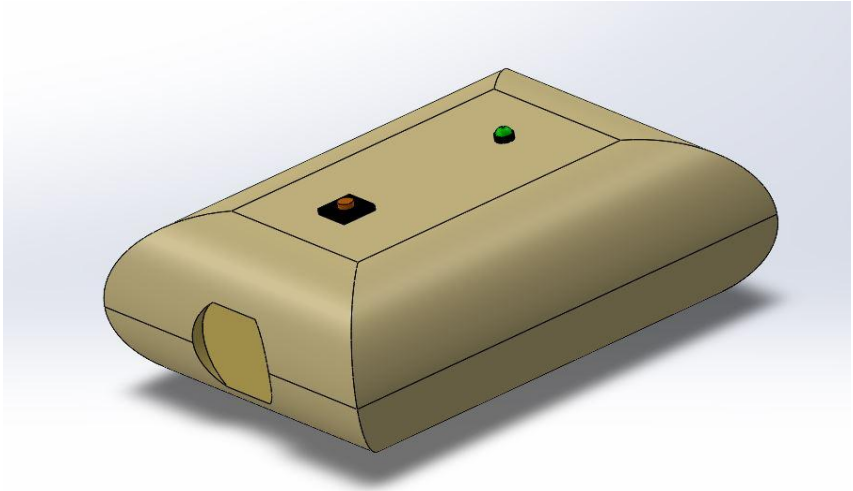
Belly Fat Reader

HOCHSCHULE
HAMM-LIPPSTADT

Department of Electronic Engineering

Interactive Systems Engineering 2 (SS2022)

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



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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

