

MEDITATION ASSISTOR

Msc Product Design Engineering
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Background

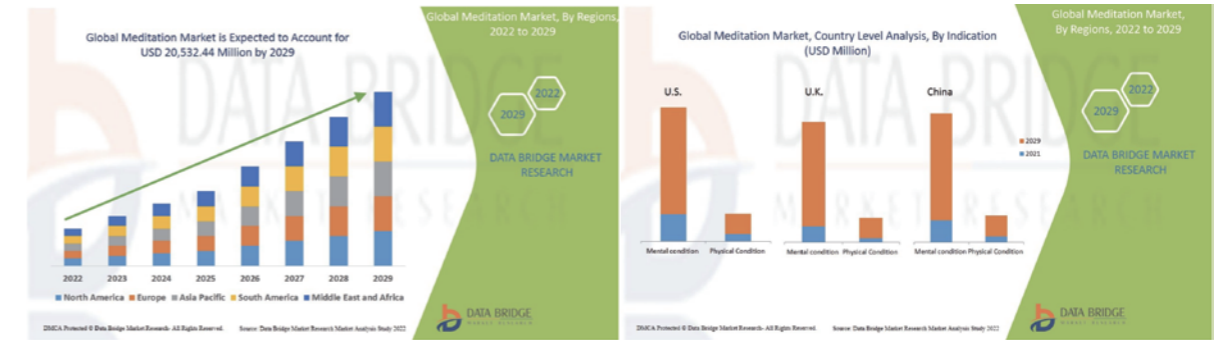


Meditation

Meditation is an ancient activity, it originated from religions. In modern society, it has gradually become a way for many people to exercise in their daily life, it is essentially a skill, a way of training our mind. It's a concentration training without any mental activity.

People can have a calmer, clearer mind, and a greater sense of eases in their mind and body. In medical study, It has been proven to shape the structure of the participants' brains which can reduce stress, frustration, depression, and also increase happiness after a long term of meditation.[1]

Global trend



Meditation practice has entered the lives of many people in recent years, and the global meditation market is growing with a CAGR of 18.5% in the forecast period of 2022 to 2029 and is expected to reach USD 20,532.44 million by 2029 from USD 5,295.07 million in 2022. [2] Especially after the epidemic era, more and more people began to focus and participate in activities beneficial to mental health.

Problem

Previous



How to meditate for beginners?

The initial focus was on the problems that inexperienced beginners might encounter when they start to learn how to meditate.



Potential problem ?



For example, how to control time and use the right posture, how to focus without distractions, how to keep practicing? These problems can be a barrier to effective meditation for beginners.

Interview

' I use apps to listen to pure music and adjust my breathing to help me concentrate effectively'

' I usually use an app or watch videos on websites to learn how to meditate.'

' I tried meditation once because I was interested in it, but after three days I felt it didn't work so I didn't continue.'

' Sometimes I do it every day, but sometimes I only do it every two or three days because I'm busy with work.'

' I've been meditating for five years, because I feel so effective that I fall asleep quickly and have a regular sleep schedule'

' Sometimes when I go out to play or travel and not at home, I find it inconvenient to meditate'

Redefine

Through interviews with six experienced users and relevant research. For the inexperienced beginners, the major obstacles are keep practice and stay focused into a meditative state in the beginning. How do they maintain continuity and achieve regular and effective practice after they start to try meditation practice and that's the real challenge they face.

Lack motivation

'Can not feel the feedback, can not feel the benefit, feel like wasting time'

Lack concentration

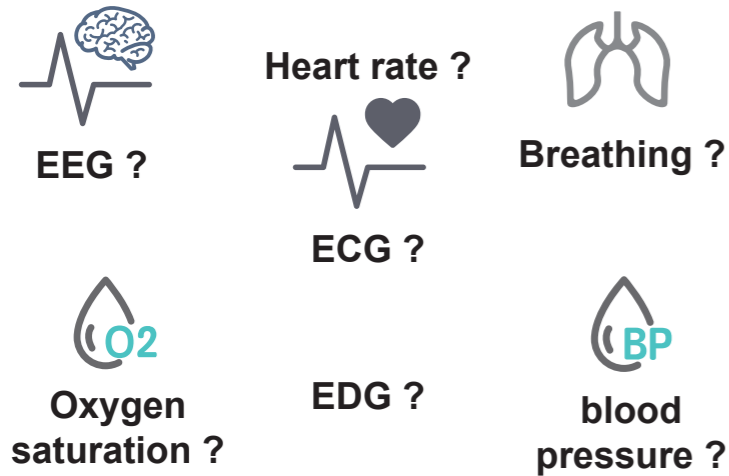
Lack of experience makes it difficult to stay focused and meditative

Space restrict

'The space of routine life is broken, such as at a friend's house, hotel on a trip.'

Opportunities | What If

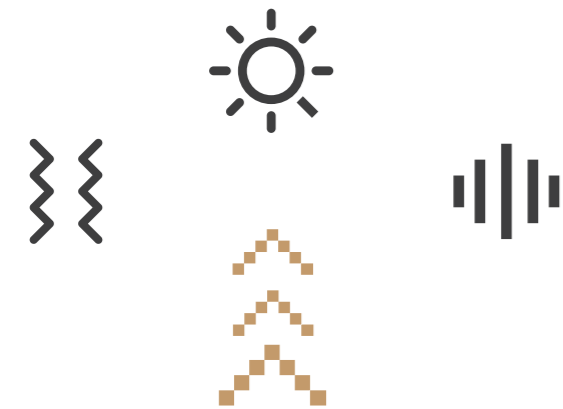
What If users could receive positive feedback and become more motivated



Monitor the changes in biological indicators during meditation and demonstrate the benefits of meditation practice through biofeedback.

