Heart Rate Monitoring System

Health and Wellness: Wearable

Alexandra Hutan

Jaivkumar Shah

Kanjav Patel

Pushpinder kaur

# Declaration of Joint Authorship

I, Alexandra Hutan, Kanjav Patel, Jaivkumar Shah, and Pushpinder Kaur confirm that this breakdown of authorship represents my contribution to the work submitted for assessment and my contribution is my own work and is expressed in my own words. Any uses made within the Technology Report of the works of any other author, separate to the work group, in any form (ideas, equations, figures, texts, tables, programs), are properly acknowledged at the point of use. A list of the references used is included

# Executive Summary

The paper proposes an IoT based system that monitors the heart rate from an output given by a hardware system consisting of a microcontroller and a pulse sensor. The user will use this device as a wearable to check heart rate and/or blood oxygen levels, be able to monitor their own heart rate through a mobile application.

The main board for this device will be the STM32 Microcontroller. This board will be connected to the Firebase database where our app will be in constant communication to show real-time values.

MKR Wi-Fi 1010 will be one of the peripherals. It contains an ESP32 module to simplify connecting to the Wi-Fi. The second peripheral is SparkFun Pulse Oximeter and Heart Rate Sensor. This chip will be on the user’s finger where the sensor will pick up data.

Table of Contents

[Declaration of Joint Authorship 2](#_Toc63023192)

[Executive Summary 3](#_Toc63023193)

[**No table of figures entries found.** 5](#_Toc63023194)

[1.1.0 Introduction 6](#_Toc63023195)

[1.1.1Background 8](#_Toc63023196)

[1.7.0 References 10](#_Toc63023197)

# **No table of figures entries found.**

# 1.1.0 Introduction

The heart is one of the most important organs in the human body. It is responsible to pump the blood with oxygen throughout the body. Today heart related problems are very common and are one of the causes of death among people claiming 1 million lives each year. Heart rate is one parameter that is important in keeping track of the heart’s health, which means that monitoring the heart rate is crucial when studying heart performance and thus maintaining its health. It is used by medical professionals to diagnose and track medical conditions, as well as individuals, such as athletes, who want to monitor their heart rate and be aware of their health and maximum capabilities. Heart rate is the number of heartbeats expressed in beats per minute (BPM), and can vary depending of the demand of muscle in need to absorb oxygen and eliminate carbon dioxide. The rate can vary between different age groups, genetics and a person’s fitness. During sport exercises, the heart rate gives a strong indication on how the efficient is the heart routine in pumping oxygen-rich blood throughout the body.

Hospitals have a very long waiting period making it harder for the medical stuff to monitor each patient. Because of these problems, a heart monitoring system is needed to assist the medical practitioners. This paper proposes a heart rate monitoring system using IoT. Today some of the heart problems require continuous monitoring, the IoT makes it possible to replace the conventional monitoring system with a more efficient one providing information to the doctor about the patient’s condition remotely at any time. The device includes an ECG sensor and pulse sensor adapted to a wrist band design. The sensor collects the data from the user and a microcontroller will sent the data to the firebase in real-time through a WI-FI module and from there display it on the mobile application. The proposed system consists of a sensor, an embedded system, together with a WI-FI enabled module.

Smart wearable IoT systems for healthcare monitoring can change people lives. Patients can control and monitor their own health metrics. This being beneficial to patients since they are made aware of their condition at any time. The information retrieved by the device can be made available to a healthcare professional, so that in case of an emergency appropriate actions can be taken with regard to the patient’s condition. The goal of this device is to help patients understand better their health and provide immediate warnings of any medical condition. The advantages of such a device are that the user is able to track their won heart rate, be aware of their physical condition and health, and they can share their information with their doctor remotely because of the device’s connectivity to the internet and shared database. IoT is important in health care because it facilitates an evolution in medicine, because it personalizes treatment for each patient and helps in reducing the cost of healthcare.

## 1.1.1Background

Before any of these heart rate monitors existed, physicians calculated heart rate by placing their fingers on patient’s wrist while they counted number of beats in a minute. Being able to calculate heart rate was a big achievement during those times. Fast forward to the 21st century, wearable fitness trackers have been widely adopted by consumers and are currently gaining increased amount of attention. Wearable fitness trackers are convenient to use and measure wide variety of measurements noninvasively making it the No. 1 in fitness trends in the years 2016, 2017, 2019, and 2020.

