Belly Fat Reader

Department of Electronic Engineering
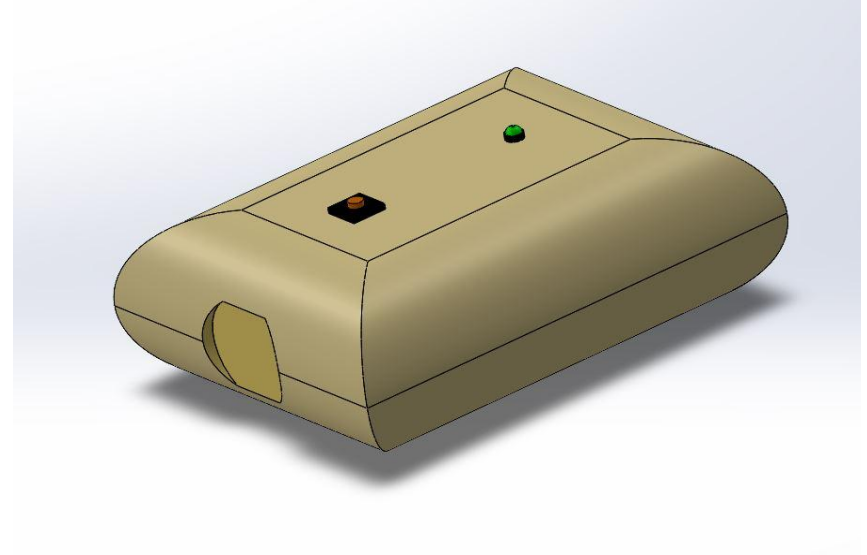
Interactive Systems Engineering 2 (SS2022)

Semester task: Medical device for monitoring patients
Date: 07th of June 2022

HOCHSCHULE
HAMM-LIPPSTADT

Lochana Abhayawardana

Overview

Reasons for human Belly-fat

- Because of the busy lifestyle people are tend to eat lot of unhealthy foods such as fast foods and foods including too much fat,sugar and calories.
- Too much alcohol, smoking
- Stress and poor sleep
- Lack of physical exercises

In order to maintain a healthy lifestyle we should know how many fat has gathered in your belly.

Therefore we came to an idea of designing a device to measure fat levels in human belly area.

- Targeted group: People who wish to regularly monitor their belly fat level.

Fig: 2 Fast foods

Fig: 3 A person with high obesity
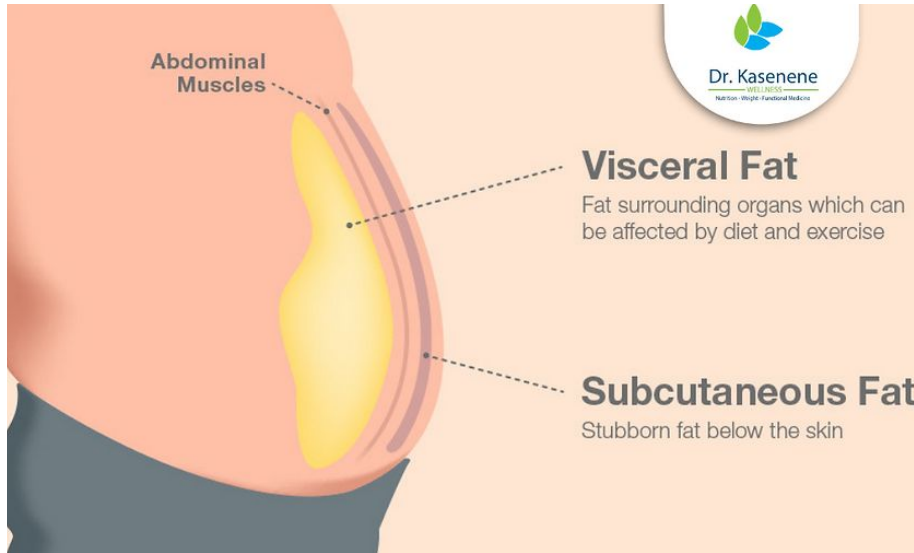
Understanding the problems

Fig: 4: Kind of fat in human belly

Subcutaneous fat : healthy fat
Visceral Fat : unhealthy fat

We have to figure out a way to measure visceral fat level.

