WEARABLE HEALTH MONITORING DEVICE

PRODUCT DESIGN PROJECT III

ANULAL VS
136130012

GUIDE :
PROF. PURBA JOSHI

INDUSTRIAL DESIGN CENTRE
INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

2015

WEARABLE HEALTH MONITORING DEVICE

Project 3:
Submitted by:

Anulal VS | 136130012

Guide :
Prof. Purba Joshi

ACKNOWLEDGMENT

I would like to sincerely thank my project guide Prof.Purba Joshi for her time, support and guidance throughout my project.

I am also grateful to Prof. V.P Bapat, Prof. P Kumaresan For their valuable inputs during the presentations.

A Large credit goes to my best friends Anju Dinesh, Gautham R Varma, Manu Revi Poovakkat and Isaac Junior for their valuable suggestions and support. I also would like to thank Baisampayyan Saha and Ashok Mawade sir for helping me with the model making.

Last but not the least, I would like to thank all my batch-mates who have helped in various situation. I am thankful to IDC, IIT Bombay for providing me with the infra structure and support of all kinds.

APPROVAL SHEET

Industrial Design Project 03
Wearable health monitoring device

By : Anulal VS
M.Des. Product Design 2013-2015
136130012

is approved as a partial fulfilment of requirement of post graduate degree in Industrial design.

Prof. Purba Joshi
(Project guide)

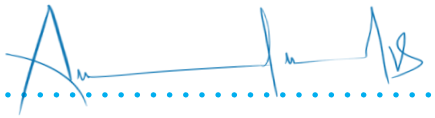
External Examiner:

Internal Examiner:

Chairperson;

DECLARATION

I hereby declare that this written submission represents my idea in my own words and where others' ideas have been included; it has been adequately cited and referenced the original source. I declare that I have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any data/ idea/facts sources in my submission. I understand that any violation of the above entitles the institute to take disciplinary action against me to which I shall be answerable to.

Sign : 

Date: 24 - 5 - 2015

Anulal VS
136130012
Industrial Design
Bach 2013-2015

ABSTRACT

This project aims at helping the mid-aged earning category in the metros, by predicting the risk factors that occurs due to their life style. Being in a busy city, these people have a very busy life style which makes it difficult for them to take care of their health. By having this wearable device, the monitoring of the vital parameters like heartbeat and Spo2 along with their physical activity level will happen involuntarily. This project targets only those people who are in touch with the computer and wireless connectivity , or have a basic idea about the technologies. The wearable device along with the connected smart-phone helps the user to be in the vicinity of their close ones always. The device functions as an involuntary bridge between the user and their closed ones, giving the user a feeling that he or she is not alone.

The project includes selection of concept based on user survey and market study. An in depth study of the forms were done in all possible directions to come up with to separate forms for male and female users.

The project also includes the design of a mobile application to work along with the device. Various visual elements were designed so that the user interaction becomes simple and friendly.

CONTENTS

INTRODUCTION

Wearable Technology:

The wearable products have been around since decades, but its only recently that it is becoming vogue and fashionable. The Term wearable product was coined in nineties and popular in the medical field for a long time, with products which helps people in hearing, eye wears and Pacemakers.

While the wearable technology has been already offering applications for consumer, business, emergency service and military users. Wearable technology companies, entrepreneurs, marketers and developers are now looking for novel ideas and concepts to come up with smart wearable devices that can serve the needful to the mass. The most intuitive aspect of wearable devices is that, it can be incredibly advanced, and at the same time it is efficient enough to provide simple functionalities to the Users. Interestingly, there are more and more wearable technology companies who are putting in their utmost efforts to conceptualize the next ground breaking wearable device.

The Good news for wearable technology is that Users have slowly yet consistently welcomed the entire concept of wearable by making themselves aware of what is wearable technology. Some of the present day wearable devices includes smart watches, fitness bands, wearable tech gadgets and many more competitive devices.

Role of Wearable Technology In Middle Aged People

The wearable products have been around since decades, but its only recently that it is becoming vogue and fashionable. The Term wearable product was coined in nineties and popular in the medical field for a long time, with products which helps people in hearing, eye wears and Pacemakers.

While the wearable technology has been already offering applications for consumer, business, emergency service and military users. Wearable technology companies, entrepreneurs, marketers and developers are now looking for novel ideas and concepts to come up with smart wearable devices that can serve the needful to the mass. The most intuitive aspect of wearable devices is that, it can be incredibly advanced, and at the same time it is efficient enough to provide simple functionalities to the Users. Interestingly, there are more and more wearable technology companies who are putting in their utmost efforts to conceptualize the next ground breaking wearable device.

The Good news for wearable technology is that Users have slowly yet consistently welcomed the entire concept of wearable by making themselves aware of what is wearable technology. Some of the present day wearable devices includes smart watches, fitness bands, wearable tech gadgets and many more competitive devices.

The kids are too young to essentially understand the working or the dynamics of a wearable. The youth of our race are evolutionarily healthier. They normally do not require the assistance

of a wearable to stay healthy. The middle-aged are the part of earning population who are constantly working, frequently in transit, and who do not generally find the time or the energy to hit the gym. Being always averse to the idea of prevention is better than cure, they find it more fascinating to take treatment in case they are diagnosed with a potentially avoidable health situation. So, the wearable like fitness bands or watches or shirts (change it) which helps them in vital signal monitoring will help them gain an insight into their own physical condition regularly which would save them many visits to the hospital.

With the advent of wearable technology,medical researchers operating in the private and public sectors would have access to a vast database of continually updated non-personal medical data on 100s of millions or even billions of individuals. Researchers would be able to correlate trends in measured parameters with other user data, for instance, age, eating behaviour, location, socio-economic status etc . This could in turn help our citizens have better access to healthcare services and facilities which would result in the eventuality of a healthier generation.
Medical practitioners would have access to a patient's 'bio history' which would help identify the cause of a patient's symptoms. In addition, the patient will also have an access to the database and will gain an understanding of his own medical situation. He can provide a cumulative study of how his health has been in the recent past which would stimulate a more detailed and precise diagnosis of an ailment.

The year 2015 may well go down as the year of wearable technology. The impact of wearable is already being felt in education, communication, navigating, and entertainment; but perhaps the greatest was in healthcare and fitness.

Fig 01 : Source : www.alivemeter.com

A GLIMPSE ON THE PROJECT

BACKGROUND

This is a Life-style project which was proposed as a sponsored project by the start-up firm named "Alivemeter" . The firm provides a single platform to provide complete control of your health and that of your loved ones. The all-round health data are available to the User across various platforms – mobile, web and tablet – so User can access good health from anywhere, at convenience.

[Initial Design Brief] The brief given by the firm is to design a wearable device which monitors various health parameters (ECG , SPO2, Physical activity, Blood Pressure, temperature) of the user and sends it automatically to the dedicated online portal developed by the firm. This online portal connects the users to various health experts and doctors who can access the user data and give proper recommendations to the users.

The project will be aiming at the middle aged professionals who are well settled both professionally and in life.

INITIAL DESIGN BRIEF

To design a wearable device which would monitor the following health parameters.

- ECG
- SpO2
- Physical Activity
- Blood Pressure
- Temperature

The device should monitor the user for the whole day. The device Should connect to the online portal http;//www.alivemeter.com and send the collected user data's to the portal which the registered doctors can access.

The device form should go well among the mid aged working class users.

Keywords given by the clients:

Sleek Classy Flaunt-able High-tech Hi-Fi

DATA RESEARCH

USER SURVEY

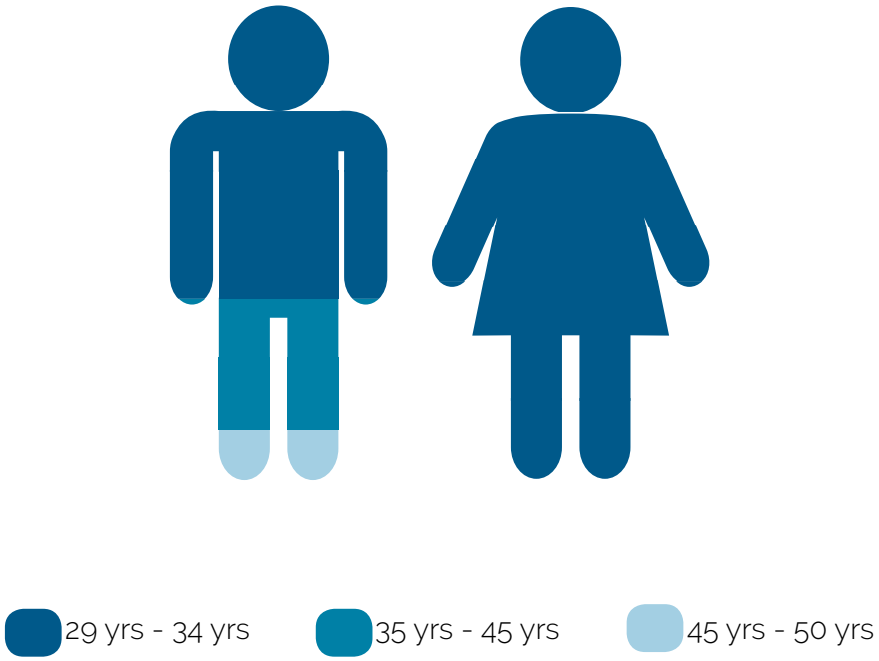


Fig 02 : image showing different user groups contacted for survey

The primary research was mainly concentrated on the Middle aged user category. For the research purpose, the people working in various private and government firms were contacted. Due to the busy work schedule, these category doesn't get enough time to care for their health properly. Majority belonging to this category are diagnosed to have health issues like body pain, diabetes , cholesterol etc.. The research was mainly conducted through surveys, personal interviews and shadowing. The main motive of the research was to understand the lifestyle of the users and the trends they follow.

This particular age group are the people who are well settled and have a well professional background. Since the aim is to create a lifestyle product, the users are chosen such that they have enough earning/savings to afford the product.

The majority of the users interviewed/ studied belonged to the age group of 29 -34 , followed by age group 35-45 and the users belonging to the age group 45-50 were very less in number.

In the survey, majority of the users were people working in IT industry. Most of the IT professionals were belonging to the age group close to their thirties and mid forties. From the study it was clearly seen that, as expected , a little more than half percentage of the users were having various health issues. According to the users the main reason for the health problems are their city life style, eating habits and lack of proper exercise. Majority among the users posses own house, and a four wheeler adds to their pride. Some of the users were seen updating their mobile phones and gadgets regularly with the arrival of the new and updated ones.

The IT industry people is generally in touch with computers and technology in their professional world. This makes it easy for them to adapt to the new gadgets being launched in the market. With the smart phones and tablets, majority of the users keeps themselves aware about the latest trends in the markets, whether in technology or fashion. Most of the people like and use online shopping to purchase latest arrivals.

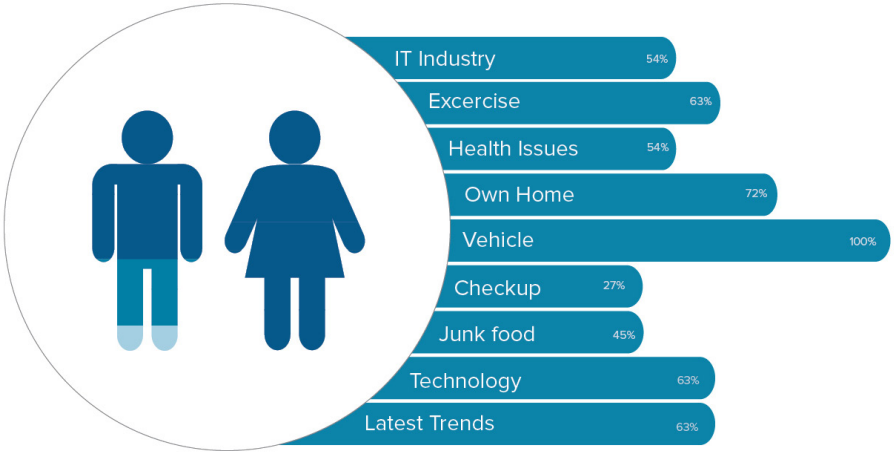


Fig 03 : image showing different user groups contacted for survey

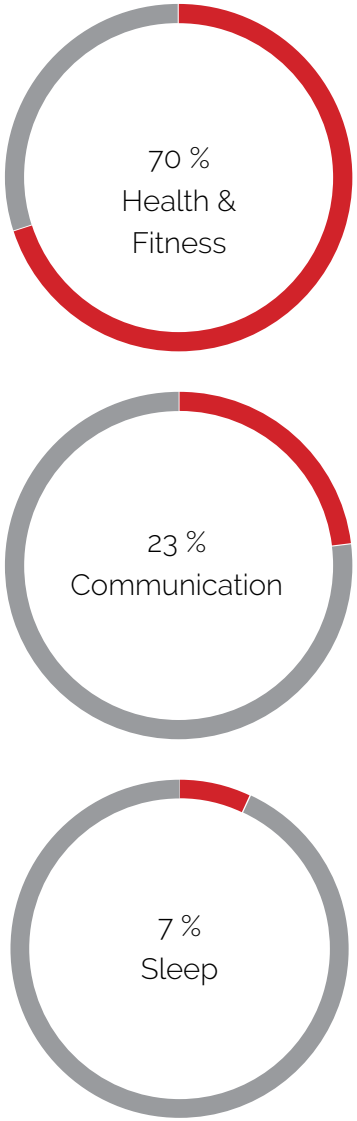


Fig 04 : the current markets of wearable devices , Source : FJORD Design and Innovation from Accenture

SECONDARY RESEARCH

Present Market

The current market is already witnessing the hype of wearable products, even reached the era of giving virtual realities. A variety of products were studied to know the trends existing in the current market. The study was based on the similar wearable activity monitors which resembles the current project to very close extend.

In the research process, it was seen that, in the total wearable devices out in the market, a large portion of the market space (70% of the market space) is captured by the wearable devices concentrating on Health and Fitness. More and more marketing and developers are researching on the same for the future markets. The fitness bands and activity monitors have become a style statement among the youths and fitness freaks. The development in technology and communication field also added to the pace of growth of wearable in this field. Even the hospitals have started using wearable devices for diagnosis, this helps the patient to have free movement along with sending real-time data's to the person monitoring them.

Following the Fitness field, the communication field also plays a vital role in making wearable devices. Twenty three percent (23%) of the market is focusing on the wearable devices for communication between users and computers. The blue-tooth hearing devices, gesture controlled rings etc includes in this category,

A very small percentage of the market concentrates on the devices used for monitoring sleep patterns of the users.

Wearable Device On Human Body

The wearable devices are again classified based on the human body part were it is attached or used. The devices focusing on the wrist, upper body and head are more in the lot. The user survey also projects that majority of the users prefers wearing wearable devices in hand or attached to their upper body cloths. Many of the fitness and health tracking devices are designed to be worn on wrist, which gives optimum results when doing the tasks. Very less devices are designed to be worn on feet. But nowadays, researches are going on in this area to develop devices which can monitor the physical activity levels and help users navigate to destinations in the form of haptic feedbacks. The devices which are designed to be used on human head are generally concentrating on the communication field. Various devices which helps the users to communicate with the users are currently present in the market, these depends on the smart phones for their functions.

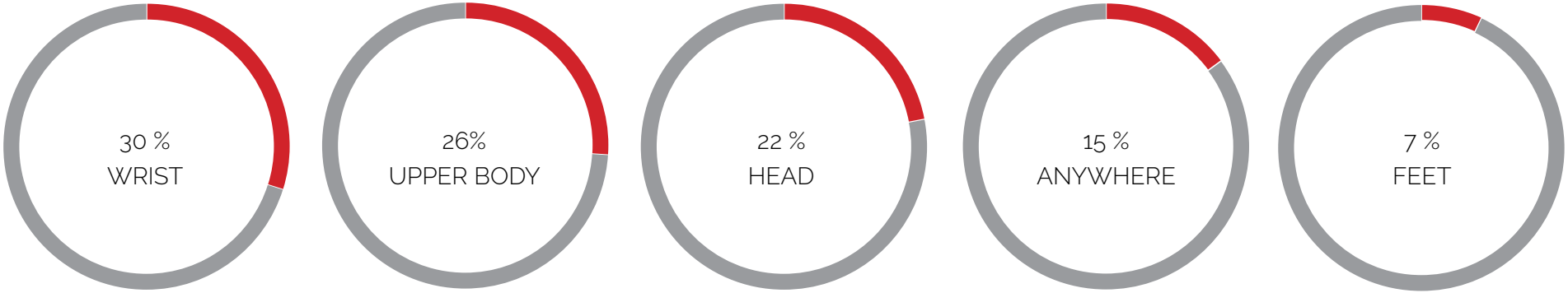
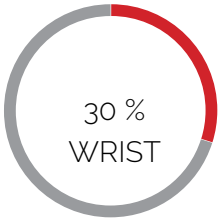


Fig 05 : the wearable device market based on the mode of usage , Source : FJORD Design and Innovation from Accenture



Parallel Product Study

Fig 06 : JAwbone Up, Source : http://content.jawbone.com/static/www/pdf/manuals/up/up-by-jawbone-extended-manual-en.pdf

Jawbone UP

FEATURES
- Revolutionary system (wristband + free iPhone® app)that tracks your sleep, activity & eating habits
- tracks your daily activity workouts, and phases of sleep
- Vibration alerts including Smart Alarm &Activity Reminders
- Sweat-proof & water-resistant design
- Designed to be worn 24/7
- Built-in rechargeable Li-ion polymer battery
- Small: Wrist size 14.00–15.50cm; 19 grams
- Medium: Wrist size 15.50–18.00cm; 21 grams
- Large: Wrist size 18.00–20.00; 23 grams

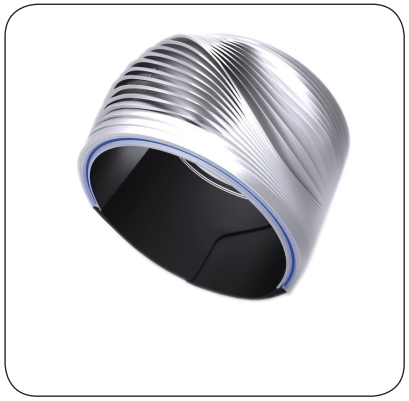


Fig 07 : Wristify, Source : http://www.extremetech.com/extreme/169951-wristify-a-personal-peltier-wrist-cooler-that-could-save-the-us-millions-in-energy-costs

Wristify,

Currently in development, is a device that lets you tailor thermal profiles for an optimized thermal stimulation to the wrist, ultimately regulating the temperature of the person wearing it. a copper alloy heat-sink that uses thermoelectric cooling to reduce the skin temperature of your wrist Thermoelectric cooling is governed by the Peltier effect

Samsung Galaxy Gear

Smart Watch
Requires android phone for initial setup
Designed for Wrist
Built in Camera (1..9 mega pixel)
Receive phone calls and messages
Notifications of social networks
Gesture controlled displays

Fig 08 : Samsung Galaxy gear, Source : http://www.gsmarena.com/samsung_gear_s-6620.php

Nike Fuel Band

Sizes (circumference): small (5.97 in), medium (6.77 in), large (7.76 in)
Width: 0.63in at LED, 0.75in at latch
Thickness: 0.27in at LED, 0.32in at latch
Weight: 27 g - 35 g (higher end includes insert)
Battery type: 2 Lithium Polymer Batteries (3.7 V)
Display type: 20 color red/green LED, 100 white LED
Display Modes: Time, Energy burned (measured in Calories), Steps taken, NikeFuel earned
Materials: Thermoplastic elastomers (TPE) 43%, Polypropylene (PP) 34%, Magnesium 14%, Stainless Steel 9%
Water Resistant: Yes
Waterproof: No

Fig 09 : Nike Fuel Band, Source : http://www.trustedreviews.com/nike-fuelband-se-review

Fig 10 : June Wrist Band, Source : https://www.netatmo.com/en-US/product/june#view3

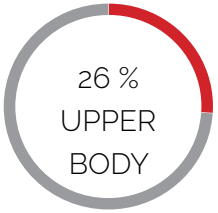
June Wristband

- JUNE measures your exposure to the sun throughout the day.
- It communicates with your Smartphone.
- real-time advice on how to protect yourself from the sun.
- One size. Both bracelets suit wrists sizes between 15,5cm and 19cm.
- Requires iOS7 or later.
- Bluetooth Low Energy connection.
- rain, splash and sweat resistant.

Fig 11 : Addidas Micoach, Source : https://www.google.com/images

Addidas Micoach

- Wearable / clip-on
- Speed, GPS / location, Heart rate
- 0.61 inches (h), 1.91 inches (w), 10.36 inches (d)
- Use Bluetooth connectivity
- Needs Smartphone
- Capacitive Screen
- Water resistant



OMSignal Shirt

- Comfort fit
- Machine washable
- Moisture management
- Odour control
- Deep heart and breathing signal capture.
- Connects to your phone using Bluetooth Low Energy (BLE).
- Designed to fit comfortably onto your OM shirt
- Built with rain, splash and sweat-resistant materials.

Fig 12 : OMSignal Shirt, Source : http://www.omsignal.com/

Hexo skin

- Accelerometer, Digital compass, GPS, Gyroscope, Heart rate
- Blue-tooth connectivity
- iOS, Android
- Works using the hexo skin app

Fig 13 : Hexo Skin, Source : http://www.digitaltrends.com/fitness-apparel-reviews/wearable-body-metrics-hexoskin-review/

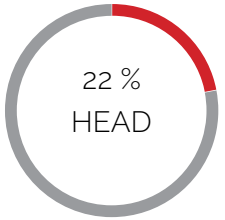


Fig 14 : HRM Headphone, Source : http://www.lg.com/us/cell-phone-accessories/lg-FR74-heart-rate-monitor

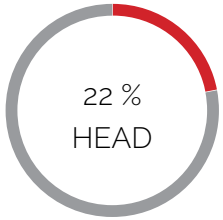
Fig 15 : Cheacklight, Source : http://www.mc10inc.com/consumer-products/sports/checklight/

LG HRM Headphones

- Hands Free
- Music Playback Control
- LG Fitness Smartphone App Suppor
- Measuring time, Consumed Calories, Distance, Speed, Pace, Heart Rate, Heart Rate Zone
- Workout Start, End, Time, Consumed Calories, Distance, Speed, Pace, Heart Rate, Heart Rate Zone, Goal Achievement Notification
- VO_2Max
- Bluetooth connectivity

Checklight

- Consistent, reliable and actionable impact data
- Sensors that are directly coupled to the head to reflect direct accelerations that the head, not a helmet or chin strap, experiences
- Easy to use and comfortable to wear
- Can be worn with or without a helmet and in multiple activities
- Logs the total number of impacts recorded



Google glass

- Adjustable nose-pads and durable frame fits any face.
- Extra nose-pads in two sizes
- Take pictures and vidoes
- Connects by bluetooth and wifi
- High resolution display is the equivalent of a 25 inch high definition screen from eight feet away.
- Inbuilt storage
- Smart glass

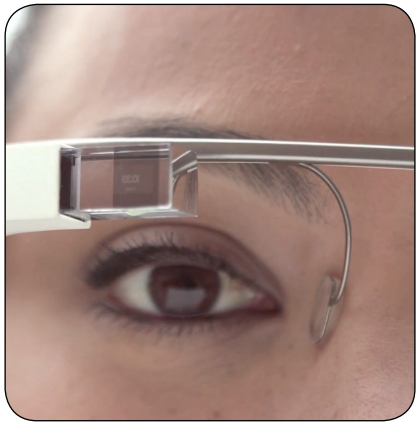


Fig 16 : Google Glass, Source : https://support.google.com/glass/answer/3064128?hl=en

Run and Read

- A tiny clip-on device that can be attached to a headband or shirt
- Track the movements of your head and shoulders
- Keeping the text bouncing in sync with your eyes
- Tap the device once for a forward page turn and twice to page backwards.
- Also a fitness tracker

Fig 17 : Run & read, Source : http://mashable.com/2013/09/08/run-n-read/

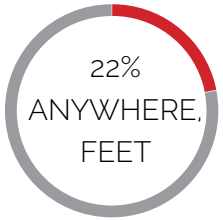


Fig 18 : Moticon Opengo, Source : http://vandrico.com/device/moticon-opengo-science

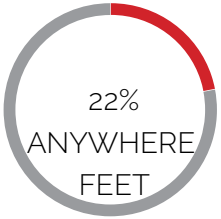
Moticon OpenGo

The Moticon OpenGo Science is a wearable device that measures plantar foot pressure for motion analysis. These wireless sensor insoles are primarily used in sports science and clinical research, especially for training and rehabilitation purposes. OpenGo works with a data-management software that records and analyzes the measurements.