Users can experience positive feedback from measured biometrics, which creates motivation to keep practicing

What If users has access to assistance to enter an effective meditative state



Increased attention through external factors, such as sound, specific frequencies, vibrations, light, etc., can help the user better maintain focus and lead the user into a meditative state.

What If users could meditate in different places



Create a shared meditation room in a public space that allows users to use it outside of their regular space.

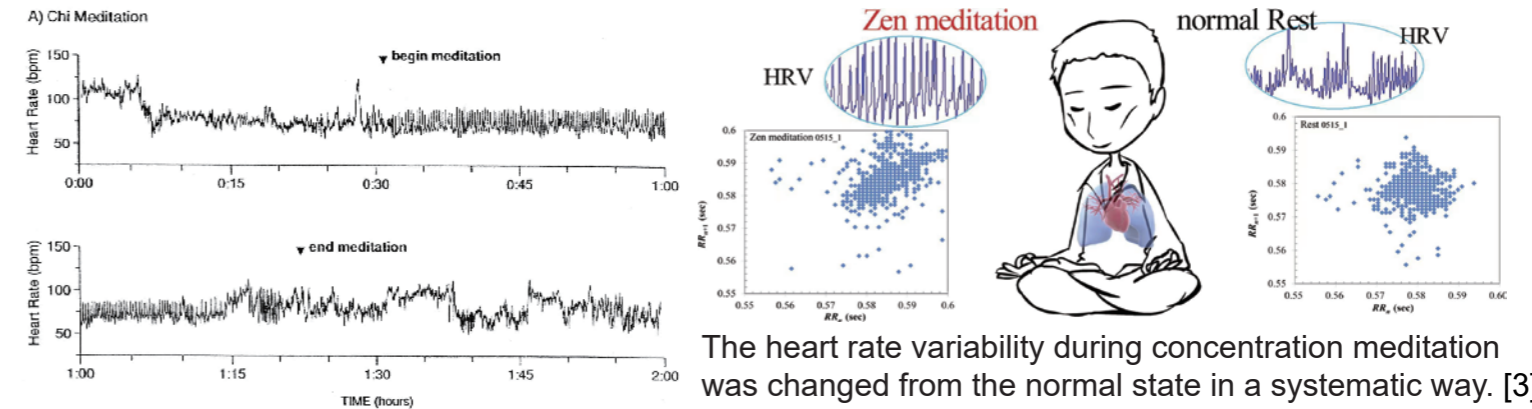


Portable devices allow users to create conditions conducive to meditation in different environments, not confined to their own homes or a fixed place.

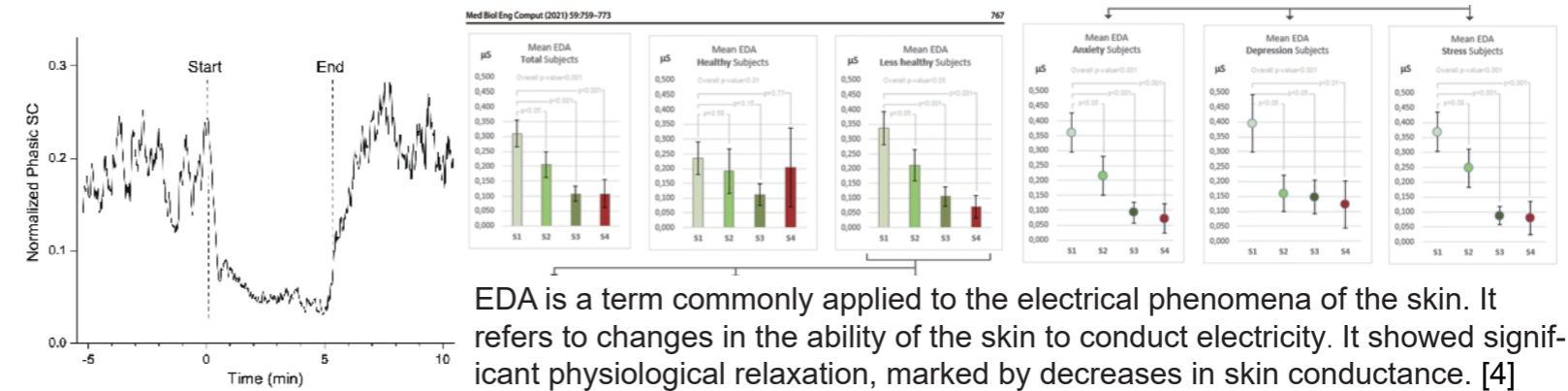
Research | Biofeedback generated by meditation

HRV(Heart Rate Variability) is a psychophysiological marker of progress in meditation.

