

Medical device to detect heart attack

Jasmeet Singh Matta

Electronics Engineering (Interactive System Engineering)

Lippstadt, Germany

jasmeet-singh-ajit-singh.matta@stud.hshl.de

I. INTRODUCTION

A. Context

In this paper for a medical device that detects heart attack, its requirement, User Interface and hardware specification are specified. This paper is purely for academic purposes and not for actual development. The device can detect a heart attack a few hours before it can happen with the help of detecting changes in the cardiac biomarker which the heart releases when it is under stress, The device also measures heartbeat, Oxygen Level and change of electric impulse of the heart.

B. Problem

As the user is free to travel and uses modern-day technologies sometimes due to technical issues user may not be able to contact emergency services using the normal method and also other medical devices which rely on the user's phone to call service may fail at a given moment. To also have redundancy on the data read by patch and also to distinguish when the patch is not working properly. The device should also warn the user when there is a problem in the device. It is also necessary to make a device that can be used by all types of people. In this paper, we have covered all the issues mentioned here.

C. Motivation

My motivation for making such a medical device is because of the 2020 pandemic. In this pandemic, we have seen many people losing their life not only to the COVID-19 but also due to heart attacks. so there needed a device that can warn the user in case of emergency.

II. CONCEPT

A. Image of Medical Device and Use Case

In the Fig. 1, there is a sensor substrate that will be attach to the user body and it will be attached to wearable device from which the data transmission to the cloud and if require call to emergency service will take place.

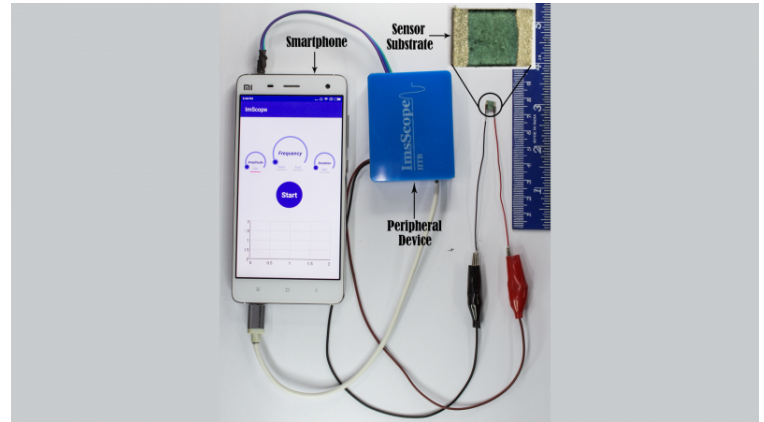


Fig. 1. [2]

III. DESIGNING AND CONCEPT

A. Requirements

1) Design:

- The Device should be under specific weight to not make it heavy.
- It should be design correctly as it will be carried by user.
- It should also be able to use by people with disability and people who have hard time with modern technology.
- It should also satisfy all the system requirements.

2) System:

- It should be able to communicate with other devices/Networks.
- It should be able to send SOS Alert when needed.
- It should be refined from the Government policies on medical device.
- It should have a User Interface which is easy to use.

By easy to use it mean it should be simple by making interaction as less as possible.

B. Hardware

1) Connectivity:

- GSM - OPTIGA™ Connect Consumer OC1120 - eSIM solution
- Wifi Bluetooth - WL1835MOD

2) Others:

- Medical Sensor (Sensor for detecting change in heart rate, cardiac biomarkers)

The Sensor designed by D.Mondal and his team in [1] is being used in this project.

- 66AK2G12 Processor by Texas Instruments

The use of this processor is crucial because it is designed for networking and also for security which satisfy the need of product being both secure and safe. This Processor is integrated with high-speed peripheral and memory interfaces, hardware acceleration for network and cryptography functions.

- 1 GB memory
- Buzzer

It is needed for vibrating the device to let the user know to check their status or in case of failure of system.

