HUMAN COMPUTER INTERACTION

Personal Health and fitness Management using IoT Solutions

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Motivation & Objective

- Most of the times various lite medical services such as checking of Blood pressure, temperature, blood sugar levels, body fat etc. are segregated and isolated from each other within different devices. Often this means it is not convenient to get a basic diagnostic check quickly.
- Apart from this, it is often unintuitive for the layman user to not be able to properly interpret the data that is provided by these devices and how it pertains to their overall health and how the various factors and parameters play into each other.
- Our IoT based fitness solution aims to overcome these challenges by providing a wearable health tracking band in addition to a few other devices which will be able to communicate with each other to provide a lite diagnostic of the user. In addition to this we aim to provide a warning system for emergencies in case of critical conditions that the user may face.

Members of the project (Individual contribution)

Member 1:

Member name: Suyash Gupta

Member Reg. No:19BIT0073

Contributions : Abstract, motivations, Interactions proposed Functional requirements, Mapping diagram, hardware components, comparison with existing systems, app, smartwatch, and computer interface prototypes.

Member 2:

Member name: Mohit Gupta

Member Reg. No:19BIT0055

Contributions : Advantages, applications, functionalities, HTA diagrams, entities, limitations in existing systems, comparison with existing systems, app and smartwatch interface prototypes.

Member 3:

Member name: Hritik Dubey

Member Reg. No:19BIT0150

Contributions : Entities, interactions proposed, Functional requirements, Mapping diagram, limitations in existing systems, comparison with existing systems, bp and glucometer interface prototypes.

Member 4:

Member name: Mayank Kumar

Member Reg. No: 19BIT0190

Contributions : Applications, HTAdiagrams, functionalities, software components, limitations, limitations in our project, smartphone app and computer interface prototypes, comparison with existing systems

Functional description

Applications of the project

- With the project, a person will be able to visualize detailed insights into various health indicators. Namely blood sugar, Blood pressure, the pulse rate at various points of the day, step stacking, and sleep tracking.
- Using the android app, the user will be able to understand and tweak various aspects of his daily life.
- A health goal-oriented interface will be able to encourage the user to lead a healthy lifestyle.
- Detecting any disease in the early stages will be possible.
- Managing serious diseases like diabetes, hypotension, etc, will be easy.
- During any medical emergency, the data from the app will help medical professionals to know more about the patient.
- Since the app has insights into goals achieved by other users, the service leads to healthy competition to improve oneself.

Advantages of the project

- This product will help the user to supervise his own medical parameters such as blood sugar level , BP level, etc in the body just by wearing a bracelet-like object around the wrist .
- It is portable and light-weight and will help the user to know these above mentioned parameters anywhere and everywhere .
- If there is any fluctuation in the readings from the normal parameters the product also provides early warning signals such as “HIGH BLOOD PRESSURE”, etc, which will help the user to take necessary actions before it is too late .
- For anyone who would like to keep a track on their health by supervising the amount of calories burnt in a day or during an activity.
- The product will have a special mode for this which will connect through an app which would take the targets as inputs from the user. The targets for example may be like achieving a minimum amount of steps in a day or throughout a week ,

maintaining the calorie intake from the food entered in the app .

- Using the android app, the user will be able to understand and tweak various aspects of his daily life.
- The app will have insights into goals achieved by other users and this service will lead to a healthy competition between users to improve themself.
- This beats the misconception between the people regarding health bands that they are only for “gym goers / health conscious people”
- With the project, a person / a user will be able to visualize detailed insights into various health indicators at various points of the day . Managing serious diseases like diabetes, hypotension, etc, will be easy.
- Sleep tracking is also a feature of this device which produces results such as , for how long the user was in deep sleep etc .
- Pulse rate tracking sensors are also embedded in these devices which help the user to know about the pulse rate at any given point of time .
- During any medical emergency, the data from the app will help medical professionals to know more about the patient.
- The app will have insights into goals achieved by other users and this service will lead to a healthy competition between users to improve themself.

Entities of our project.

HUMAN COMPONENT:

Human component involves the end user being health concerned people who want to proactively make their lives better.

The input/output to and from end user entity is interfaced by

- **Visual channel:** For visual interaction of explicit health statistics.
- **Auditory channel**: For critical health alerts and important messages, For measuring pulse rate.
- **Haptic channel**: For haptic feedback regarding detection of Movement, Blood pressure, counting number of steps, sleep time & other motor activities
- **Blood Samples Analysis**: Input for glucometer to measure blood sugar.
- **Touch Channel:** For inputs using the smart phone touch interface that is the gateway of the interaction of the whole IoT ecosystem.

COMPUTING COMPONENT

Computing components involves the smart watch, BP Measuring device, Blood Sugar measuring device, and a Smartphone Mobile Application.

BP Monitoring device:

Interfaces with the user to record BP using touch, visual and haptic feedback, and also with the Mobile Application using bluetooth.

Blood sugar measuring device (Glucometer IoT Device):

Interfaces with the user using touch, visual and haptic feedback and also with Mobile Application using bluetooth.

Smart watch:

Interfaces with the user using touch, auditory, visual and haptic feedback and also with Mobile Application using bluetooth.

Smartphone mobile application:

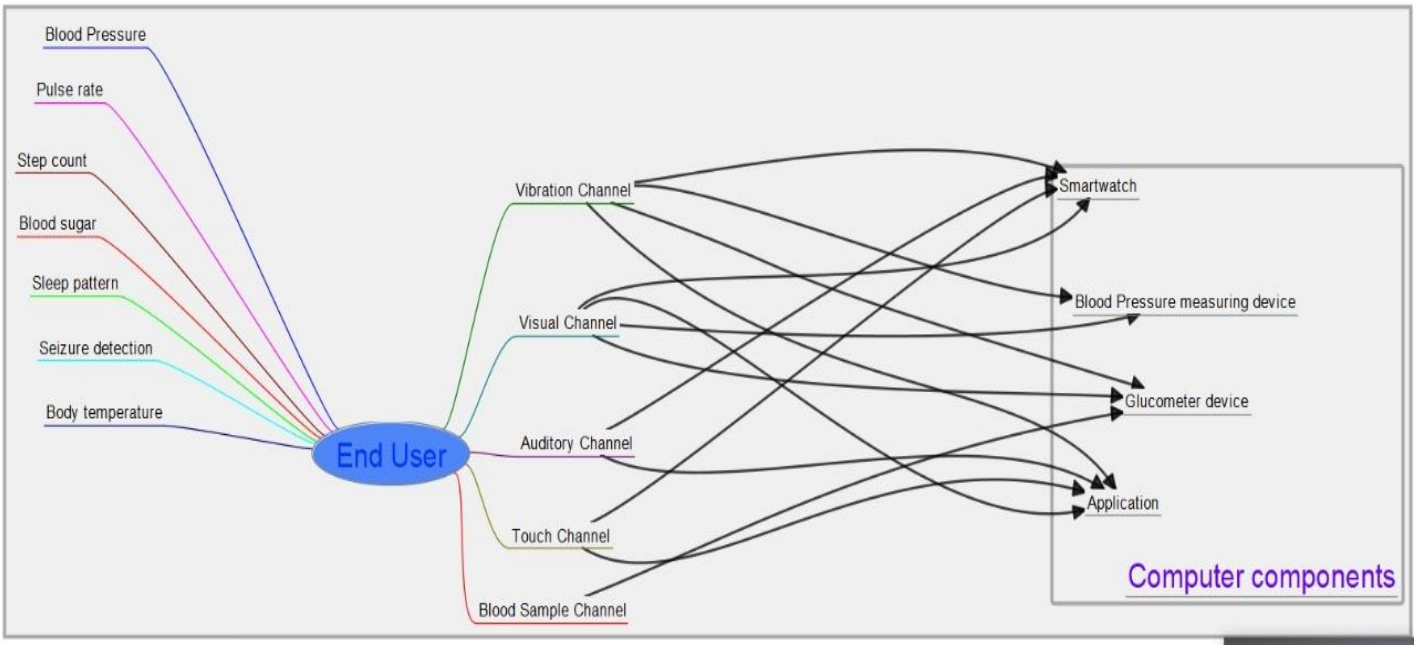
Interfaces with the user using touch, auditory, visual and haptic feedback

Interface between Human and Computer Component

The smartwatch, BP Monitoring Device, Blood sugar measuring device and the mobile application together on an IoT platform interfaces together with the user using various Human I/O Channels and Memory. To create a very intricately woven ecosystem that works on improving the ease of living of the user. The two main components of the ecosystem are the mobile application and the smart watch.

The screen of the smart watch as well as the mobile app are the part of the interface component linked to a cloud server. It helps users to track live information and real time data to monitor their pulse rate, sleep time, blood sugar level, step count & other health parameter.compare results and generate useful insights using ML/AI Technologies.

Interactions proposed



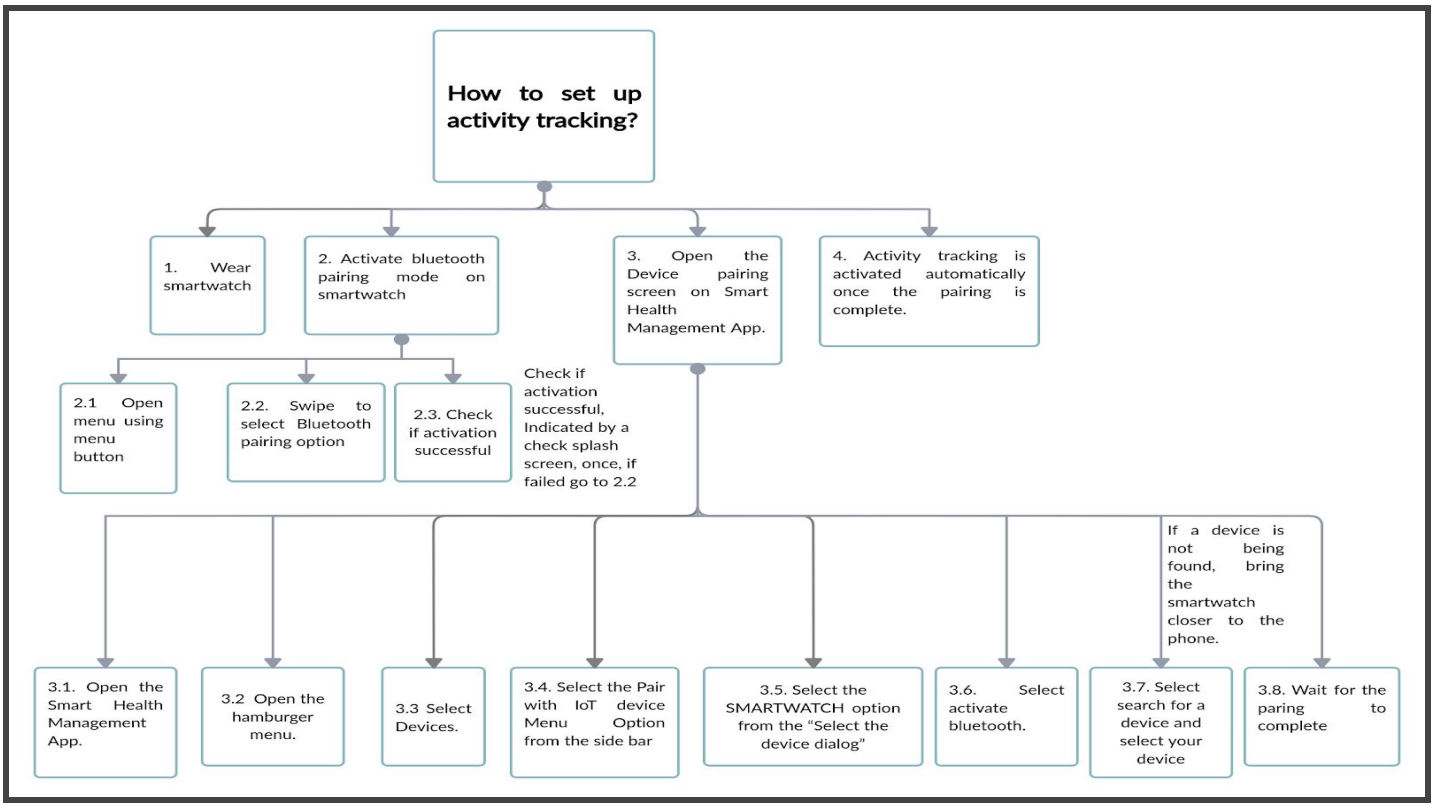
Functionality of Application

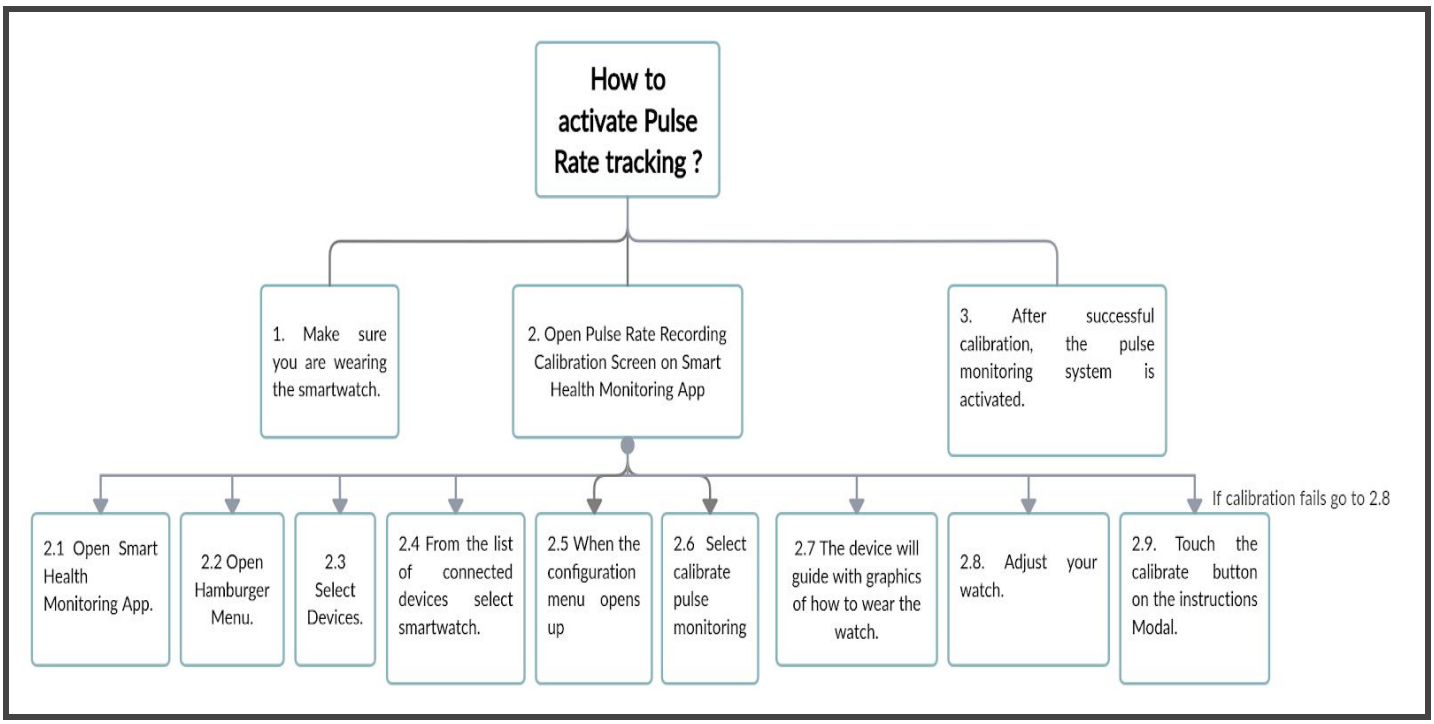
- Continuous activity tracking. (Shared with control module - Smartphone application using bluetooth continuously).
- Actively measuring pulse rate at various times of the day.
- Measure and store blood pressure data obtained when the user takes BP measure using the required module.
- Measure and store blood sugar data obtained when the user takes BP measure using the required module.
- Provide notification when the amount of user activity doesn't match the requirements to keep a healthy lifestyle.
- Provide an interface for doctors to keep track of lifestyle data collected by the Smart Health Management Service. (This also includes emergency situations)
- Provide interactive alerts to users to show various stress peak hours that may be affecting the users wellbeing.