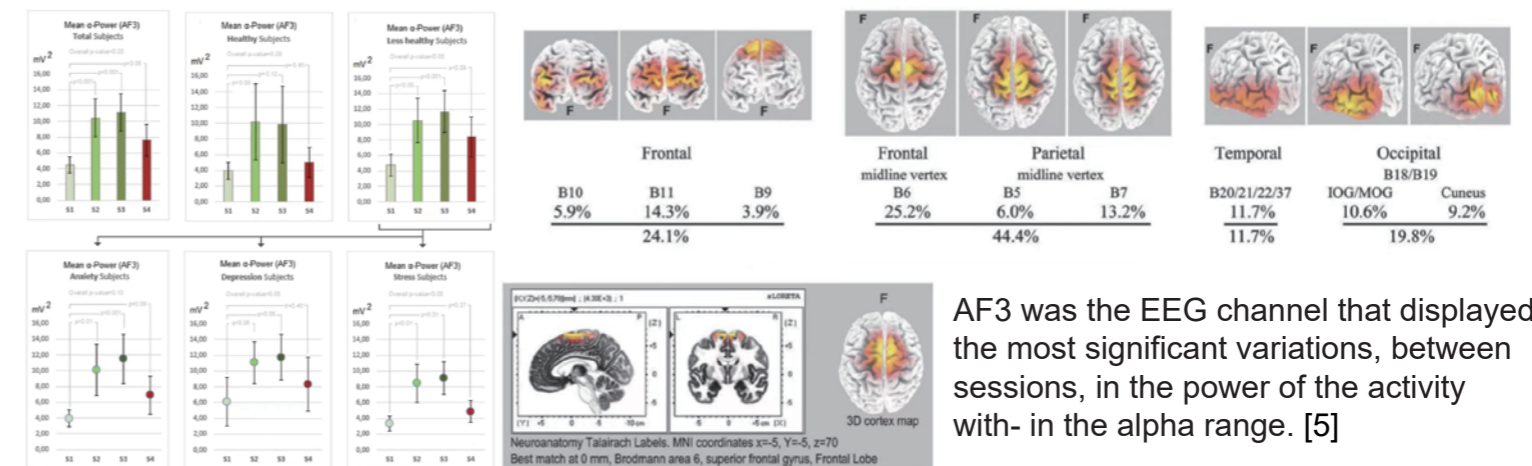
Meditation techniques activate the calming parasympathetic nervous system, there will be an increase in HRV



EDA(Electrodermal Activity) is a significant indicator of emotional state in meditation



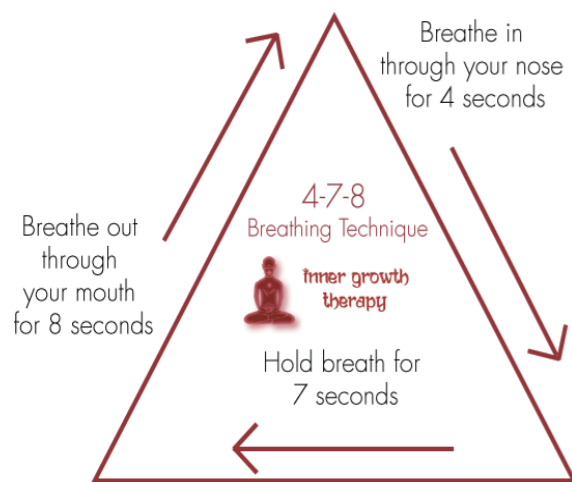
EEG(electroencephalography) is the embodiment of neural activity in meditation



Research | Ways to help meditation

4-7-8 Breathing Technique

The 4-7-8 breathing method is a technique for breathing according to a specific rhythm. Developed by Dr. Andrew Weil, founder of the Arizona Center for Integrative Medicine.



The technique is performed by breathing in through the nose for four seconds, holding the breath for seven seconds, and then exhaling through the mouth for eight seconds. (Timothy J. Legg, PhD, PsyD 2018) This breathing pattern helps the practitioner to remain calm and focused by directing regular breathing. (Arlin Cuncic 2021) Therefore, this way of breathing helps to enter a meditative state during the meditation process. [6]

Initial Concept

Concept 1



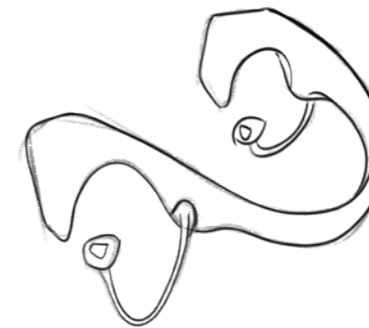
EEG

The brain's alpha waves are measured



BINAURAL BEATS:

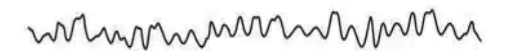
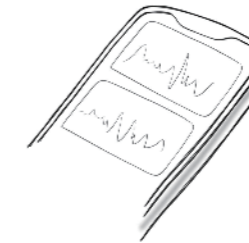
Use binaural beats from headphones to guide alpha waves in user's brain to help you enter a meditative state



Headphones



Receive feedback



Users view the biometric data on their phones to see how well they meditate

Concept 2



Simulates changes in the chest cavity during breathing, guiding the user's breathing rhythm and making them more focused