- LED (Green, Orange , Red , Yellow)

It is used as indicator to let user know their health status it is also used for indicating system failure, low battery.

- Speaker

It is used to let user know their status or device status through auditory perception.

- Button

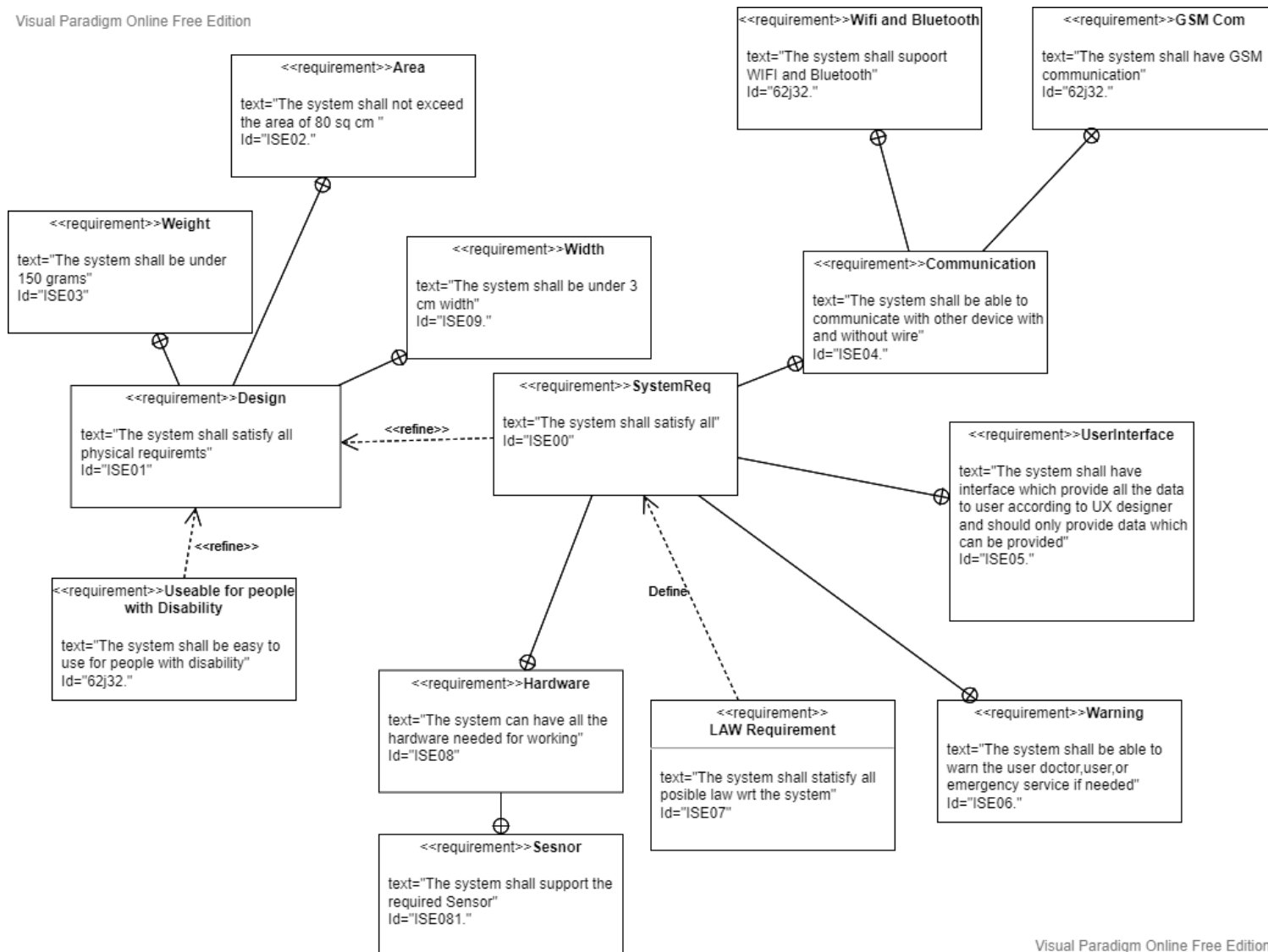
It is needed to turn on or off the device and also to activate the speaker for that instance.