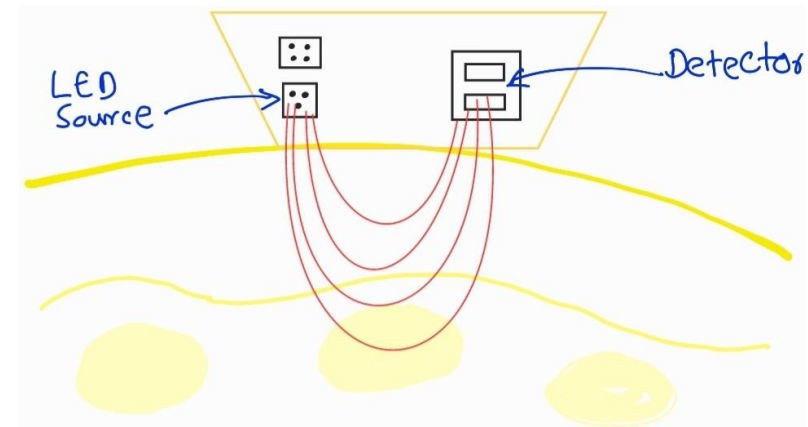# What is Near InfraRed (NIR) technology

Fig: 5: how to recognize belly fat using NIR sensor

Fig 6: Near Infrared Interactance

Near-Infrared (NIR) refers to **electromagnetic wavelengths that range from about 780 to 2500 nm**. Belly Fat Reader uses NIR measurements to determine a person's health status by **measuring tissue chromophores**. **A spectral range of approximately 650 to 1100 nm is used for our real-time tissue measurements**. **Utilizing 8-wavelength NIR LEDs** (Light Emitting Diodes), we can measure **tissue absorption and scattering to calculate oxyhaemoglobin, deoxyhemoglobin, water, and lipid. [1]**

Health Issues

If someone wants to measure belly fat level,

1) Skinfold calipers
- cheap,
- but user requires basic anatomy Knowledge,
- skin needed to be fold

2) Dual Energy X-ray Absorptiometry (DXA) or Air Displacement or Bioimpedance Spectroscopy (BIS)
   - Accuracy is high but, highly expensive,
   - can not use it in daily basis,
   - chance to exposure radiation

   shorter wavelengths and Higher Energy [2]

   Could harm your body!

But, We use NIR technology,

- longer wavelengths and weak energy than UV
- Very short time for taking measurements: the BFR device need only 3 seconds to get the measurements. (latency , L=3s)

About the device - Belly Fat Reader

Fig: 7: How to measure your belly fat

- About the device:
    1. compact device (size: 80*60*30)
    2. Anyone can use it
    3. Cheaper
    4. One button and One LED light
    5. Long-lasting battery power
    6. Uses NIR technology - no healthy/radiation problems
    7. Encrypted user and measurement data
    8. The app can analyse, track and record the measurements and display in userfienly way.
    9. Ability to get direct medical assistance

- What is included: BFR device, BFR app (For the patients-users), BFR app (For the doctors/ fitness trainers)

About the app

App For the users

After taking measurements from the device everything else is happening from the app. You can see your,

1) Belly fat level
2) Daily / weekly/ monthly progress
3) Fat level forecast (based on your history) (Pro version)
4) Doctor's medical assistance (Pro version)
5) 24/7 Technical support
6) Updatable

Fig: 8 to 12: user interfaces

About the app

App For the doctors/ Sport Trainers,

The registered doctors can log in to the BFR doctor's profile (either with smartphone app or the web version) and can review their patient's history and reports sent by the BFT apps. They can provide medical assistance if required.

Our basic Business model

The device itself cost 100€

1. Basic version (app): comes free with the device

2. Pro version (app): users can buy in order to gain BFT readers' full potential.

   A yearly subscription of 50€: Doctors' medical assistance, belly fat forecast, free device repair, etc...

3. Registered doctors/ fitness trainers can earn money through medical assistance to the patients.

Fig: 13: the user interface for doctor

Hardware specification

01) NIR sensor: Qwiic AS726X; Low cost, only need two pins to implement,Low gate count, to identify belly fat level

Fig 14: NIR sensor

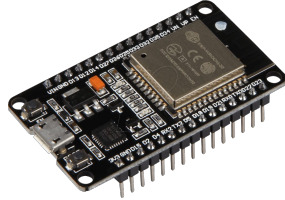02) Microcontroller: ESP32 ; cheap, Built in Bluetooth modular, to control everything

Fig 15: microcontroller

3) Battery: LiPo; 1200mAh,3.7V, cheap,No need for a voltage regulator,micro USB charger, power source

Fig 16: Battery

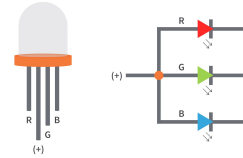4) RGB LED: low cost, one RGB LED is enough to indicate everything

Fig 17: RGB LED

5) Push button: cheap, needed for switch on, take measurement, switch off.