Expand



Inhale

Shrink



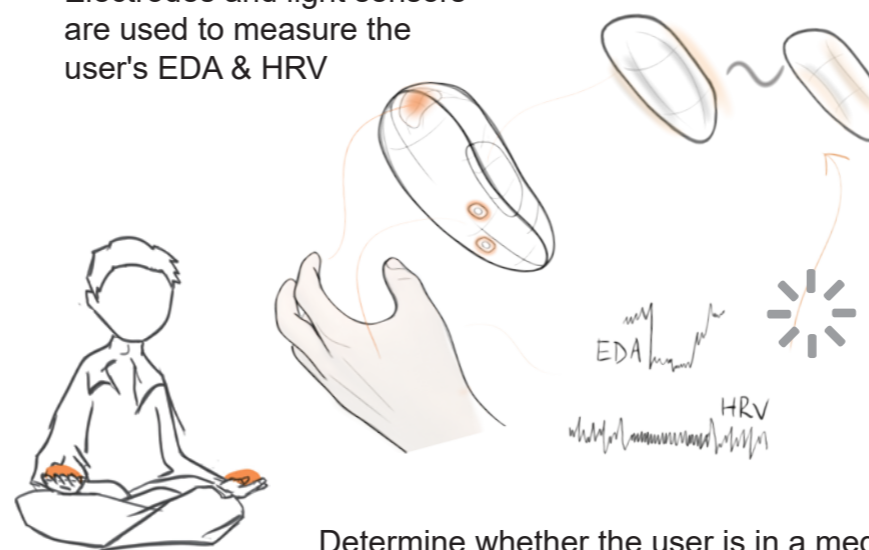
Hold



Exhale

Users hold the product in their hands while meditating, and the product guides users to adjust their breathing with the rhythm through rhythmic expansion and contraction combined with vibration, so that users can effectively enter the meditative state by focusing their attention on the rhythmic breathing through the product in their hands.

Electrodes and light sensors are used to measure the user's EDA & HRV

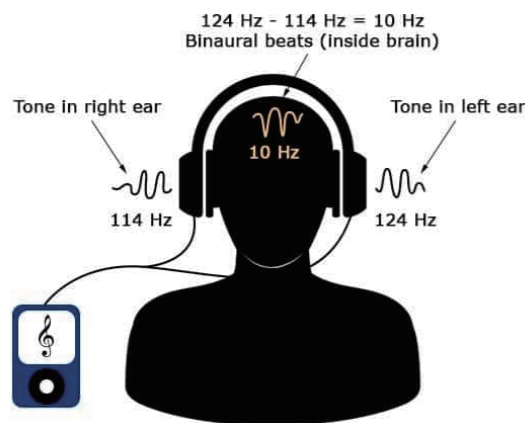


Users can check their biological data to know how long they really reach the effective meditation state during the entire exercise. Meanwhile, the data of each time is recorded, so that users can know their meditation effect in a period

When the user is detected to be gradually out of the meditation state, the interaction with the user will be restarted, and the user will be guided to consciously adjust breathing through regular expansion and vibration to help the user to re-enter the meditation state.

Determine whether the user is in a meditative state based on the measured biometric data.

BINAURAL BEATS

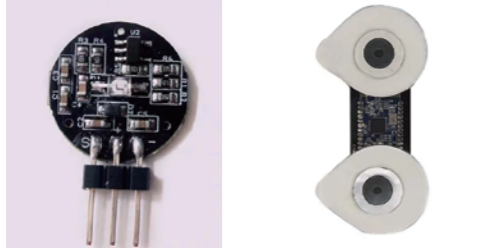
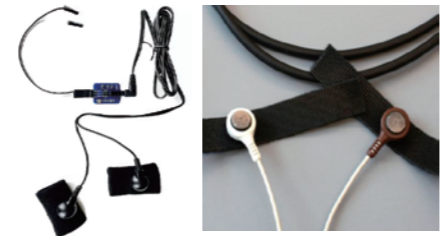



When two tones slightly dissimilar in frequency are processed by the brain, it registers a beat at the difference of the frequencies. If people listen to a 124 Hz sound in the left ear, and a 114 Hz sound in the right, our brains entrain to the difference — in this case, to 10 Hz, which is in the alpha brainwave frequency range.

Alpha waves are associated with relaxed wakefulness and can occur during light meditation. Many brainwave meditations seek to induce this state since the alpha state is thought to facilitate a bridge between conscious thought and the unconscious mind.

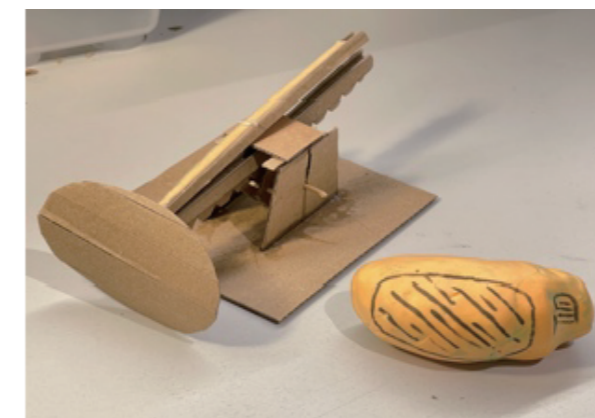
Evaluation and Test

In view of the three biological responses in meditation discussed above, the currently available detection technologies are evaluated and compared, including the cost of detection components, methods, and related products on the market.


	Heart Rate Variability	Electrodermal Activity	Electroencephalography
Technology Measuring Devices	 Photoelectric pulse wave sensor Electrical heart sensor	 Galvanic Skin Response	 Brain potential electrode
Measurement site	Palms, wrist, fingers, and chest	Palms, soles, fingers, and shoulders	Head
Costing range	5~200 £	20~110 £	40~300 £




By using the model to test the posture of the hand when holding, the mechanical structure was made to simulate the expansion and expansion function of the product. After testing, it was found that the design of the user's grip the device in their hand was sometimes unnecessary because it might conflict with other inclined meditation gestures.