Fig 19 : Sensoria Smart Socks, Source : https://www.indiegogo.com/projects/sensoria-smart-sock-fitness-tracker

Sensoria Smart Socks

- Fitness Tracker
- A smart sock completely made of fabric, which can go through wash & dry cycles.
- An electronic anklet that magnetically snaps on the cuff of the sock.
- A mobile application that monitors and guides you through real-time audio cues.



Fitbug Orb

- Fitness Tracker
- Clip on device, that can be clipped anywhere.
- Connects via bluetooth
- Non rechargeable Battery

Fig 20 : Fitbug Orb, Source :http://www.theverge.com/products/orb/6476

Fig 21 : http://images.clipartpanda.com/heartbeat-clipart-ECG-Line3.png

ECG - Electro Cardiogram

The understanding about electro cardiogram ECG is a must in this project as it is dealing measuring the heart rate of the patient. ECG is the representation of hearts electrical activity in the form of waves. The electrical conductivity of the heart is caused by the depolarisation and re-polarisation of the cardiac tissues, which in turn results in the pumping of the blood to various parts of the body. For the hospital grade diagnostics, a 12 lead ECG is the commonly used device. Which in turn is a complex device with lots of electrical wires attached to the body . This completely restricts the movement of the patient or the user to whom it's attached. The electrical wires will be having the conducting electrodes at the end of the wire which will be in contact with the human body, and thereby measures the electrical charge differences produced by the heart activities. One of the main objective of this project is to reduce the number of leads to 4 instead of 12 and give a proper continuous monitoring of the heart. Some devices are already in the market with less than 4 leads, which gives the ECG as a singular wave.

Since we are continuously monitoring the heart activity, we will get a pattern, from which the irregularities in the heart Beats can be recognised and thereby helps to predict the chances for sever problems like heart attacks.

To get the proper ECG outputs the ECG probes have to be placed in certain predefined positions, these positions are the touch

points to be considered while designing the device to get a proper monitoring of the heart. For a four lead ECG system, the touch-points for the probes are both the shoulders and the hip or lower abdomen. Another common ECG configuration used in case of moving users are the 3Lead ECG, Which further reduce the number of wires present from 5 to 3. This makes the 3 lead ECG practical for small wearable devices.

Few wearable devices are already in market featuring the 3 lead ECG system. The touch points for the 3 Lead ECG system is shown in the fig [23].

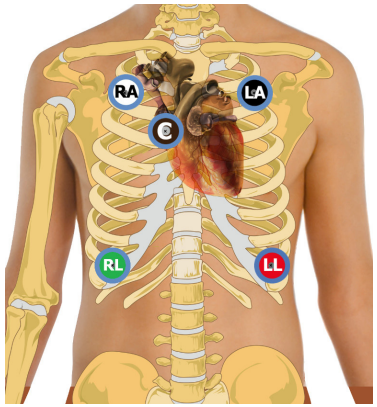


Fig 22 : 5 Lead ECG Touch-pints

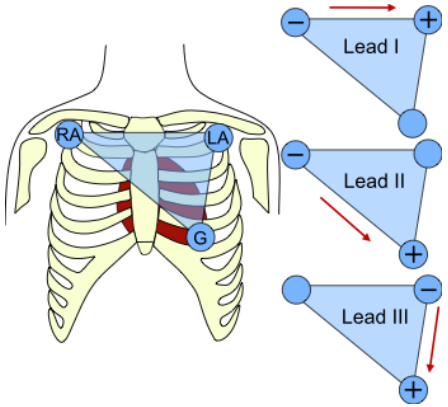


Fig 23 : 3 Lead ECG Touch-pints

Output Waveform :

The out put wave form from the device is expected to be stored and send to the online dedicated server. This same output is accessed by the doctor for diagnosis. The sample output form of the ECG is given in the fig [25], The wave contains three distinct regions, named p, q-r-s and t. The first 'P' wave represents the atrial depolarisation resulting in the initialisation of the electrical activity of heart. When the valves between the atria and ventricles open, 70% of the blood in the atria falls through with the aid of gravity, but mainly due to suction caused by the ventricles as they expand.

As the ventricles fill, the growing pressure causes the valves between the atria and ventricles to close. At this point the electrical stimulus passes from the bundle into the bundle branches and Purkinje fibres. The amount of electrical energy generated is recorded as a complex of 3 waves known collectively as the QRS wave.
The T wave is the result of re-polarisation of both the ventricles

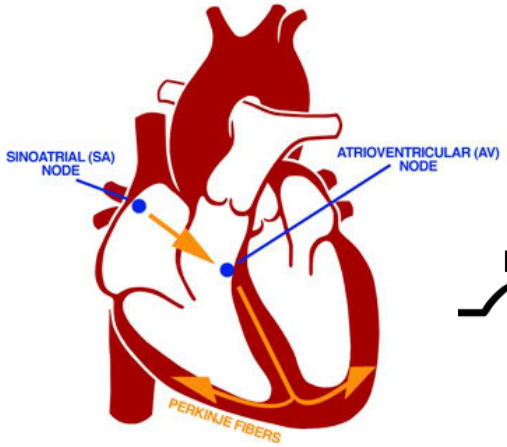


Fig 24 : Different nodes in heart causing the ECG Signals

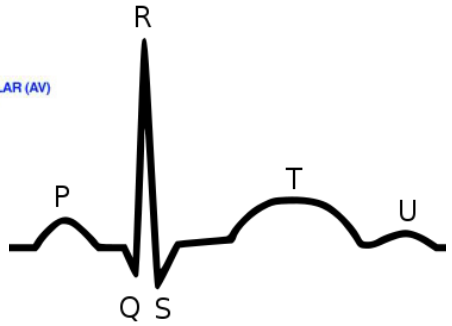


Fig 25 : The Sample ECG WAve

Source : http://find.galegroup.com/nrcx/Toolbox/1401879330-00050.htm

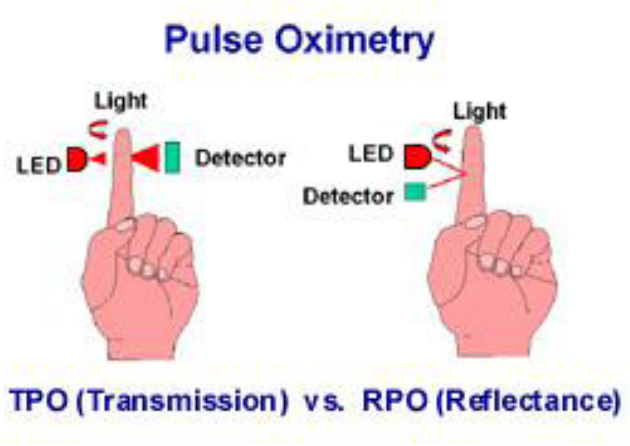


Fig 26 : Different types of Pulse Oximetry, Source : http://embedded-computing.com/articles/measuring-levels-portable-medical-wearable-devices/

before the repetition of the cycle.

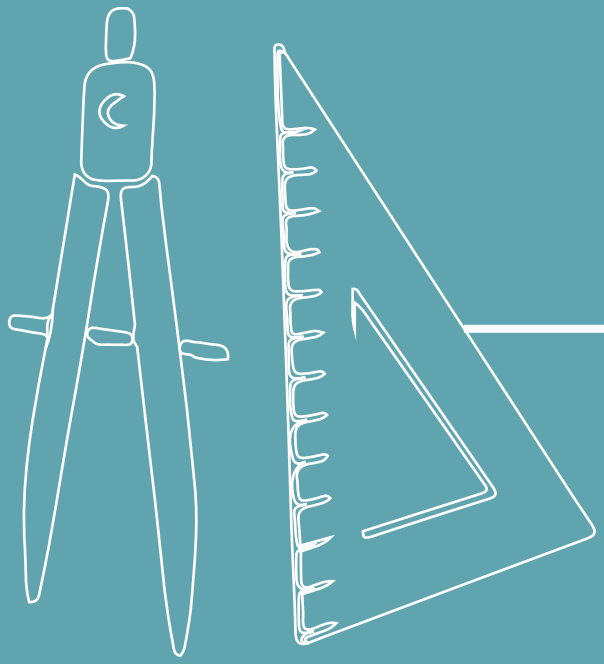
The intervals between the consecutive QRS waves are noted for diagnosing various heart related problems.

Pulse Oximetry (SPO2)

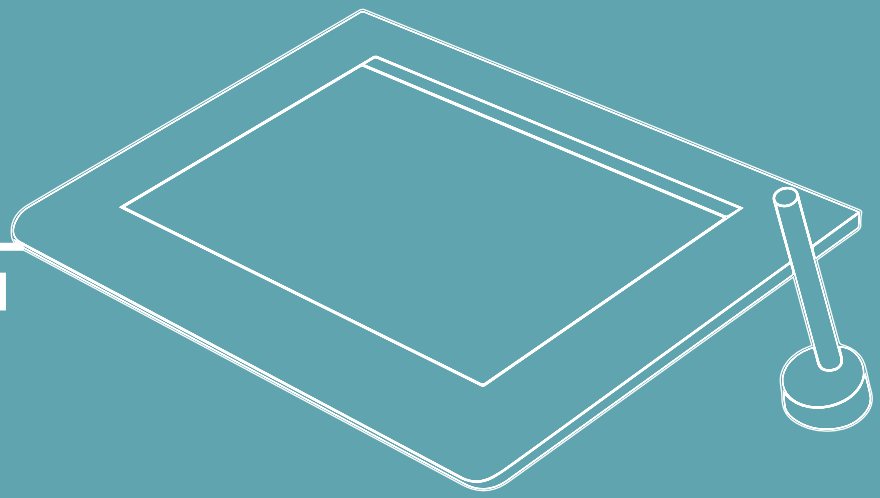
The pulse oximetry is a non-invasive method of measuring the persons Oxygen saturation level. The device used is called the pulse oximeter.

One of the common (transmissive) application mode consist of a sensor device placed on the thin part of the users body, usually a fingertip or earlobe, or in the case of an infant, across a foot. Two wavelengths of light is passed through the body part to a photo-detector, which measures the changing absorbance at each of the wavelengths, allowing it to determine the absorbances due to the pulsing arterial blood alone, excluding venous blood, skin, bone, muscle, fat, and (in most cases) nail polish

Another method is called Reflectance pulse oximetry. This method does not require a thin section of the person's body and is therefore well suited for wearable applications, which uses various parts of human body like the feet, forehead and chest, but it also has some limitations.



PRODUCT DESIGN



REFINED AND FINAL DESIGN BRIEF

After discussion with Guide and other professors in idc, the design brief had been refined and finalised. The suggestions from the professors were that the addition of ECG into product itself is very complex and if the project is aiming at just diagnosis and prediction of risks causing due to irregular heartbeats, a heart rate monitor (HRM) can replace the whole ECG unit in the device. This will help to reduce the complexity in creating and using the device. Further research on wearable device which gives ECG also helped to take the decision as many devices are actually having heart monitor which gives output in the form ECG.

Final design Brief

To Design a comfortable wearable device which will monitor various vital health related parameters such as

1. Heart rate
2. Pulse Oximetry
3. Physical activity

The device should not create any interference to the users freedom of doing normal day to day activities.

USER PERSONA

Jacob
Techie

Age Group : 29 - 39yrs

Married

Works as a software engineer in a reputed IT firm. He loves his job and works hard to complete every tasks given to him. He likes going out with friends on free time. He always keeps himself updated with the latest technologies and software available in the market. He keeps himself fit by doing daily workouts in GYM.

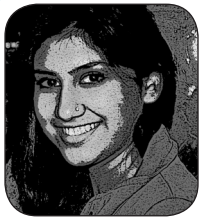
Computer usage

Health conscious

Trend Following

Technology awareness

Internet Usage



Zara
Socialite

Age Group : 29- 34 yrs

Married

Works in a Software firm as HR manager. Works in a daily shift of 11 hours. Takes the weekend to visit the parents and spend time with the friends. She likes going out with friends for parties. Even-though she uses the latest smart phones and gadgets, she s not aware of the technology side powering it.

Computer usage

Health conscious

Trend Following

Technology awareness

Internet Usage

John
Cost- Conscious

Age Group : 40- 50 yrs

Married

John Is the GM for a Reputed automobile firm. He loves sports, had participated in several sports when he was young. He is not that expert in technology, but likes to have Cool stuffs in hand. He is quite comfortable using the computers and Latest smart phones. He goes for playing badminton in the near by club every weekends.

Computer usage

Health conscious

Trend Following

Technology awareness

Internet Usage

Based on the research, the user persona is created as shown. Persona was created based mainly on three age groups. The characteristics of people belonging to each category is represented by each persona.

BRAINSTORMING AND IDEATION

Brainstorming

For getting an idea about what to ideate, brainstorming was done. A mind map was created were all the words which came to the mind was plotted on to the paper. This helped to narrow-down the ideas to certain fields, on which the ideation process can be started. In the brainstorming process there is nothing called as a bad idea or an irrelevant idea. All the thoughts that comes to the mind are treated valuable. A small brainstorming session was conducted with my fellow mates, which gave me more directions towards the ideation process.

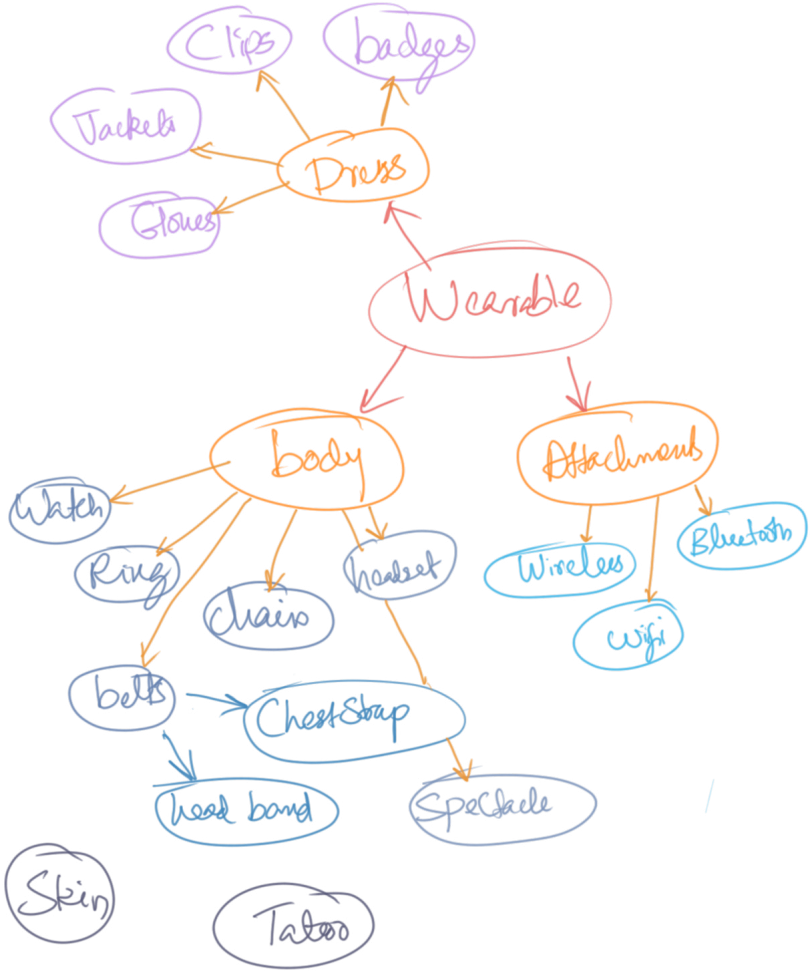


Fig 27 : The image showing the mind-map created for starting the ideation process.

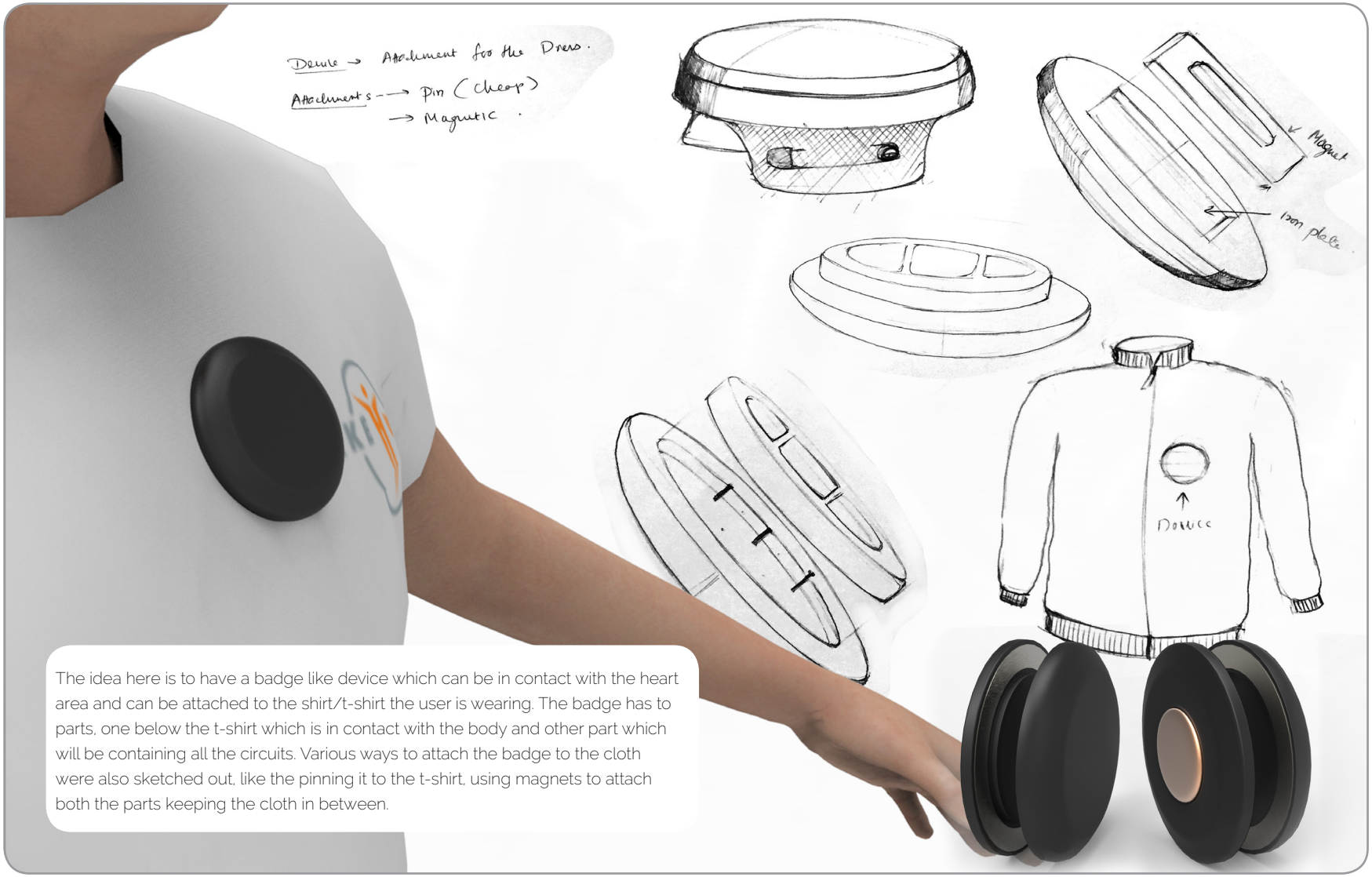
Ideation

For creating ideas, the various wearable technologies already available in the market were considered as a basic platform. Along with providing a base for ideation, it helped to think about what else can be done with every ideas. The various ways of attaching the device to the human body were also thought of while doing the ideation process The ideas which were created were analysed and grouped into different clusters based on the way it is used or connected to human body. A number of sketches and graphic renderings for each cluster were also done to make the ideas clear to all. . Some restrictions/limitations that were felt during the ideation process was the touch-points in the human body were the sensors are to be placed for proper monitoring. Around these touch points, the ideas were created and sketched on to paper for further discussion with the guide.

The ideation clusters are shown in coming pages.