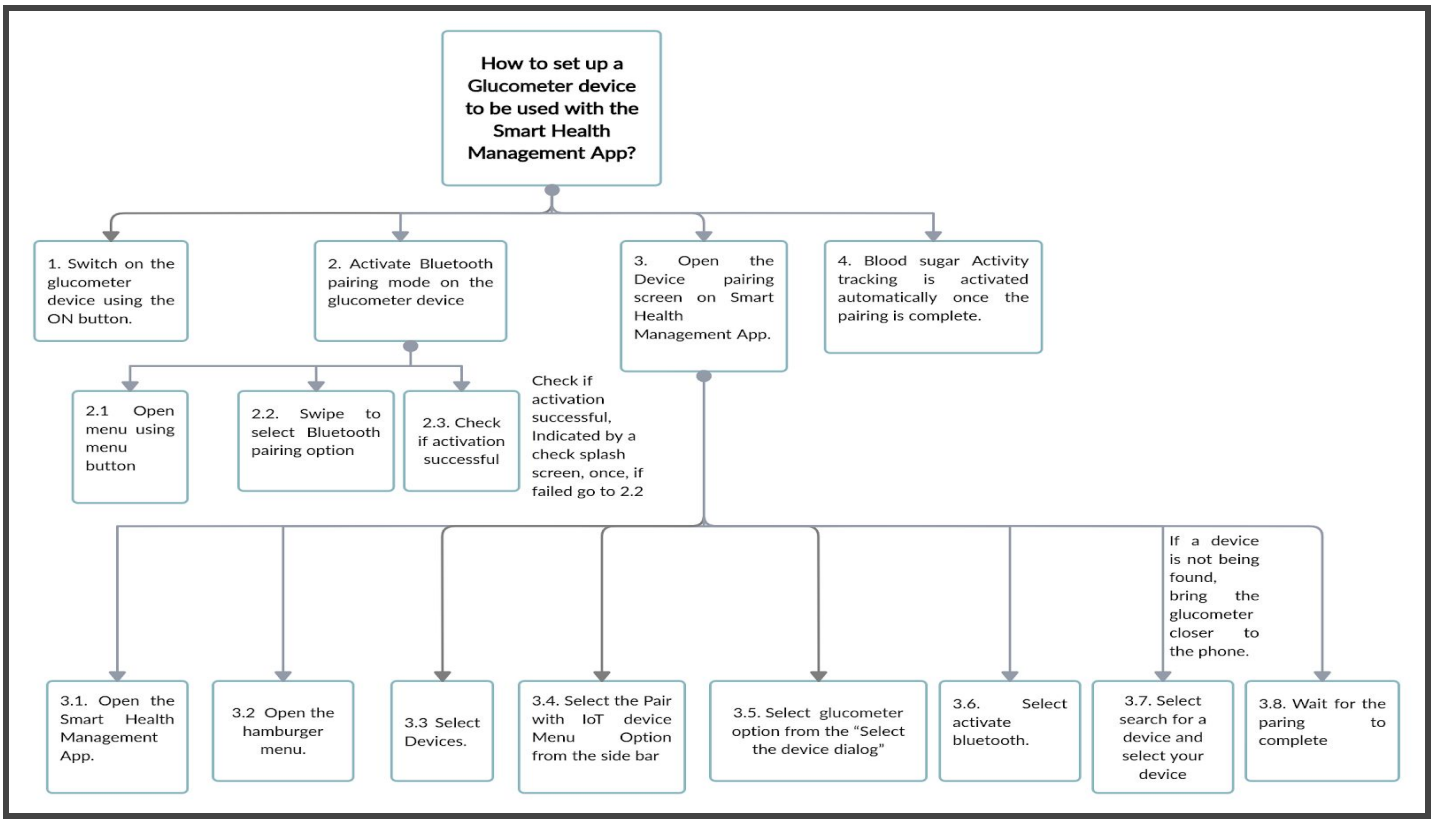
- Show a user's sleep cycle data over a period of time.
- Show data for the user’s pulse rate measured during the whole day.
- Show a user's blood sugar data over a period of time. (Users can make sense of data and can proactively make lifestyle changes).
- Show a user's blood pressure data over a period of time. (Users can make sense of data and can proactively make lifestyle changes).
- Give a user score using ML and the data collected about the lifestyle of the user.
- Give updates to users when our ML models predict high health risks for our users.
- Suggest positive lifestyle changes to our users for a better life.

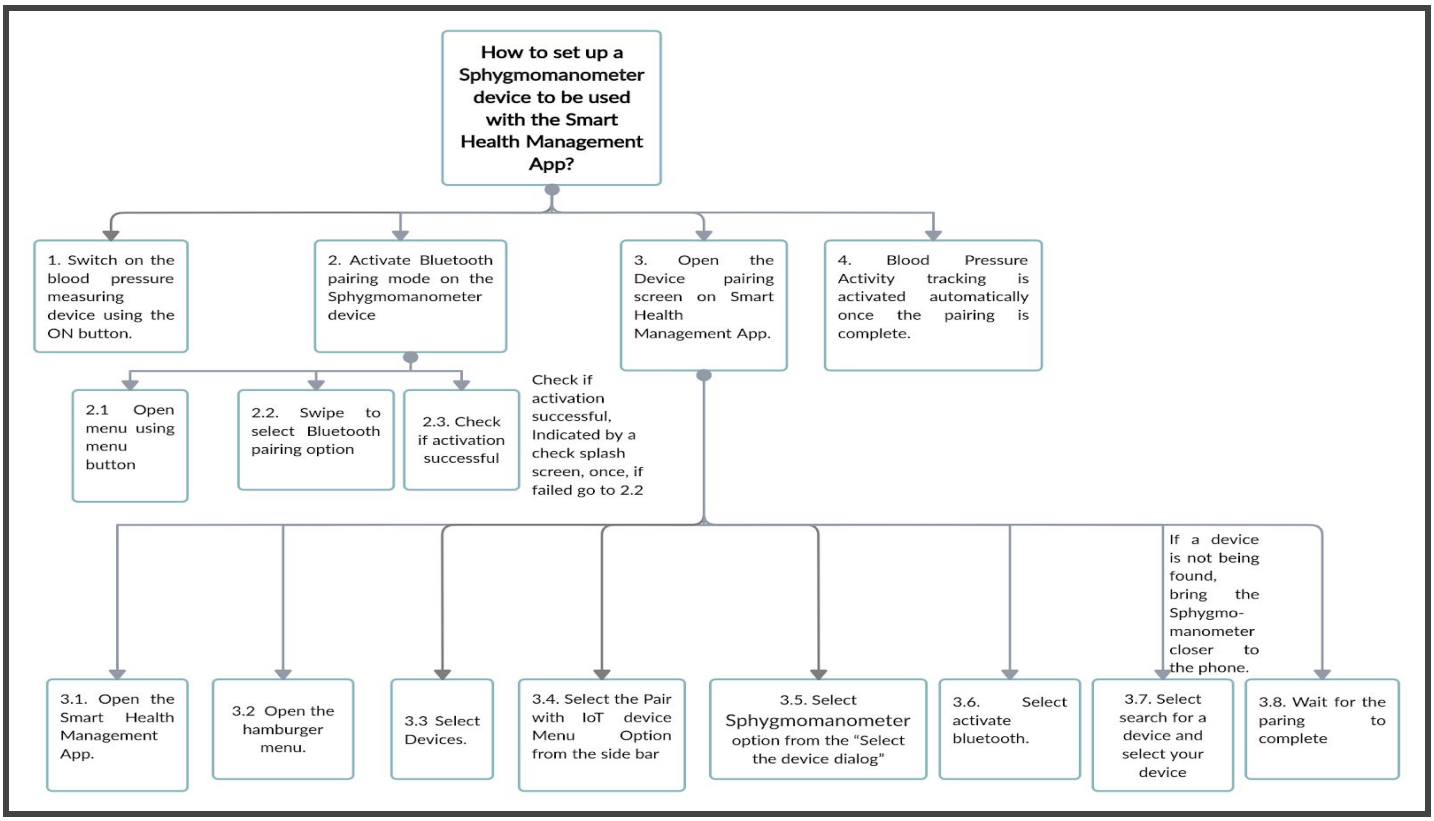
Functional Requirement

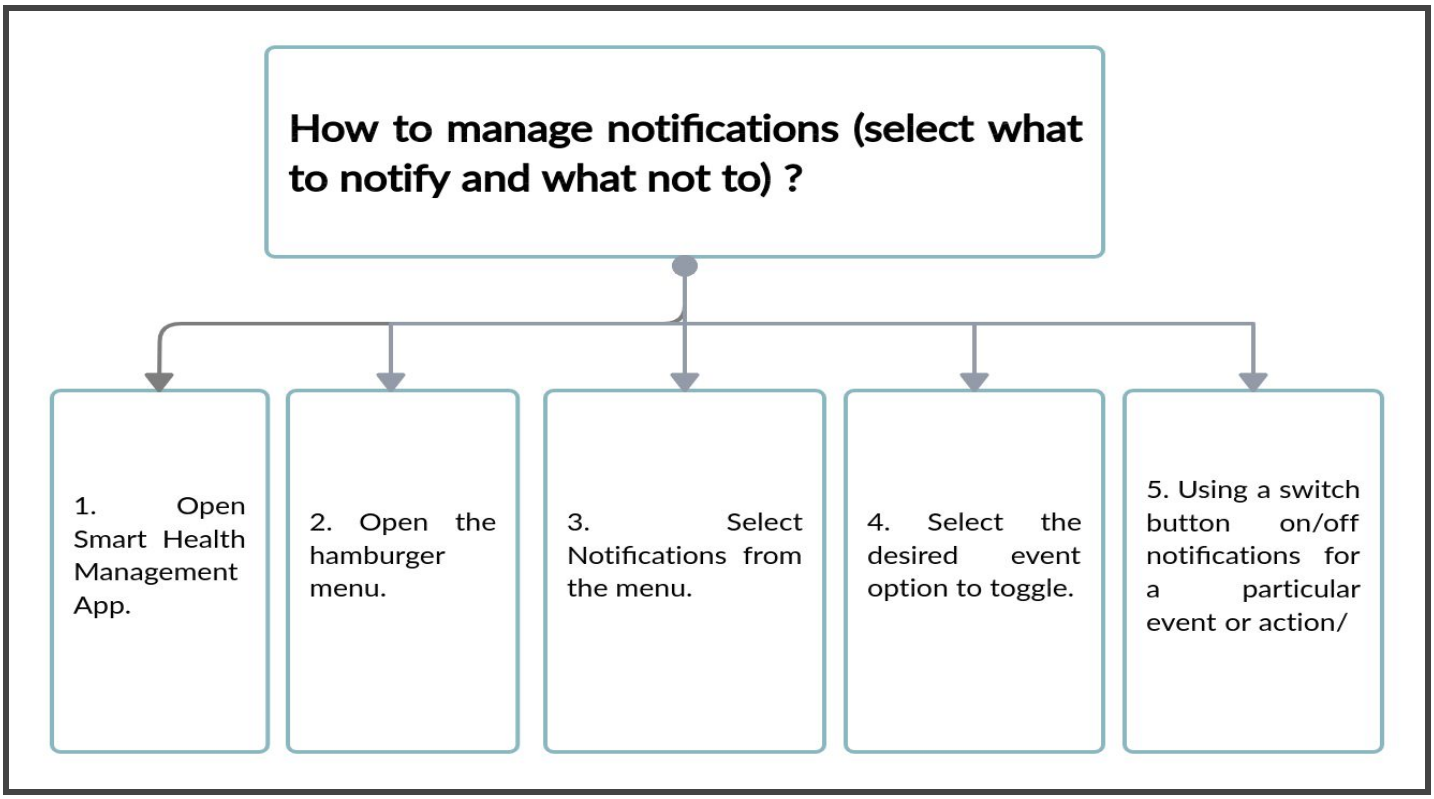
- Fitness-band must be able to detect the user taking steps and record the steps taken.
- Fitness-band should be able to measure a user's pulse rate.
- Fitness-band should be able to measure duration of sleep & rest time.
- Fitness-band should send all the recorded data to the app in intervals of 1 hour for non-critical readings using bluetooth.
- Fitness-band should send all the recorded data to the app in intervals of 1 minute for critical readings using bluetooth.
- Fitness-band should allow users to use it’s touchscreen to navigate menus.
- Date and Time along with other recorded readings should be displayed to the user.
- BP monitor should allow the user to use it’s touchscreen to navigate menus.
- BP monitor should send all the recorded data to the app after every measurement.
- BP monitor should be able to get the user's blood pressure.
- BP monitor should alert users when the process of taking readings is complete.
- Glucometer should allow the user to use it’s touchscreen to navigate menus.
- Glucometer should be able to accept blood samples and give a reading for blood sugar level.
- Glucometer should be able to send all recorded data to the app after every measurement.
- Glucometer should give alerts when the level of blood sugar is calculated.
- Phone apps should give navigation options to view all readings recorded by the devices.
- Phone app should return the health results inferred by the readings.
- Phone apps should give notifications in case of anomalous readings.
- Phone applications should be able to store and receive readings from the database.

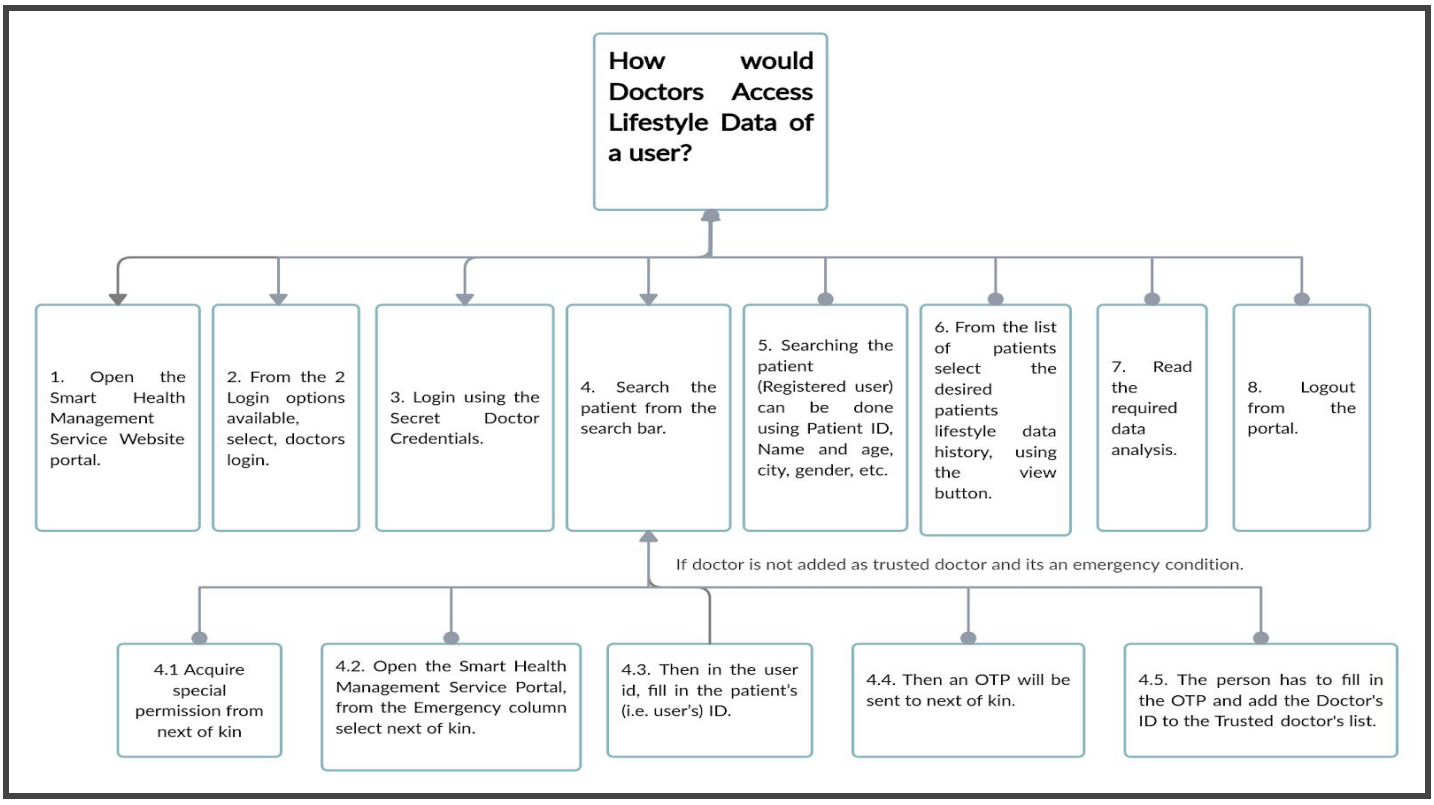

How to set up activity tracking?
1. Wear smartwatch
2. Activate bluetooth pairing mode on smartwatch
3. Open the Device pairing screen on Smart Health Management App.
4. Activity tracking is activated automatically once the pairing is complete.
2.1 Open menu using menu button
2.2. Swipe to select Bluetooth pairing option
2.3. Check if activation successful
Check if activation successful, Indicated by a check splash screen, once, if failed go to 2.2
3.1. Open the Smart Health Management App.
3.2 Open the hamburger menu.
3.3 Select Devices.
3.4. Select the Pair with IoT device Menu Option from the side bar
3.5. Select the SMARTWATCH option from the "Select the device dialog"
3.6. Select activate bluetooth.
3.7. Select search for a device and select your device
If a device is not being found, bring the smartwatch closer to the phone.
3.8. Wait for the paring to complete