C. Redundancy

For Redundancy the system will always check the condition of the software, store data from the sensor two times, and in case of failure it will try to self boot in safe mode and alert the user. Each patch is made up of two sensors with each subdivided into two parts giving us the total 2ⁿ data values. For a better understanding of data, we use Advanced Evidence Theory or Dempster Shafer Theory for combining the data from the sensor. To know when the sensor is not working the Divergence Measure is being used to measure the conflict in data from the sensor. We store this conflict and calculate the error rate over time and once the time period is over we notify the user that there is a need for servicing of the sensor.

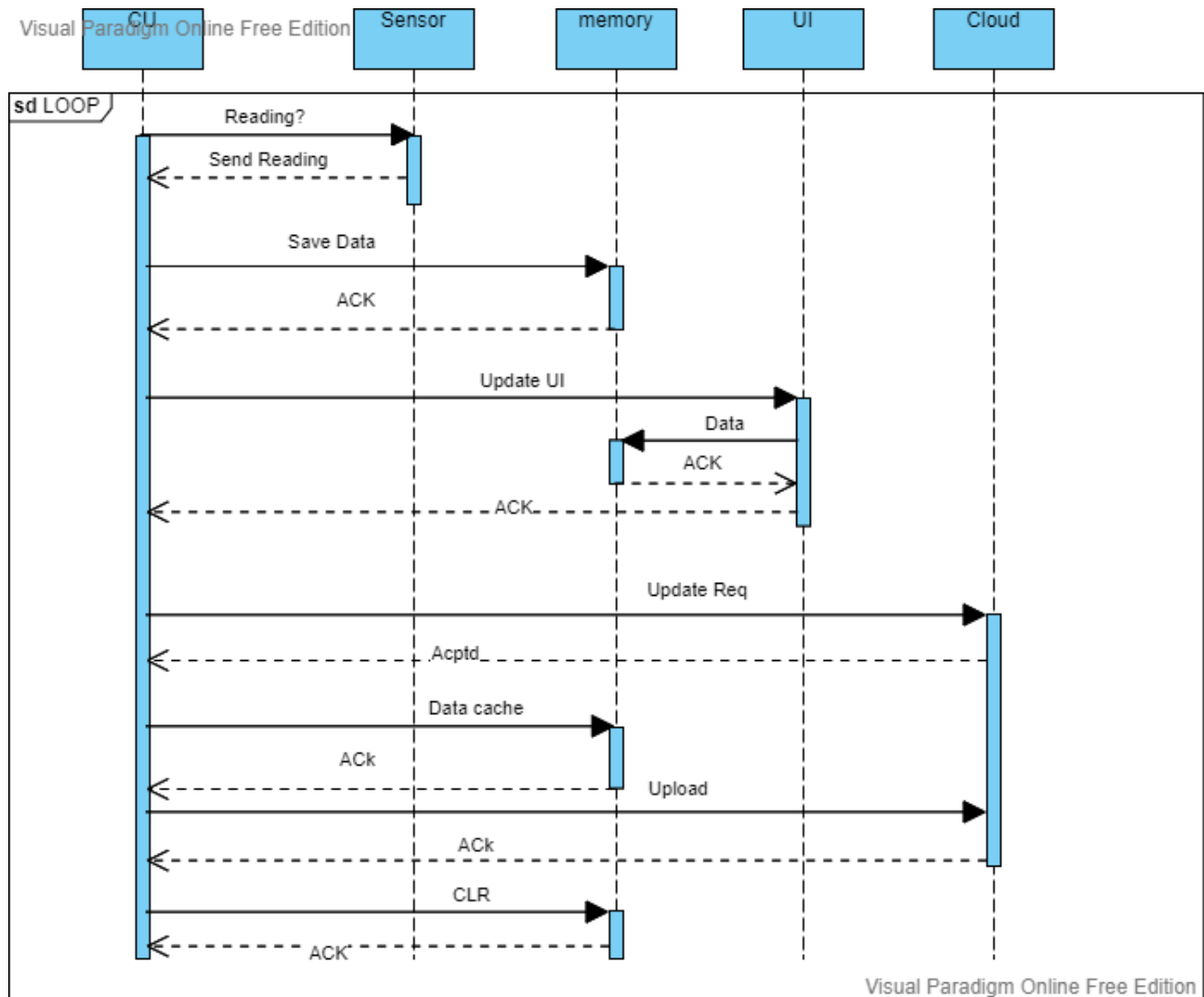
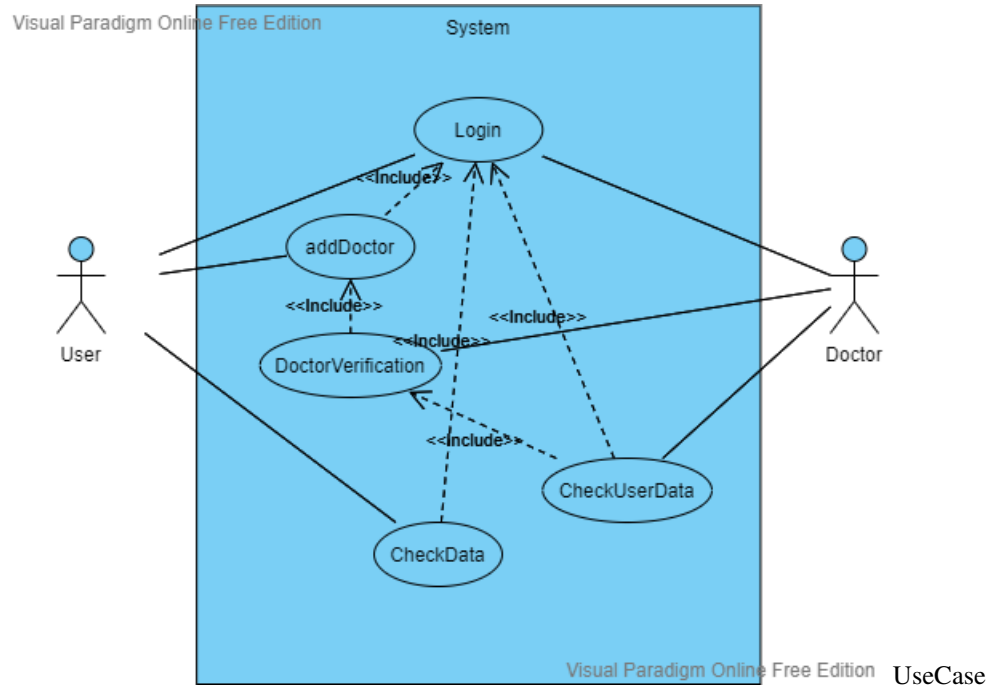
D. Models