PTO

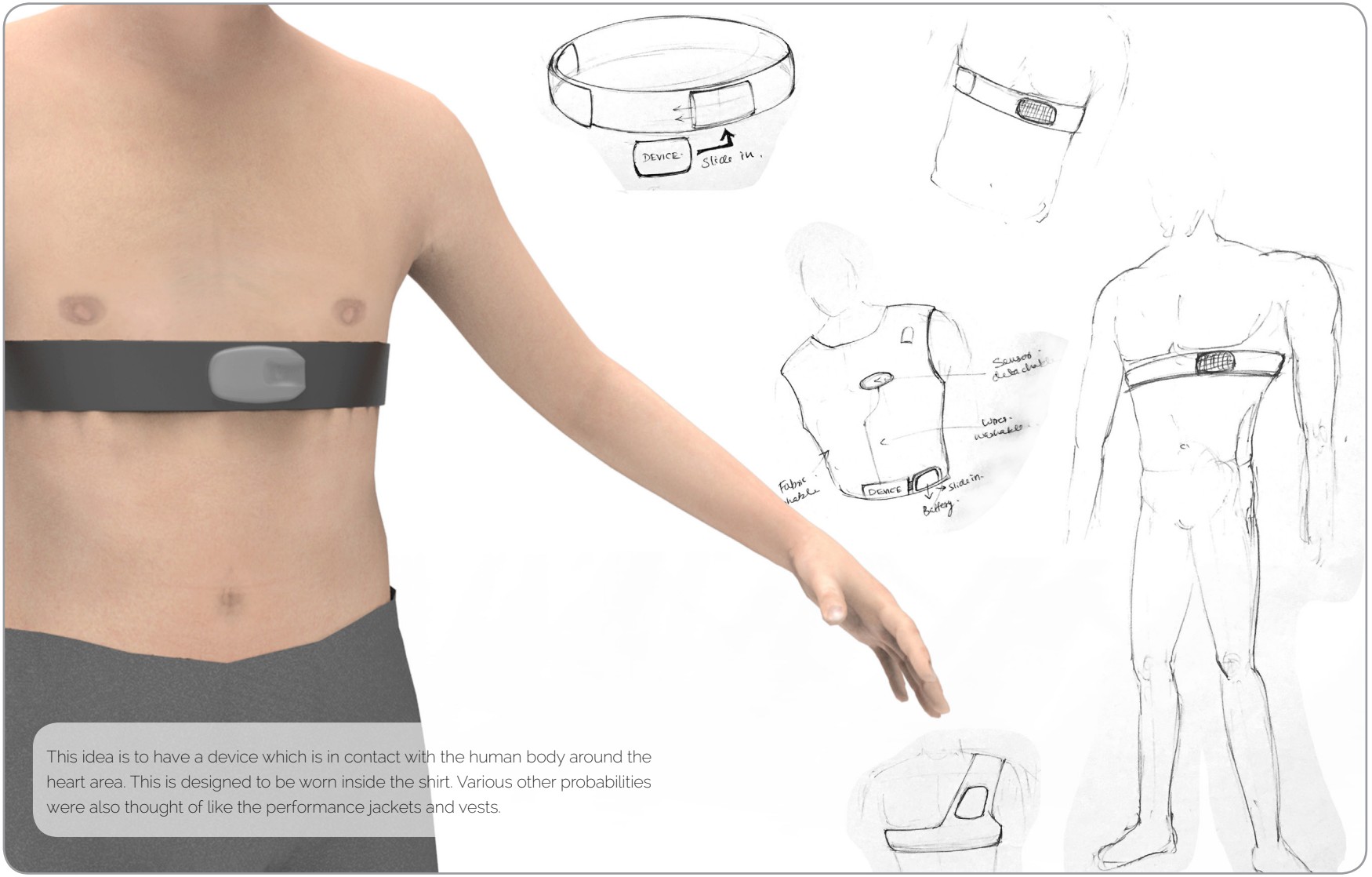
Ideation 1



The idea here is to have a badge like device which can be in contact with the heart area and can be attached to the shirt/t-shirt the user is wearing. The badge has to parts, one below the t-shirt which is in contact with the body and other part which will be containing all the circuits. Various ways to attach the badge to the cloth were also sketched out, like the pinning it to the t-shirt, using magnets to attach both the parts keeping the cloth in between.

Fig 28 : Ideation 1, A badge like looking device, which could be attached to shirt.

Ideation 2



This idea is to have a device which is in contact with the human body around the heart area. This is designed to be worn inside the shirt. Various other probabilities were also thought of like the performance jackets and vests.

Fig 29 : Ideation 2, The chest band, performance jacket, vests

Ideation 3

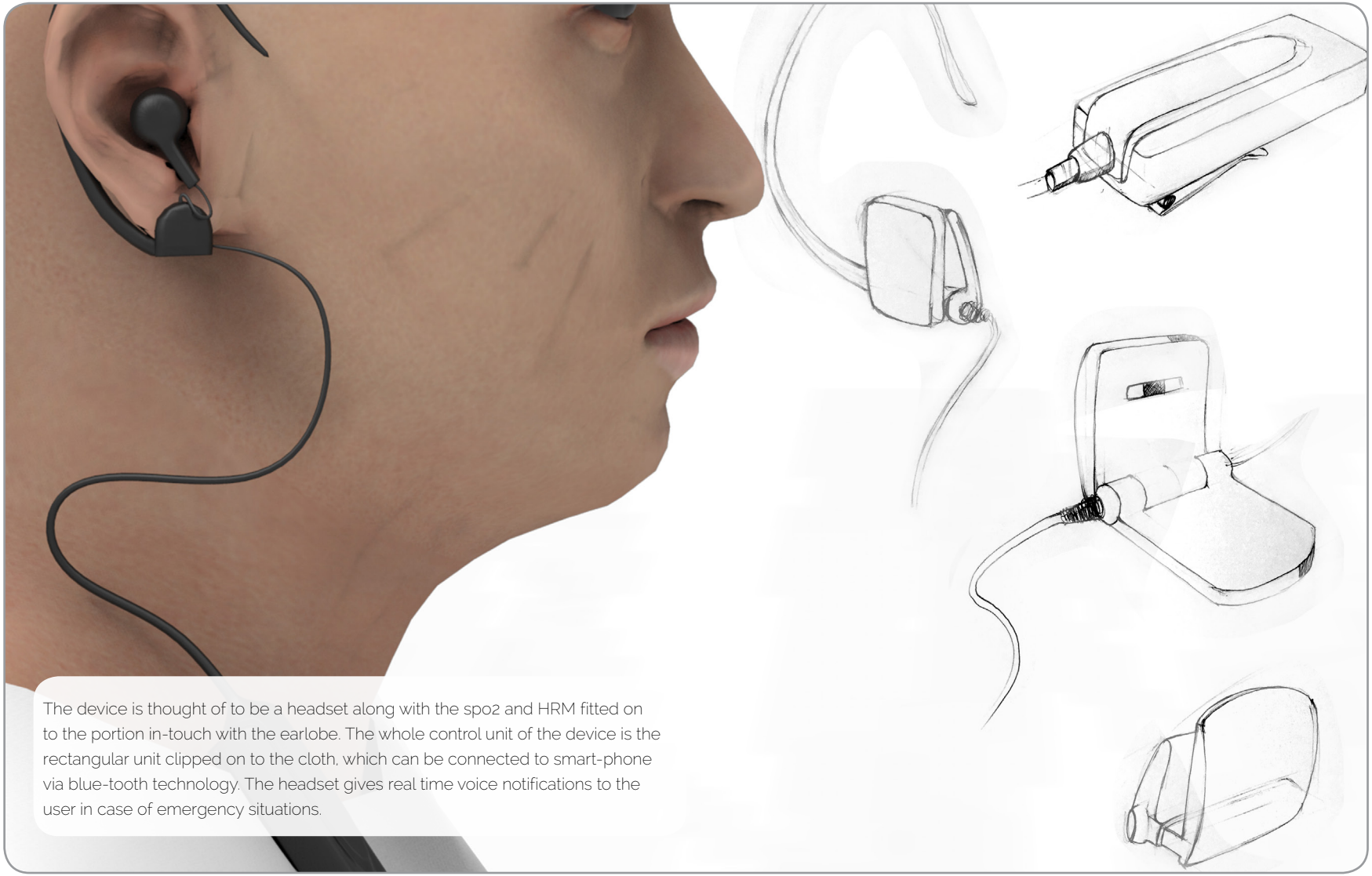


Fig 30 : Ideation 3, Headphone HRM

Ideation 4

Instead of designing a device which is to be separately worn, the idea here is to have a device that can be attached on to the existing wearable device which people use everyday. The device is to be attached on to the watch, and it gives the heart rate reading through the technology called bio-impedence method. As this device doesnt use optical sensors, this will consume less battery compared to others.

Fig 31 : Ideation 4, The watch attachment device.

Ideation 5

Fig 32 : Ideation 4, Wrist band with the ring extension.

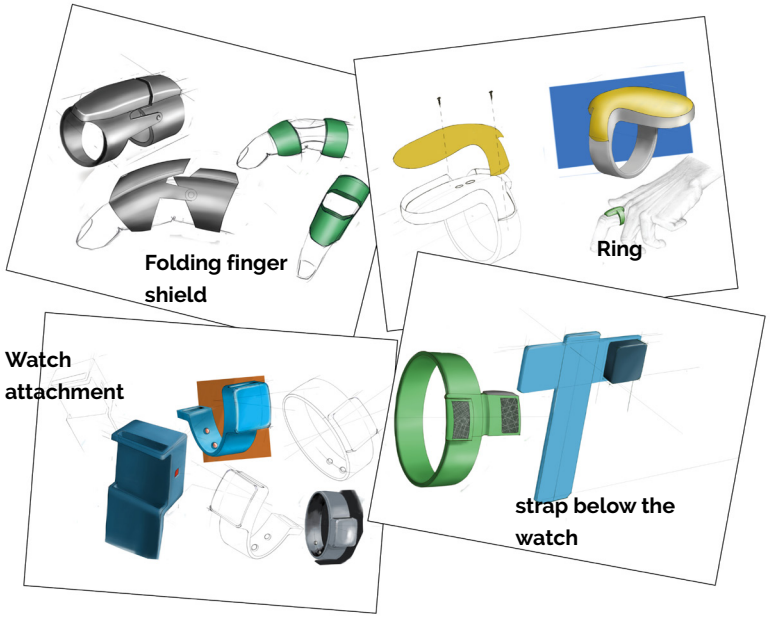


Fig 33 : The rendering of the concepts for which mock-ups are created

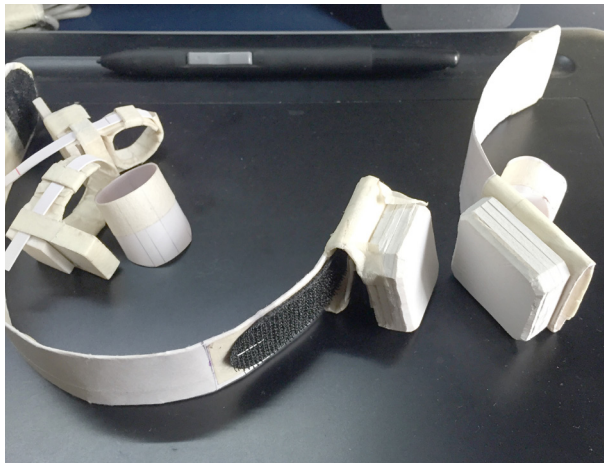


Fig 34 : The Mock-ups created for conducting activity analysis

MOCK-UPS

The ideation stage was followed by the creation of quick dirty mock-ups and getting feedbacks from the users . The mock-ups were created using sun-board/foam-board . Mock-ups helps a lot in understanding various pros and cons of the ideas. It also helps to convey the design to the users in the best way so that they give a proper valuable feedback regarding the same. With the help of the mock-ups , the real time use of the product can be simulated. The mock-ups also helps to do the detailed activity analysis, which will help to solve many confusions which are in the creators mind.

The mock-ups also helped to realise that certain designs doesn't work in every situations, which led to further modifications or even discarding the idea and taking forward the design which worked the best among the concepts. The ring concept had to be trashed as it will not work in a daily basis situation. It actually becomes difficult to put hands in the pocket when you want to take the mobile phone out. After the activity analysis, the watch attachment concept was finalised considering all the factors which would occur when the product will be used for a full day basis.

ACTIVITY ANALYSIS

The created mock-up models were then taken to my friends and hostel mates to do the activity analysis. The activity analysis were carried out mainly on an office working background as the device is designed for the office going people. Many activities which will be carried out in the office environment by the real users were simulated while wearing the mock-ups to see if any hindrance is caused by the device in performing any activities.

Some of the activities include working on computer/laptop. Holding files, Reading books/ Files, making phone calls, taking phone from pocket, drinking water/coffee/tea, interacting with the device, wearing and removing the watch, taking out purse from back pockets, smoking cigarettes etc.

From this task it could be seen that the wrist based concept is working fine in every situations. Users doesn't have to give much attention to the device in any of these situations, which is exactly what its designed for.

Fig 35 : The various activities carried out by wearing the mock-ups. The green circles points out the device in the images.

SELECTED CONCEPT

Fig 36 : Image showing renderings of final concept (watch attachment)

Among the various concepts and mock-ups created, the final concept was selected based on considering situation analysis and activity analysis conducted. Since the device is to designed for a daily use several factors had to be considered. Priority was given to various factors like comfortability, Style, Hygiene, Ease of use, User interaction etc.

The initial research also shows that majority of the users likes having wearable device on the wrist than on any other part of the body. As a result the wrist based wearable device concept is selected as final for the refinement and detailing.

The concept

The final concept that was selected is to have an attachment to the existing watches which the users use. Provisions are also thought of to make the product usable if the user doesn't use watches. In cases were users doesn't like wearing watches the same device can be fitted on to a wrist strap and worn in the wrist. Since the device would be worn full day, special considerations were given to factors like sweating, ware and tare, look and feel, texture etc. The technologies used in this devices are the already existing technologies available in the market, which is explained in the coming

pages.

The concept has two main parts , the one which would be seen on top of the watch strap and the other below the watch strap, which will be in contact with the skin. The outside part would be the main unit of the device containing all the micro circuits and the part below the strap has the sensors for continuous monitoring of the heart beat. The users were happy about this device because unlike the normal fitness trackers and bands, they don't have to wear an additional device to the watch they wear. Here both the watch and the device gets attached in way that it becomes like a single wearable device. The schematic view of the device attached to the watch worn on the hand is shown on the left side.

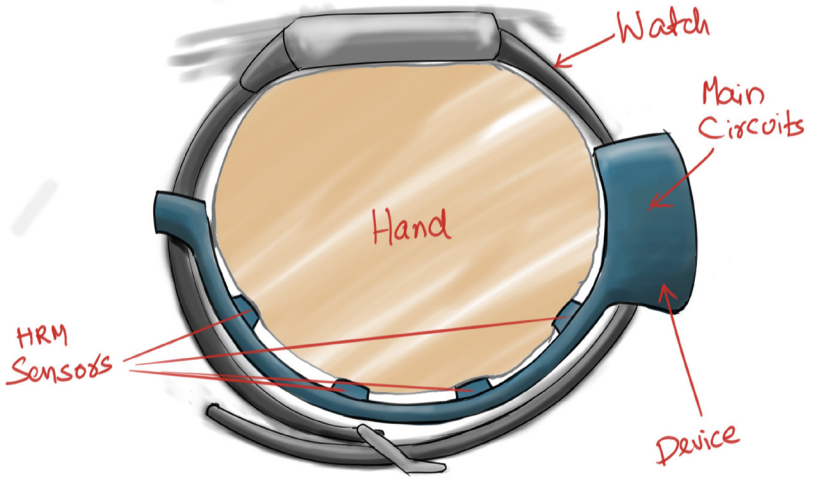


Fig 37 : Cross-sectional view of the hand with watch and device attached on to it.

Technologies used:

The technologies used in this device is not anything new to the market, already available technologies have been adapted for this project, but in a new way. The main hardware part for this device would consist of a bio-impedence sensor, optical spo2 sensors, 3D Accelerometer, Vibration motor, Led Lights.

The bio-impedence technology is the latest technology being accepted in the wearable heart rate monitors in the present time. The Device "Jawbone Up3 (https://jawbone.com/store/buy/up3)" is the latest device introduced in the market having bio-impedence technology to monitor heart rate. In this technology a small electric charge is transferred to the skin through one electrode and received at other end by another positive electrode. The difference in the transferred charge and received charge will give the resistance offered by the skin due to the blood flow which in turn is counted for the heart beat.

Evaluation criteria for selection of the concept

Usage Considerations
- 24/7 use
- daily base usage
- Ease of use
- Battery consumption

Material Consideration
- Sweating
- Moisture

Manufacturing
- Single mould design

The optical sensors are used for the monitoring of Spo2, throughout the research it was seen that there is no need to have a continuous monitoring of the spo2. Instead the spo2 has to calculated after exercise or doing any hard work. So the optical sensors are placed on the main unit, where the user can keep the finger tip and measure the spo2 reading. The optical sensors consist of red and green LEDs and a photo detector to detect the reflected light.

For measuring the physical activity scale of the user, a 3D accelerometer is to be used. This as its name indicates, measures the changes in 3dimensons x,y and z with respect to a reference point. This reference point has to be set in the code used for programming the micro controller. This difference is calculated as walk or run by the device.

The device is designed not to have any screen on it which requires more battery, The concept is to have a simple device with simple user interactions which doesn't require the users to perform any additional tasks to interact with the device.

HOW IT WORKS (SYSTEM DESIGN)

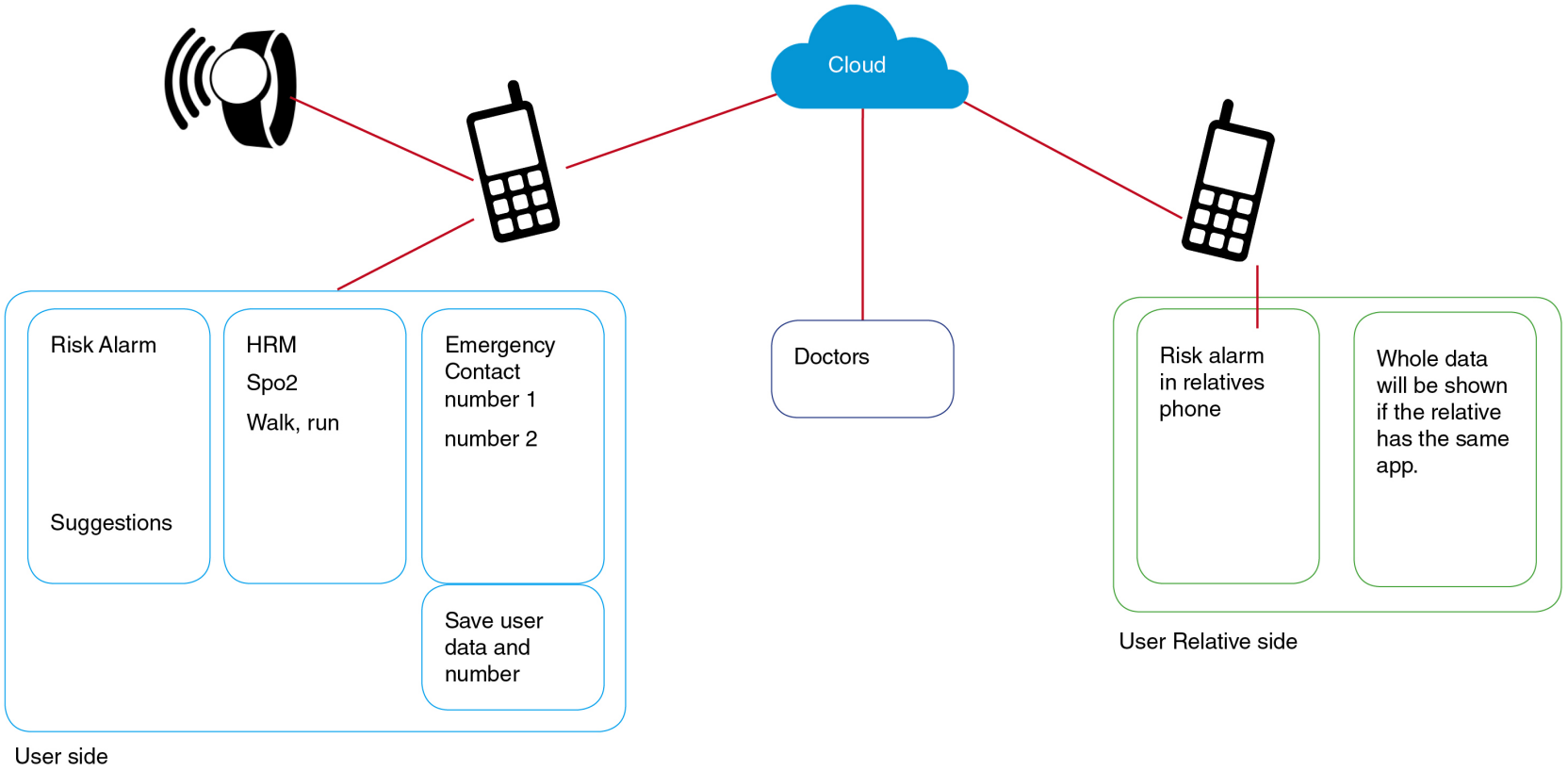


Fig 38 : Block diagram showing the device in the system.

The device doesn't work on its own, it needs to be connected to a smart-phone running the dedicated software. The smart-phone acts as the bridge between all the communication between device and the user, User to relative and user to doctor.

The user can save up-to three numbers of their close friends or relatives, in case of any risk factor in the measurement of vital parameters, the application will send alerts and notifications to the saved phone numbers. If the recipients are using the same application, they will be able to view the health data of the user in real time.

The monitored data is saved in the cloud space on the online portal for the device. This is were the registered doctors can access and view the health data's of their patients.

VOLUMETRIC EXPLORATION :

Deciding the dimension of the device was the task which was very important as the device has to be small and sleek enough to be used comfortably as a wearable device. In-order to decide the dimensions, a little bit of online search for the various sensors and mechanisms used in the wearable devices was done. This study was done mainly on the currently available technologies in the market so that it can be easily adopted into this device without the need for testing it. Some of the sensors and mechanisms considered for doing the volumetric explorations of the device is listed below.

Vibration motor:

Coin vibration motors, also known as shaft-less or pancake vibrator motors, in 8mm - 10mm diameters. Pancake motors are compact and convenient to use. They integrate into many designs, because they have no external moving parts, and can be affixed in place with a very strong permanent self-adhesive mounting system.

They are great for haptics, particularly in handheld instruments where space can be at a premium

Mobile phones,
Industrial tools or equipment user interfaces,
Portable instruments,
Medical applications.

Size : 8mm - 10 mm diameter
Height : 3mm - 3.5mm

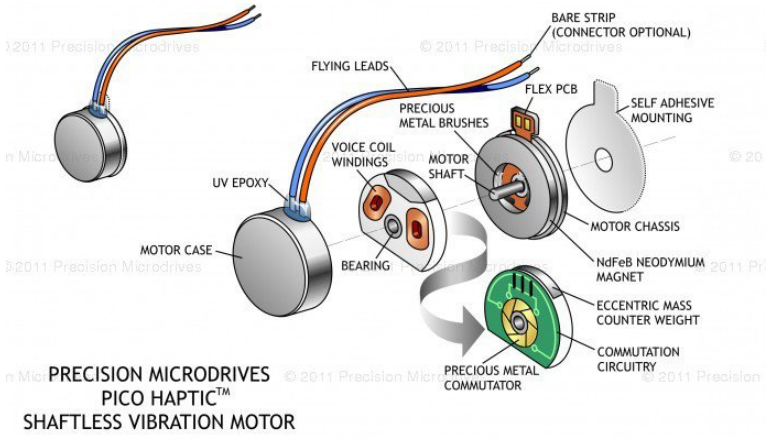


Fig 39 : Image showing the casing assembly of the vibration motor. Source : http://www.precisionmicrodrives.com/vibrating-vibrator-vibration-motors/pancake-shaftless-coin-vibration-motors

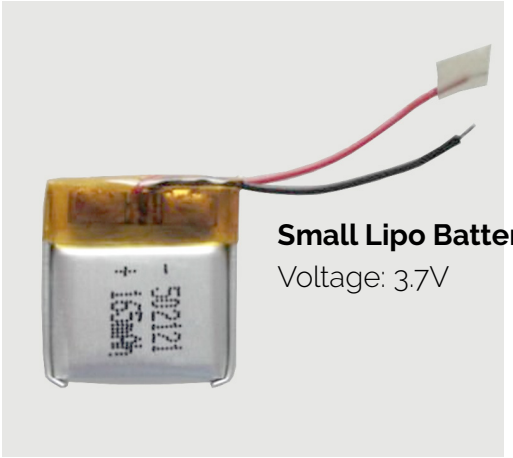


Fig 40 : SOURCE:http://www.alibaba.com/product-detail/Small-Lipo-Battery-165mAh_378816170.html

Size : 10mm X 10mm X 2mm

Fig 41 : Source : http://www.ti.com/product/msp430f133

Li-po Battery :

A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated variously as LiPo, LIP, Li-poly and others), is a rechargeable battery of lithium-ion technology in a pouch format. Unlike cylindrical and prismatic cells, LiPos come in a soft package or pouch, which makes them lighter but also lack rigidity.