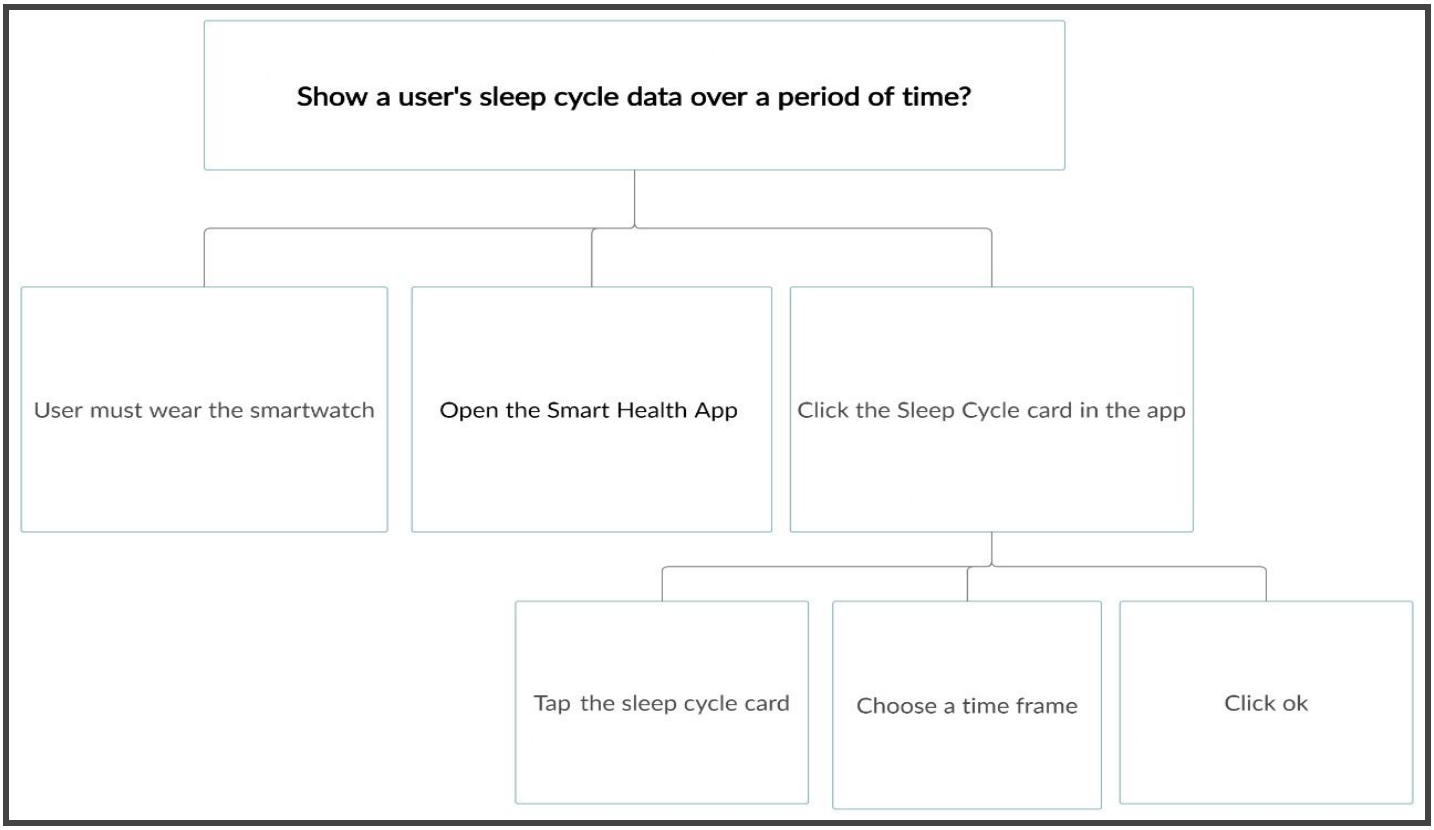

How to activate Pulse Rate tracking ?
1. Make sure you are wearing the smartwatch.
2. Open Pulse Rate Recording Calibration Screen on Smart Health Monitoring App
3. After successful calibration, the pulse monitoring system is activated.
2.1 Open Smart Health Monitoring App.
2.2 Open Hamburger Menu.
2.3 Select Devices.
2.4 From the list of connected devices select smartwatch.
2.5 When the configuration menu opens up
2.6 Select calibrate pulse monitoring
2.7 The device will guide with graphics of how to wear the watch.
2.8. Adjust your watch.
2.9. Touch the calibrate button on the instructions Modal.
If calibration fails go to 2.8

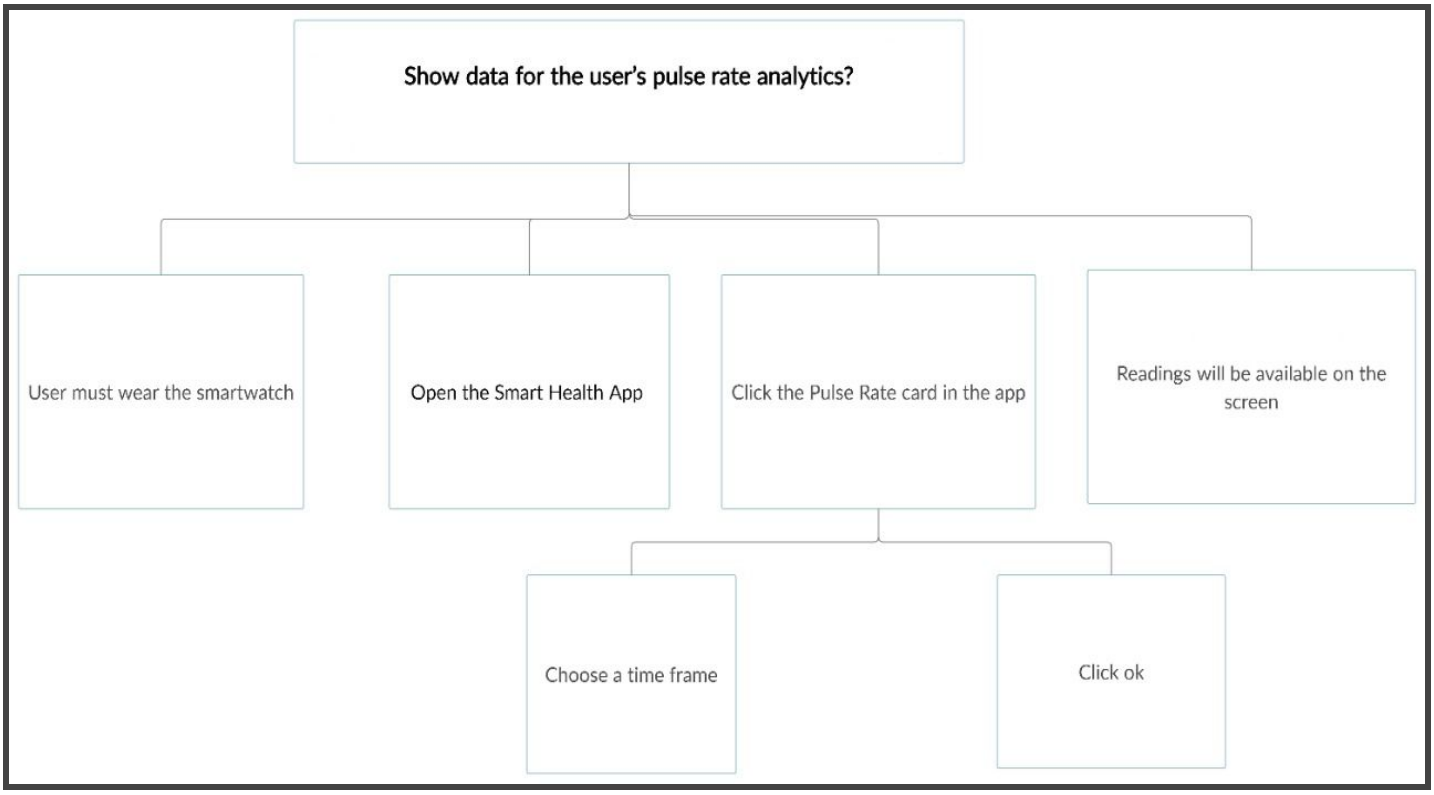

How to set up a Glucometer device to be used with the Smart Health Management App?
1. Switch on the glucometer device using the ON button.
2. Activate Bluetooth pairing mode on the glucometer device
3. Open the Device pairing screen on Smart Health Management App.
4. Blood sugar Activity tracking is activated automatically once the pairing is complete.
2.1 Open menu using menu button
2.2. Swipe to select Bluetooth pairing option
2.3. Check if activation successful
Check if activation successful, Indicated by a check splash screen, once, if failed go to 2.2
3.1. Open the Smart Health Management App.
3.2 Open the hamburger menu.
3.3 Select Devices.
3.4. Select the Pair with IoT device Menu Option from the side bar
3.5. Select glucometer option from the "Select the device dialog"
3.6. Select activate bluetooth.
3.7. Select search for a device and select your device
If a device is not being found, bring the glucometer closer to the phone.
3.8. Wait for the paring to complete

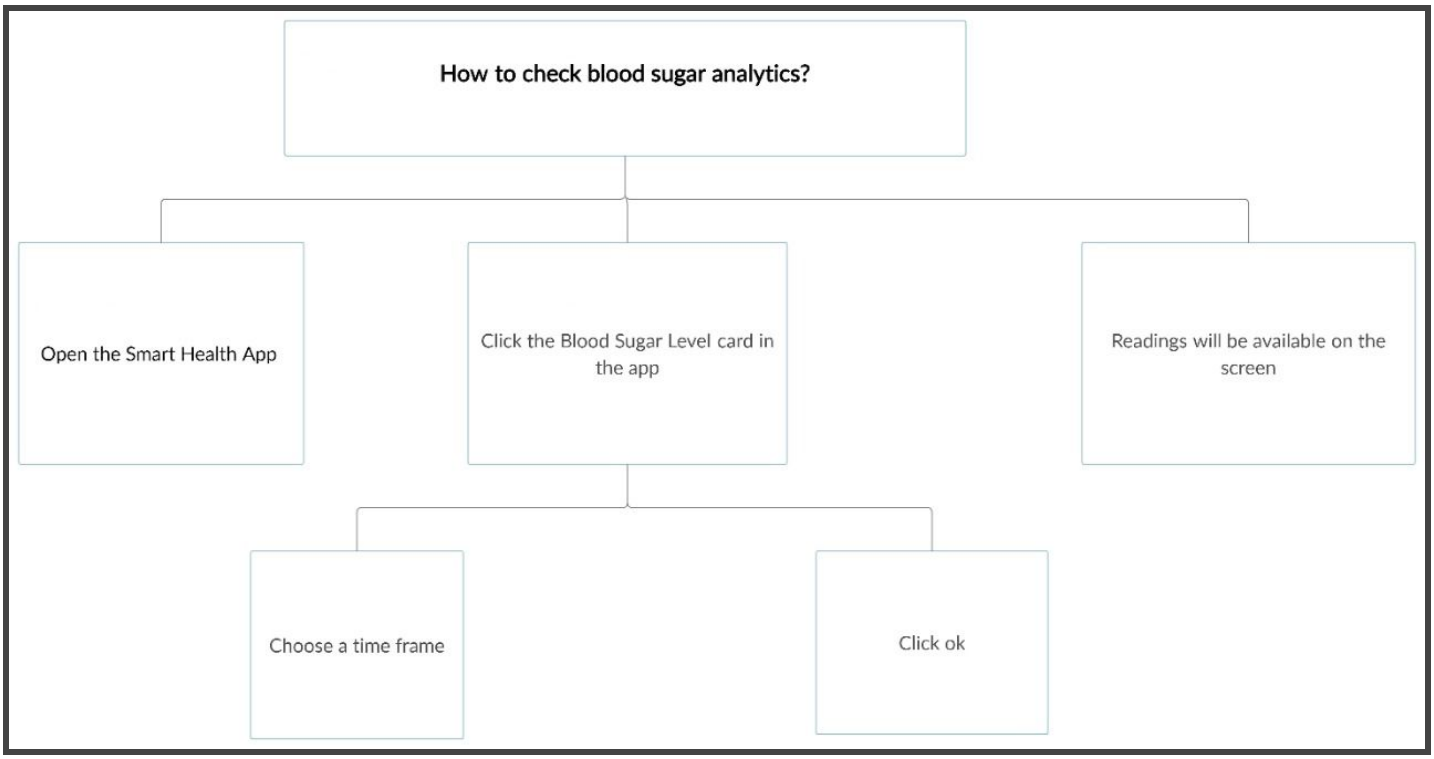

How to set up a Sphygmomanometer device to be used with the Smart Health Management App?
1. Switch on the blood pressure measuring device using the ON button.
2. Activate Bluetooth pairing mode on the Sphygmomanometer device
3. Open the Device pairing screen on Smart Health Management App.
4. Blood Pressure Activity tracking is activated automatically once the pairing is complete.
2.1 Open menu using menu button
2.2. Swipe to select Bluetooth pairing option
2.3. Check if activation successful
Check if activation successful, Indicated by a check splash screen, once, if failed go to 2.2
3.1. Open the Smart Health Management App.
3.2 Open the hamburger menu.
3.3 Select Devices.
3.4. Select the Pair with IoT device Menu Option from the side bar
3.5. Select Sphygmomanometer option from the "Select the device dialog"
3.6. Select activate bluetooth.
3.7. Select search for a device and select your device
If a device is not being found, bring the Sphygmo-manometer closer to the phone.
3.8. Wait for the paring to complete