Fig 18: Push Button
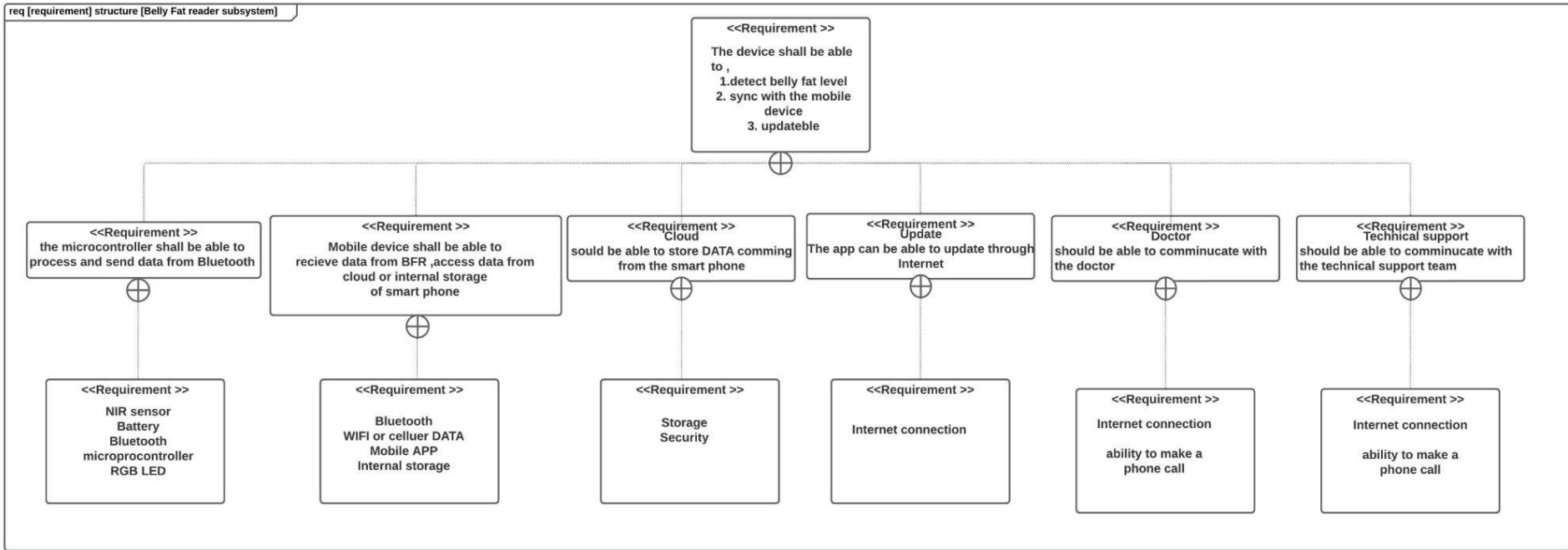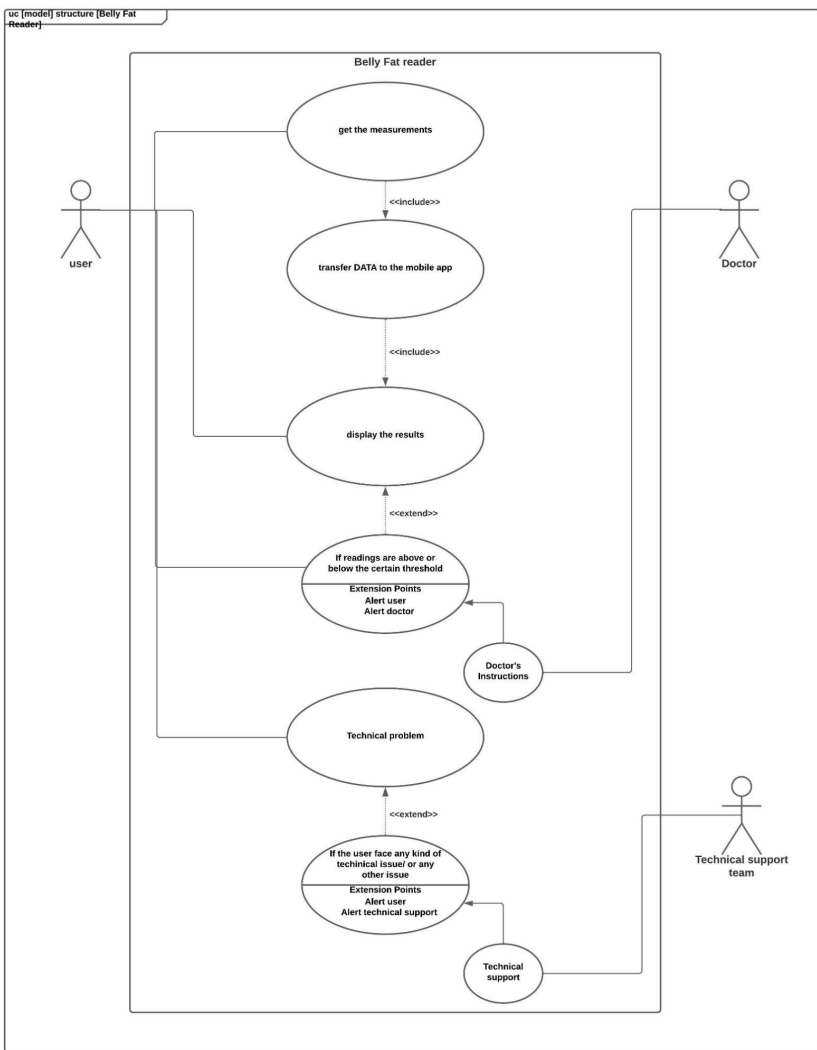
The Requirement Diagram