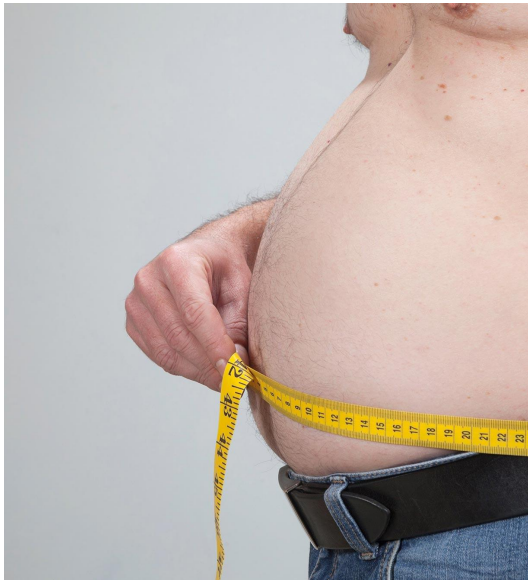


Fig: 3 A person with high obesity

Understanding the problems

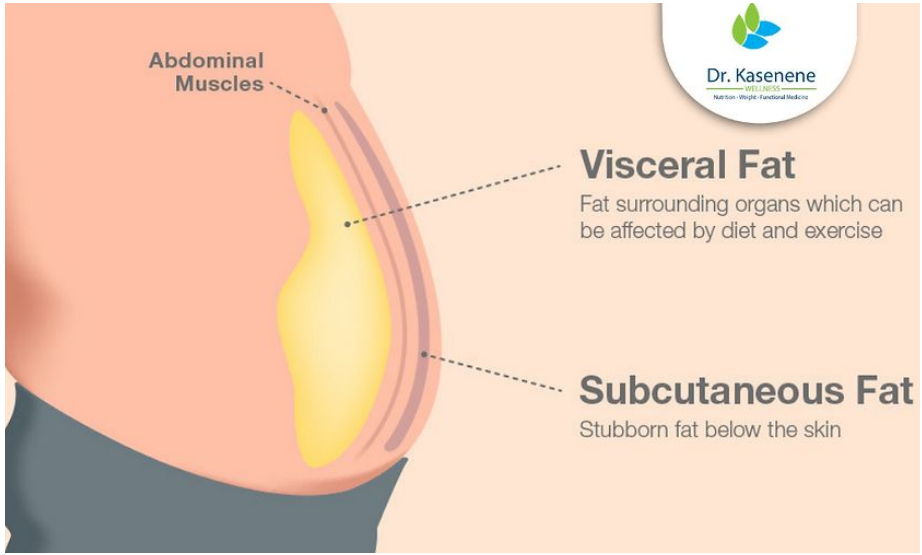
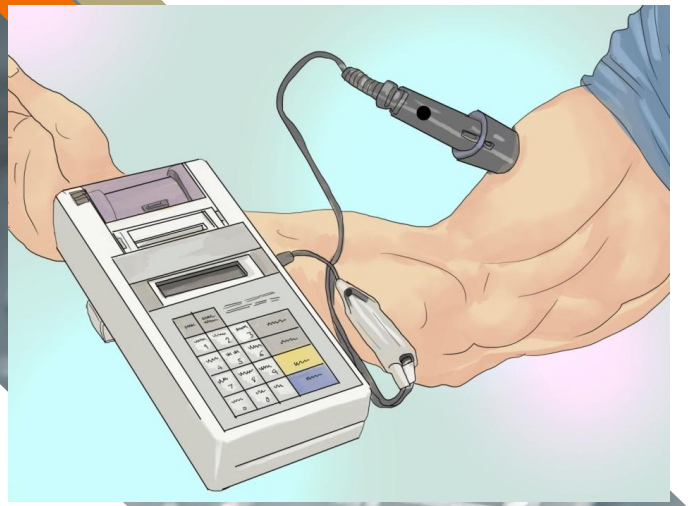


Fig: 4: Kind of fat in human belly

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



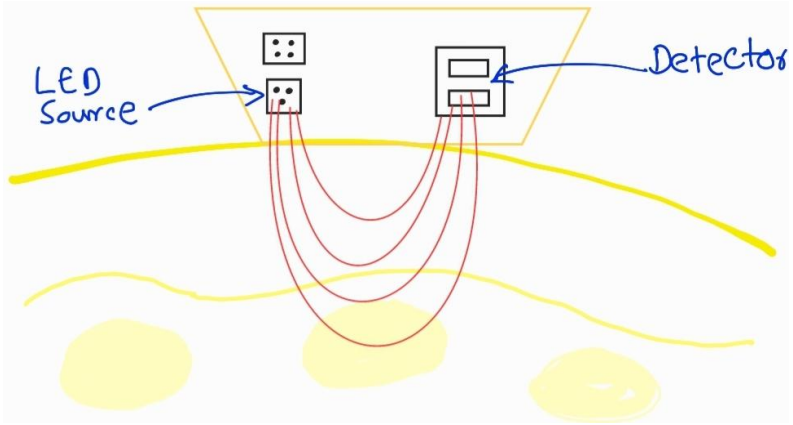


Fig: 5: how to recognize belly fat using NIR sensor

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)

How to interact with the device

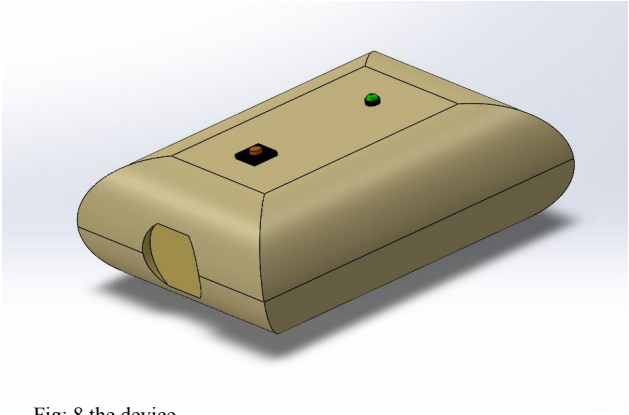


Fig: 8 the device

Push button : 1) press and hold: turn on

2) press once: get measurements

3) press and hold again: turn off (or turn off automatically after 3 mins after sending measurement data to app)