- Cycle life: 500 times
- Charging voltage: 4.2V
- Maximum charging current: 1C mA
- Maximum discharging current: 2C mA
- Discharging end voltage: 3.0V
- Charging end voltage: 4.2V
- Dimensions : 15mmX12mmX4mm

Micro-controller : MSP430F133 (ACTIVE)

"16-Bit Ultra-Low-Power Microcontroller, 8kB Flash, 256B RAM, 12 bit

ADC, USART"

Typical applications include sensor systems that capture analog signals, convert them to digital values, and process and transmit the data to a host system. The timers make the configurations ideal for indu strial control applications such as ripple counters, digital motor control, EE-meters, hand-held meters, etc.

3 Axis - Accelerometer : LIS3DSH

- 3-Axis Digital Accelerometer with Smart State Machine:

Size: 3mm x 3mm x 1mm

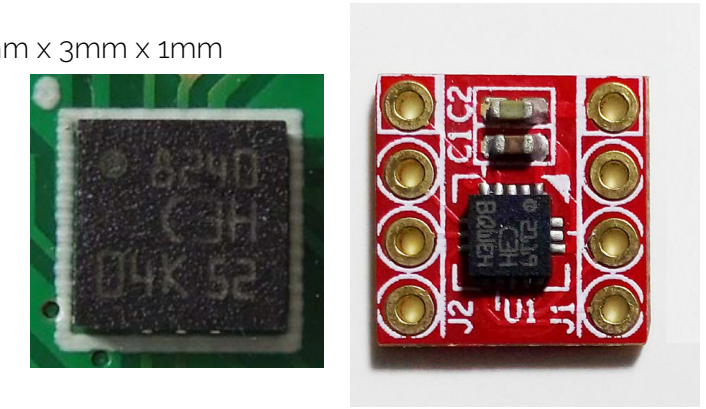


Fig 42 : Source :http://www.emcu.it/MEMS/LIS3DSH/LIS3DSH_State_Machine.pdf

- Wide supply voltage, 1.7V to 3.6V
- Independent IOs supply (1.8 V) and supply voltage
- compatible
- Ultra low-power consumption down to 11 µA
- ±2g/±4g/±6g//±8g//±16g selectable full scale
- Low noise 150 ug/√Hz, 14bit resolution
- 16-bit data output, embedded FIFO
- 2 Programmable Embedded State Machine to run selectable motion detection patterns, Free-fall detection, Motion detection, Tap&Double-tap detection etc
- 2 independent programmable interrupts
- Ultra high stability over temperature
- I2C/SPI digital output interface
- Embedded self-test
- Package : LGA 3x3x1mm

Bluetooth module : nRF8001 (Bluetooth Smart Connectivity IC)

The nRF8001 is a highly integrated single-chip Bluetooth® Smart Connectivity IC. It integrates a fully compliant Bluetooth Smart

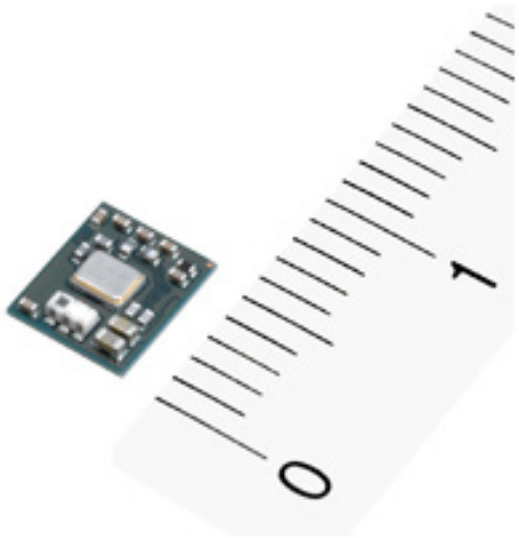


Fig 43 : Source -http://itersnews.com/?p=68347&print=1

Size : 5.6mm x 2.8mm x 1.2mm

Fig 44 : Source - http://www.maximintegrated.com/en/products/analog/sensors-and-sensor-interface/MAX30100.html

v4.0 Radio, Link Layer, and Host stack and features a simple serial interface that supports a wide range of external application micro-controllers. With peak currents as low as 12.5mA and average currents down to 9µA (for a 1s connection interval), the nRF8001 enables battery lifetimes of months to years from a single coin cell. The nRF8001 is a fully qualified Bluetooth Smart v4.0 design and combines the Radio, Link Layer, and Host into a single EPL (End Product Listing) enabling designers to easily create new Bluetooth end products without additional listing fees.

The nRF8001 is specifically designed for Bluetooth Smart applications that operate in the Peripheral (Slave) role. Examples include: proximity tags, PUID watches, remote controls, and sports/fitness/healthcare sensors. The on-chip Link Layer and Host stack also include support for Peripheral GAP role, client, server and security functions.

In addition to best-in-class power consumption, the nRF8001 features an ADC for battery level monitoring, a low tolerance 32kHz RC oscillator that eliminates the need for an external 32kHz crystal, plus a 16MHz crystal oscillator supporting the use of low cost 16MHz crystals. The chip also integrates two voltage regulators, a linear voltage regulator providing a 1.9 to 3.6V supply range, and a DC/DC voltage regulator that when enabled can further cut current consumption by up to 20% when running from a 3V battery cell.

The nRF8001 is available in a 32-pin 5 x 5mm QFN package.

Pulse oximeter - MAX30100

The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current,

permitting the power supply to remain connected at all times.

Key Features

Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
Integrated LEDs, Photo Sensor, and High-Performance Analog Front-End
Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package
Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
Programmable Sample Rate and LED Current for Power Savings
Ultra-Low Shutdown Current (0.7µA, typ)
Advanced Functionality Improves Measurement Performance
High SNR Provides Robust Motion Artifact Resilience
Integrated Ambient Light Cancellation
High Sample Rate Capability
Fast Data Output Capability

Applications/Uses

Fitness Assistant Devices
Medical Monitoring Devices
Wearable Devices

FINDING THE VOLUME

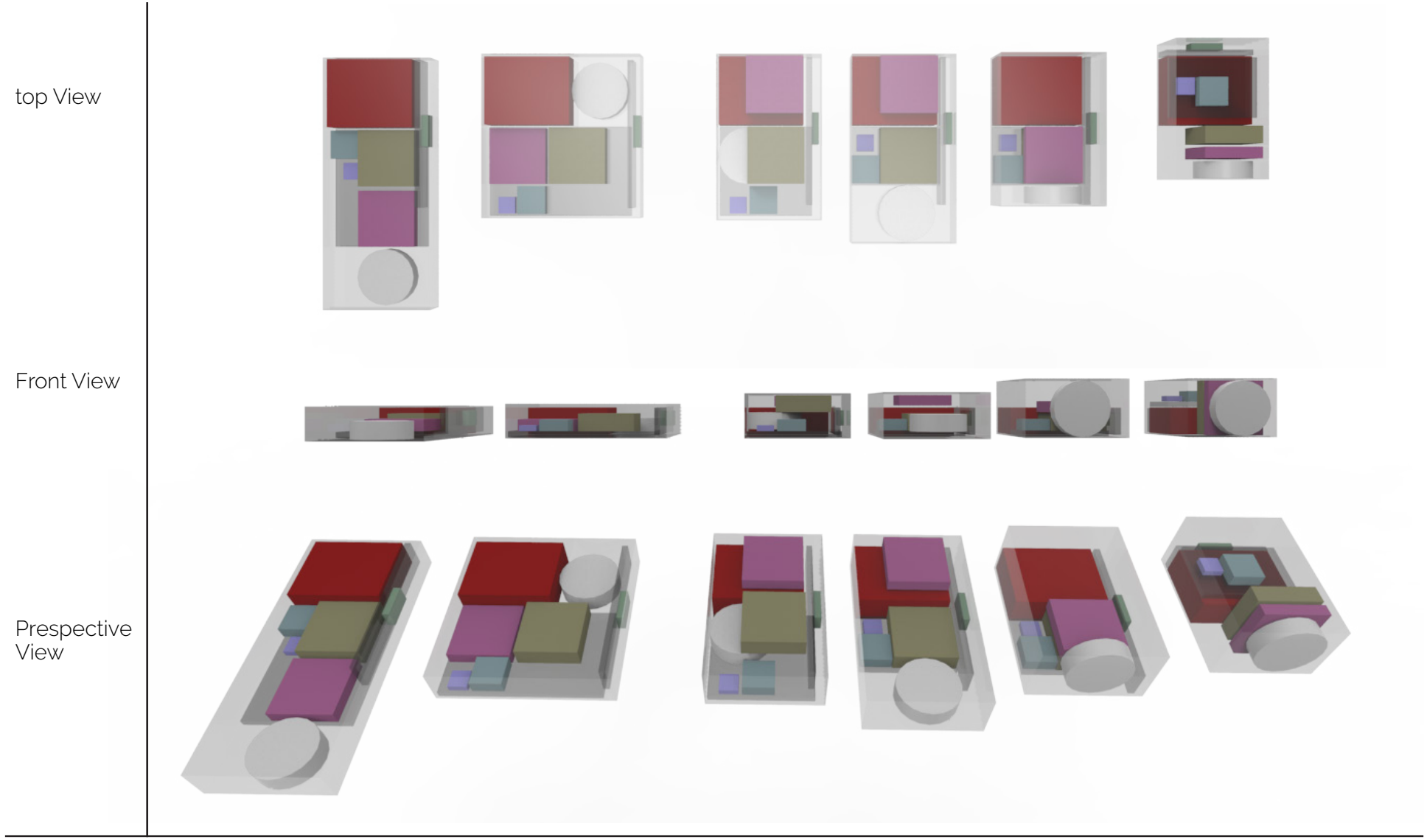
After understanding various sensors and modules which would make the device, the volume which each module will occupy inside the device is calculated by taking the dimensions of each module from the data sheet attached with it. With this data, the volumetric explorations were done to find how much would be the total volume occupied by the modules when placed together.

For finding the appropriate size of the device, the volume of each modules were made in CAD software and arranged in various possible combinations. These combinations varied from keeping the modules straight to stacking it on top of each other to reduce space. Based on the combinations, the over all volume seemed to vary drastically. Since the wearable device have to be sleek and small the appropriate volume for the device was found to be 28mm X 28 mm X5.5 mm .

This size was chosen from all the variations because, it accommodated all modules properly and also provided little room for further circuit boards that can be incorporated to the device.

The image showing the various explorations done to find the volume along with the dimensions are given in the page[49].

The differently coloured square boxes represents the volume of each modules in the 1:1 ratio.



Dimensions (L x W x H)					
L: 45mm W:19mm H:5.5mm	L: 28mm W:28mm H:5.5mm	L: 30mm W:18.5mm H:8mm	L: 33mm W:18mm H:8mm	L: 16.5mm W:18.5mm H:10.5mm	L: 24.5mm W:16mm H:10.5mm

Fig 45 : The image showing the various explorations done to find the volume along with the dimensions .

FORM STUDY

The wearable device project here is targeting a general audience, which makes it necessary to know about the form and aesthetics, which both men and women likes. To study about the form relation in feminine and male oriented forms, various products which are designed for both the user categories were picked from internet and a form analysis was done on the same. Separate image boars were created for both male and female targeting products. From these image boards the lines and curves and various parameters which differentiated the feminine products from the male ones were studied.

The image boards taken for studying the form and deriving the form language for both female and male users are shown in the coming pages.

Fig 46 : Image showing the analysis of product forms targeting male users.

Study of male targeting products

From the mood board certain features of the male products were found to be sharp straight lines, bulkiness, rough textures, rugged lines and structures, thick and wide neck when compared to body, muscular structures etc. To know what exactly makes these features prominent in the form, the images were cropped and analysed.

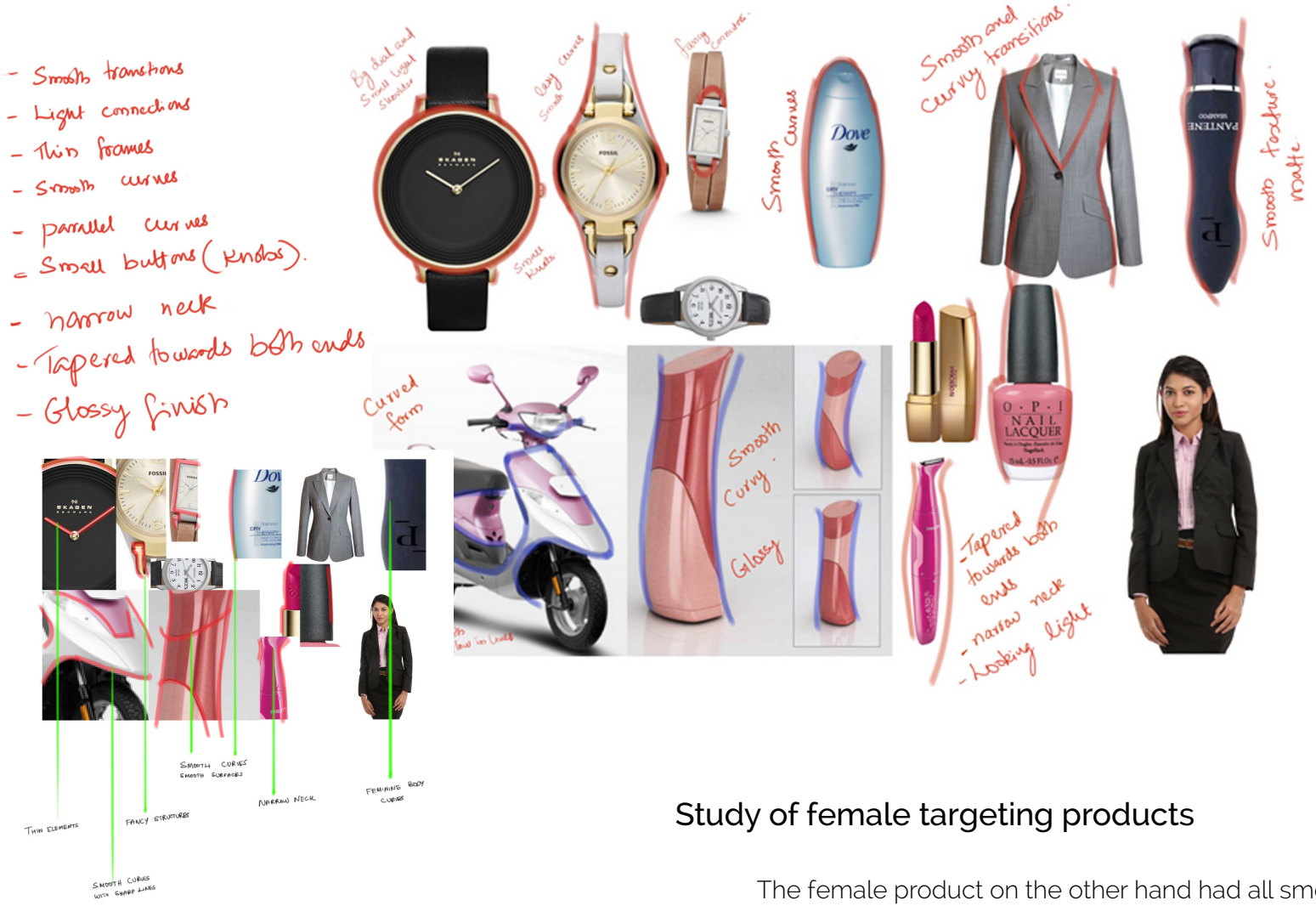


Fig 47 : Image showing the analysis of product forms targeting female users.

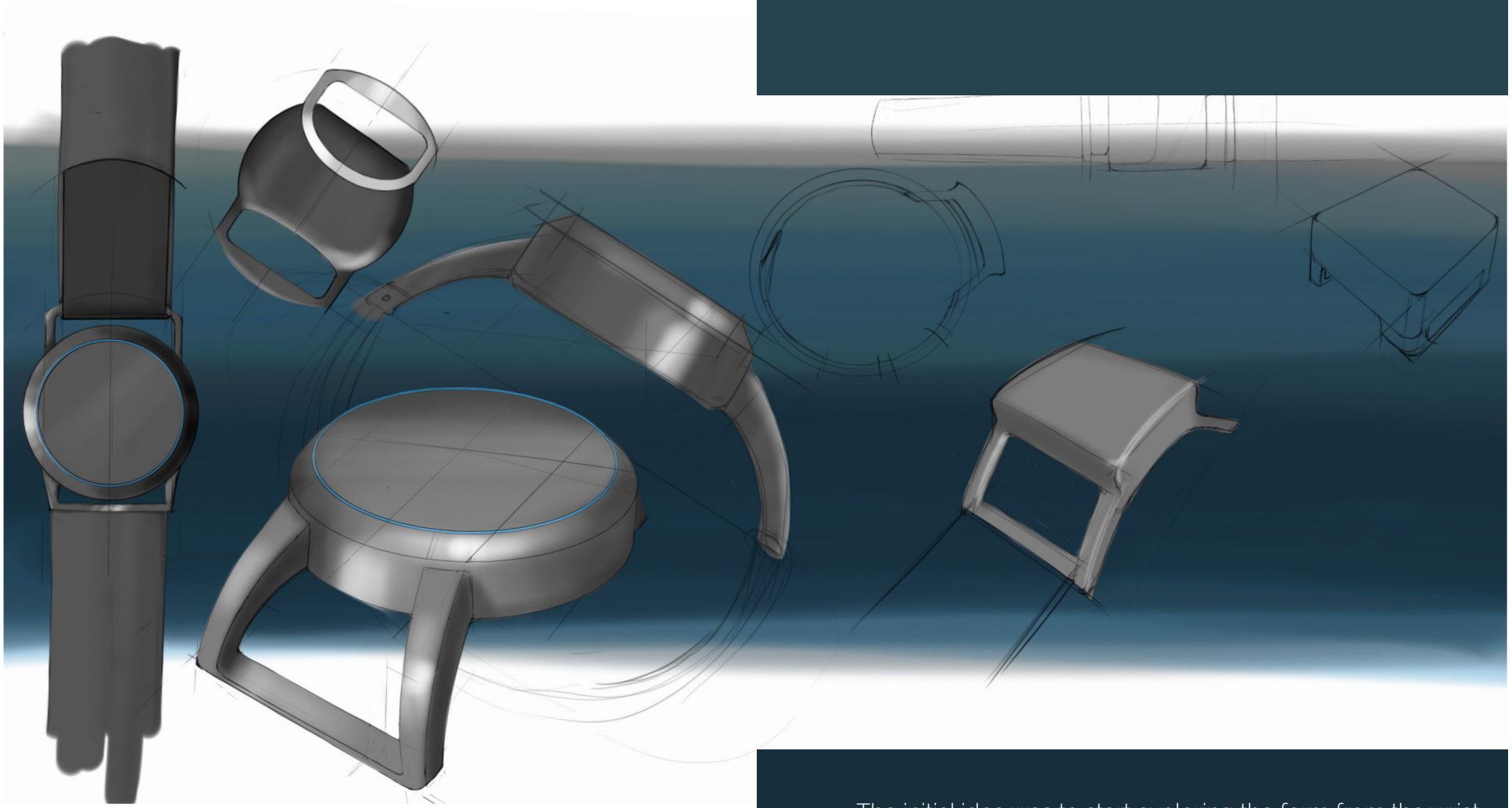
Study of female targeting products

The female product on the other hand had all smooth curves and flow to the entire form. Thin frames and narrow necks also were prominent in feminine products. Many products were seen to have copied the female natural curves on to the product form.

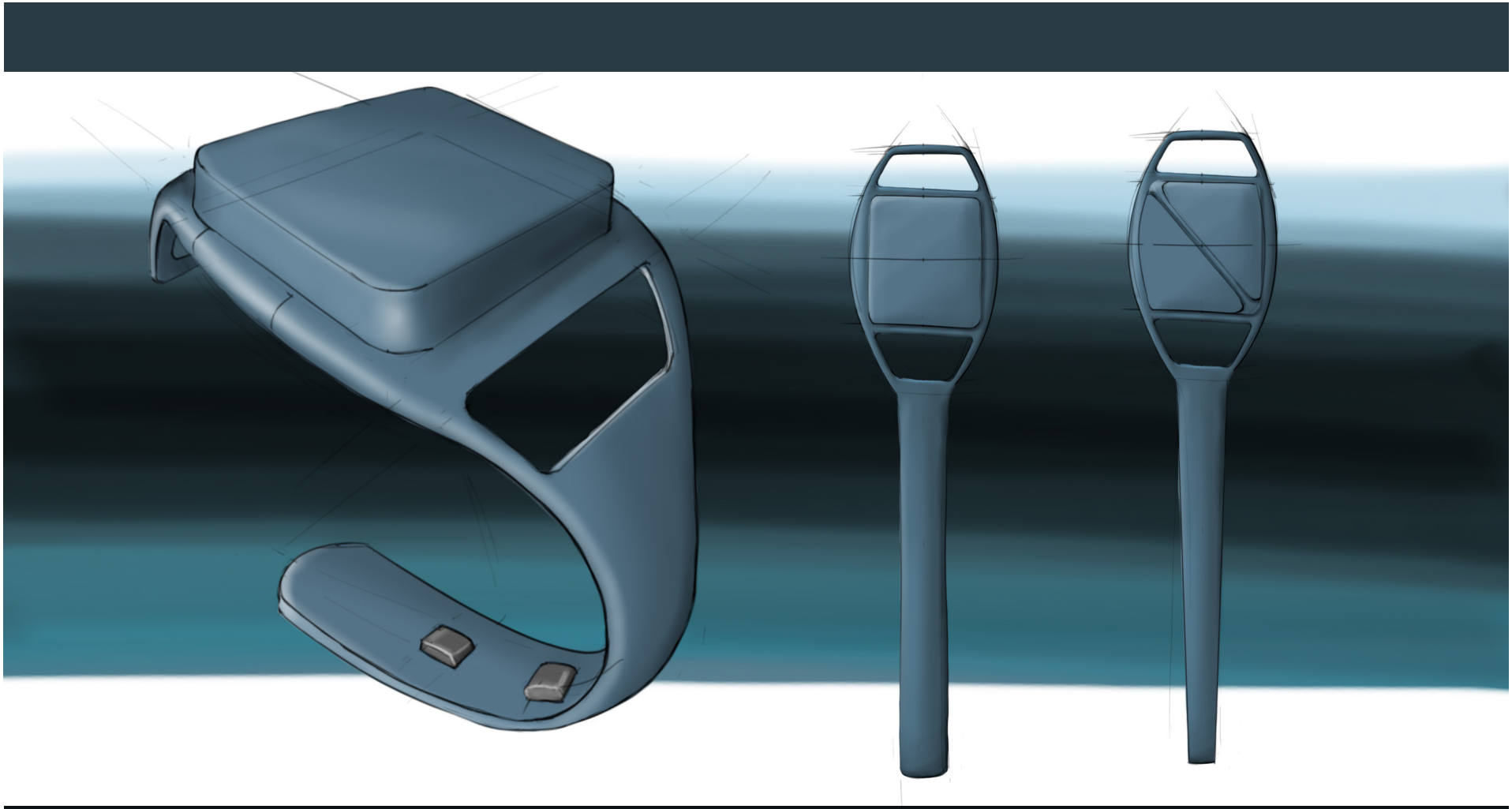
FORM EXPLORATIONS

Initially the explorations started by creating some random forms which could represent both male and female users. This approach didn't take the form explorations to anywhere, mind started getting stuck here and there as there was no guideline for the forms created. Later on after doing the form study from the image boards, certain rules were set in exploring the forms. The image board helped extensively in creating a form language for both male and feminine device.