The expansion mode simulated by mechanical structure can not produce relatively ideal expansion effect. In addition, due to the size of the product, the internal space limits the mechanical structure to achieve expansion.




Flowtime: Biosensing Meditation Headband with...
£188.00
Amazon.co.uk




MindPlace Kasina DeepVision Bundle
£520.00
NineLife UK




Muse 2: the Brain-Sensing Headband
£308.00
Amazon.co.uk




MindPlace Kasina DeepVision Bundle Meditation Aid Audio Visuals...
£450.00
www.ebay.co.uk
★★★★★ (8)



Mindplace Kasina DeepVision Bundle - Light & Sound Meditation Aid...
£360.00
Amazon.co.uk



Emotiv Insight Headset 2.0 - 5 Channel EEG Brainwear...
£599.00
www.ebay.co.uk



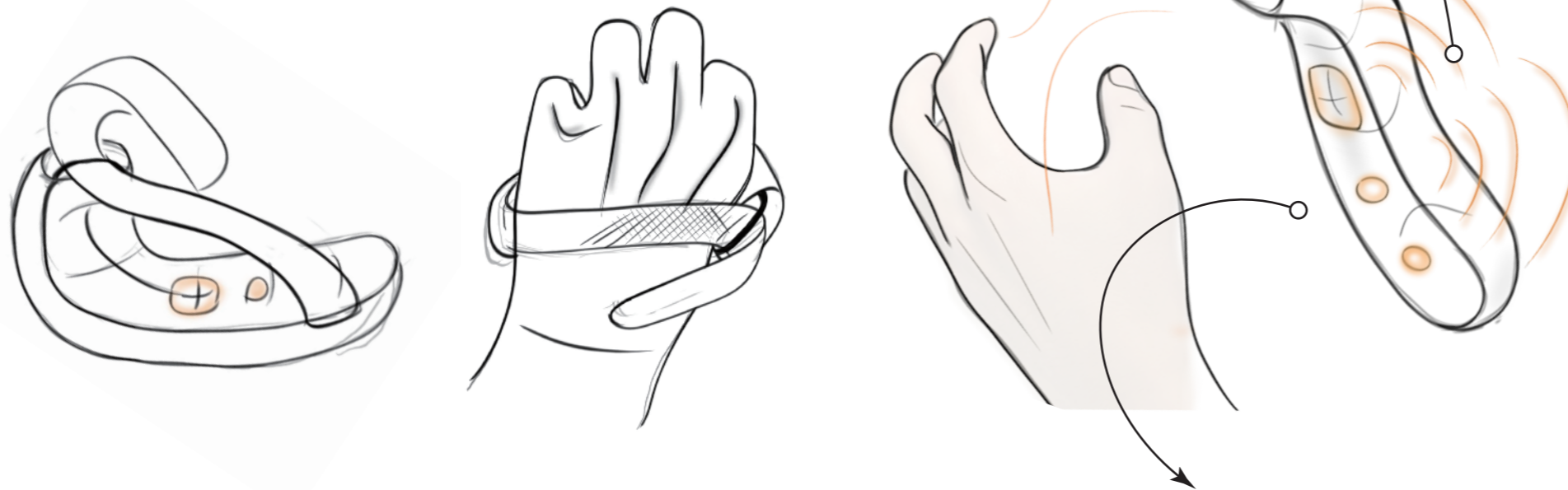
FocusCalm EEG Headband. Focuscalm. Other Health & Beauty.
£145.00
www.ebay.co.uk

There are many kinds of meditation-related products based on brainwave technology in the market. Their prices are all over £200, and most of them are between £300 and £500. In conclusion, users need high-cost meditation-related products using brainwave technology, which is not cost-effective for beginners. Heart rate variability and electrodermal response techniques are generally advantageous because of their low cost and a relatively large number of measurement locations in the body.

Final Concept

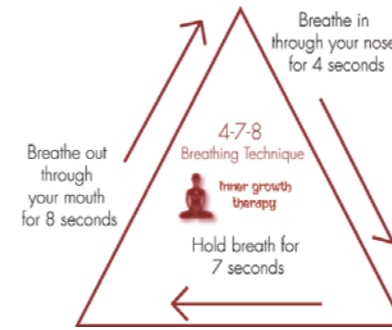


In final concept, the form of the product was reshaped. The product can fit between the palm of the hand and the thumb and index finger by a curvature, instead of requiring the user to hold it with all fingers.



The back of the product is combined with an adjustable elastic band, which helps the user to keep the product in the palm of the hand and collect biological data during use.

Electrodes and light sensors are used to measure the user's Electrodermal activity and Heart rate variability



Vibrations of different rhythms guide the user to exhale and inhale, and the user adjusts the breath to stay focused into a meditative state

↑ If the user is detected not in a meditative state

The product uses vibration instead of expanding to respond to the detected meditative state of the user and to guide breathing.

↓ If the user is detected to have entered a meditative state

The vibration mode that guides the breathing is converted to a regular vibration that mimics the rhythm of the heart beat, and the user can sense that they have entered an effective meditative state.