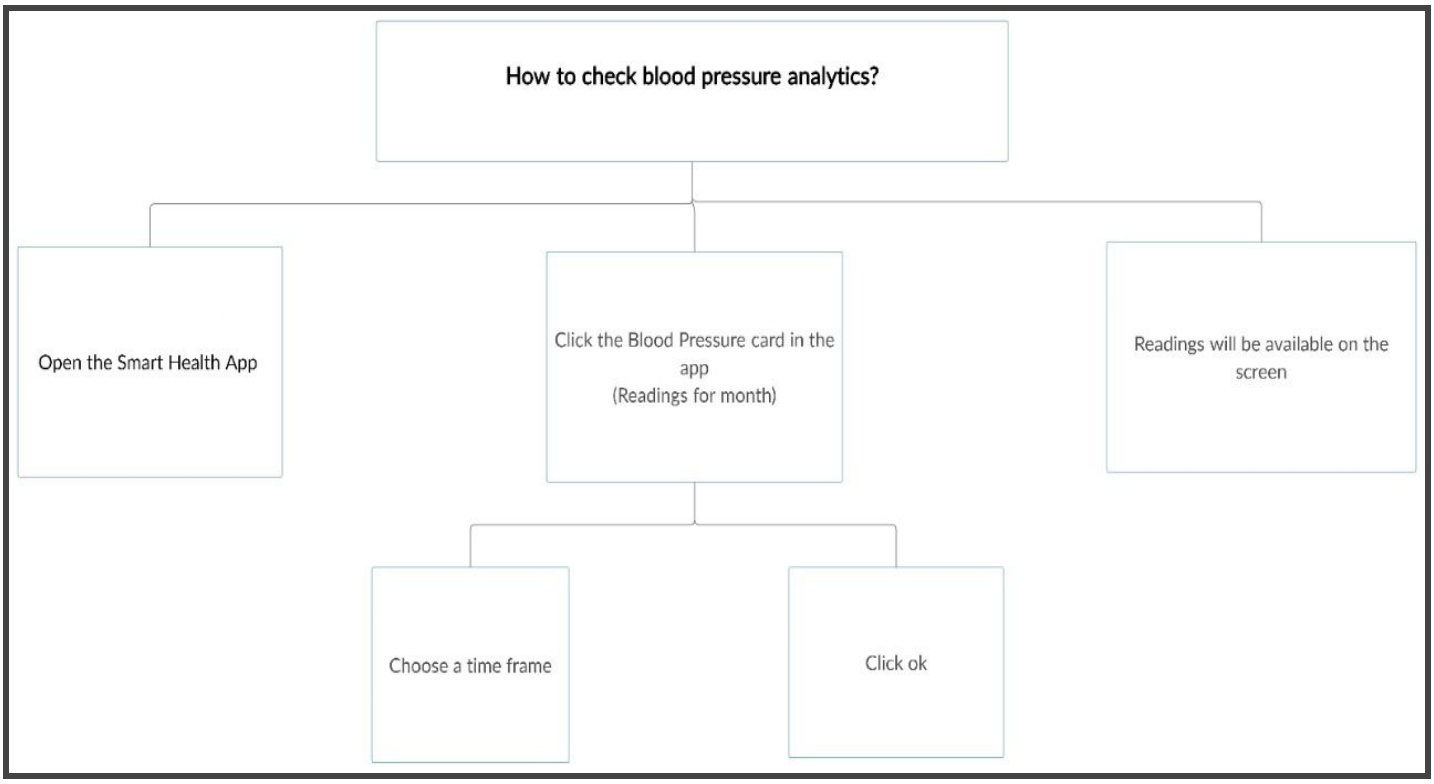

How to manage notifications (select what to notify and what not to) ?
1. Open Smart Health Management App.
2. Open the hamburger menu.
3. Select Notifications from the menu.
4. Select the desired event option to toggle.
5. Using a switch button on/off notifications for a particular event or action/

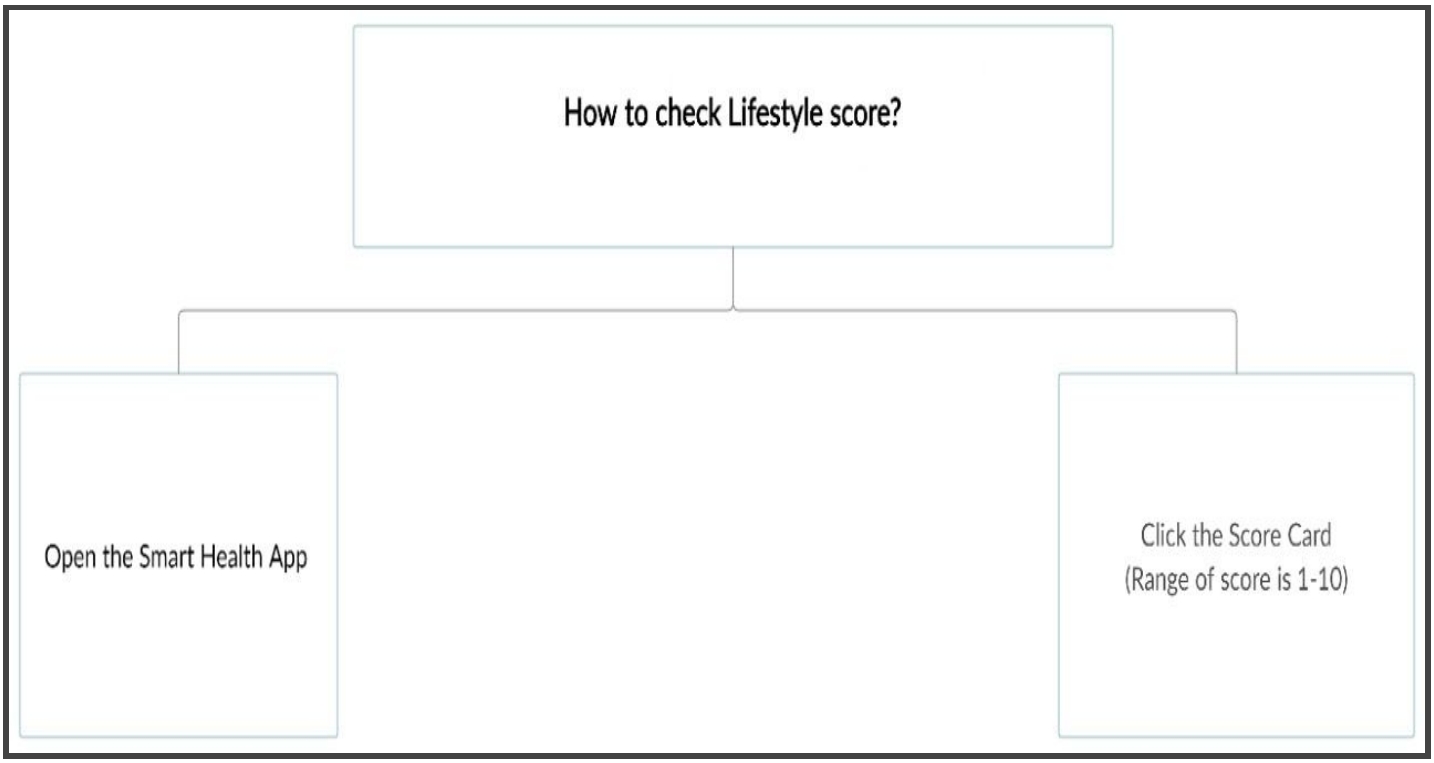

How would Doctors Access Lifestyle Data of a user?
1. Open the Smart Health Management Service Website portal.
2. From the 2 Login options available, select, doctors login.
3. Login using the Secret Doctor Credentials.
4. Search the patient from the search bar.
5. Searching the patient (Registered user) can be done using Patient ID, Name and age, city, gender, etc.
6. From the list of patients select the desired patients lifestyle data history, using the view button.
7. Read the required data analysis.
8. Logout from the portal.
If doctor is not added as trusted doctor and its an emergency condition.
4.1 Acquire special permission from next of kin
4.2. Open the Smart Health Management Service Portal, from the Emergency column select next of kin.
4.3. Then in the user id, fill in the patient's (i.e. user's) ID.
4.4. Then an OTP will be sent to next of kin.
4.5. The person has to fill in the OTP and add the Doctor's ID to the Trusted doctor's list.

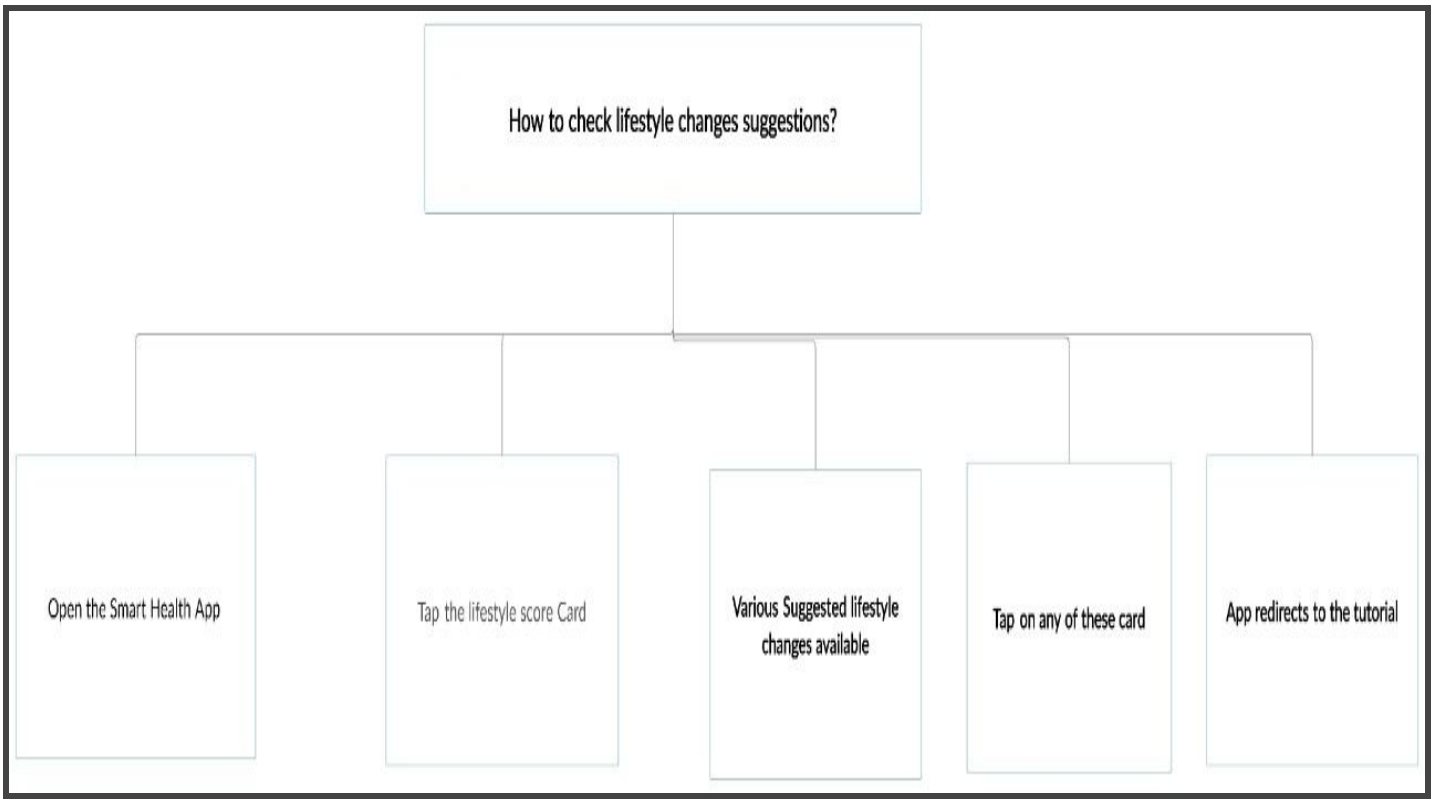

Show a user's sleep cycle data over a period of time?
User must wear the smartwatch
Open the Smart Health App
Click the Sleep Cycle card in the app
Tap the sleep cycle card
Choose a time frame
Click ok


Show data for the user's pulse rate analytics?
User must wear the smartwatch
Open the Smart Health App
Click the Pulse Rate card in the app
Readings will be available on the screen
Choose a time frame
Click ok


How to check blood sugar analytics?
Open the Smart Health App
Click the Blood Sugar Level card in the app
Readings will be available on the screen
Choose a time frame
Click ok


How to check blood pressure analytics?
Open the Smart Health App
Click the Blood Pressure card in the app
(Readings for month)
Readings will be available on the screen
Choose a time frame
Click ok


How to check Lifestyle score?
Open the Smart Health App
Click the Score Card
(Range of score is 1-10)


How to check lifestyle changes suggestions?
Open the Smart Health App
Tap the lifestyle score Card
Various Suggested lifestyle changes available
Tap on any of these card
App redirects to the tutorial

Functional Requirement

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- Fitness-band should be able to measure duration of sleep & rest time.
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- Date and Time along with other recorded readings should be displayed to the user.
- BP monitor should allow the user to use it’s touchscreen to navigate menus.
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- BP monitor should be able to get the user's blood pressure.
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- Glucometer should allow the user to use it’s touchscreen to navigate menus.
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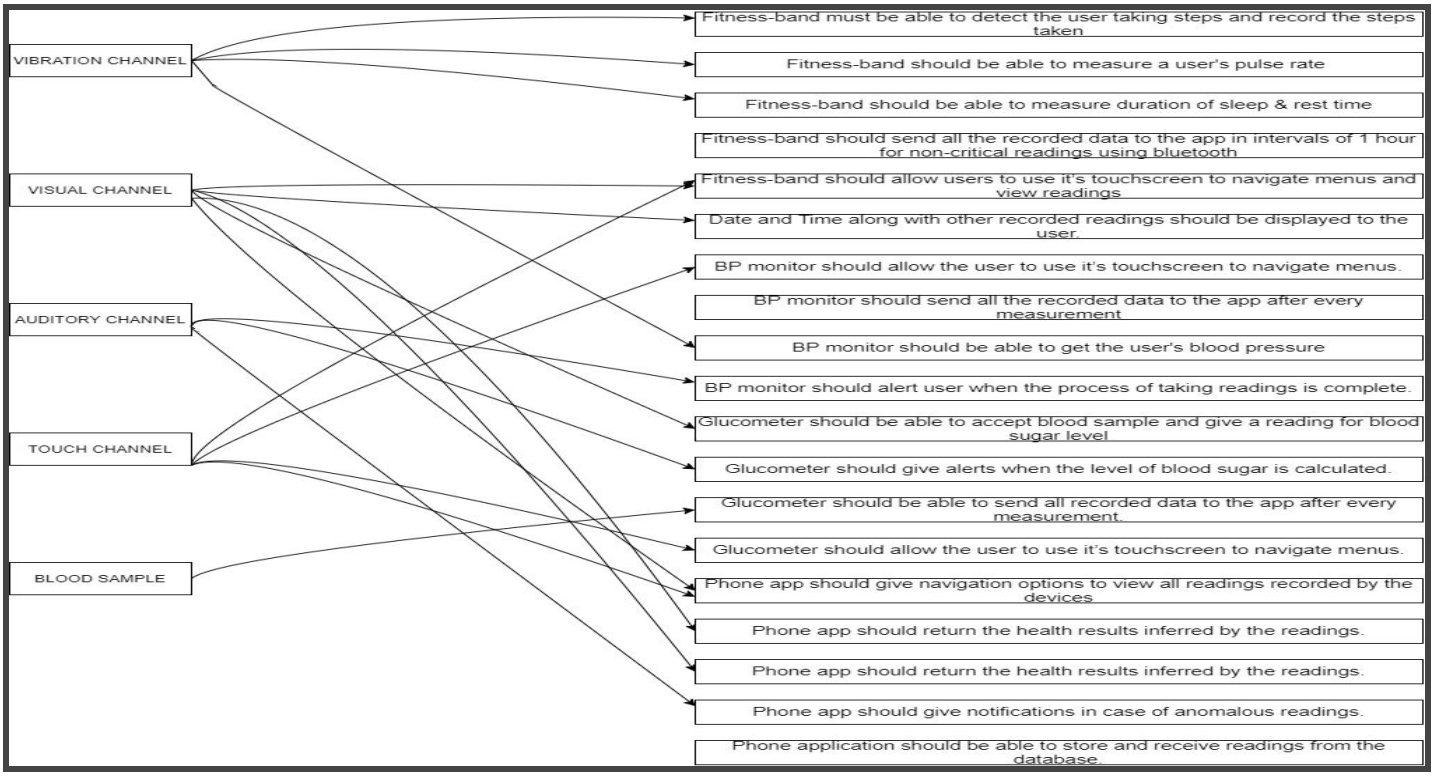


Hardware Component

- Arduino uno/NodeMCU microcontrollers
- Heartbeat/pulse sensor
- Pedometer(step counting sensor)
- 60 volt current sensor(for sleep tracking)
- Barometric pressure sensor(for blood pressure)
- Glucometer(to sense blood sugar levels)
- Bluetooth module(for assorted devices to communicate with the mobile application)
- Touch screen interface
- Touch sensor, button inputs
- Smartphone device to run the app

Software Requirement

1. Backend:
    a. Golang Microservice
    b. gRPC Framework
    c. Kafka
    d. Node JS Runtime
2. Deployment Requirements:
    a. AWS EC2 Service
    b. AWS Elastic Kubernetes Service
    c. AWS Lambda
    d. AWS Amazon Sagemaker
3. Machine Learning Frameworks:
    a. Tensorflow
    b. Torch
4. Frontend Requirements:
    a. HTML/CSS/JS/Flutter/React JS

Interface Required

- Home screen (app)
- Hamburger menu (app)
- Statistics screens for all readings x 3 (app)
- Lifestyle page (app)
- Settings screen (app)
- Devices screen (app)
- Calibration screen (app)
- Device adding screen(app)
- Basic interface (smartwatch)
- Glucometer interface
- Blood pressure interface

Comparison of the existing system/app with proposed design

Limitations	**Solutions**	**HCI Principles**
All the current systems are isolated	One unified product	Ease of use
As isolated cost is high	One unified product hence lesser cost.	Ease of access to the product.
Time dissonance between what is present in the system vs. what is displayed.	Realtime results and measurements are provided to the user.	Dialogues provide closure to the user as to what is going on in the system.
Current systems are inconsistent between different components.	The interfaces in our application follow a more uniform format	Consistency Is provided in between the different interfaces.
The system provides vague results which users may find harn to interpret.	Our system provides an interpretation of what our readings entail and an overall fitness score.	This system provides clear feedback to the user.
Huawei Health app. For a user who wants a general outlook of his/her health, The Tabbed interface increases the time that he/she might takes to get information from all the required tabs	Give information at a consolidated place with easy to understand cards, which gives a general outlook of his health.	Decrease stress to improve under experience.
Huawei Health App. The Reading of health indicators are shown in a very blandway, it's difficult for a user who doesn't remember what reading is healthy to make sence of the information	Give a color coded indicator on the screen which shows if a health indicator is severe or healthy.	Recognition rather than recall.
Huawei Health App. No interface for the users to know about errors, and how to mitigate any errors while pairing with a hardware device.	A youtube video deep linked button available when errors occur. Users can use the link to get help by watching the videos and mitigating the error.	Better Help and documentation for better learnability.