Lots of sketches and renderings were made to create a bank of forms. From these forms the prominent features were mixed in sketching the next set of forms. Based on the rules set by the image board, the created forms were clustered into different groups and final forms were designed.



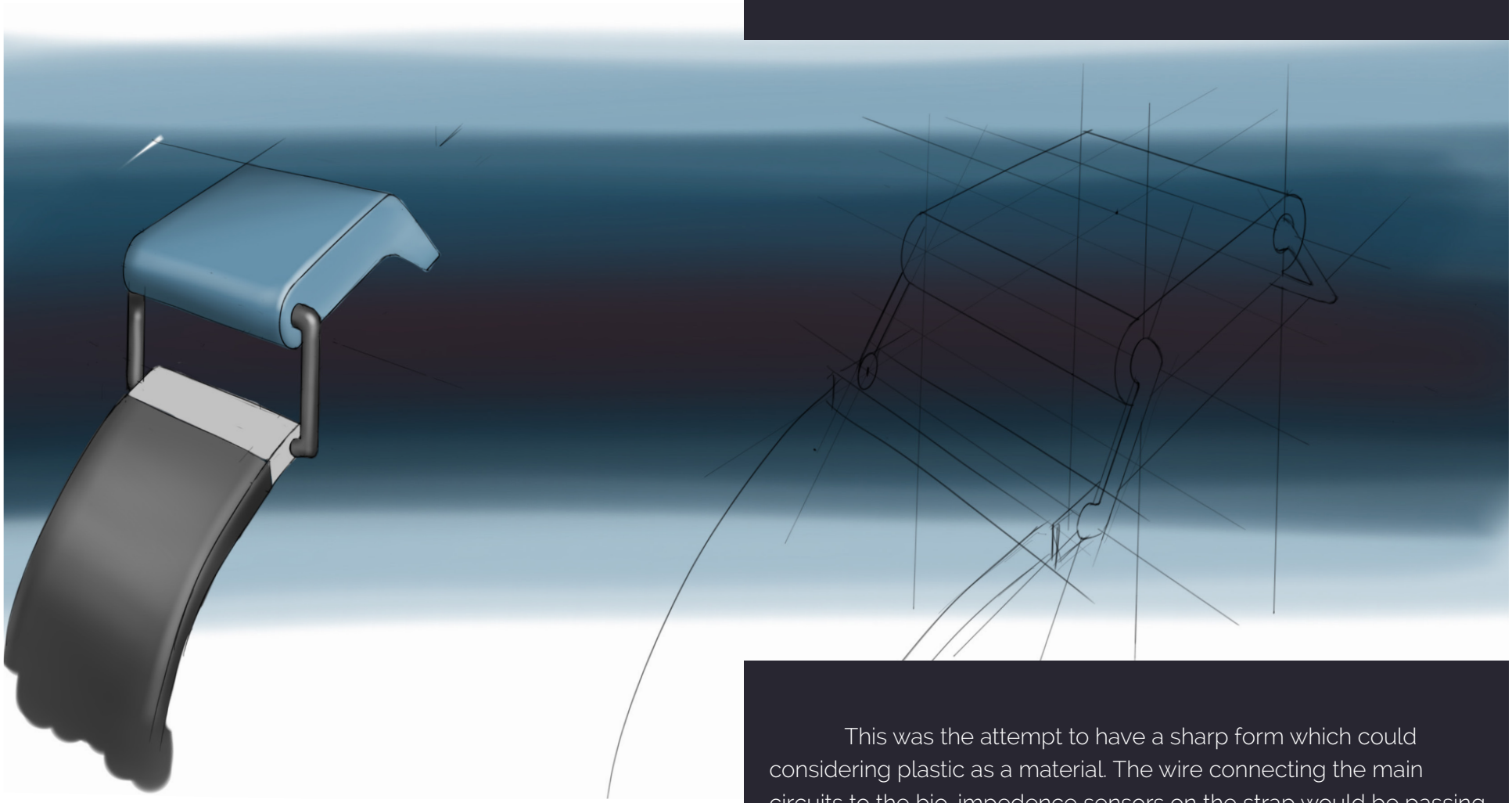
The initial idea was to start exploring the form from the wrist watches itself. Simple basic cylindrical form with a sleek circular blue light was given to make the form adaptive to all the wrist watches. Certain fancy connectors were also though of for giving it a touch of feminine effect



A thought of giving s sporty touch to the device ended up in this form, making it look simple yet sporty. The curved base which surrounds the square sharp top gives the support element to make it look strong to handle all the sport related activities.

Here the exploration was mainly based on the inspirations from the musical instruments like Veena, violin and guitar. This was done just to break ma thought process from the gadget point of view.

Here the attempt was to try exploring forms with sharp corners and curves for the female user category.



This was the attempt to have a sharp form which could considering plastic as a material. The wire connecting the main circuits to the bio-impedence sensors on the strap would be passing through the connector which connects both the units.

REFINED FORMS

From the set of form explorations did, it was not enough to be taken forward as a final form for the device. As both male and female user categories are expected to use the device, it was necessary to have a connection between the two forms. Both the forms should belong to the same family of forms. For this purpose certain metaphors were considered while creating the final forms. Inspirations from nature , animals and basic geometries were also considered for generating the family of forms. Having a common theme for both feminine and male form made it little easy to make the two genders belong to the same family.

Three such form families were sketched out on paper and rendered. In-order to get the proper feeling of the form in 3D space, CAD modelling was done. The CAD models also helped to visualise the forms in different suitable colours and textures.

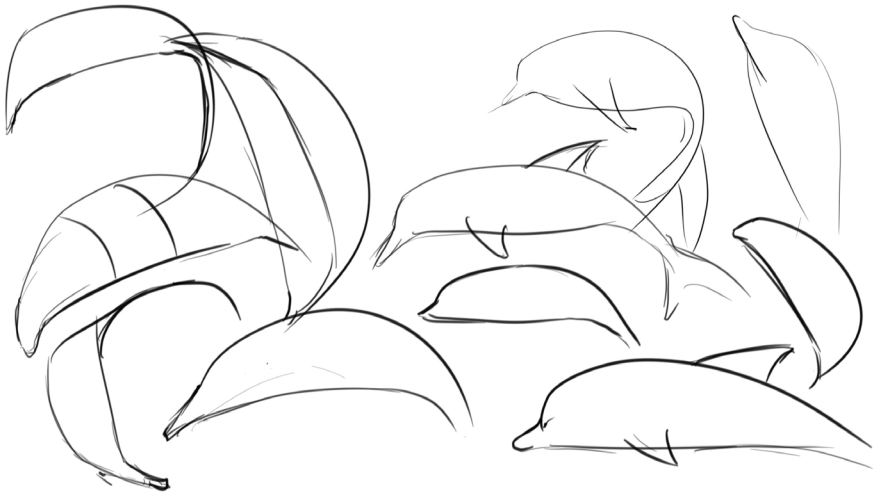


Fig 48 : Figure showing the dolphin silhouette as an inspiration for creating the form

FORM 1 - DOLPHIN

This is created by taking inspiration from the dolphins. Dolphins are known to be humans best friend in water. It saves life whenever it got a chance. This wearable device is also designed to be saving users life by predicting risks. The smooth curvy form of the dolphin is extracted and sketched out to give a smooth and curvy form to the device. The feminine form is given all smooth surface with a sharp bottom to have a feeling of confidence and a little bit of attitude.

The male form is given the same curves as the feminine form , but with more sharp lines it give a look of more rough than the female form.

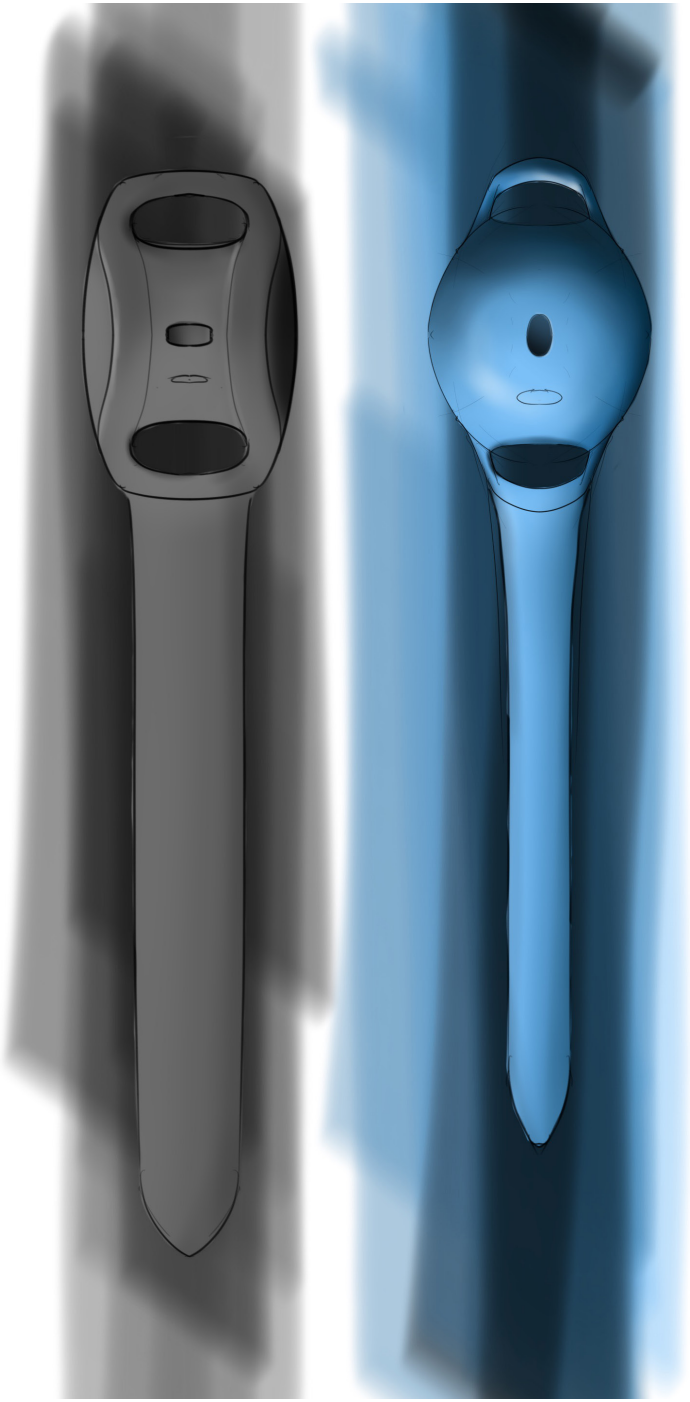


Fig 49 : figure showing the refined form created by taking dolphins as inspiration

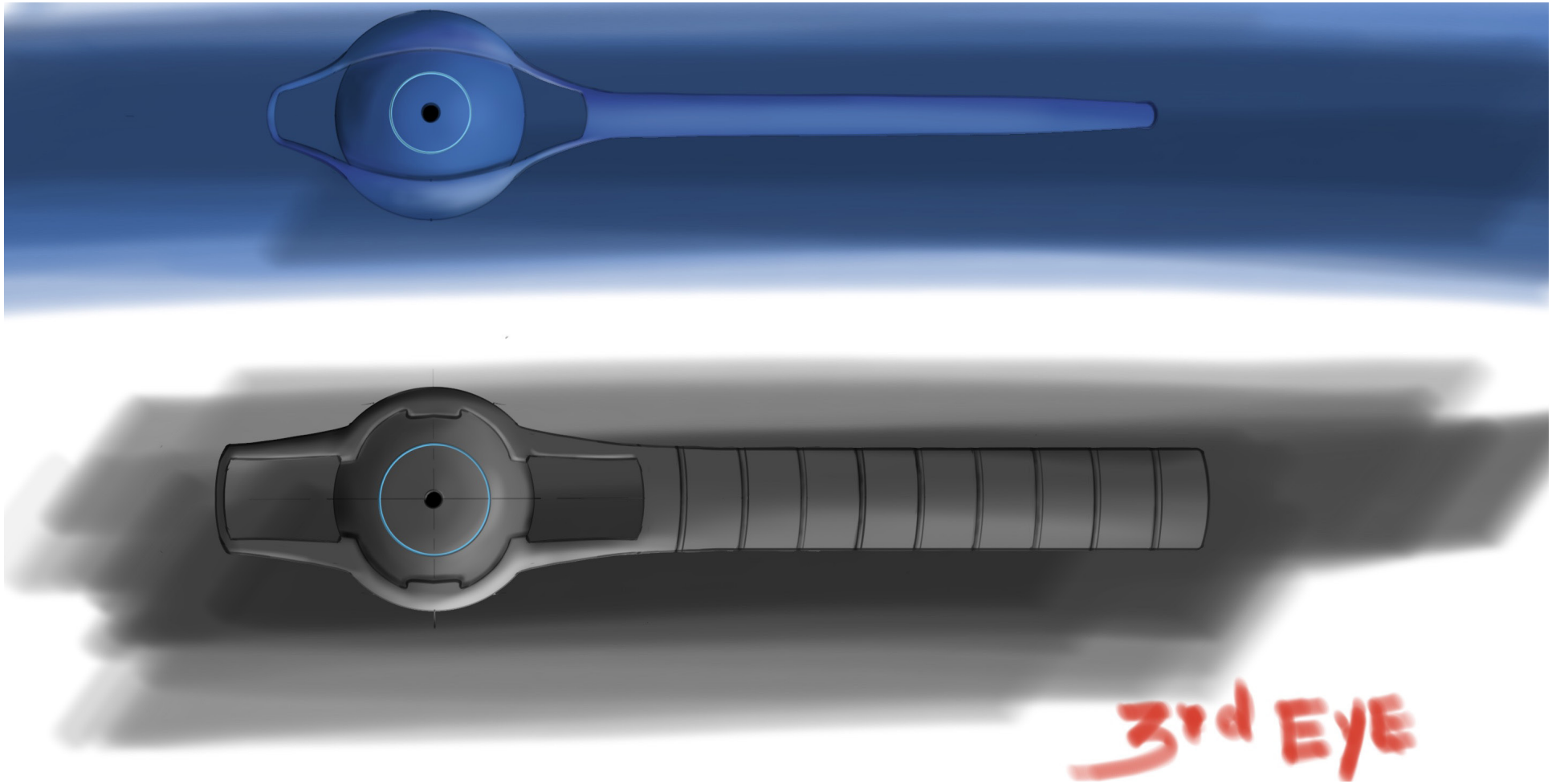
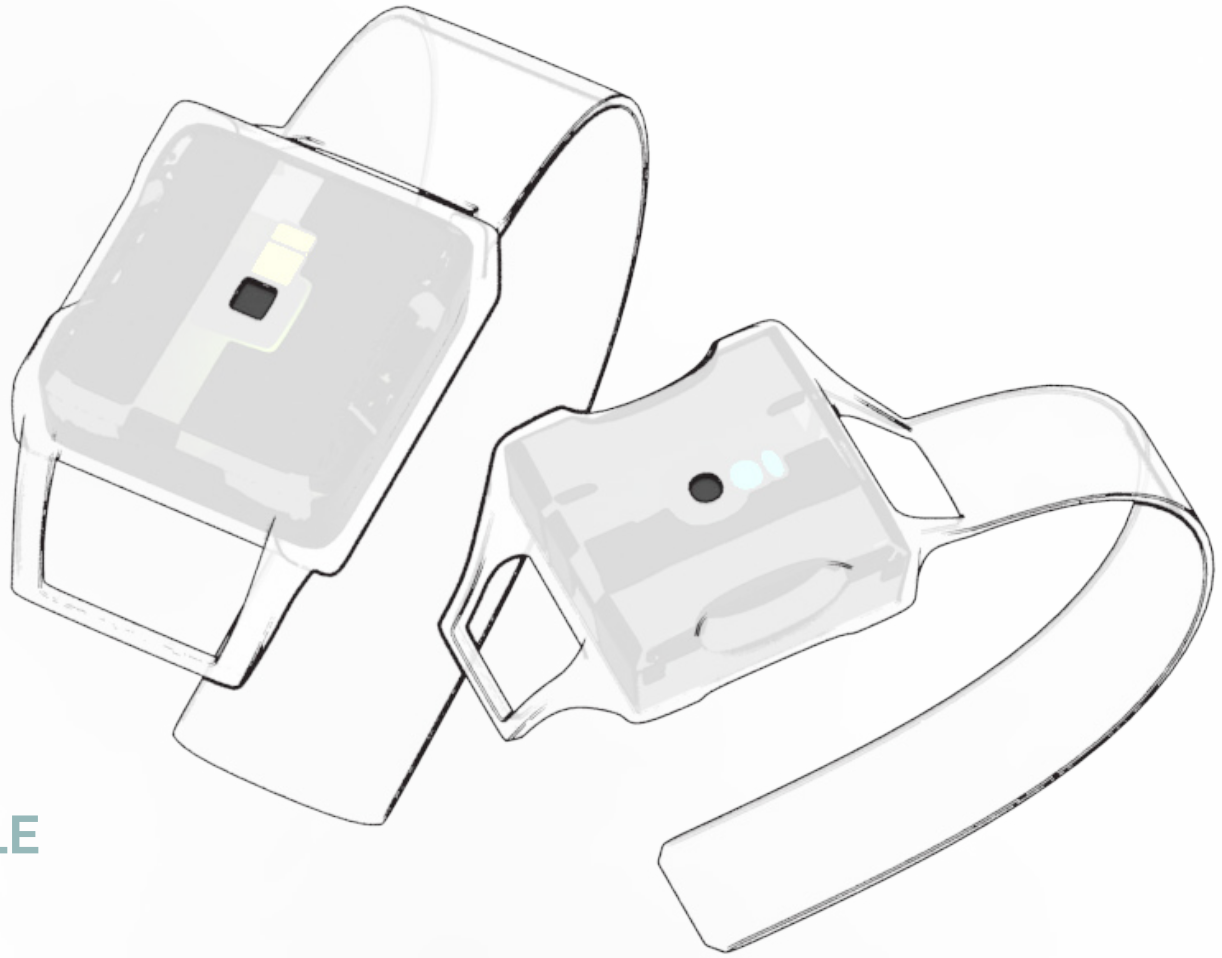


Fig 50 : figure showing the hand rendering for the 2nd refined concept (the 3rd eye)

FORM 2 - THE 3RD EYE

This form is made from the concept of 3rd eye, which always watches the user. The notification light is given as simple streak circular light to give the feeling of the cornea in the eye. The feminine form is all smooth surface, whereas the male form have few rugged cuts and extrusions.

Fig 51 : figure showing the 3d renderings of the form, The third eye



FORM 3 - SIMPLE

This is the 3rd refined form designed for the device . Here the care was given to keeping the form simple looking. For this, the inspiration was taken from simple basic forms like the cube, rectangle, ellipse and circle. The idea came from the fact that the elderly people showed more interest towards the simple objects when compared to fancy ones.

Here the differentiation between the male and female form is done with help of different basic 2D forms.

Fig 52 : Image of the 3rd refined form (the simple form)

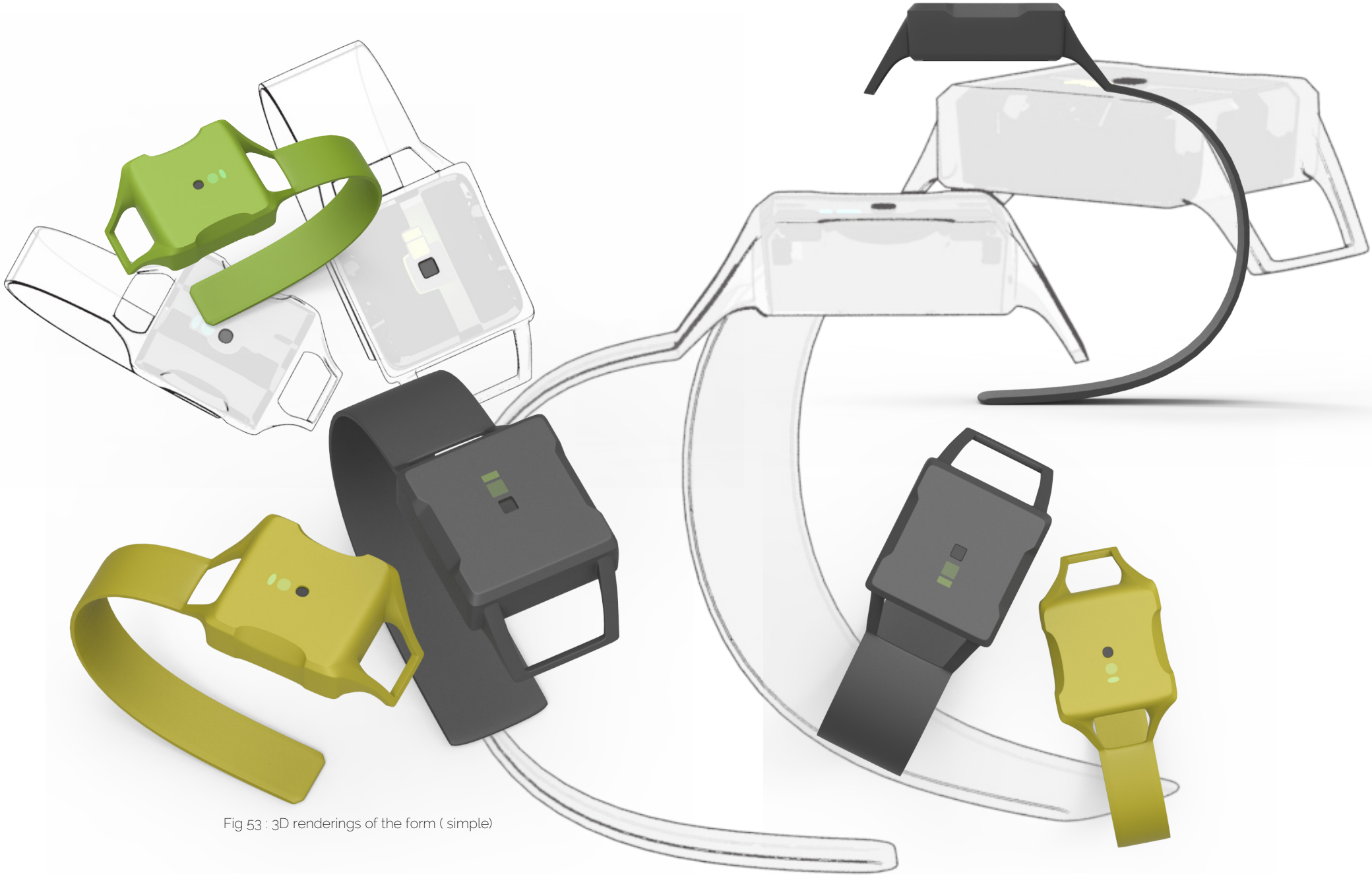


Fig 53 : 3D renderings of the form (simple)

USER FEEDBACKS ON THE FORM

The refined forms were then taken to the public to know their likes and feedbacks . For taking the feedbacks, the ideas were printed on A3 size sheets and taken to the IIT Gymkhana ground were people use to gather at evenings. It also helped in taking feedbacks from the students who have high physical activity levels. A total of 34 people were contacted and their likes have been shown in the left side .