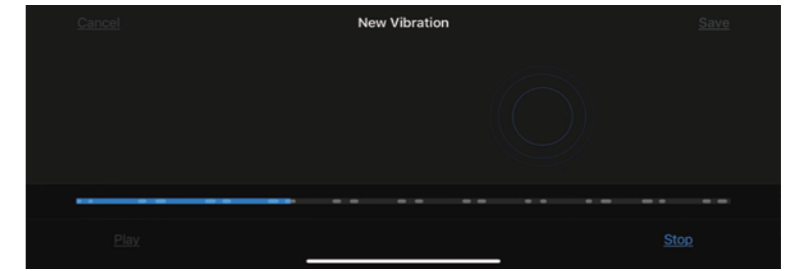
Bluetooth connection

Users can check their biological data to know how long they really reach the effective meditation state during the entire exercise. Meanwhile, the data of each time is recorded, so that users can know their meditation effect in a period

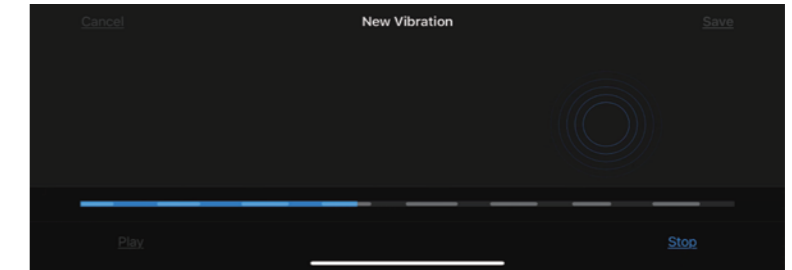
Prototyping and Testing



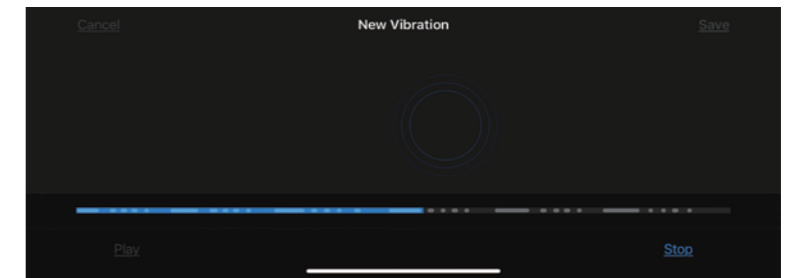
Use the mobile phone to record different vibration types to simulate the vibration mode of the product and feedback



A brief double vibration mimicking the rhythm of a heartbeat indicates that the user has entered a meditative state.



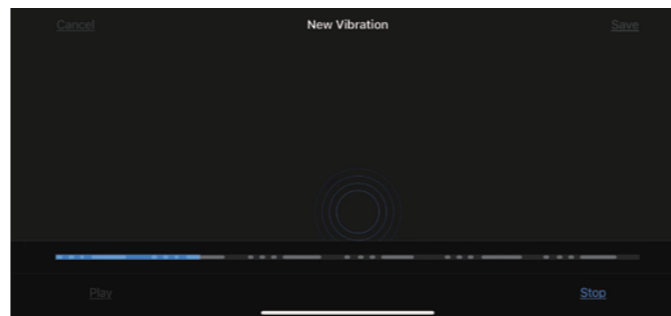
Continuous regular vibrations guide the user to hold their breath.



The gradual, rapid rhythm of the shaking induces the user to exhale.



Use foam prototypes to test different sizes and comfort, select the thickness and radian that most easily fit the hand, and test the use angle and effect of the adjustable tape.



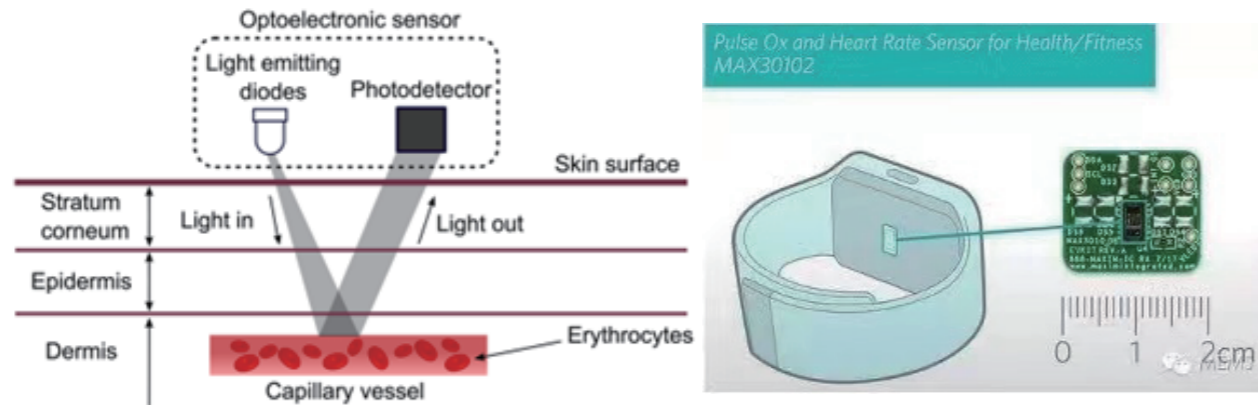
The vibration rhythm, which is gradually prolonged, guides the user to inhale



After testing, a model of the product is made using 3D printing and demonstrates how the user uses the product in their hands.