Dr.Morepen, Accu-Chek, Dr.Trust Glucometer. Omron,Dr.Trust BP monitor. Have a limited number of readings to store in devices with no menu to see them in an organised manner.	In the new Glucometer & BP monitor Add a menu button which opens the list of previous readings with Date,Time,& Day displayed in a very organised manner.	Dialogues are provided to give clarity to the user.
Dr.Morepen, Accu-Chek, Dr.Trust Glucometer. Omron,Dr.Trust BP monitor. Save previous readings in the device only with limited memory.	In the new Glucometer & BP monitor, After every reading of BP & sugar level, Data will be uploaded to the mobile cloud.	This helps to prevent errors such as errors leading to the loss of this data.

Existing systems to be compared with

- Name (features, pros/cons, drawbacks and inspirations taken if any) [limit it to 4-5 lines] add references if any.
- MI band - steps, calories burnt, heart rate. We have used this for inspiration as it has some basic features which are easily accessible on the device. However, it is limited in its features and does not interface with many other devices.
- Apple smart watch- steps, calories burnt, detection and notification of abnormalities, This device has many key features which we implemented, including notifications of abnormalities, however, it lacks the comprehensive list and interpretations of the readings.
- Huawei Health App
- Dr.Morepen, Accu-Chek, Dr.Trust Glucometer : Used to measure Glucose level, with basic display & limited memory to save previous readings. The device measures the reading very accurately.
- Omron,Dr.Trust BP monitor : Used to measure Blood pressure and Pulse rate, basic display & features. High accuracy of measurement

Developed system

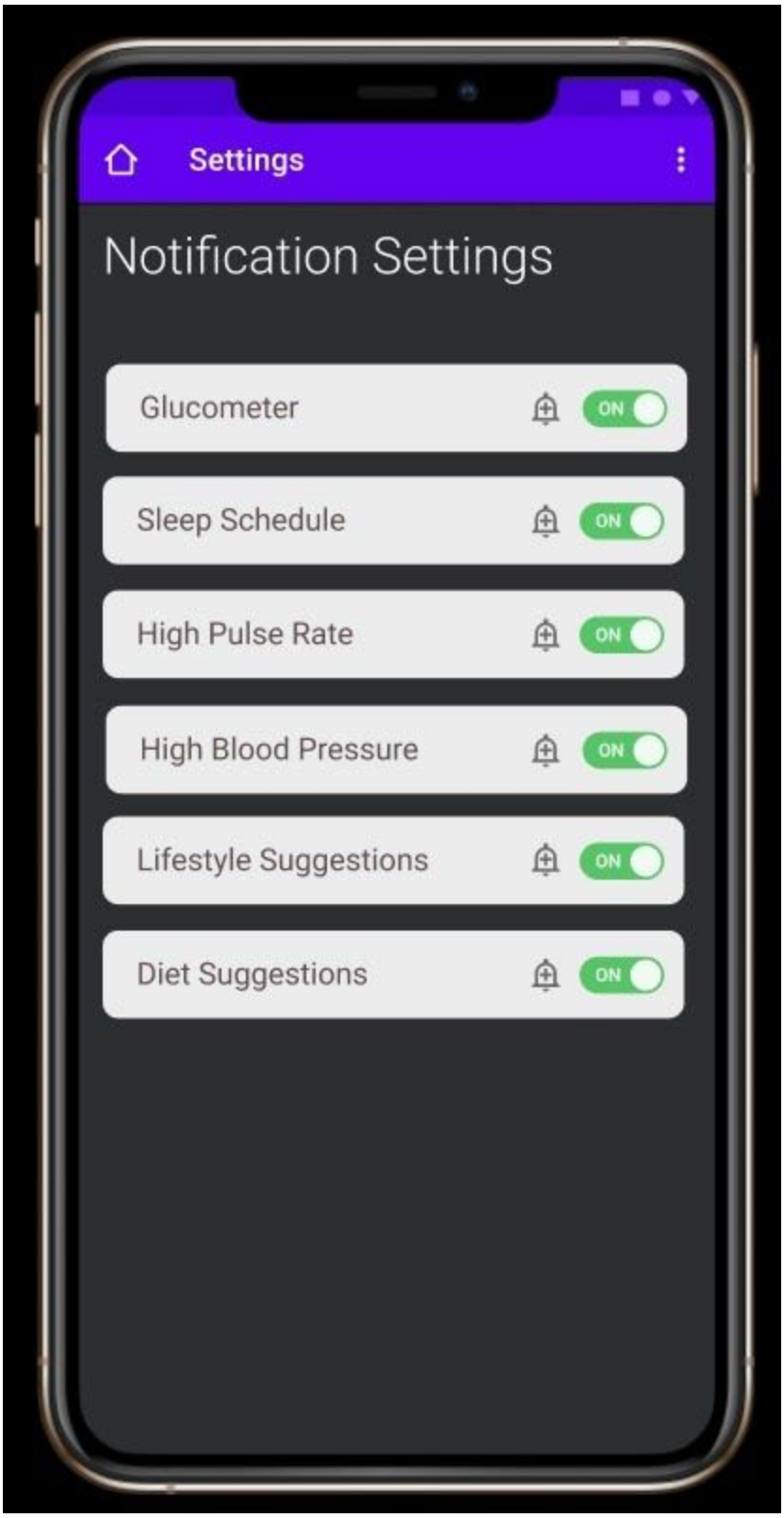
Home page of the app consists of buttons to open the hamburger menu and cards to access the lifestyle and the detailed device readings pages.

The device readings page is accessed from the homepage hamburger menu and is a list of all the devices involved and leads to the specific readings of each device.

This is the Glucometer readings page which shows the detailed readings of blood sugar levels collected over a certain period of time.

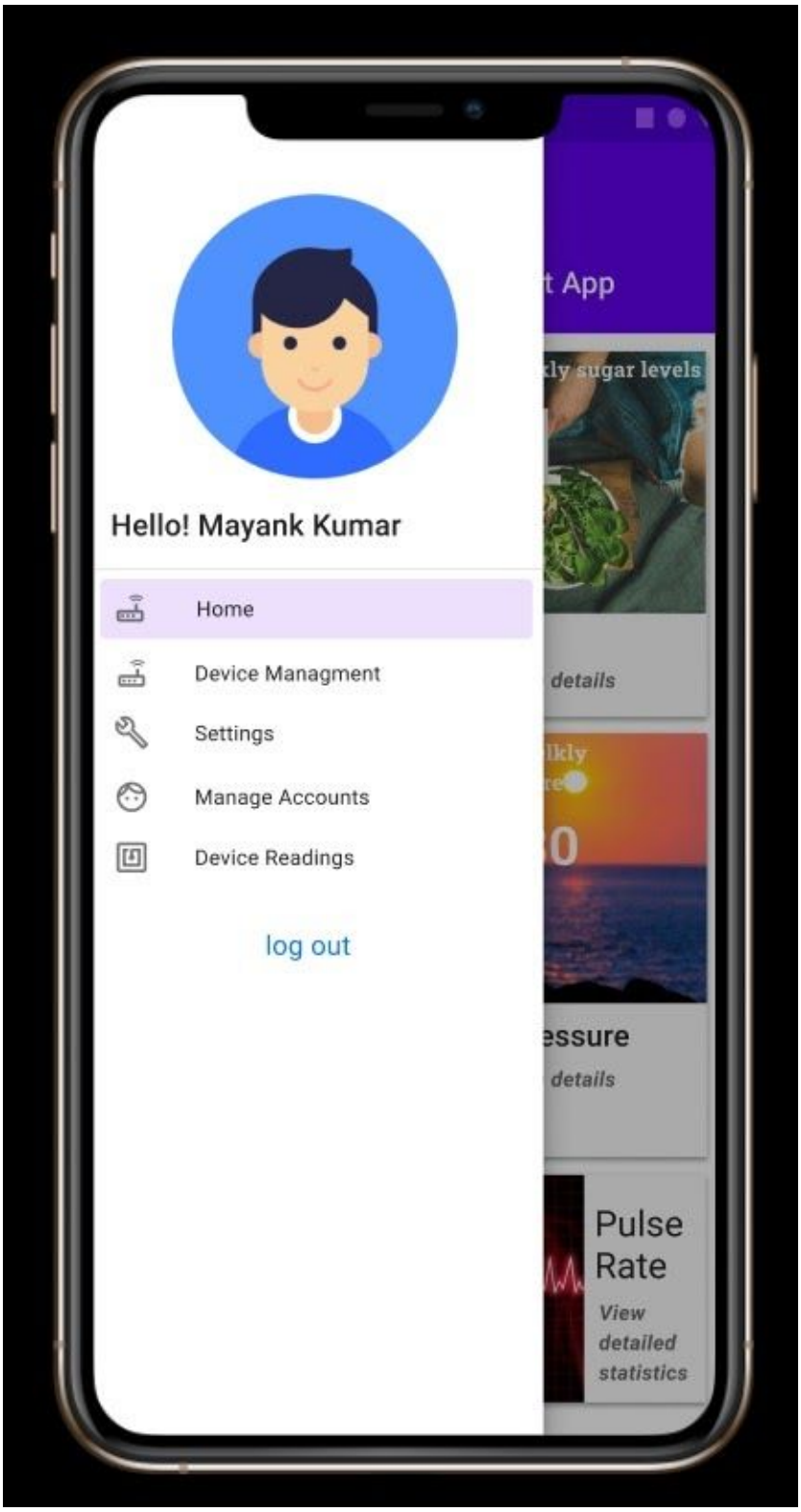
The blood pressure readings page shows the readings collected by the blood pressure sensor over a selected period of time.

The smart watch readings page allows one to view a list of all the readings collected by the smartwatch and access each one of those individually to view the details of the readings, both daily and on a weekly basis.



The settings page, accessed from the homepage hamburger menu allows the user to choose whether they want to receive notifications for certain devices' readings and other notifications for lifestyle and diet suggestions.

The lifestyle Score page includes an overall lite diagnostic of the user based on all the readings collected from the various devices, and based on that provides an overall score of your habits as well as ways to improve your overall health.



This is the hamburger menu mentioned earlier which is accessed through the menu button on the homepage, and it has a persona in the form of Mayank and it provides the option for a user to log out as well as various key options like managing devices, accounts, settings, and readings.

The device management page allows a user to configure and add a device of choice to the app and the network of other devices via bluetooth.

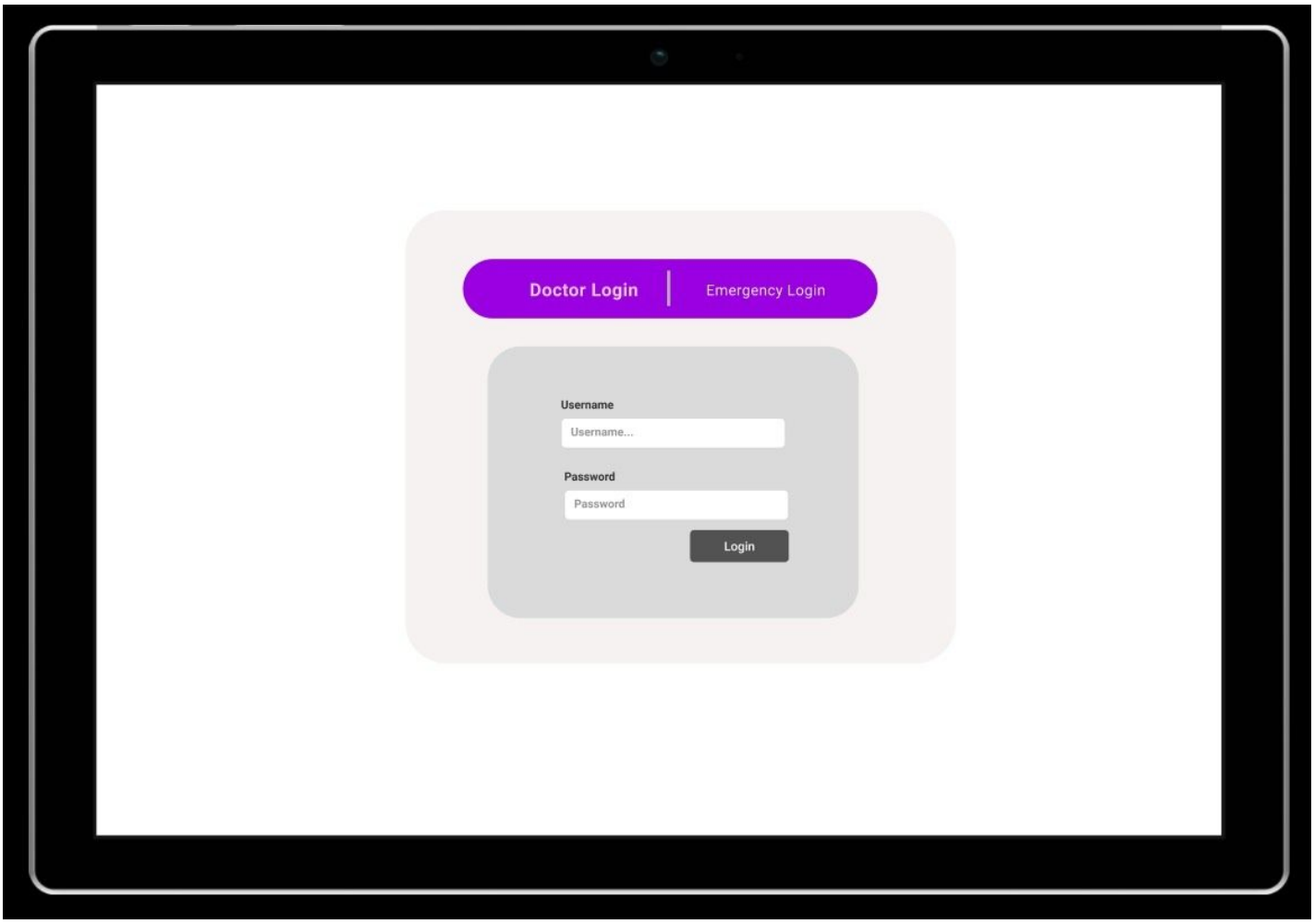
Here, on clicking the pair device button given in the device management we get the choice of the type of device that we wish to pair to the app.

Here, the user is given full disclosure as the process goes on, where the app is searching for nearby devices for it to pair with.

