optical fiber is rather fragile and more vulnerable to damage compared to copper wires. Current generation smartphones video camera technologies enable Photoplethysmography (PPG) and heart rate (HR) measurement, but challenges faced in these are they can be expensive, measurement of heart rate is not the most accurate, especially during the exercise. MEMS based piezoelectric pressure sensor will be the most efficient sensor in measuring the heart rate as they possess high linearity and stability. MEMS sensors have the advantage of very small size, this means they can respond rapidly to small changes in pressure.

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