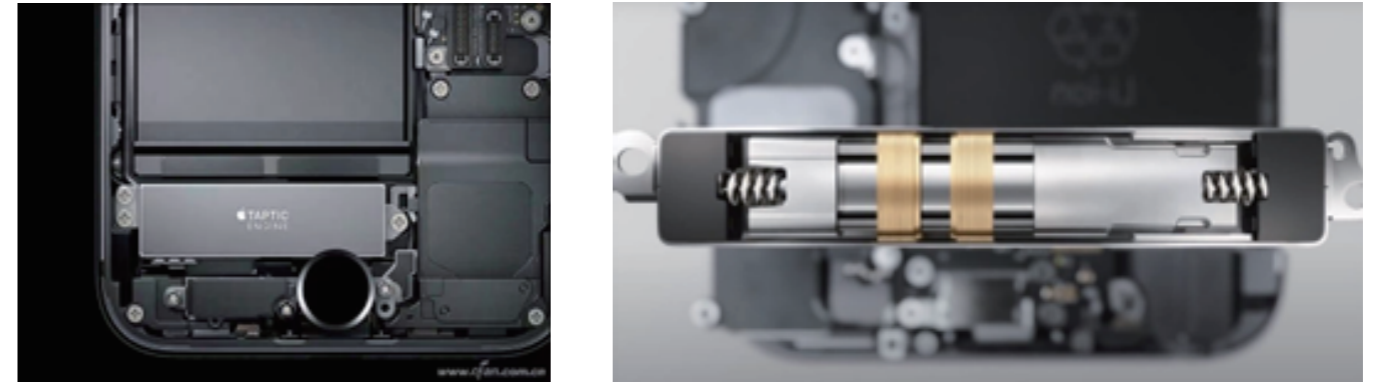
Users are able to fit the product to their hands through an adjustable strap and meditate using specific gestures

Photoplethysmogram sensor



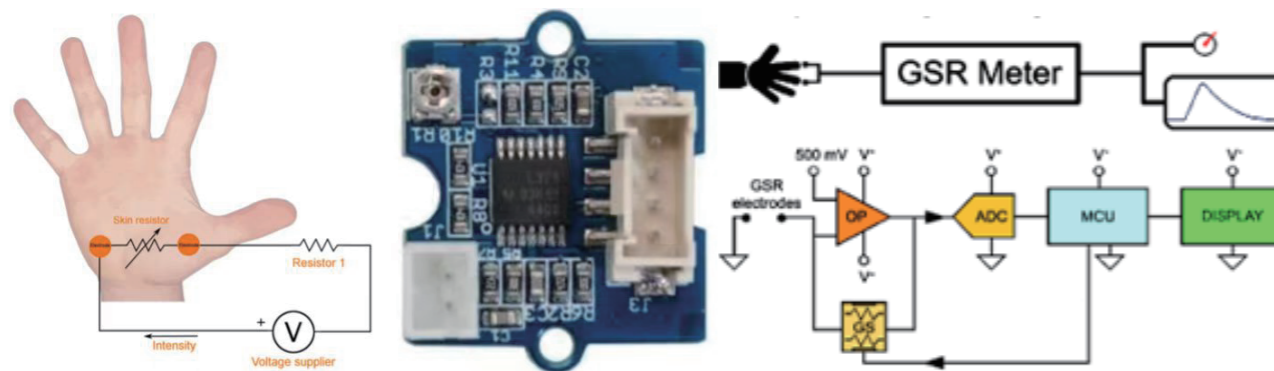
Photoplethysmogram sensor is the main component of heart rate variability monitoring in the product. The principle is that when light is emitted to the skin by a capacitive light, as it passes through biological tissues, it is absorbed by bone skin pigments as well as venous and arterial blood. Since blood absorbs light more strongly than surrounding tissue, the photosensitive sensor can detect changes in blood flow as changes in light intensity and convert them into electrical signals, which are then converted into digital signals to calculate heart rate based on the absorbance of blood. [7]

X-axis linear motor



The X-axis linear motor is a component that is often used in mobile phones to provide vibration feedback. For example, the pressing effect of the home button in the iPhone is simulated by the linear motor. The X-axis type motor generates vibration by converting electrical energy into the mechanical for a spring to drive the built-in moving block to reciprocate in a linear direction. This motor can provide better intensity and consistency of vibration and has a better sense of vibration direction. So the x-axis linear motor is used for the element in this product that produces the vibrating function, which guides the user to meditate breathing. [9]

Galvanic skin sensor



The galvanic skin sensor in the product is used to detect the electrodermal activity of the user in response to the user's emotional state during meditation. The ions in the sweat secreted by the sweat glands on the surface of the skin can produce electrical conductivity, so the working principle of this sensor is to detect the user's emotional changes by measuring the change in the conductance between the skin and reflecting the activity of the sweat glands on the skin surface. [8]

Bluetooth module



Bluetooth module is the selected component to realize the function of product data transmission to mobile devices because the Bluetooth connection mode can achieve wireless, low power consumption and fast data transmission within a certain distance.

At the same time, the Bluetooth standard is fully compatible with different mobile phone systems in the market such as Android and iOS. Users can use the mobile phone to read the data detected by the product in the process of meditation through Bluetooth, to understand their meditation effect and get positive feedback. [10]

Engineering Details

Power

According to the design requirements of product functions, the main components in the product that need power supply, and their corresponding working conditions and parameters are shown in the following table.

Component	Function	Working voltage	Power
Photoplethysmogram Sensor	Detect Heart Rate Variability	3.3 V	0.03W
Galvanic Skin Sensor	Detect Electrodermal Activity	3.3 V	0.01 W
X-axis Linear Motor	Vibration	3 V	0.05 W
Bluetooth Module	Data transmission	3.3 V	0.02 W

$$(0.03w + 0.01w + 0.05w + 0.02w) \times 15 \text{ min} \times 60s = 99 \text{ J}$$

1. In this case, assuming that the user uses the product for 15 minutes per day, once per day, Equation 1 calculates that the energy required per use is 99 joules

$$3.7 \times 0.82 \times 3600 = 10922.4 \text{ J}$$

2. The rechargeable lithium battery is used for power supply. The battery has a capacity of 820 mA and can provide 3.7 volts, so the energy provided by the lithium battery can be calculated to be 10922.4 joules per cycle.