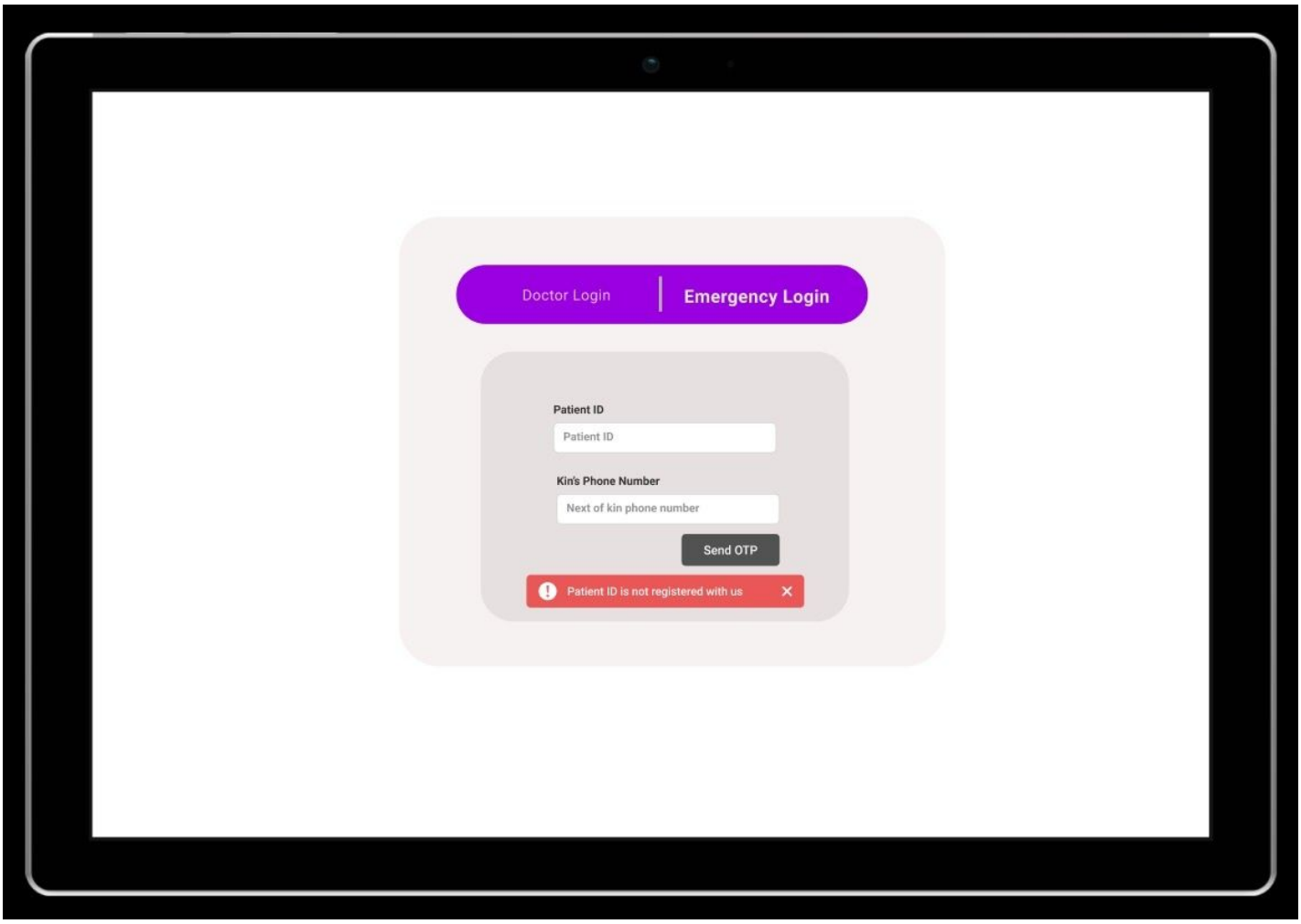
Here, in case the app fails to pair with any nearby devices, it provides this error message and a link to a help video. The user can retry paring.

This screen is displayed upon successfully detecting devices which can be paired with the apps, and here the user chooses which device to pair.

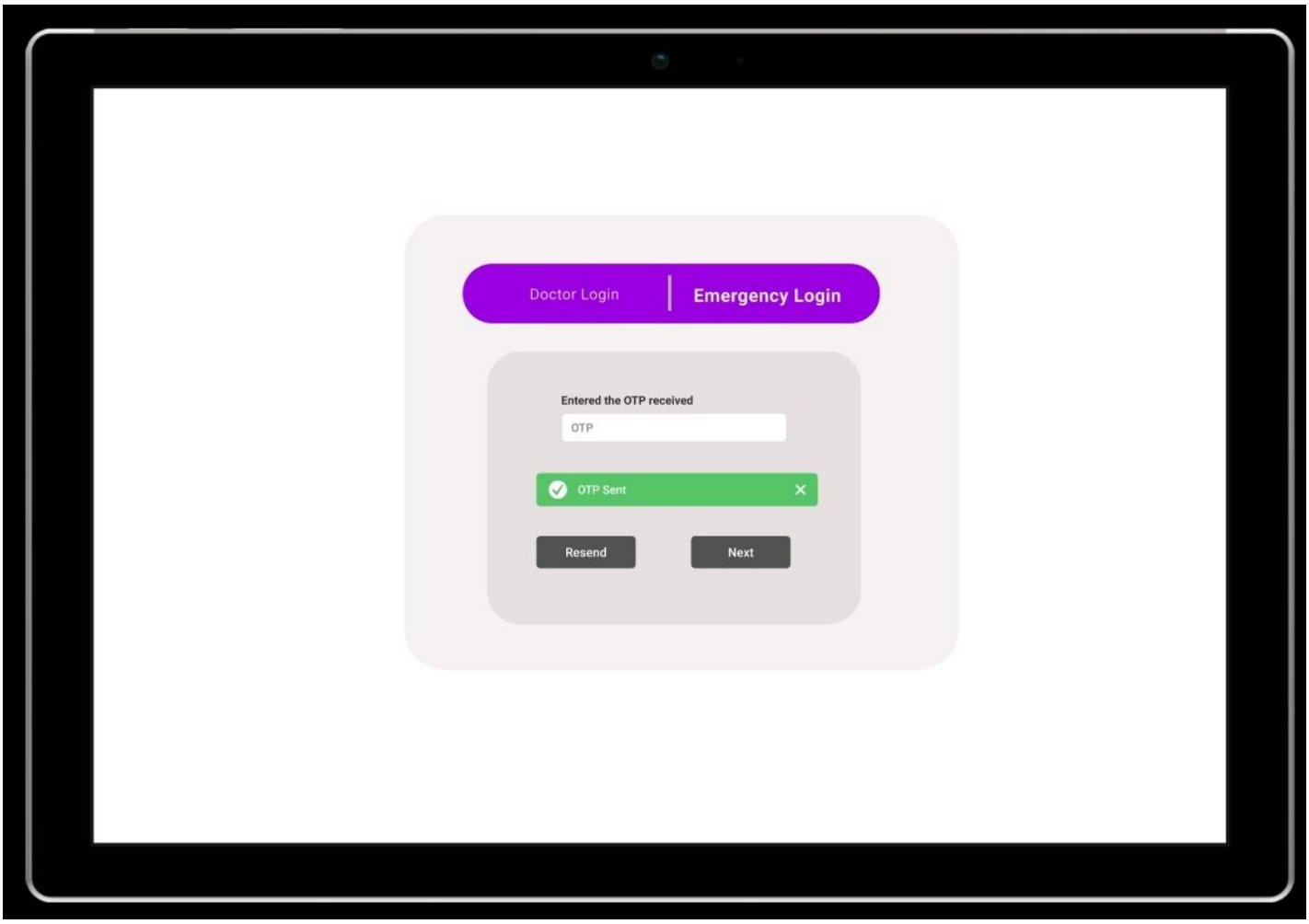
This is the next screen in the sequence and it verifies the device in question has been successfully paired with the app, and the user can exit.



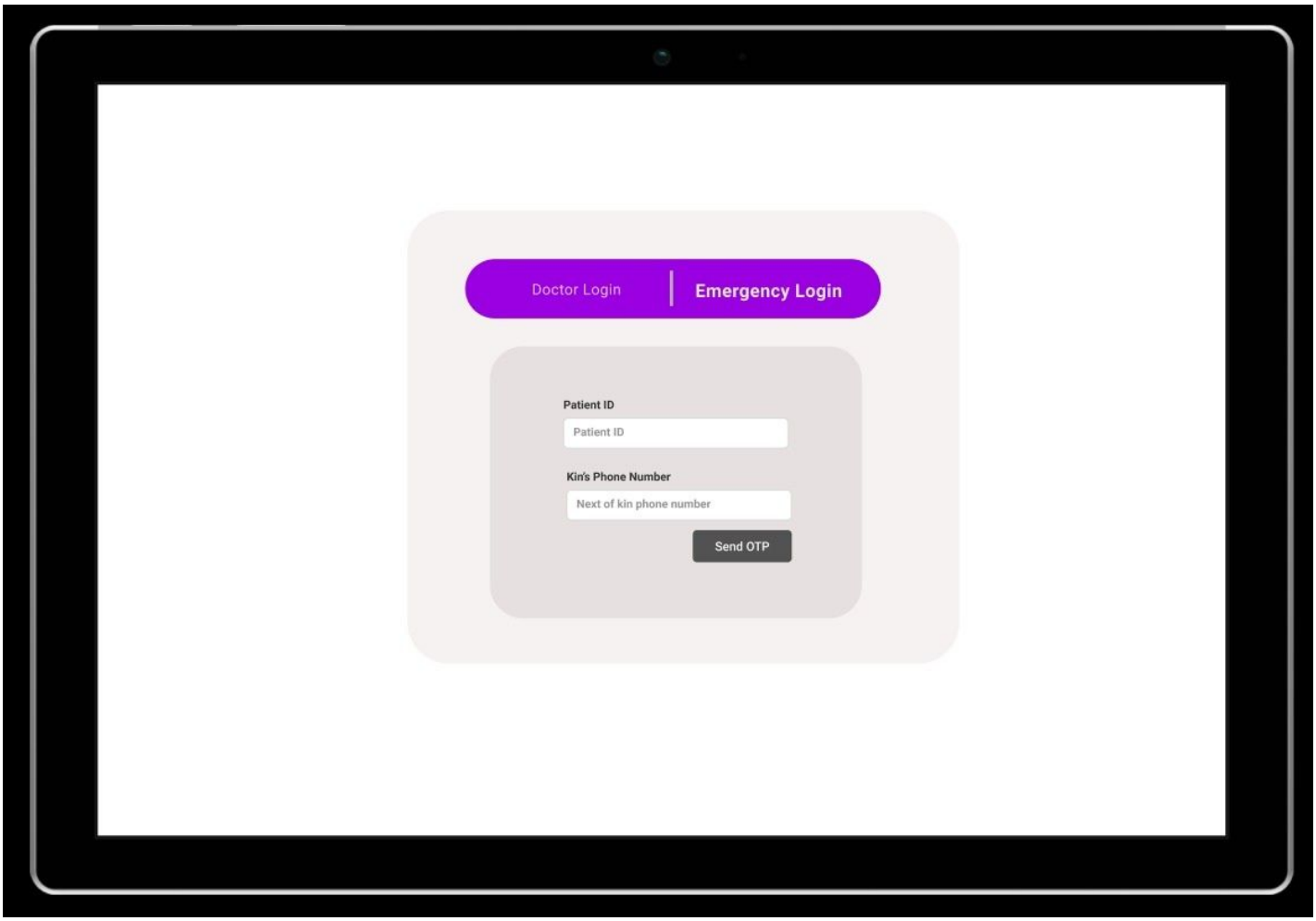
This is the first page when accessing the website for doctors and it provides the option for the doctor to log in, or to use an emergency login in case he forgets the credentials.



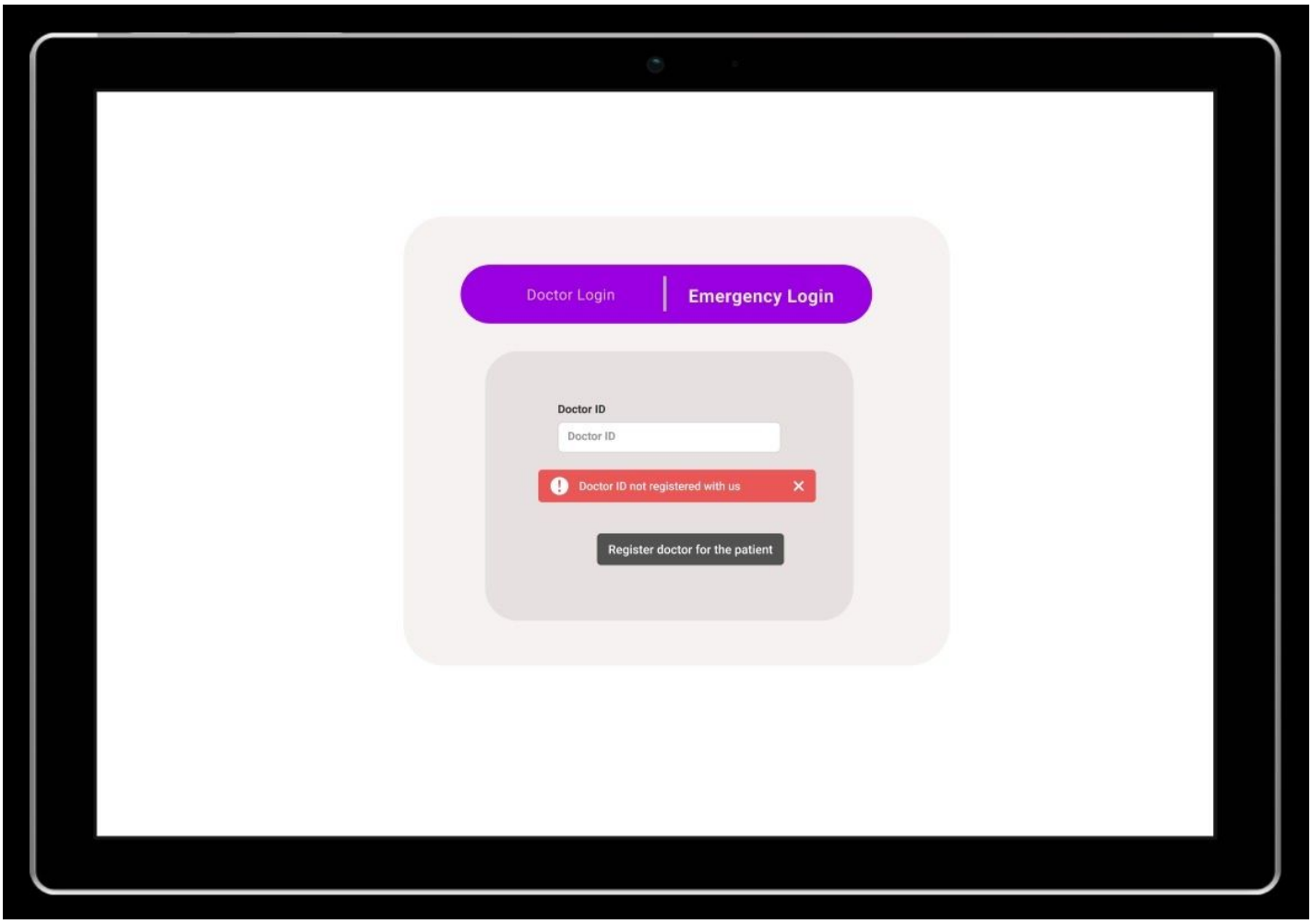
This error message is displayed in case the otp verification in the emergency login fails.