req [requirement] structure [Belly Fat reader subsystem]

<<Requirement >>
The device shall be able to ,
1. detect belly fat level
2. sync with the mobile device
3. updateble

<<Requirement >>
the microcontroller shall be able to process and send data from Bluetooth

<<Requirement >>
Mobile device shall be able to recieve data from BFR ,access data from cloud or internal storage of smart phone

<<Requirement >>
Cloud
sould be able to store DATA comming from the smart phone

<<Requirement >>
Update
The app can be able to update through Internet

<<Requirement >>
Doctor
should be able to comminucate with the doctor

<<Requirement >>
Technical support
should be able to comminucate with the technical support team

<<Requirement >>
NIR sensor
Battery
Bluetooth
microprocontroller
RGB LED

<<Requirement >>
Bluetooth
WIFI or celluer DATA
Mobile APP
Internal storage

<<Requirement >>
Storage
Security

<<Requirement >>
Internet connection

<<Requirement >>
Internet connection
ability to make a phone call

<<Requirement >>
Internet connection
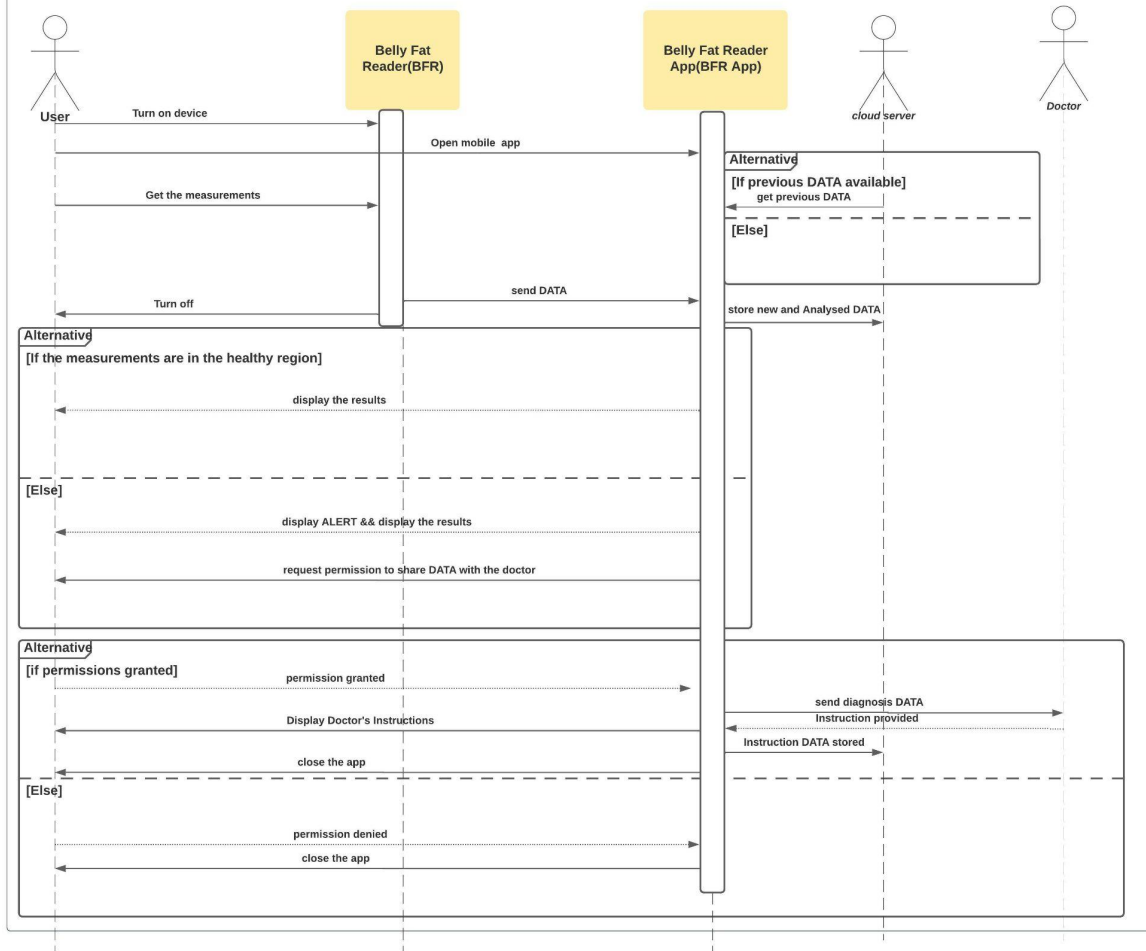ability to make a phone call

Fig: 19: the requirement diagram

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The Use Case Diagram

Fig: 20: the use case diagram

The Sequence Diagram

Fig: 21: The requirement diagram

Future directions

- In the future upgrades, it is possible to add some functions like other lipid levels and H_2O , HbO_2

- The components should be updated with better components in the future.

- Make the app more user friendly

References

[1] "The theory of Near Infrared Spectroscopy",artinis, 2020,