One of the most prominent consumer wearables that measure heart rate is the Fitbit watches. Fitbit takes advantages of the concept photoplethysmography (PPG). It is uncomplicated and inexpensive optical measurement tool to capture heart rate. Blood has an interesting property that it lets any green light to be absorbed. Using this information, the smart watches will emit green LED light many times per second. When your heart beats, the capillaries will expand and contract based on the blood flow. Using light-sensitive photodiodes in addition with flashing green LED many times per second, the Fitbit will detect these volumetric changes in the blood vessels. The higher the blood flow, the greener light is absorbed. Using this info, the Fitbit will calculate heart beats per minute (BPM) value for the user. Heart rate sensors can be used for many more things than just to calculate real-time 24/7 heart rate. The Fitbit uses the heart rate senor to provide calorie burn information, quality of sleep, and fitness intensity scores. It even accounts for the type of activity the user is performing and will calculate heart rate values depending on that. Fitbit has created four different zones (Peak, Cardio, Fat burn and resting) to better provide accurate heart rate values. These zones have different max and min values of what a healthy heart rate should be. Now the technology has got to a point that it can detect when the user is sleeping, and be able to declare user’s real-time sleep cycle they are on.

Another leading company in the smart watches industry that measures heart rate is the Apple Watches. Apple takes advantage of the concept of electrocardiography (ECG). A typical ECG would capture electrical activity in the heart by placing electrodes over the patient’s skin.

One of the growing concerns regards to heart rate monitoring by wearables is the data accuracy. The major brands provide an acceptable accuracy but depends on various factors. The skin tone, room temperature, placement of the sensors, and intensity of the activity are all things that would affect the data accuracy of the beats per minute (BPM). One study found that increase in exercise intensity would reduce the accuracy of the heart rate measurement. While another study found a deviation in heart rate values from participants that have a dark skin tone. Another dilemma is wearable heart sensors being used in the medical field is still a big question mark. More study and research need to be done for it to be relied upon during a life and death situations.

# 1.7.0 References

Allison, C. A. (2020, February 20). *Fitbit heart rate monitoring explained*. Wareable. <https://www.wareable.com/fitbit/fitbit-heart-rate-monitor-guide-330>

Allison, C. A. (2020b, February 25). *Apple Watch ECG app: what is it, how does it work and is it accurate?* Wareable. <https://www.wareable.com/apple/how-to-take-ecg-reading-on-apple-watch-6817>

Amritha G., Kanimozhi G., Rathore K. S., Sethuraman T. V., (2019, June 5). *IoT based system for heart rate monitoring and heart attack detection.* International Journal of Engineering and Advanced Technology(IJEAT). <https://www.ijeat.org/wp-content/uploads/papers/v8i5/E7480068519.pdf>

Castaneda,Esparza,Ghamari,Soltanpur,Nazeran, D. S. A. E. M. G. C. S. H. N. (2018, August 6). *A review on wearable photoplethysmography sensors and their potential future applications in health care*. US National Library of Medicine National Institutes of Health Search Database PMC. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6426305/>

Chow, Yang, H. C. C. Y. (2020, April 28). *Accuracy of Optical Heart Rate Sensing Technology in Wearable Fitness Trackers for Young and Older Adults: Validation and Comparison Study*. US National Library of Medicine National Institutes of Health Search Database. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7218601>

Islam M. M., Rahaman A., Islam M. R. (2020, May 26). *Development of smart healthcare monitoring system in IoT environment.* NCBI. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7250268/>

Learning Mole. (2020, May 6). *Inside the human body: Biology made easy.* Learning Mole. <https://learningmole.com/inside-the-human-body/#:~:text=The%20heart%20is%20one%20of,blood%20away%20from%20the%20heart>.

Majumder J.A., ElSaadany Y. A., Young R., Ucci D. R. (2019, February 2019). *An energy efficient wearable smart IoT system to predict cardiac arrest.* Hindawi. <https://www.hindawi.com/journals/ahci/2019/1507465/>

McMullen, M. M. (2020, December 2). *How Fitbit Trackers Monitor Heart Rate*. Fitbit Health Solutions. <https://healthsolutions.fitbit.com/blog/how-do-fitbit-trackers-monitor-heart-rate/>

Rahman M. A., Barai A., Islam M. A., Hashem M. M. A. (n. a.). *Development of a device for remote monitoring of heart rate and body temperature.* [*https://arxiv.org/ftp/arxiv/papers/1304/1304.0156.pdf*](https://arxiv.org/ftp/arxiv/papers/1304/1304.0156.pdf)