LED configuration

Blue (blinking)	(device turned on), entered pairing mode
Blue(steady)	Connected to the smartphone via Bluetooth (normal state)
Green(blinking), for 3s	Measurement taking, will go back to the steady blue state. That means the measurement has been taken, synced with the app and went back to the `normal state'
Red (blinking)	Battery low
Red (steady)	Device is charging
Green (steady)	Fully charged
yellow(blinking)	Device is updating

Fig: 9: LED configuration

The app and user interface

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: 10 to 14: user interfaces

The app and user interface

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: 15: 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 16: NIR sensor

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

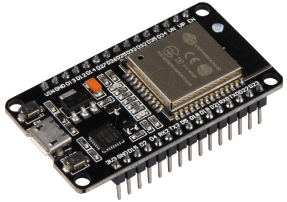


Fig 17: microcontroller

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

Fig 18: Battery

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

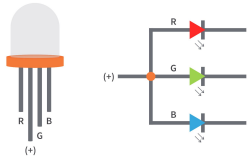


Fig 19: RGB LED

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

Fig 20: Push Button

The Requirement Diagram

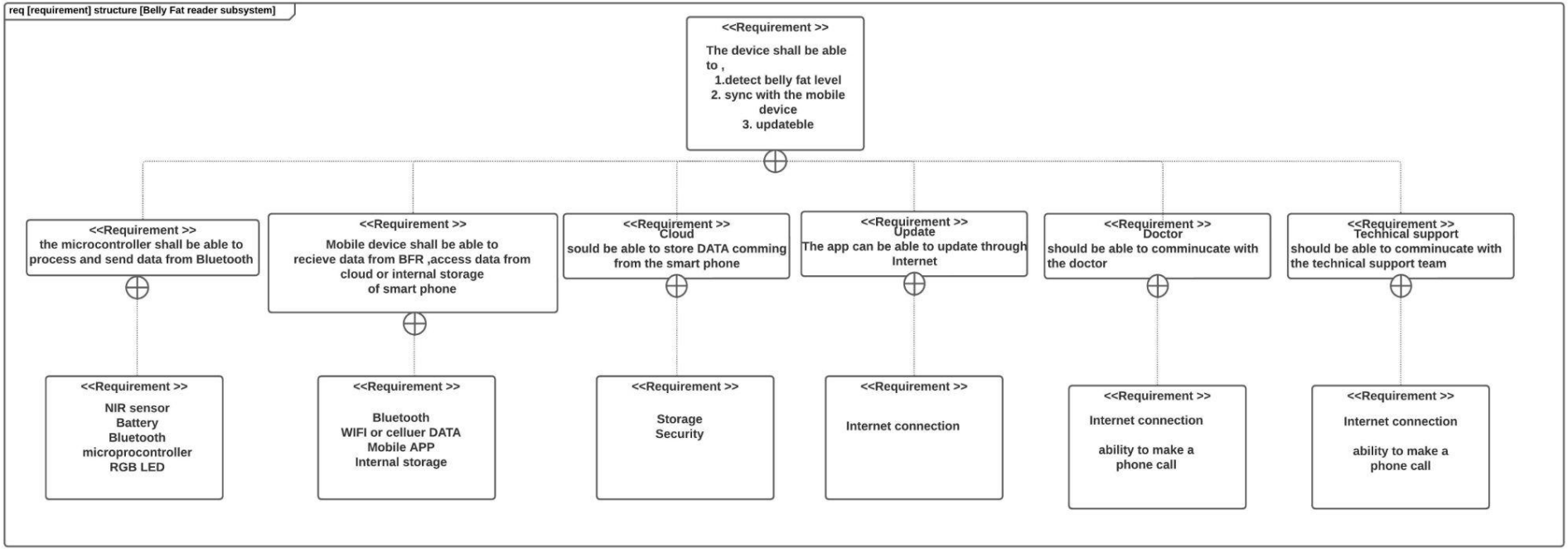


Fig: 21: the requirement diagram

The Use Case Diagram

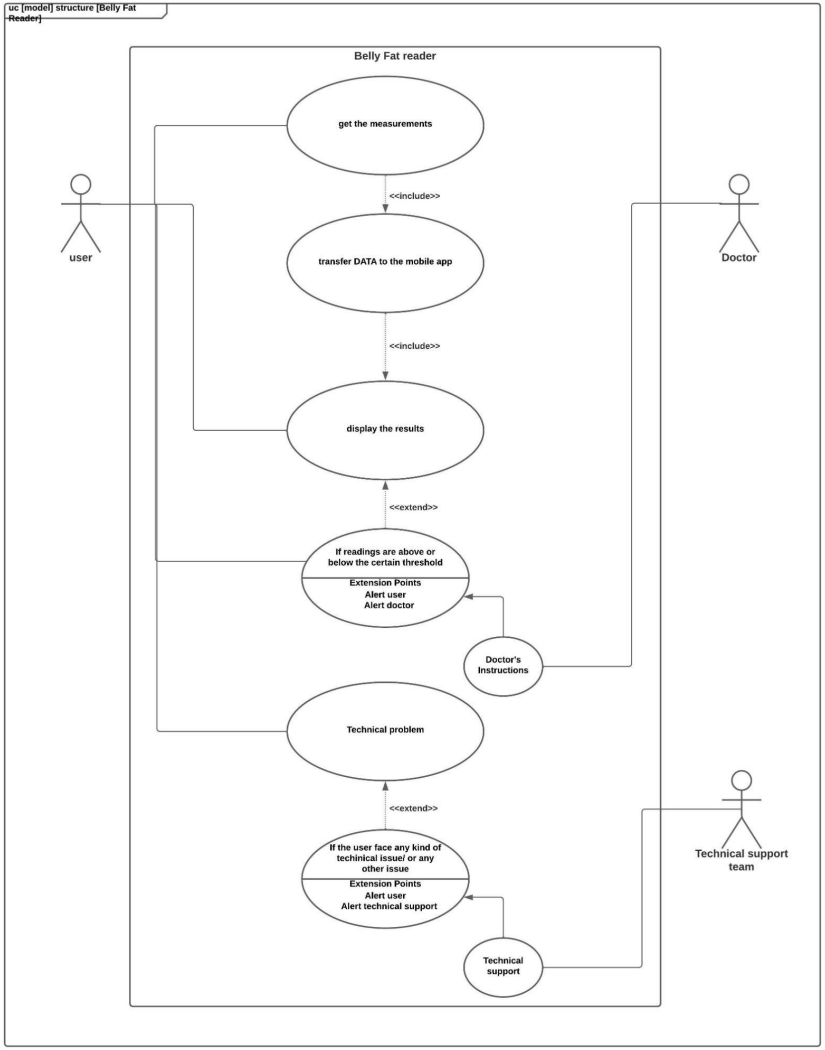
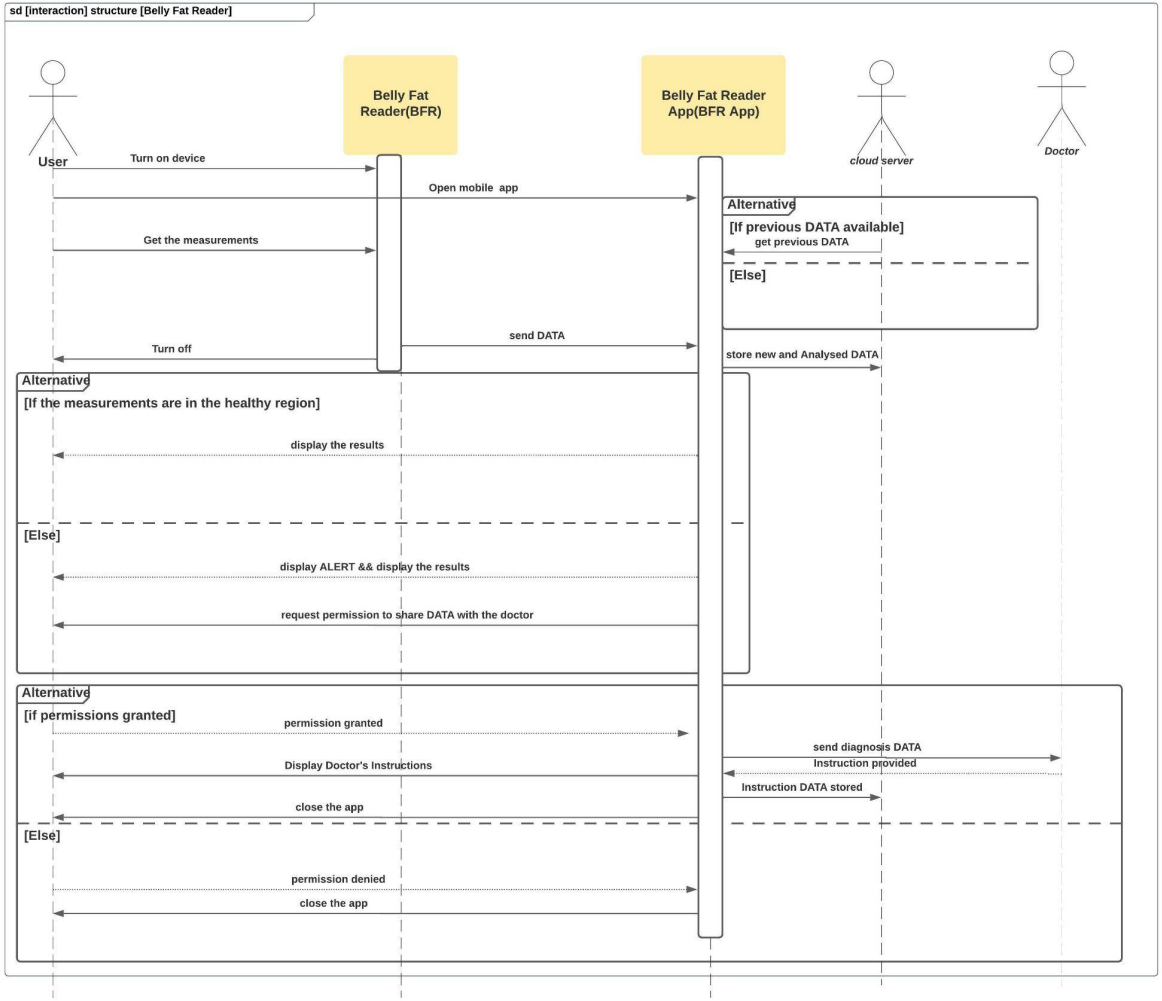


Fig: 22: the use case diagram



The Sequence Diagram

Fig: 23: 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 and 08: 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 15: drawn by the author

Figure 16: NIR Sensor

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

Figure 17: Microcontroller;
https://www.reichelt.com/de/en/development-boards-esp32-wi-fi-and-bluetooth-module-debo-jt-esp32-p219897.html?r=1

Figure 18: Battery; https://diyi0t.com/best-battery-for-esp8266/

Figure 19: RGB LED;
https://create.arduino.cc/projecthub/lewiskell/common-anode-rgb-led-4a5ece

Figure 120: Push button;
https://www.exp-tech.de/en/accessories/buttonsswitches/4342/mini-push-button-switch-x20

Figure 21: the requirement diagram; drawn by the author

Figure 22: the use case diagram; drawn by the author

Figure 23: The requirement diagram; drawn by the author

Thank you!