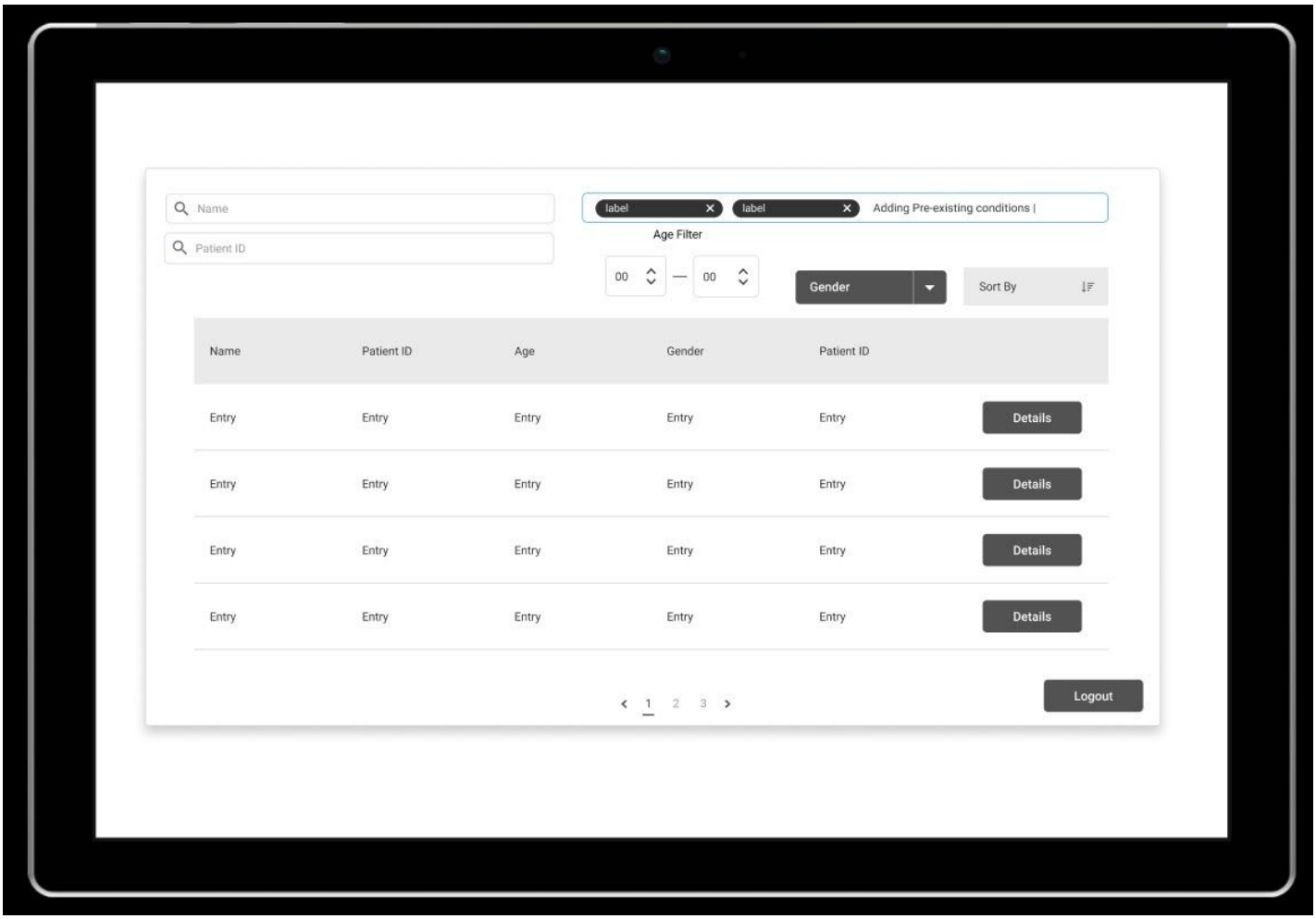
This screen is displayed when the emergency otp for the emergency login of the doctor is sent successfully.



This page provides the option of an emergency login for doctors in case they forget their credentials, by sending an otp to the required phone no.

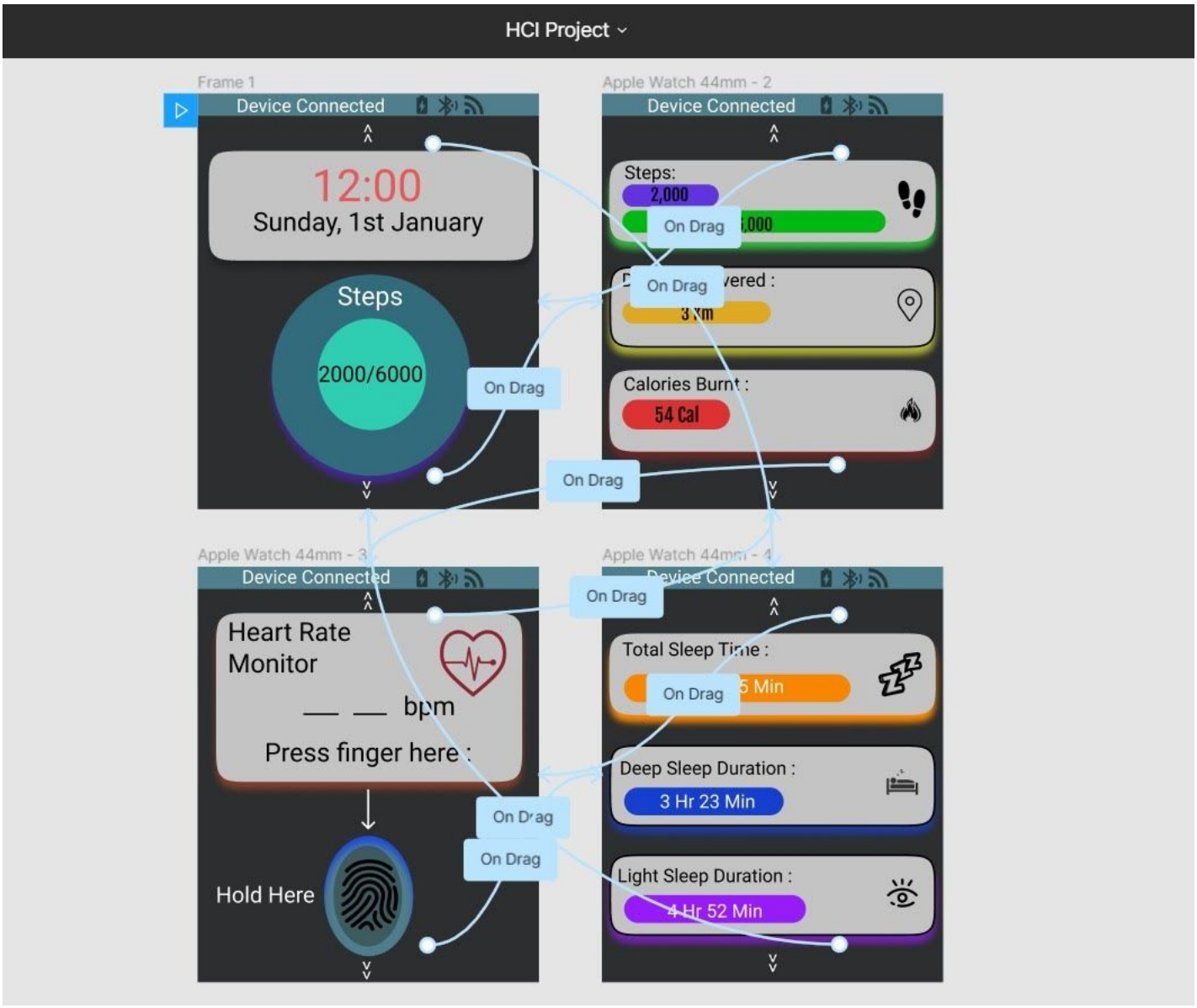


In case the login fails for a doctor, i.e. the credentials entered are wrong, then this error page pops up and shows an option to register the doctor. After sending a request to be verified, upn verification, the doctor is added and allowed to access his login page.

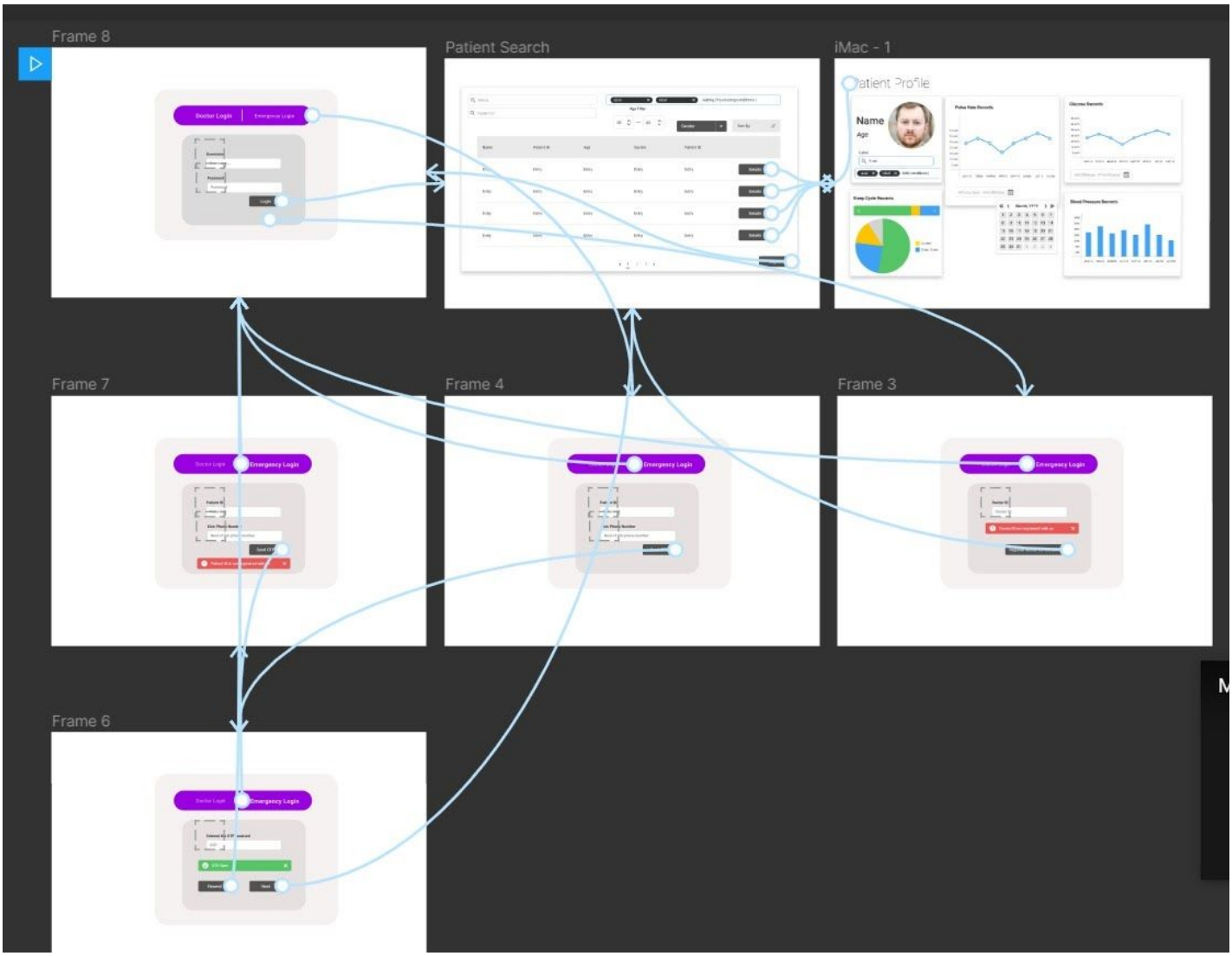


This is the main page accessed by the doctor in question after logging in and it allows for him/her to find and view the details of any patients based on various common criteria.

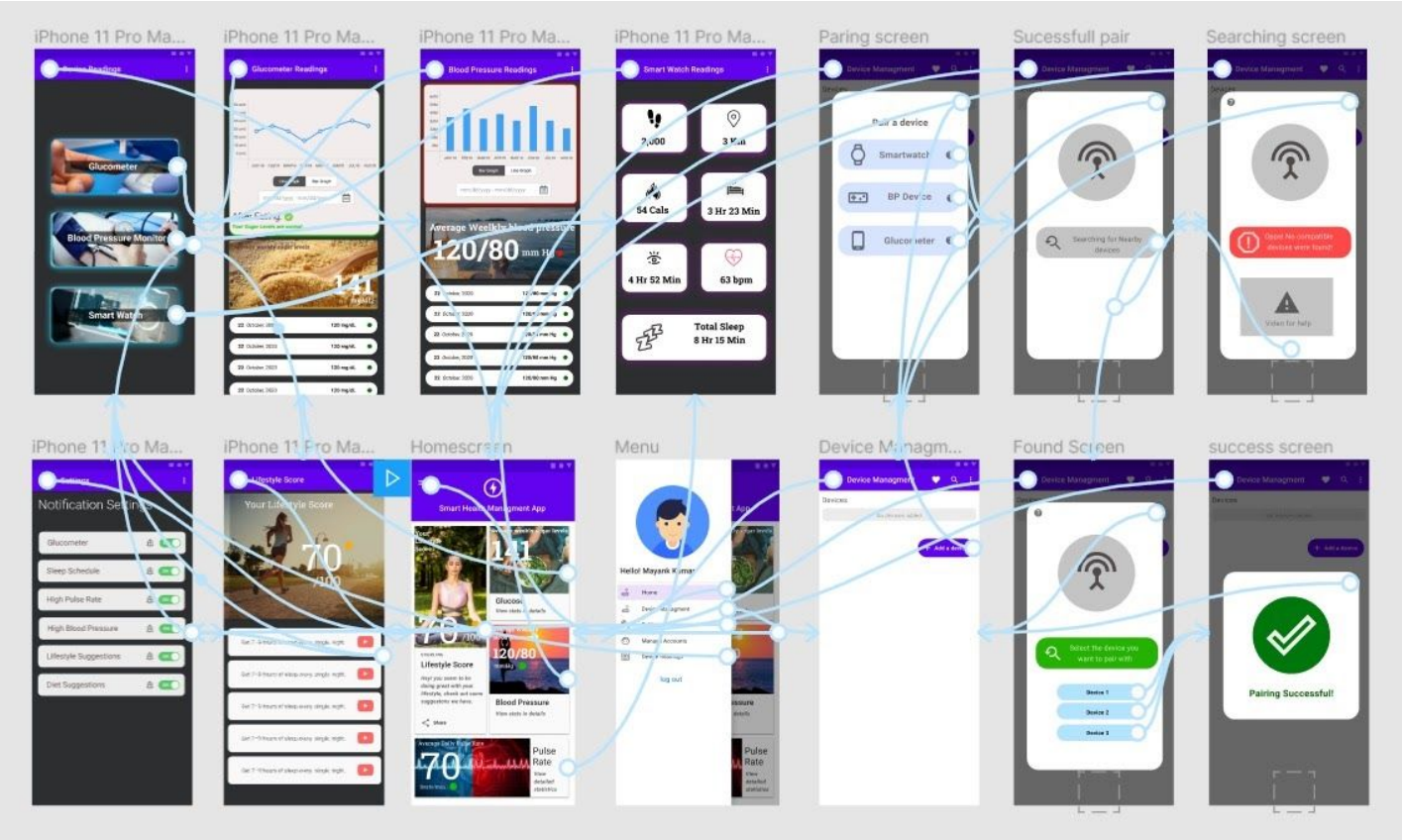
This page pops up upon selecting a patient in the main page, here the key details of the readings for the patient in question are provided.



This is the connection web/diagram for the smartwatch and it shows the simple manner in which a user wearing this watch can navigate between the pages to view the different readings collected by our smartwatch.



This is the connection diagram of the desktop site accessed by the doctors monitoring the patients with critical health requirements, and it shows how the doctor may navigate through the system.