Some of the feedbacks received were

Form 1 -

- Looks simple but trendy
- Will go with any dress
- The smooth finish is nice
- Looks nice and have a flow compared to other images.
- A Little bulky from sides

Form 2-

- Looks futuristic
- The circular line gives a feeling of eye
- The female form is not that good
- Looks very precise
- Too fancy

Total no of people asked: 34

LIKES

	Students (19 nos.)	Mid aged (15Nos)
	9	7
	7	2
	3	6

Fig 54 : figure showing the likes received from the users

Form 3-

- Looks very simple
- Very sharp and cubish
- The lights on it looks nice
- It suits me (feedback from a mid aged lady)
- it is very box type

Based on these likes and feedbacks from the users, the form with more likes were chosen forward as the final form for the product.

PRODUCT DETAILING

The Product detailing includes the ergonomic considerations and various joint details. The material selected for the product is Silicon, which can be injection moulded with 2 piece mould. The silicon is selected as the material considering many factors like its non conductivity, water resistant nature, sweat proof, flexibility, light weight etc.

For packaging the circuits, a separate plastic body is kept inside the mail silicon body, which will be injected moulded to have dedicated space for the circuit boards and the vibration motor. The screw holes are given to place the circuit boards firm in the base. Another small box it attached to the top part which will be containing the optical sensors to check the spo2. The top part has the slit for the Led and sensors of the spo2 checker. Which is covered with a glass plate glued on to the main body.

The base plate and the top part is designed to have grooves for snap-on joints for connecting both the pieces.

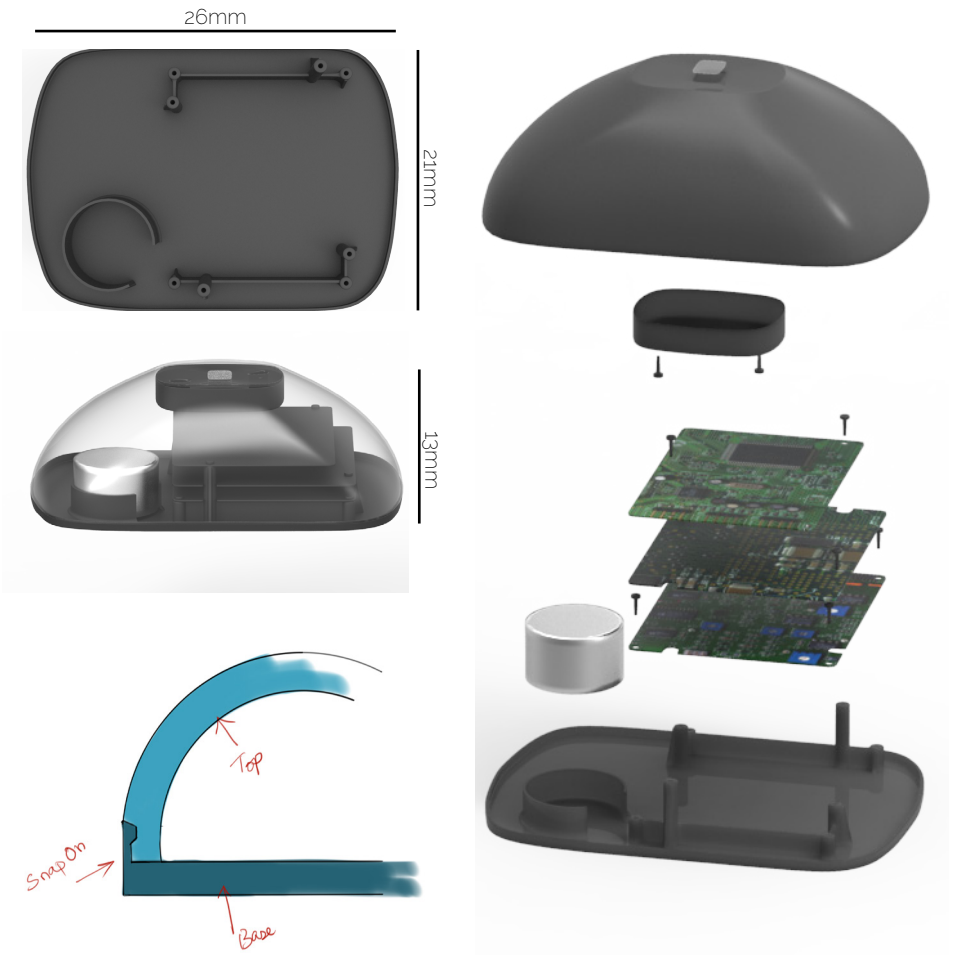


Fig 55 : figure showing the detailing for the packaging of the circuits.

Anthropometric data :

Wrist circumference:

	Male :	Female :
5th cm(inches)	16.2 (6.4)	13.7 (5.4)
50th cm(inches)	17.7 (7.0)	15.0 (5.9)
95th cm(inches)	19.3 (7.6)	16.2 (6.4)

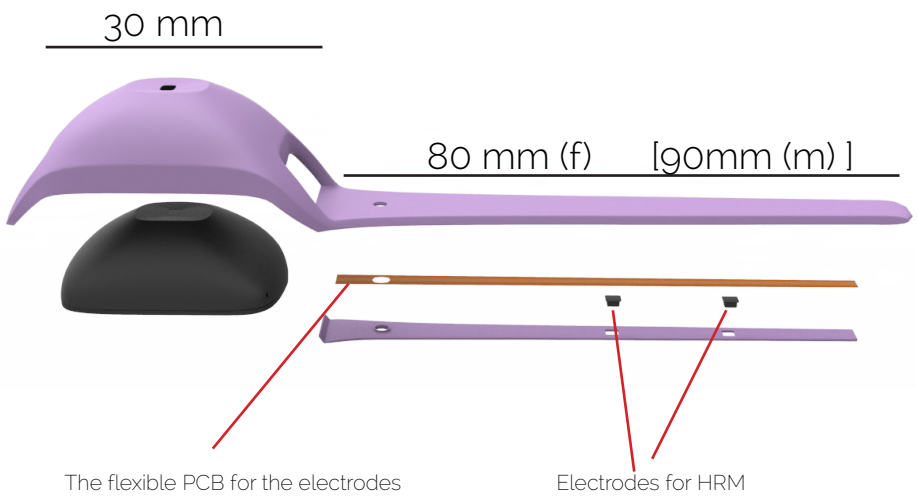


Fig 56 : figure showing the detailing of the strap with measurements.

The silicon strap detailing is done after taking in consideration of the anthropometric measurements of the wrist for both the male and female users. The strap is designed to be of 80 mm in length for the female users and 90 mm in length for the male users. The thickness of the strap also varies depending on the gender. The strap contains two parts which are glued together. Between the two parts the electrodes for the bio-impedance heart rate monitoring is fixed. The connections to the electrodes attained by keeping a flexible poly-amide PCB in between the straps. The pcb is sandwiched in between the top and bottom silicon parts with the help of silicon glue. Since the PCB is flexible, it will not affect the bending of the strap while wearing. The flexible PCB also doesn't require much space when compared to the normal pcb boards.

LIMITATIONS ON FINAL CONCEPT

The final concept is designed to come to market along with a silicon strap for people who doesn't wear watches. But the option is also given for attaching the device to the watch if the user is having a watch, But there are few limitations for this options provided by the concept. The device can be attached to only those watches which are having an open strap structure. The watches which have closed loop strap like the metal strap watches wont be able to use along with this concept. In such cases the user will have to rely on the strap provided along with the device.

The device is designed to be used on straps having a maximum strap width of 22mm in case of male users and 17mm in case of female users. Any fancy watches which has the strap width more than this couldn't be used for attaching the device.

Fig 57 : figure showing the limitations of the device.

REFINEMENT OF FINAL CONCEPT

The thought that the final concept is having a limitation that it cannot be used on both the leather and metal watches always stood as a pain in the heart. So it was decided to solve this issue by refining the final form for the concept.

Till now , through out the project, separate forms were given to both feminine product and male product. From here onwards the design direction was detoured into finding the balance between both the feminine and male character in the product, thereby creating a unisex form for both the user category. This further lead to more online research and study along with the study done for both male and female user forms. From this the design guide lines for creating unisex forms were ruled out and based on it, further concept form refinement was done to overcome the limitations faced by the previous concept.

REFINEMENT 1 - HINGED CLIP

Here the idea was to have a clip sort of device which can be fitted on to anything. The device has a top part which contains all circuits and the bottom part which contains the bio-impedence sensors. Both these parts are connected through a hinge which helps in clipping the device to the watch straps.

Though this idea overcomes the limitations of the previous concepts, it becomes difficult to attach this device on to the watch straps which is beyond a certain width as the space for the strap is fixed in this concept.

Further refinements was done on this concept to reach the final concept, which is shown in the coming pages.

Fig 58 : figure showing the new clip on device as a form refinement of the initial concept.

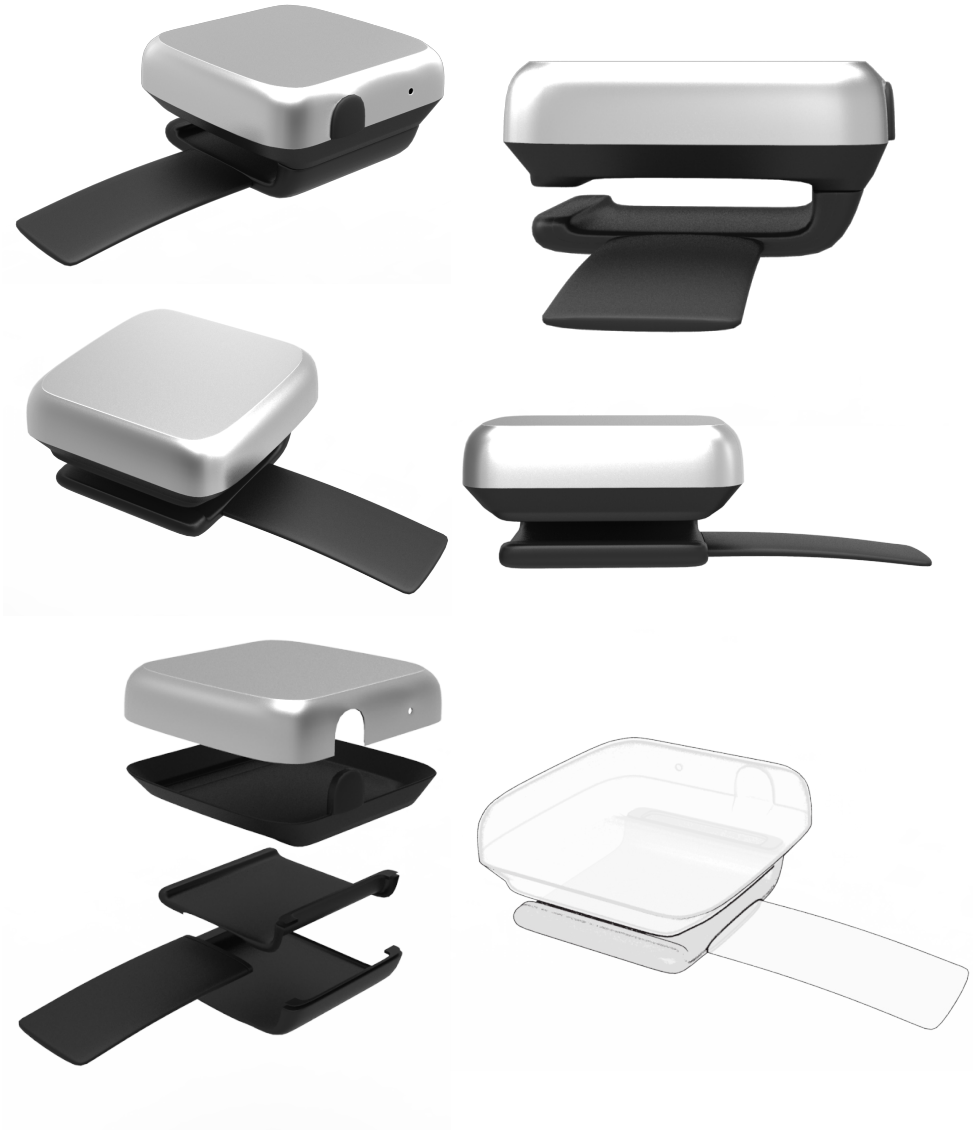
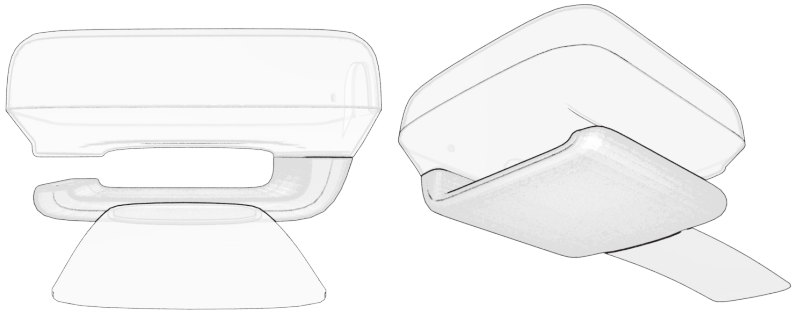


Fig 59 : figure showing the new clip on device as a form refinement of the initial clip form.

REFINEMENT 2 - U CLIP

The previous idea of having a hinged clip doesn't allow all the strap width to accommodate in the given space. To further overcome this limitation, the hinge was avoided and the device is thought of to be a U- Clip which can be slid in to the watch strap from one side. This approach made it possible for using this device on watches with straps of any size. It also became easier for the user to fit it on to the watch.

The device form is designed to be sleeker than the previous concept, which gives this idea a form factor which goes well with the contemporary lifestyle, which users follows. Inspirations were taken from the designs of the APPLE devices as they stand as a cult product among various users in the targeting group.



FINAL FORM EXPLORATION

The concept was finalised to be the U-clip device after discussion with the guide. The device has a top surface which looks very plane and character less, hence in-order to bring a character to the device, little bit of form exploration was done. Different play of lines ans patterns were tried on to the surface to give it the character of contemporariness, stylish, strong, simple, confident and smooth.

The images showing the form explorations are given below.

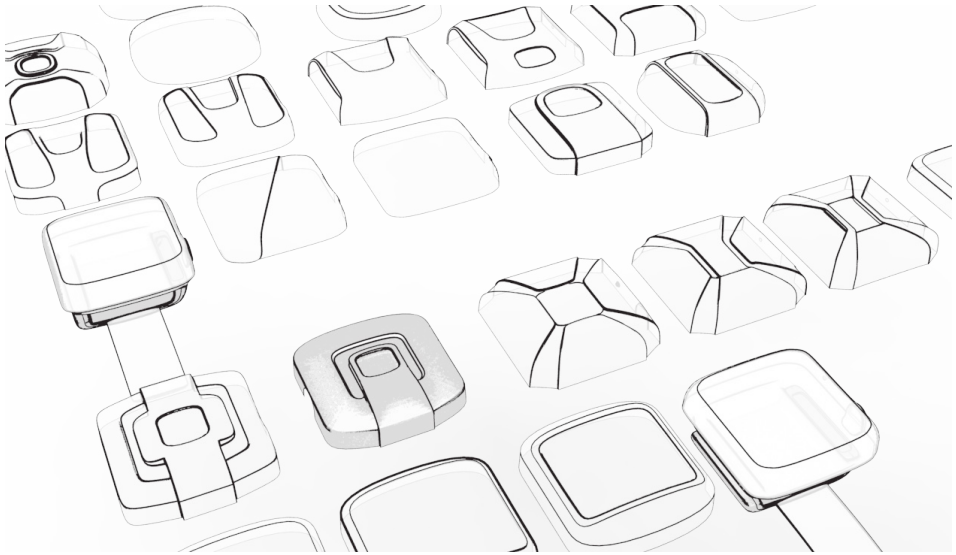


Fig 60 : figure showing the sketches made for form exploration

Fig 61 : figure showing the CAD models made for form exploration

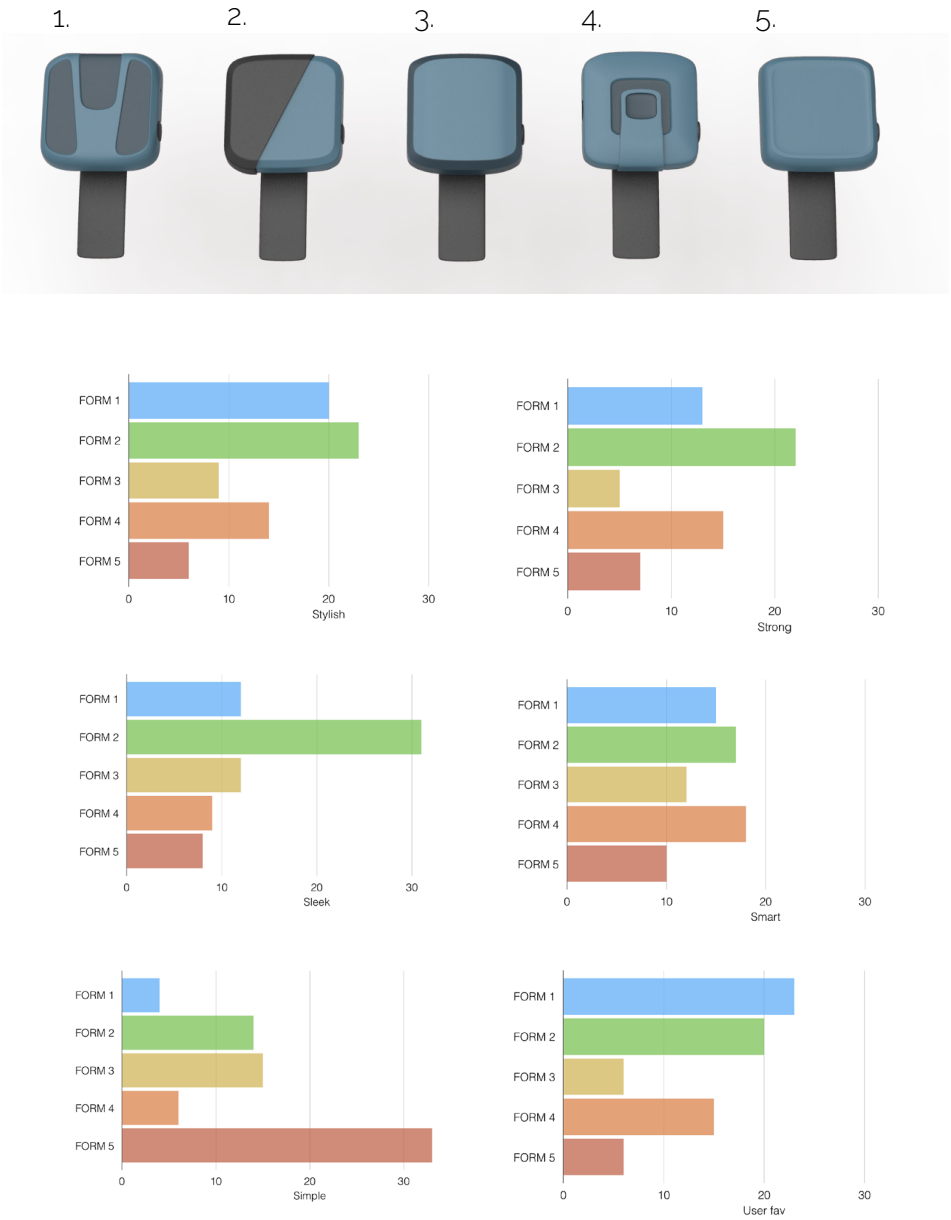


Fig 62 : figure showing the forms selected for evaluation and the resultant graphs from evaluating it among 70 users.

From the varieties of explorations done, five forms were selected for conducting the evaluation with the users. A form evaluation form was created online and share to public through internet. The selection was mainly based on the difference in the character the form has given to the surface. The selection criteria ranged from contemporary to simple form.

The forms were evaluated on various expressions like Stylish, Strong, Sleek , smart and simple. A response from around 70 people were recorded and the graph was generated for the results. The resultant graphs are shown in the life side of the page. When considering the results as whole and taking combined average, it could be seen that the form 2 was the most liked or accepted form among the five. Hence upon the users likes, the form2 was selected as the final concept.

ENGINEERING DRAWING

The device mainly consist of 3 parts, which is the top piece, the bottom piece and the clip for attaching it to the watches. The detailing of the various parts have been done with the help of CAD software "solidworks" and detailed engineering drawing was made. The detailing consists of various snap on joins which connects the top piece to the bottom one and screw holes which connects the clip to the bottom piece. The engineering drawing for the top piece is shown in Fig [63]. The wall thickness for the top piece is given to be 1mm . The engineering drawing for the bottom piece is given in Fig [64] and that of the clip is given in Fig [65].