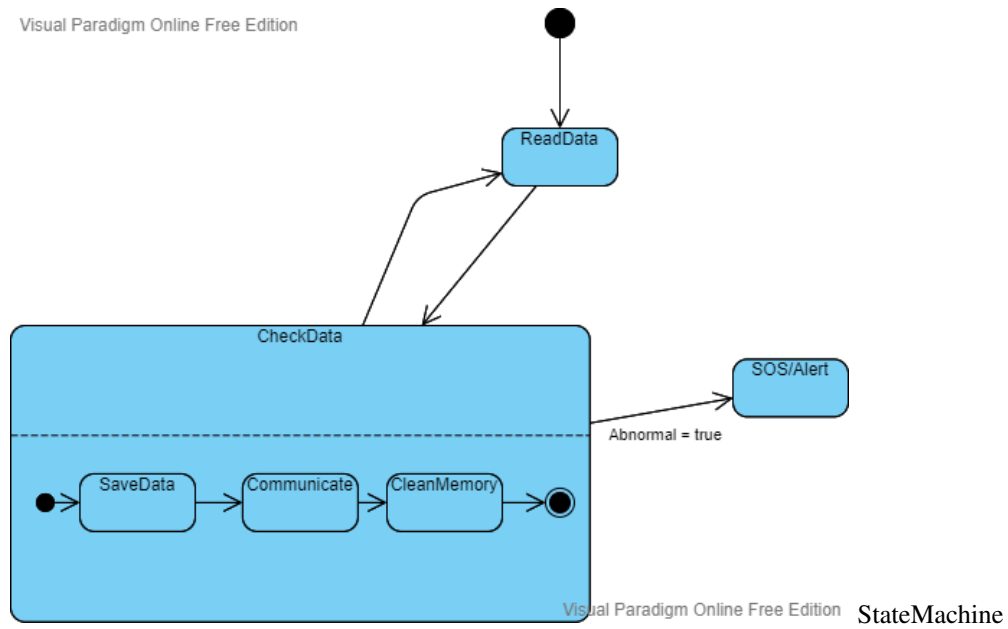
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Requirements