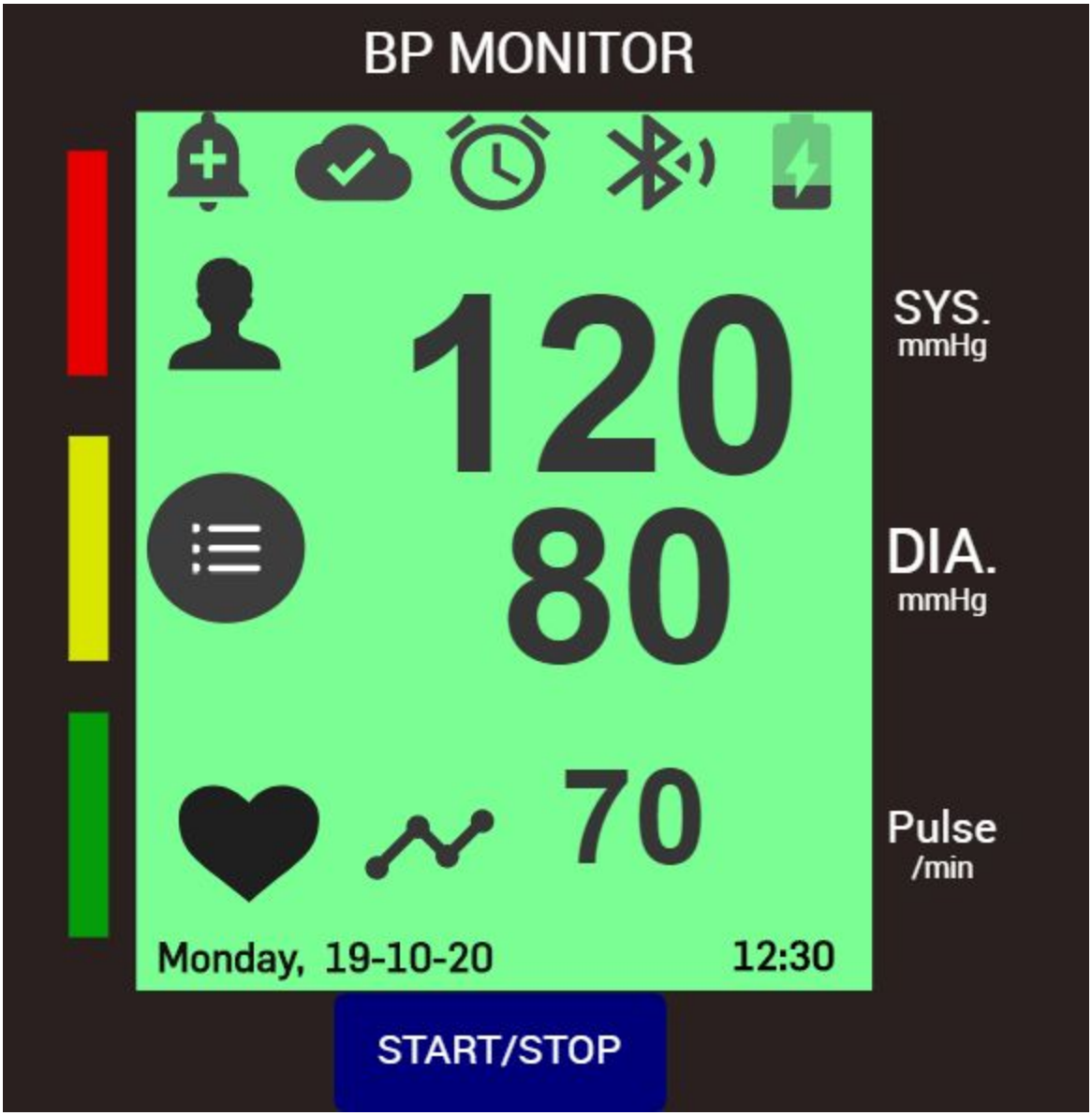
This is the connection diagram of all the pages involved in the smartphone app of the IoT network, and how a user can navigate between the pages.

The smart watch screen main page, which shows user time, status bar and live step counts.

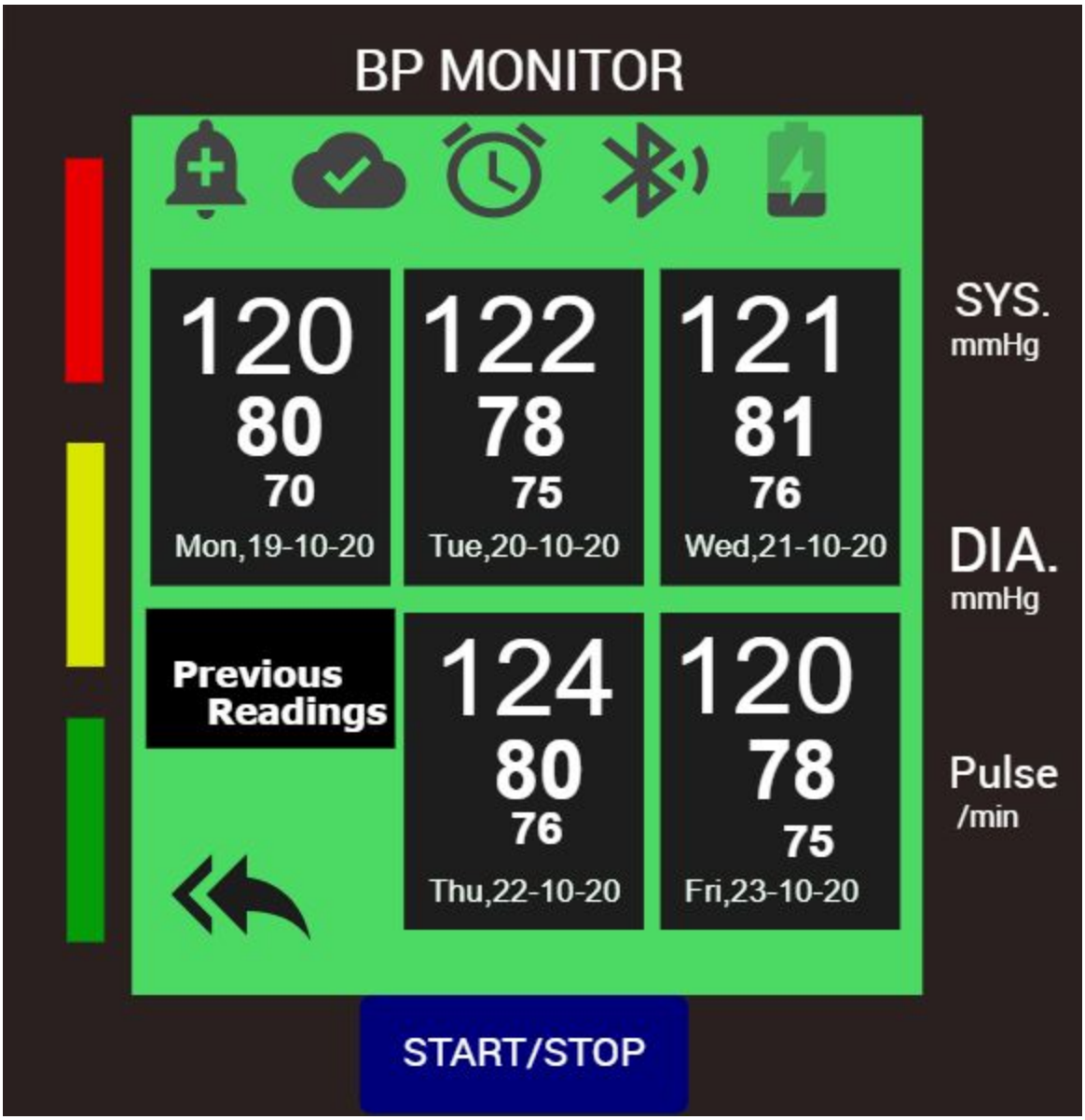
The smart watch summary page, which shows user number of steps, distance covered and the total calories burned.

This smartwatch screen displays a button for the user to touch, upon activation, a sensor at the bottom of the watch reads the heart rate of the user.

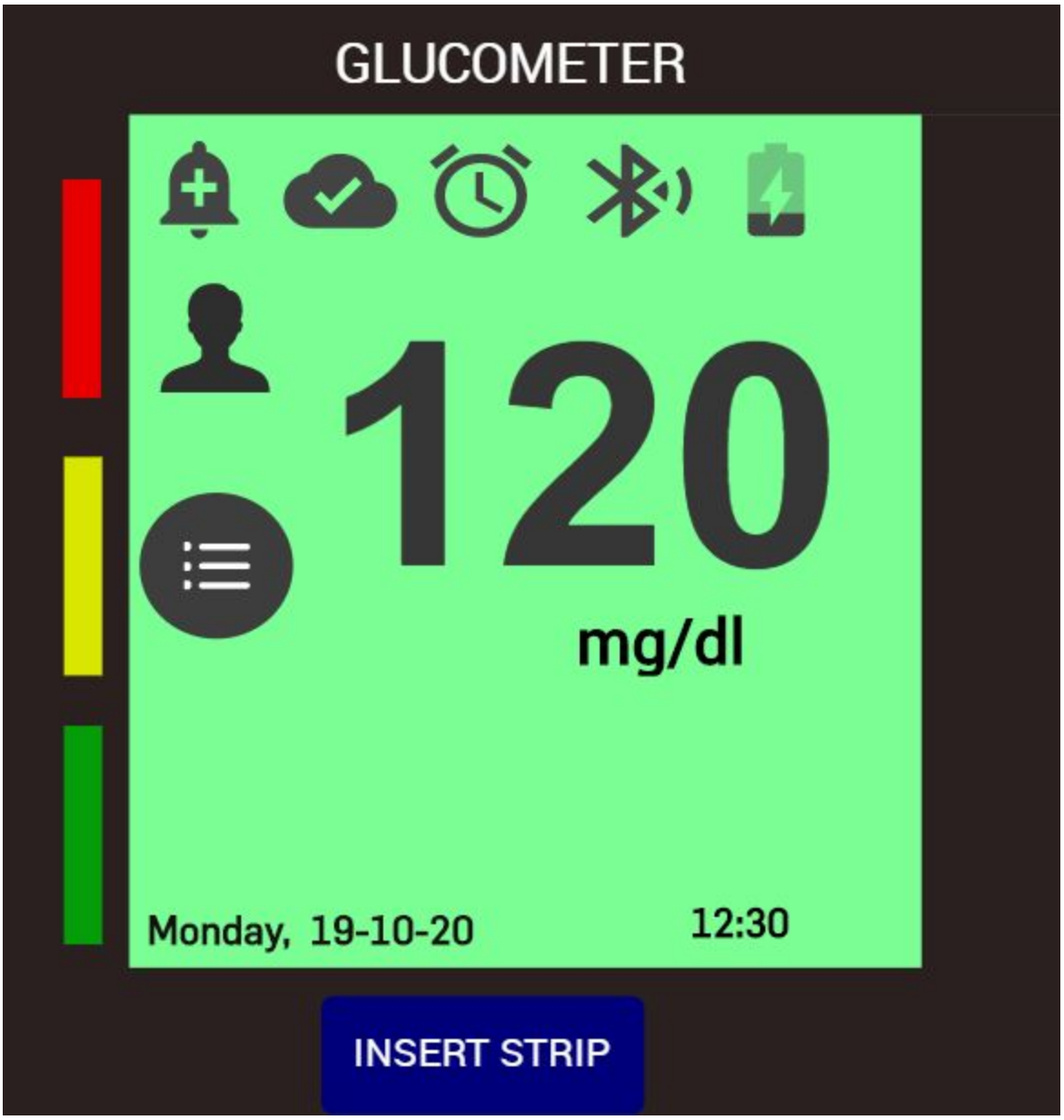
The smart watch analytics, which gives a report of Total sleep time, Deep sleep Duration & Light sleep Duration to the user.



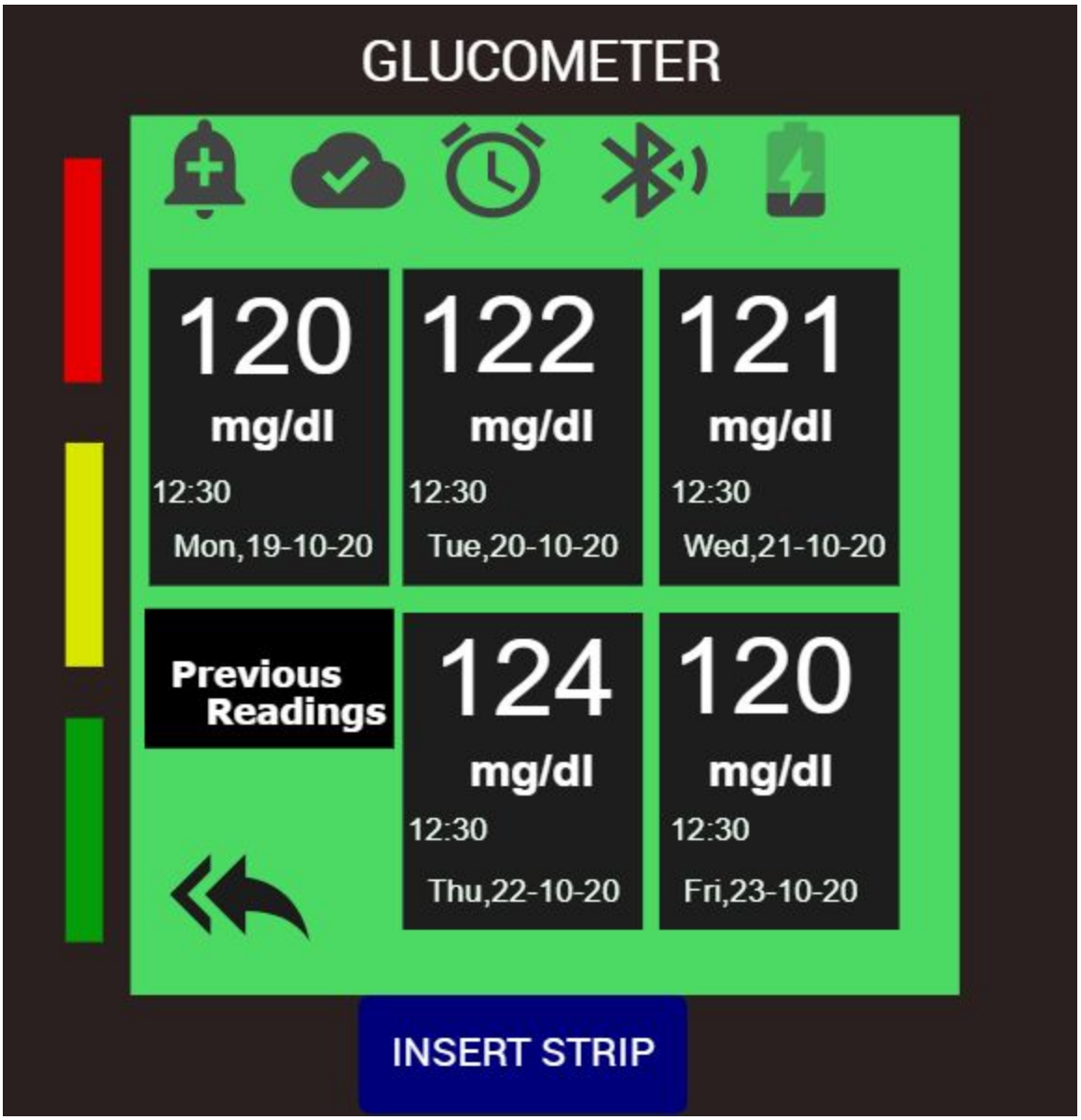
This BP monitor screen allows the user to view BP & pulse rate Readings after pressing the start button. It also shows bluetooth connectivity and notification status.



This BP monitor screen allows the user to view previous readings recorded in sequential manner with Day,Date and time.



This Glucometer screen allows the user to view Glucose level Readings after pressing inserting the blood strip . It also shows bluetooth connectivity and notification status.



This Glucometer screen allows the user to view previous readings recorded in sequential manner with Day,Date and time.

Limitations in our System

- 1. Bluetooth has a small coverage area and hence its harder to connect to the network at times.
- 2. Mobile devices with Bluetooth version prior to v4 are not supported.
- 3. Smartwatch has to be worn at all times to get accurate assessment of health
- 4. Regular blood sugar test must be done to get an accurate assessment of health
- 5. Regular blood pressure test must be done to get an accurate assessment of health
- 6. ML models used to predict lifestyle scores can only improve in accuracy once we have a larger user base.
- 7. The security mechanism put in place for the emergency situation requires next to kin, whose unavailability can cause a bottleneck in the whole workflow.

Conclusion

- Through this Project we were able to make a comprehensive Health Monitoring ecosystem which is easy, intuitive and interactive to use. We used design principles to facilitate positive knowledge transfer. The product has easy to use workflows for critical tasks i.e. during emergency situations where a doctor needs to get a detailed analysis of a patient's health.
- This Project helped us to understand how to create effective interfaces for a safety critical system and which principles should be emphasised in such a project. This has facilitated us to understand the best practices for Human Computer Interaction.

References

Prototype Tools:

- https://www.figma.com/ui-design-tool/
- https://www.fluidui.com/

Existing Systems:

- https://www.mi.com/global/miband#01
- https://www.apple.com/in/watch/
- https://consumer.huawei.com/in/support/article-list/article-detail/en-gb00816595/
- https://www.drmorepen.com/collections/homepage/products/dr-morepen-blood-pressure-monitor-bp-09
- https://www.drmorepen.com/collections/homepage/products/dr-morepen-glucoone-bg-03
- https://www.drtrustusa.com/