The top piece

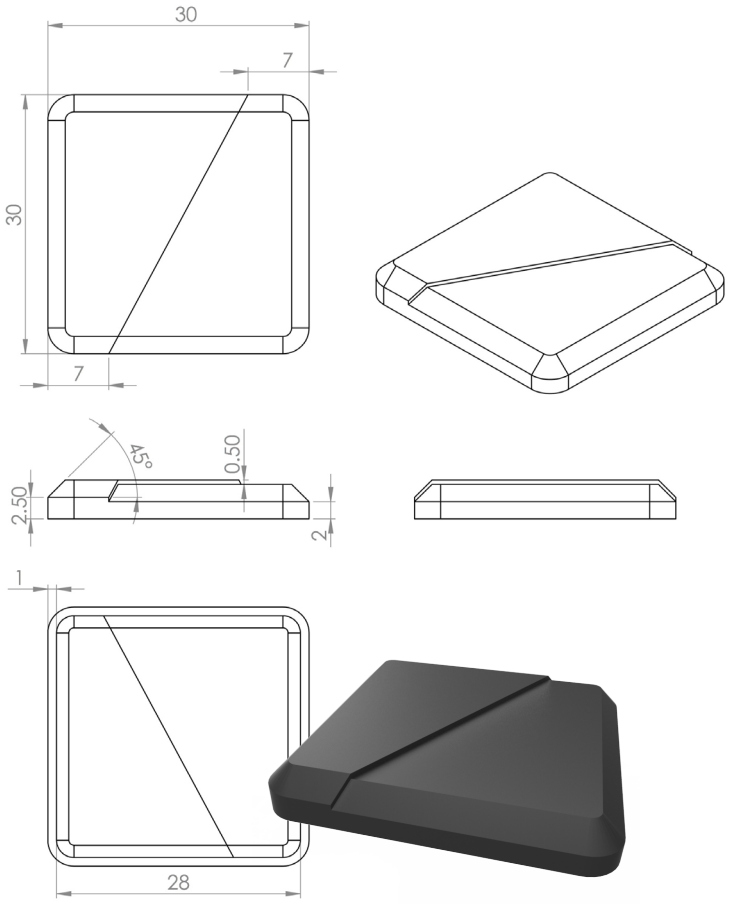


Fig 63 : Image showing the engineering drawing of the top piece. All measurements are in mr

The bottom piece

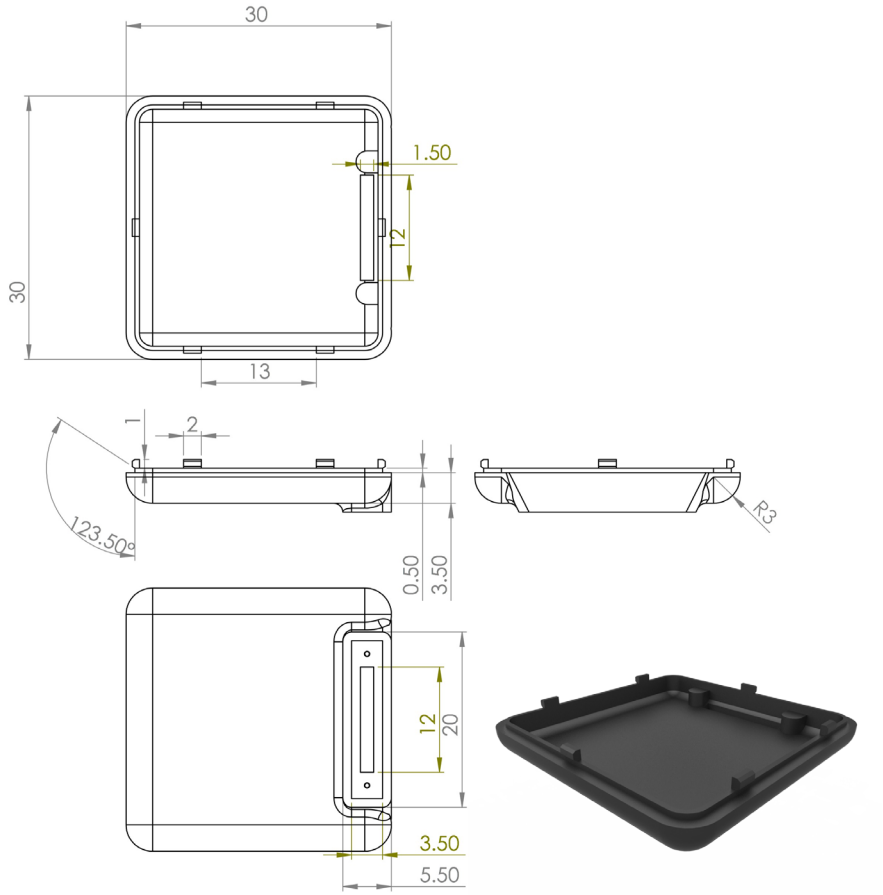


Fig 64 : Figure showing the engineering drawing of the bottom piece. All measurements are in mm.

The clip

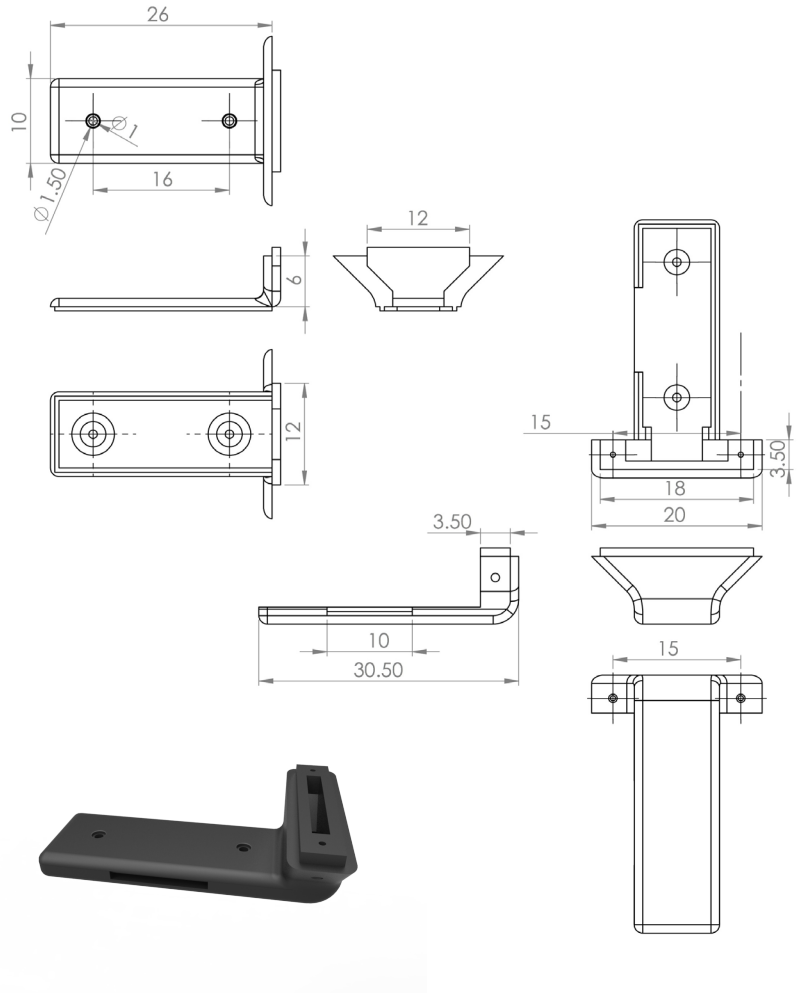


Fig 65 : Figure showing the engineering drawing of the clip, all measurements are in mm.

FOUR-PIECE DEVICE

Product Detailing

The final device is designed to be a four piece device which can be injection moulded with two-piece moulds. The design majorly consist of two kinds of joints, Snap on joints and joints with screw tightening. The main unit which accommodate all the electronic and embedded circuits consist of the top and bottom square pieces of size 30mmX30mm respectively. These two individual pieces are connected to each other with the help if Snap-on joint system. The bottom base pieces has the snap-on male plugs and the top pieces has the snap on female sockets.

The snap-on angles are given enough slop that the parts can be removed and fitted back whenever needed. This slop will also allow the mould to come out easily when manufacturing the parts.

The second main unit of the device is the clip, which on itself has two parts. For connecting these parts and the clip to the main unit, small 2mm screws has to be used. These screws are widely used in various wrist watches which are in the current market, so finding these screws in market would not be an issue.

Fig 66 : figure showing the exploded view of the device, consisting of four parts. and screw holes.

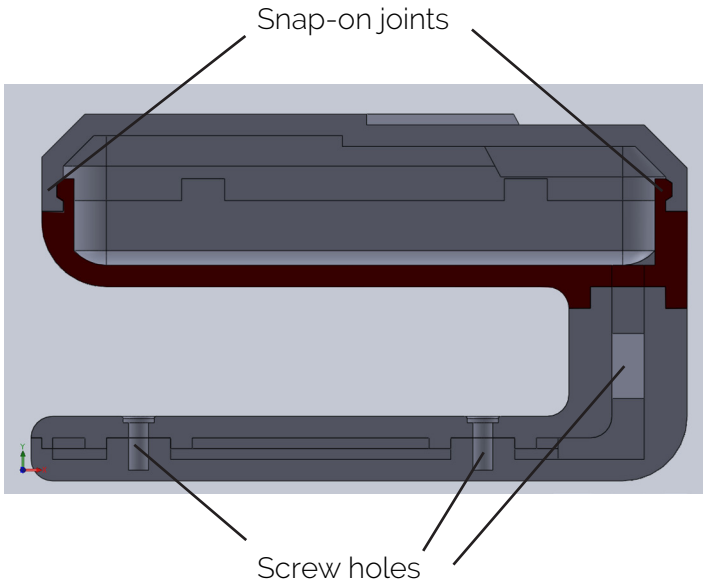
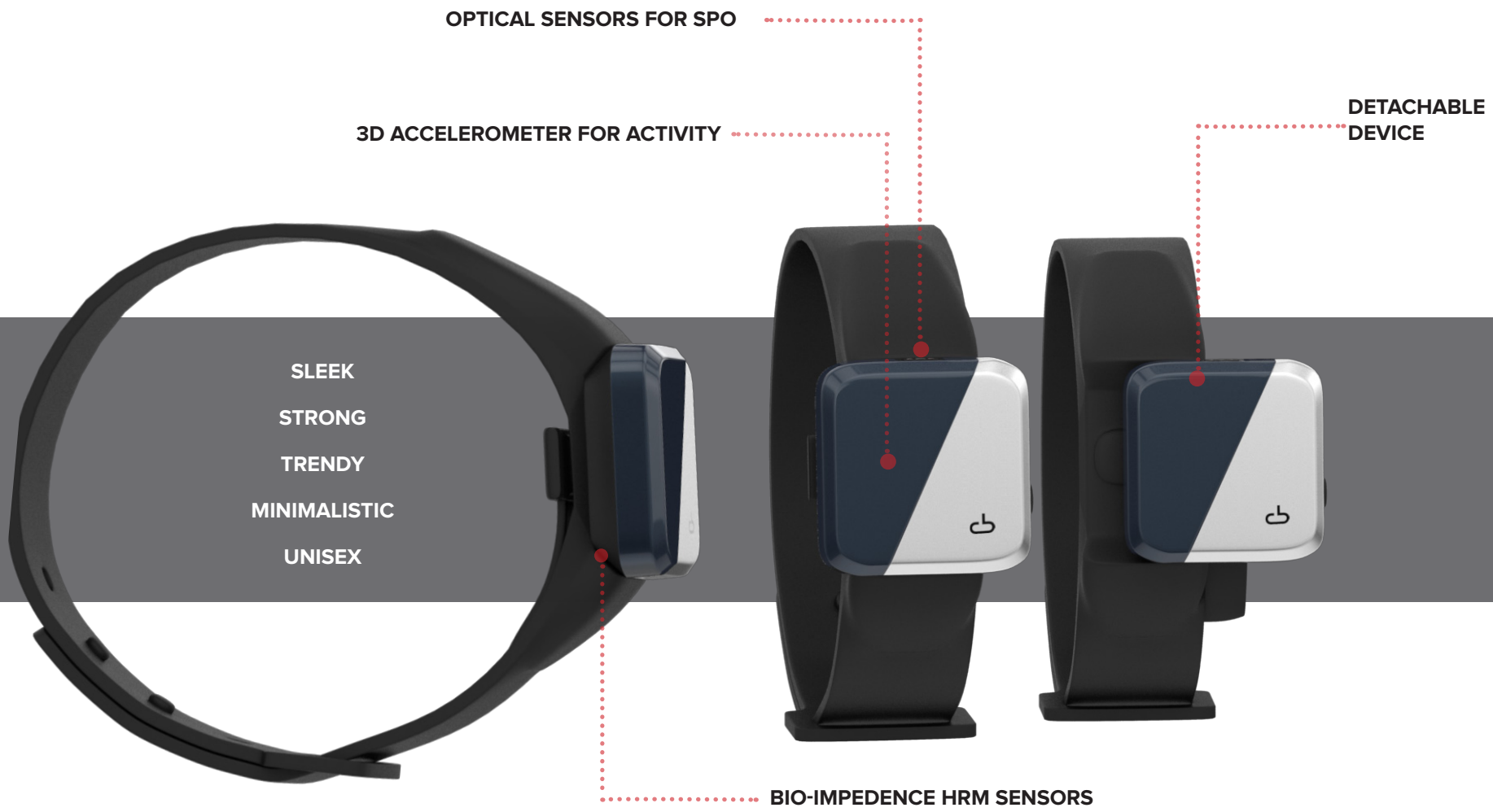


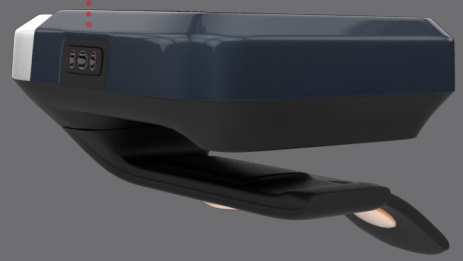
Fig 67 : figure showing the section of the deviceto illustrate the snap-on joints and the screw hole positions

The image on the left shows the section of the device, the Snap on joints are given separate colour for the identification purpose. The joints are made in such a manner that it will give protection towards the dust and water particle entering inside the device. The device is designed to be under the IP64. which gives solid protection towards the dust particles and water particles pumped at a distance from the device.

FINAL MODEL :

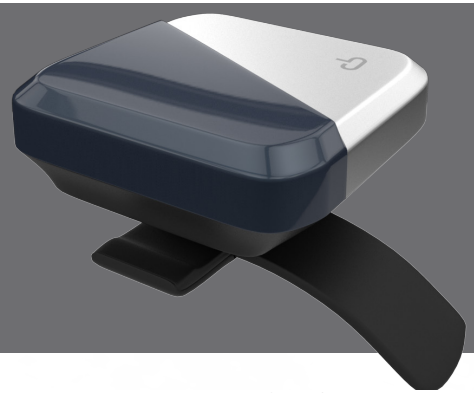

OPTICAL SENSORS FOR SPO
3D ACCELEROMETER FOR ACTIVITY
DETACHABLE DEVICE
SLEEK
STRONG
TRENDY
MINIMALISTIC
UNISEX
BIO-IMPEDENCE HRM SENSORS

SPO2 SENSORS



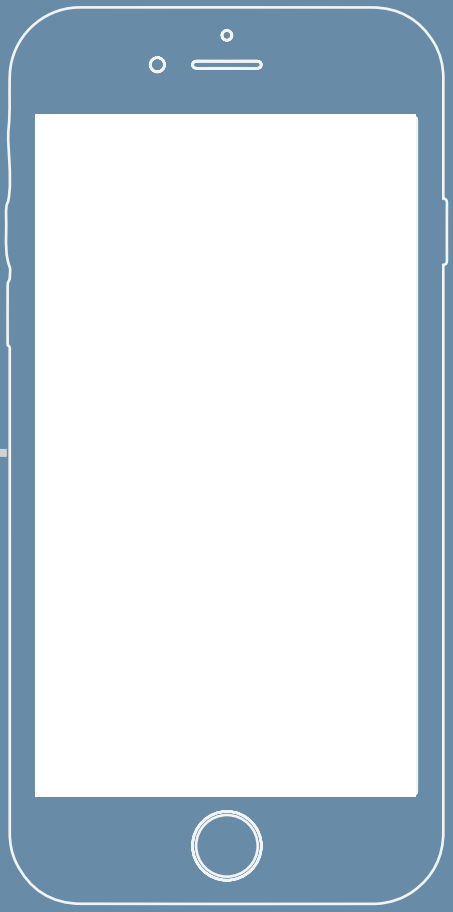
SIDE VIEW

FRONT VIEW



PERSPECTIVE

APP DESIGN



APP DESIGN

In the present lifestyle of people , the smart phones have become a normal device with majority possessing a smart-phone. In the metro cities the percentage of people having a smart-phone is somewhere close to 95%. Hence smart-phone is designed to be the platform for this device to work on. The smart phone acts as the main computer which helps the device to transfer the data's to the closed ones of the users.

For this purpose a dedicated application for the smart phone was designed. This project doesn't include in depth design of the app and user interaction with respect to the device. But just to give the look and feel of the app associated with the wearable device, a clickable prototype of the APP was designed.

Device : Iphone 6
Application mode :Portrait mode

Fig 68 : figure showing the mobile device for which the application is currently designed for.

Colour scheme used in app:

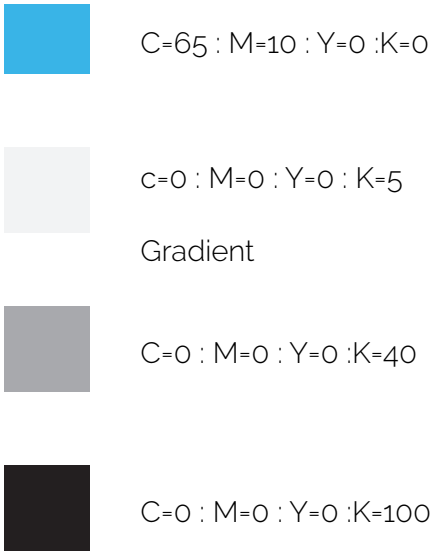


Fig 69 : figure showing the colour pallet used in application.

Visual design

The visual design for the app is designed on a very user centred approach, which makes the app user friendly and less confusing for the users to use it. A minimalistic approach is utilised for the app creation. The colours on the screen is kept light and lively for the users to have a soothing effect. The number of buttons in the app is also minimised to give the users only the required essential features making the app quite simple to use.

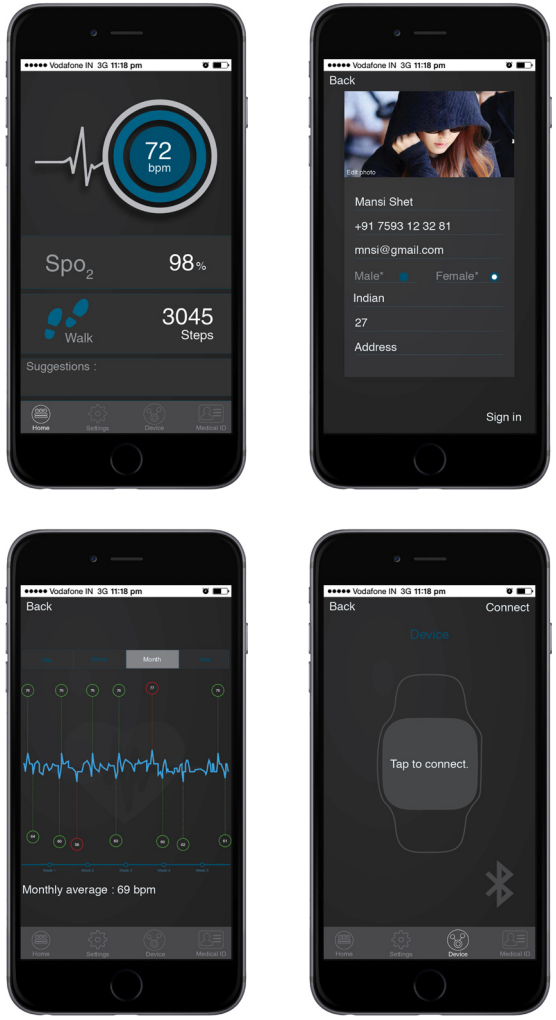
In this project, the app is designed for the ios Device particularly the iphone 6 (portrait mode, 750 x 1334)., because the device was readily available to make a click-able prototype. The click-able prototype was made with the help of software " Prototype on paper (https://popapp.in/) " and tested with few of the users around the campus for their feedbacks.

Three different iterations for the User interface was created considering the fact that the project is aiming at a large user category from early mid aged people to elderly. Hence various elderly vision related issues were taken in consideration while selecting the colour, font size and buttons of the application.

PTO

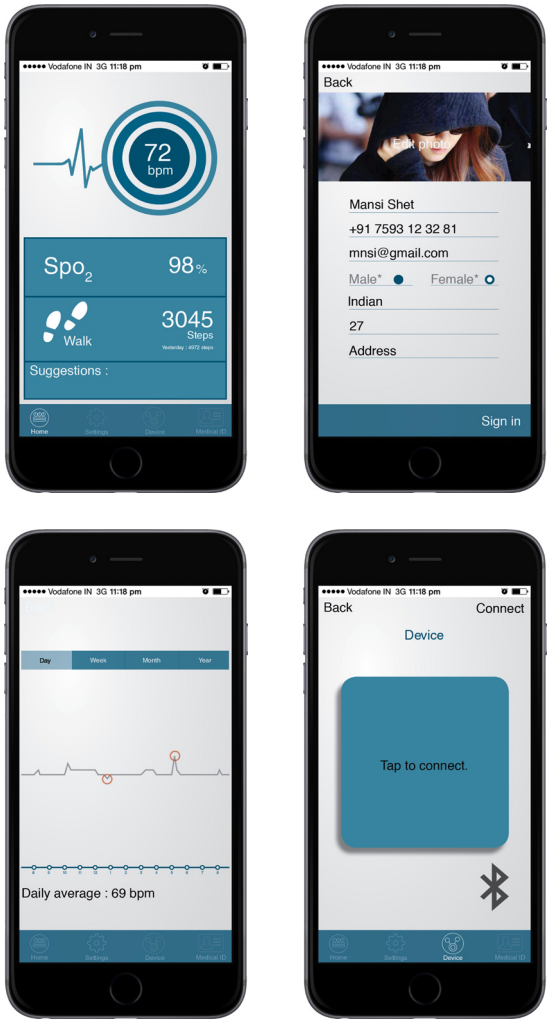
Iteration 1:

Here the idea was to have a minimalistic approach along with the usage of light colours so that the screen intensity wont hit the users eye with high effect. Basic forms are used for all buttons throughout the design.



Iteration 2:

The prominence was given to the relevant/important data's. The background and data's were given good contrast difference to make the data easily visible to the users. A contemporary design approach is used in creating these layouts.



Iteration 3:

The idea was to have the same colour scheme given to the device as the colour scheme for the app. The visual ergonomics is considered important in this approach too. This is moreover in the same line as the previous iteration, but with a different colour scheme.

The visual interface for the application is designed by taking in consideration of various vision related difficulties faced by the elderly people. As the age increases, it becomes difficult for the eye to differentiate between similar hues and contrasting colours. So the background and foreground were given enough difference in contrast so that the foreground/data can be easily identified by the users.

The font sizes were increased to make it quite readable for the elderly persons. Considering the fact that the app would be used by early mid-aged people too, a contemporary feel was maintained through out the user interface and user experience what the app delivers.