https://www.artinis.com/theory-of-nirs

[2] "The 10 Best Ways to Measure Your Body Fat Percentage", Grant Tinsley, Healthline ,April 2018,

https://www.healthline.com/nutrition/ways-to-measure-body-fat#TOC_TITLE_HDR_2

Figure 01: SOLIDWORKS prototype model created by the author

Figure 02: Fast Foods
https://businessfirstfamily.com/important-fast-food-industry-trends-to-investigate/

Figure 03: A person with high obesity

 https://scitechdaily.com/obesity-might-be-a-result-of-your-bodys-chemistry/

Figure 04: Kind of fat in human belly

https://www.drkasenene.com/post/2019/02/26/have-you-heard-about-visceral-fat

Figure 05: drawn by the author

Figure 06: Near Infrared Interactance

https://www.measurement-toolkit.mrc.ac.uk/anthropometry/objective-methods/near-infrared-interactance

Figure 07: https://shop.olivehc.com/products/

Figure 08 to figure 13: drawn by the author

Figure 14: NIR Sensor

https://www.exp-tech.de/en/sensors/light/8347/spectral-sensor-breakout-as7263-nir-qwiic

Figure 15: Microcontroller;
https://www.reichelt.com/de/en/development-boards-esp32-wi-fi-and-bluetooth-module-debo-jt-esp32-p219897.html?r=1

Figure 16: Battery; https://diyi0t.com/best-battery-for-esp8266/

Figure 17: RGB LED;
https://create.arduino.cc/projecthub/lewiskell/common-anode-rgb-led-4a5ece

Figure 18: Push button;
https://www.exp-tech.de/en/accessories/buttonsswitches/4342/mini-push-button-switch-x20

Figure 19: the requirement diagram; drawn by the author

Figure 20: the use case diagram; drawn by the author

Figure 21: The requirement diagram; drawn by the author

Thank you!