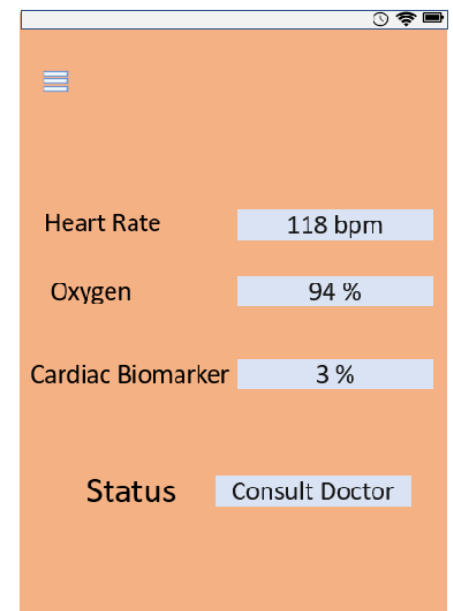
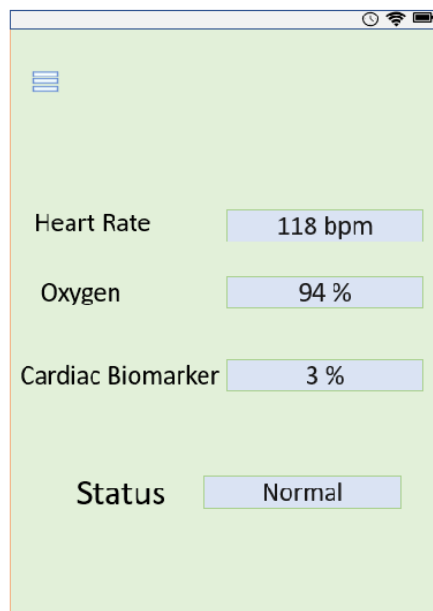
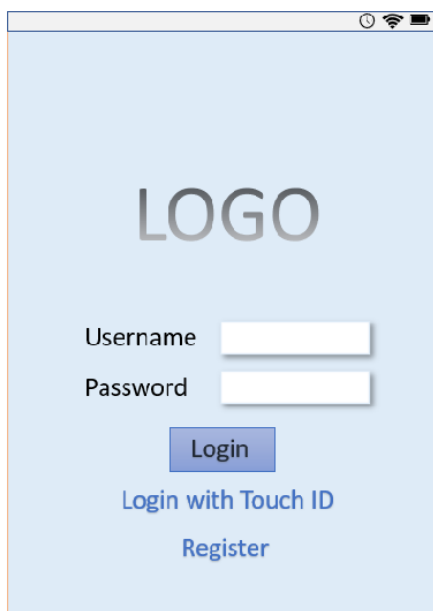
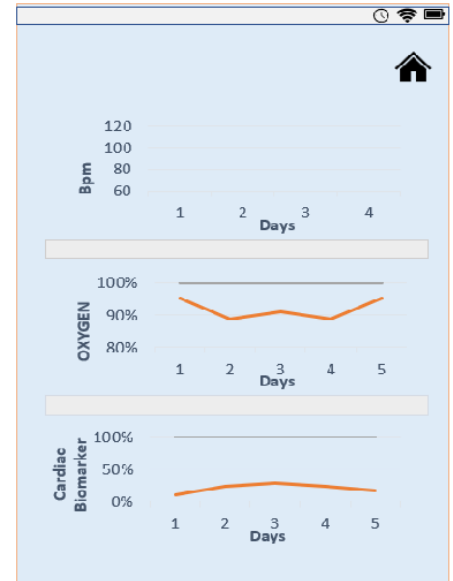