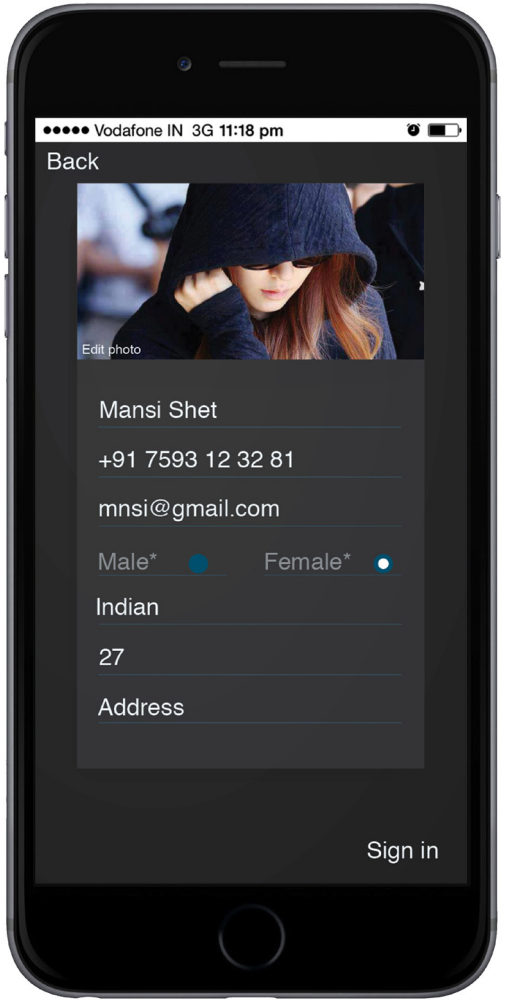
Throughout the application, special care was taken to make the user comfortable by removing all unwanted stuffs and delivering only what is relevant to the users. The number of buttons and actions were minimised to make the app more easy to use.

After creating the iterations, all the three variations were taken to the public specially elderly people to validate it for its readability and usability. Various good and bad feedbacks were obtained and the layouts were refined further to meet the requirements of the users.

1 The welcome screen will be the logo of the device which fades in and out in 2sec, followed by the user identification page.

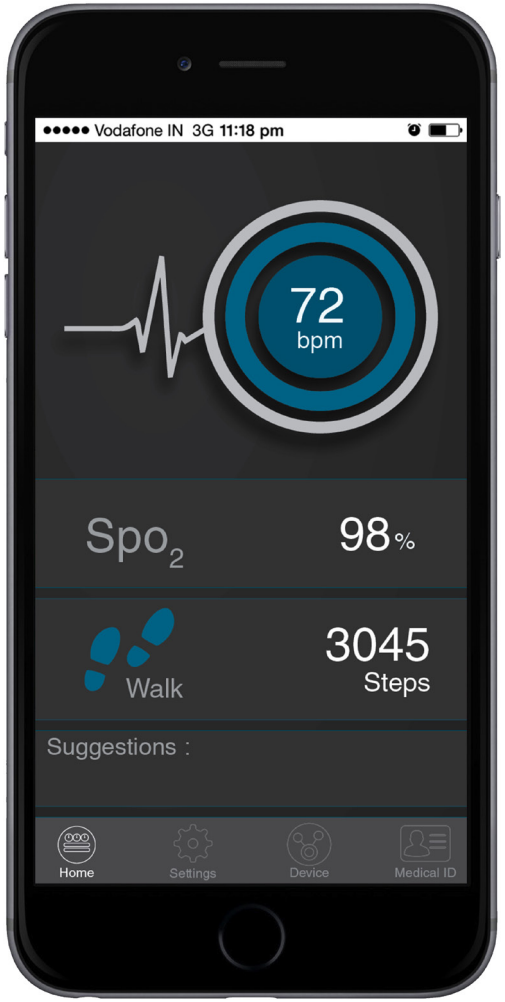
2 The user identification page having the phone and email tab for the user to input.

3 If the user is not registered prior, the sign up screen will come , were users can input all the profile datas.



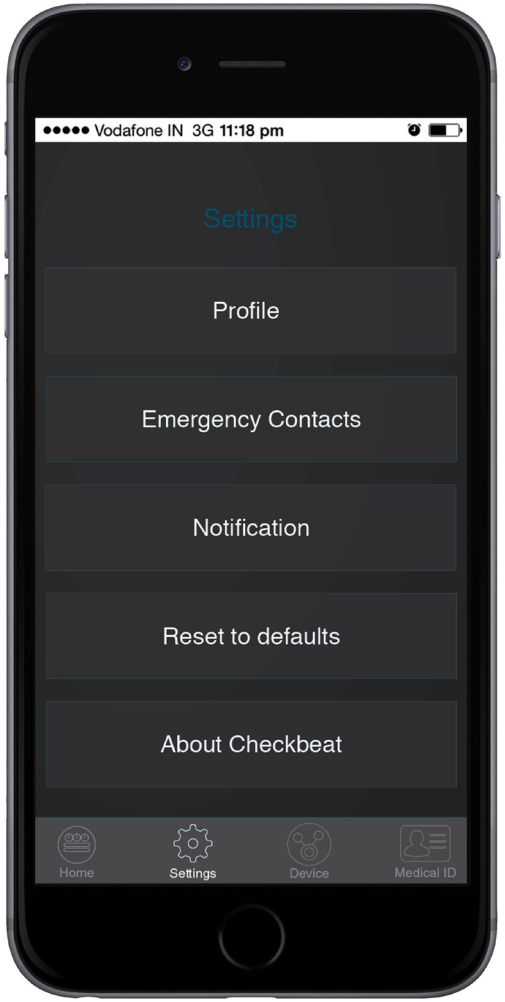
4

If the user is an already registered one, the app will identify the user from identification page and shows the sign in screen with all the profile datas in the page. Option is given to edit the data if the user wishes .



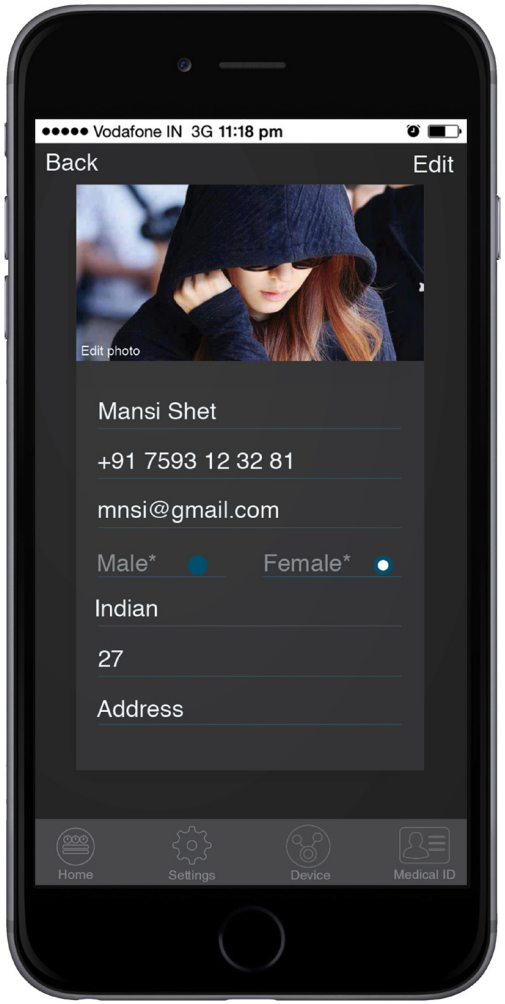
5

This will be the main dashboard of the app were all the monitored data will be shown. The green colour is given for the HRM to give more prominence, which will turn to red colour in risk cases. Rest of the tabs are maintained simple with the same family of colours.

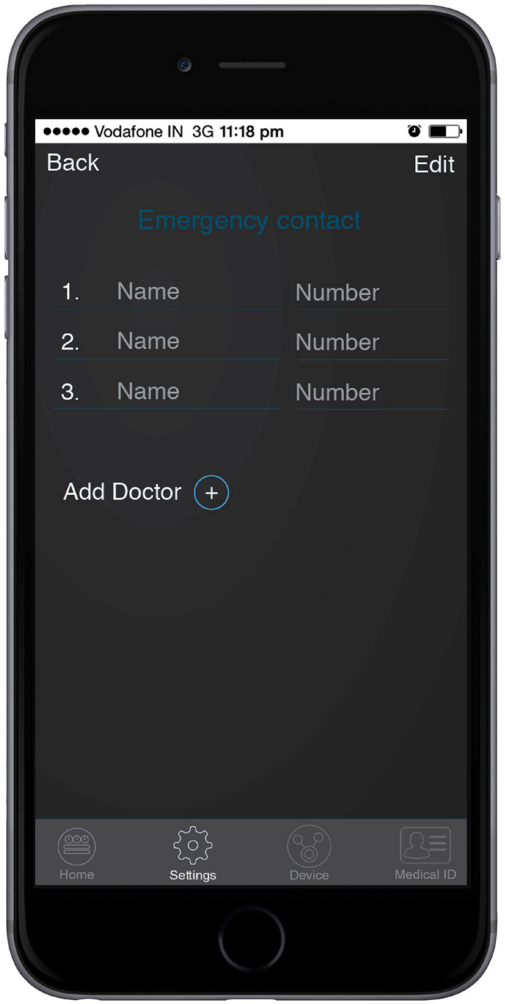


6

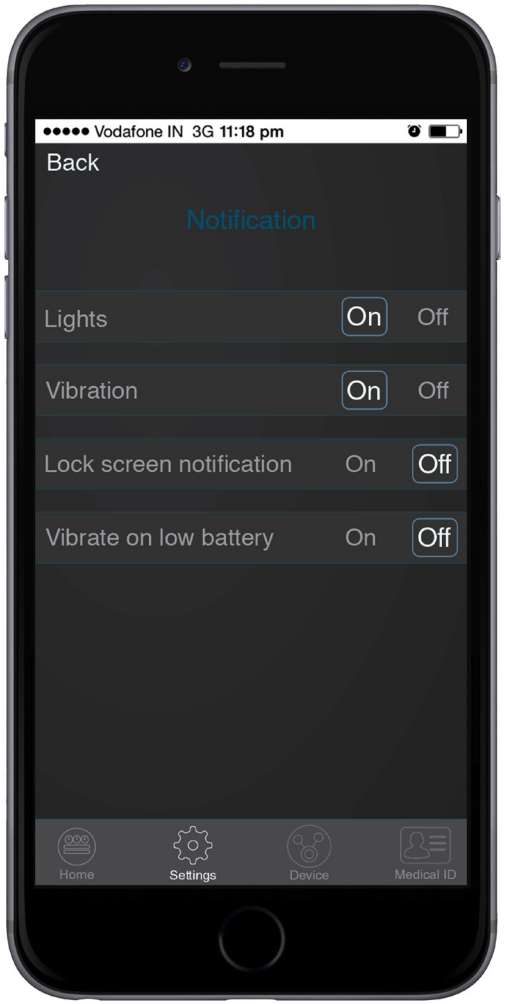
This page have the essential settings to be done according to user wish. Simple buttons gives the user the feeling that the app is simple to understand.



7 The user can save all the profile details here if he wants, which will be converted into the medical id card which can be shared to doctors registered to the app. The basic data's will be saved while the user signs up.



8 This page has the tabs to fill in 3 close friends or relatives numbers to be contacted in case of emergencies or risky fluctuations in the readings by the device. User can also add doctors numbers from the plus sign shown.

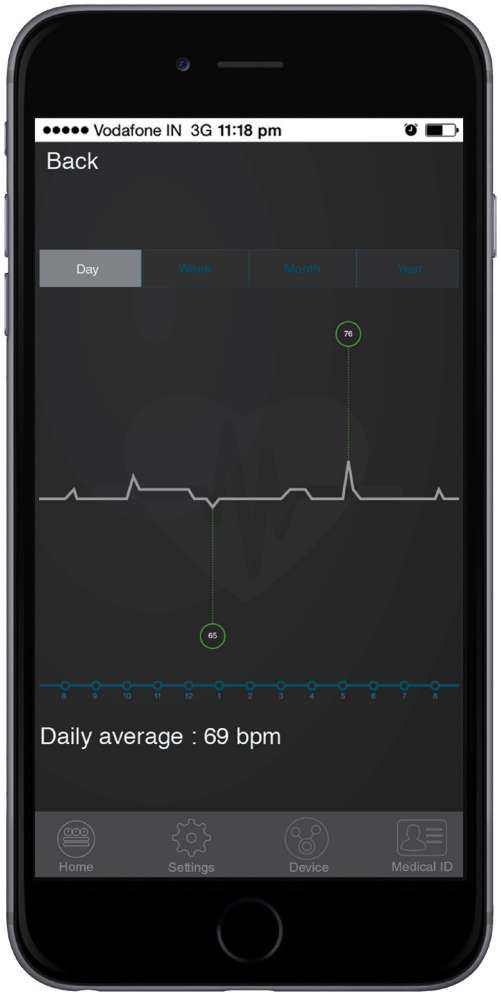


9 This the settings page for the notification and alerts the app and device is providing.

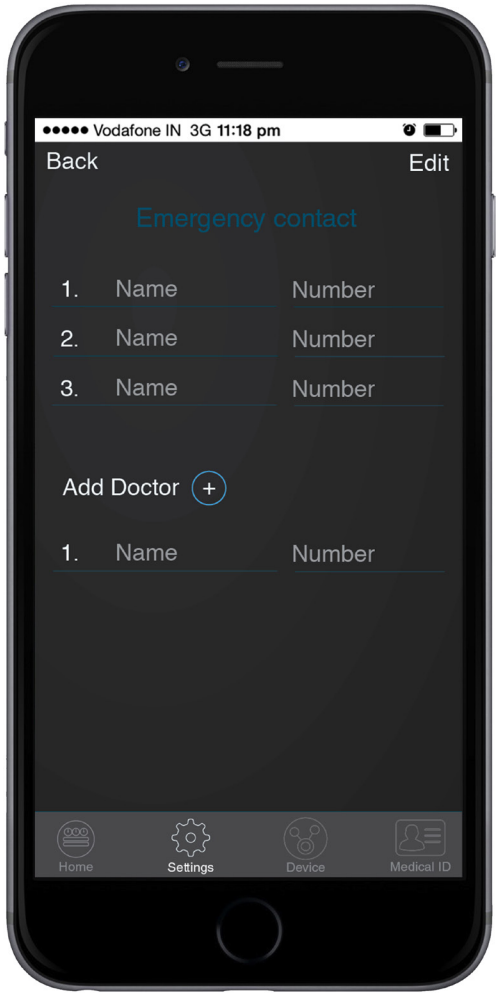
10 This is the medical id provided by the app. Once the user shares this medical id to the doctors registered in the app, they will be able to scan the bar code and get the monitored readings of the user in their screen.

11 This is the page in which the user will be able to connect and disconnect the device. Tap the circle in the centre of the screen to connect and disconnect. If connected, the circle will turn green. The blue-tooth symbol in the bottom turn grey if the blue-tooth connection is not on in the mobile.

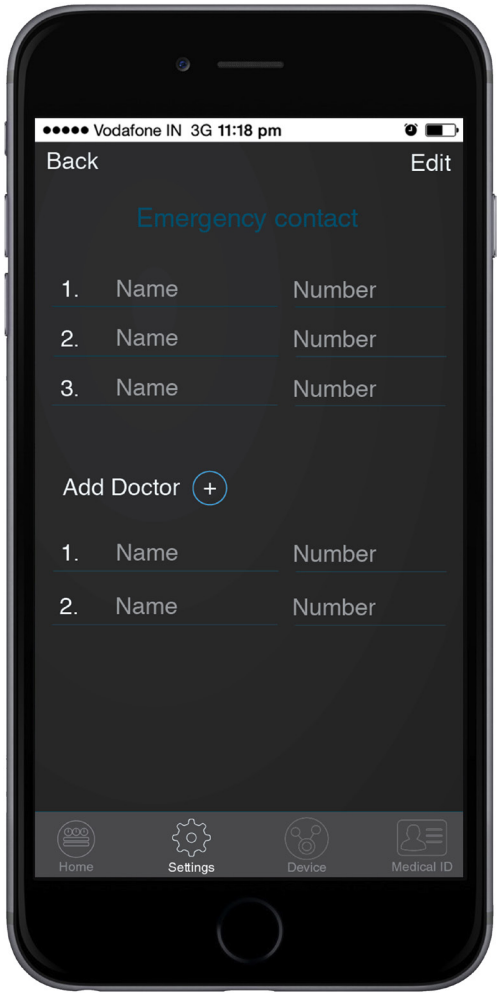
12 When no device is connected to the mobile, the circle will be blue in colour to be coherent with the app visual.. Once the user taps the circle, it will search for the device to connect.



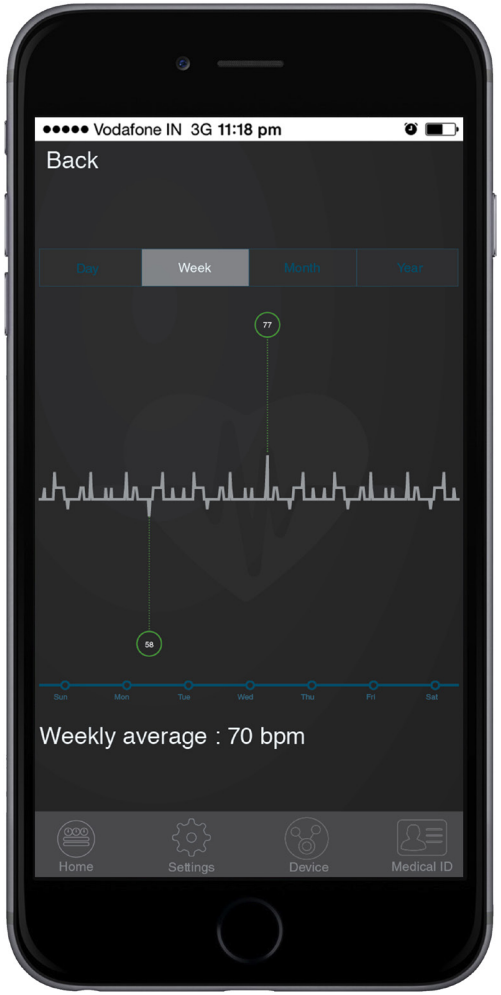
13 The pattern of the monitored data is represented in the form of waves which helps to find any sudden variation in the normal pattern and predict the risks. Similar graphs are available for both SPo2 and physical activity.



14 To add doctors number, click the Plus sign on the right side. The notification message will be send to the numbers saved in this page.

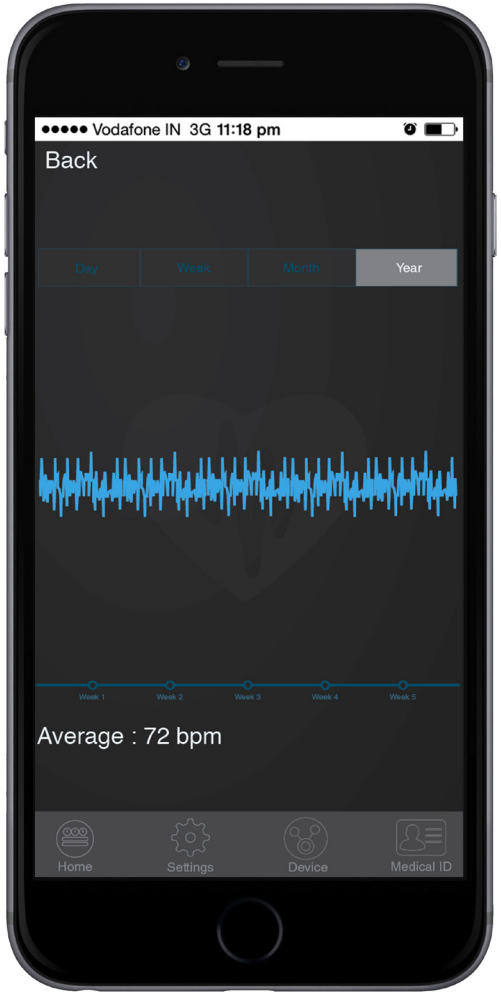


15 User can save a maximum of 2 numbers of the doctors. After that the plus sign becomes non click-able. Swipe left to delete any number and add new numbers.



16 The HRM pattern for the whole week. The highest and lowest heartbeat level for the week will be shown with the green pointers. The users can slide the waveform to go to the previous week waveforms.

17 The HRM pattern for one complete month. The peak values along with the risk values are shown in green and red pointers. The users can slide and view the previous waveform.



18 HRM pattern for one complete year.

BIBLIOGRAPHY

http://www.wearabledevices.com/

http://mashable.com/category/wearable-devices/

http://mashable.com/2013/06/18/future-navigation-touch/

http://www.wearabledevices.com/2013/12/10/wearable-medical-devices-market-is-expected-to-reach-usd-5-8-billion/

http://techcircle.vccircle.com/2014/09/03/ten-indian-startups-operating-in-the-smart-wearable-devices-iot-space/

http://www.usability.gov/how-to-and-tools/methods/personas.html

http://medsmagazine.com/2012/04/the-ever-changing-world-of-ecg-devices/

http://www.dailymail.co.uk/sciencetech/article-2562443/Has-wearable-computing-finally-got-fashionable-New-smart-specs-set-Google-Glass.html

Building Persona:

http://www.slideshare.net/ralph_poldervaart/how-to-build-a-persona

http://www.uxmatters.com/mt/archives/2010/10/using-personas-during-design-and-documentation.php

http://www.pensitdown.com/india-is-moving-towards-wearable-technology/

http://www.ux-lady.com/diy-user-personas/

Image References:

http://www.extremetech.com/extreme/169951-wristify-a-personal-peltier-wrist-cooler-that-could-save-the-us-millions-in-energy-costs

http://www.gsmarena.com/samsung_gear_s-6620.php

http://content.jawbone.com/static/www/pdf/manuals/up/up-by-jawbone-extended-manual-en.pdf

http://www.trustedreviews.com/nike-fuelband-se-review

https://www.netatmo.com/en-US/product/june#view3

http://www.omsignal.com/

http://www.digitaltrends.com/fitness-apparel-reviews/wearable-body-metrics-hexoskin-review/

http://www.lg.com/us/cell-phone-accessories/lg-FR74-heart-rate-monitor

http://www.mc10inc.com/consumer-products/sports/checklight/

https://learn.adafruit.com/reebok-checklight-teardown/inside-the-reebok-checklight

http://mashable.com/2013/09/08/run-n-read/

http://vandrico.com/device/moticon-opengo-science

https://www.indiegogo.com/projects/sensoria-smart-sock-fitness-tracker

http://www.theverge.com/products/orb/6476

http://www.mediaidinc.com/Products/S_unihingehand.jpg

https://energymicroblog.files.wordpress.com/2012/11/figure-1.png

http://find.galegroup.com/nrcx/Toolbox/1401879330_01166.jpg

http://find.galegroup.com/nrcx/Toolbox/1401879330-00050.htm

http://lifeinthefastlane.com/ecg-library/basicWs/

3Lead ECG :

http://gpads.tumblr.com/page/6

http://www.nottingham.ac.uk/nursing/practice/resources/cardiology/function/p_wave.php

Product Detailing

http://www.rutlandplastics.co.uk/advice/design_for_assembly_1.html

Bio impedence

http://field4.co.uk/physmes/project.htm

Gender tagged packaging

http://www.quicklabel.com/blog/2012/01/gender-targeted-packaging-9-packages-designed-to-appeal-to-men-or-women/