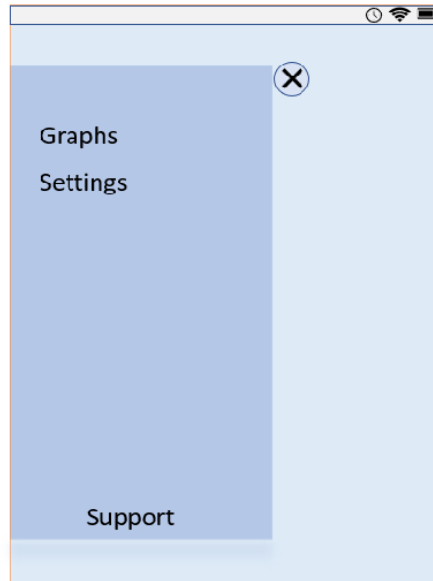
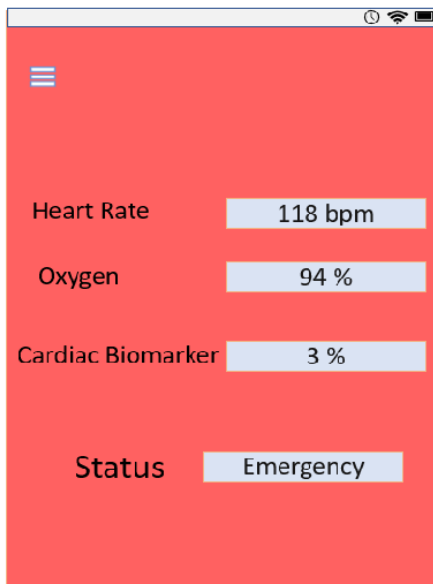
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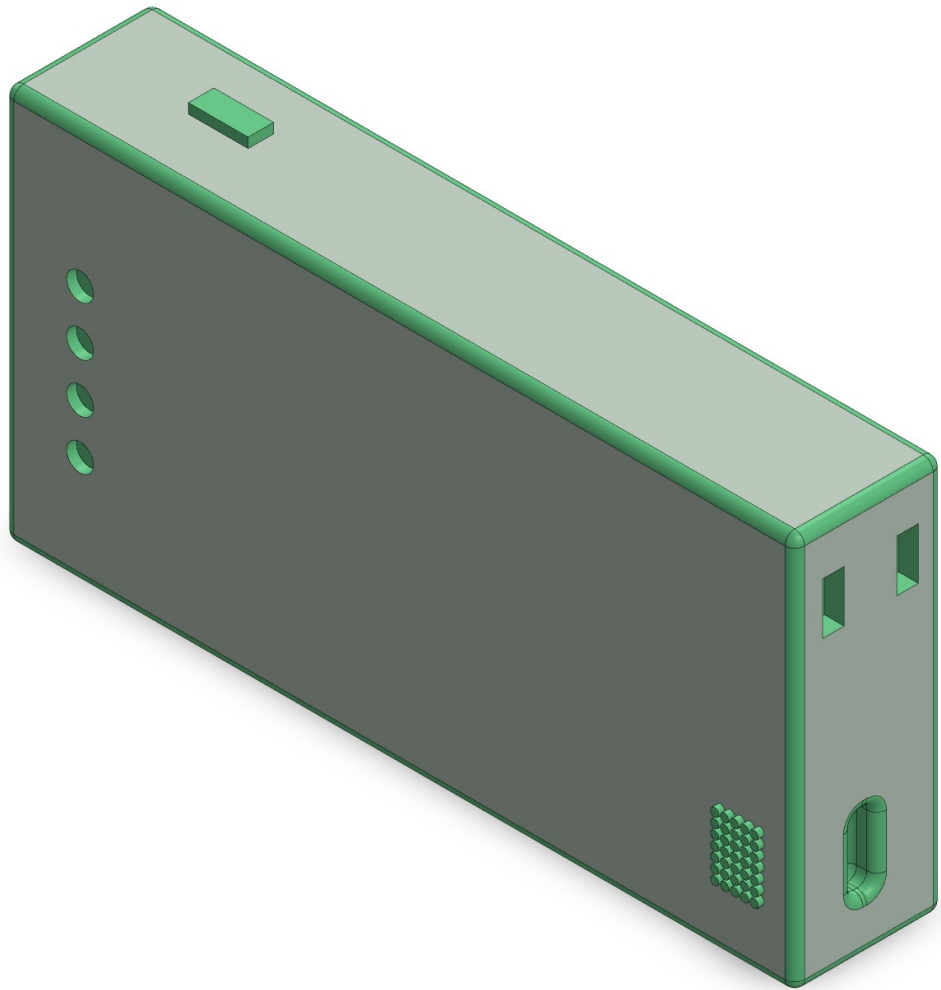




StateMachine

E. User Interface





SOLIDWORKS Educational Product. For Instructional Use Only.

IV. DISCUSSION

A. Concept

The concept is to create a state-of-the-art device that is easy to use by people of all ages and types. the main task will be to have redundancy in data, also as seen in Fig 1 the prototype is using the I/O line for audio and battery so the task is also to get rid of those. it is also a requirement to add a wireless connection method to the device independent of the mobile phone so that emergency service can be reached efficiently in the time of need.

B. Initial Problem

Not only does it solve the initial problem of having peripheral device connected to your cell phone via wire but

also efficiently increase the readiness for user to get medical feedback via doctor or emergency service making user more safe.

C. Improvement

During the phase of development, the requirements, Design went under a series of iterations to make it safe, available, reliable, and secure for the user.

V. CONCLUSION AND FUTURE DIRECTION

A. Overview

- In this project development of a device that detects heart attacks took place. the device is easy to use by a broad range of people because of the design itself.

- It is also made possible for doctor to read the daily heart rate, oxygen and Cardiac Bio-maker value so that if needed he/she can consult the user.
- It is also made possible to contact the emergency service with the location of user with the error of up to 30 cm without the use WiFi and Bluetooth to make it more reliable, available to user.
- With keeping the regulation of government on medical device in the requirement, the device modeled is safe for user.
- With current up to art technologies in the field of I.O.T and connection, it is to be said that the device is also secure for user.

B. Future Direction

- There can be an addition of more sensors to the device adding more functionality to it.
- The design of the device can also be improved.
- A satellite communication method can also be introduced to the device.

REFERENCES

- [1] D. Mondal, D. Paul and S. Mukherji, "Impedance Spectroscopy-Based Detection of Cardiac Biomarkers on Polyaniline Coated Filter Paper," in *IEEE Sensors Journal*, vol. 17, no. 16, pp. 5021-5029, 15 Aug.15, 2017, doi: 10.1109/JSEN.2017.2717701.
- [2] "Now, Your Smartphone Can Help You Detect A Heart Attack" IIT Bombay. 2018 [Online] Available <https://www.iitb.ac.in/en/research-highlight/now-your-smartphone-can-help-you-detect-heart-attack>



Fig. 2. Author - Jasmeet Singh Matta