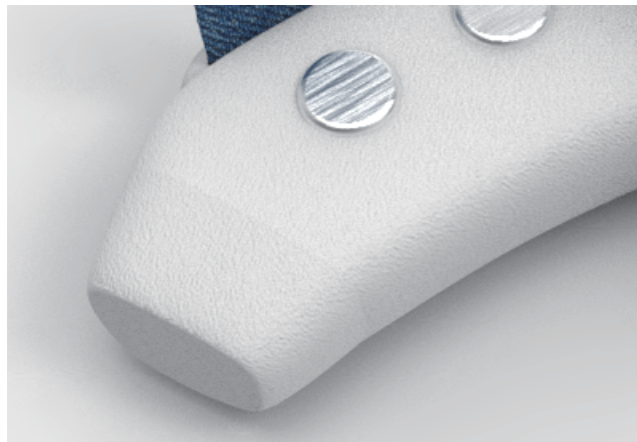
$$10922.4 \times 60\% \div 99 = 66.2$$

3. Excluding other factors such as circuit loss, the energy conversion rate of the battery is estimated to be 60 percent in the end. The battery can be used for 66 days per full charge.



The charging mode of the product is USB standard socket for charging. Users can charge the device through the charging cable.

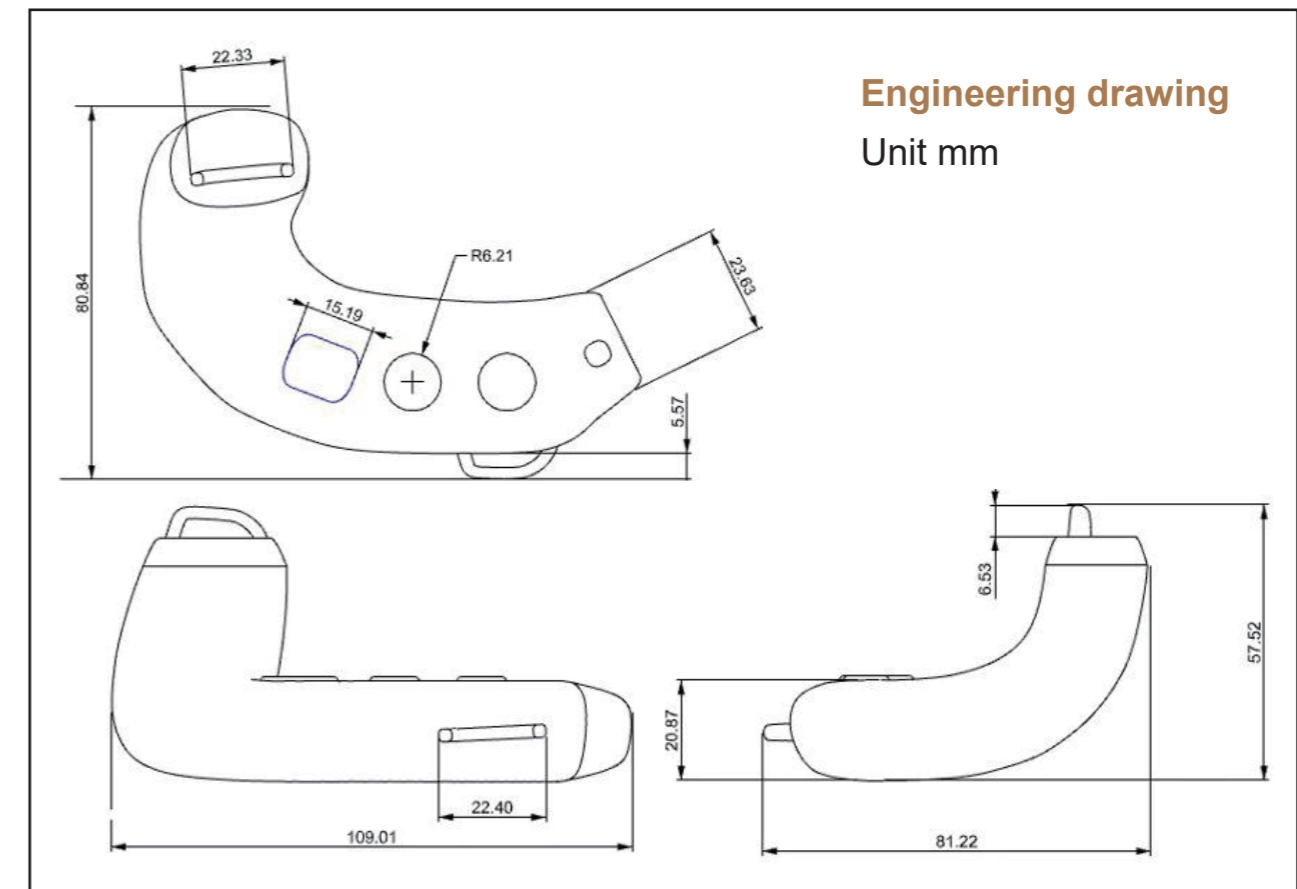
Material and manufacture process



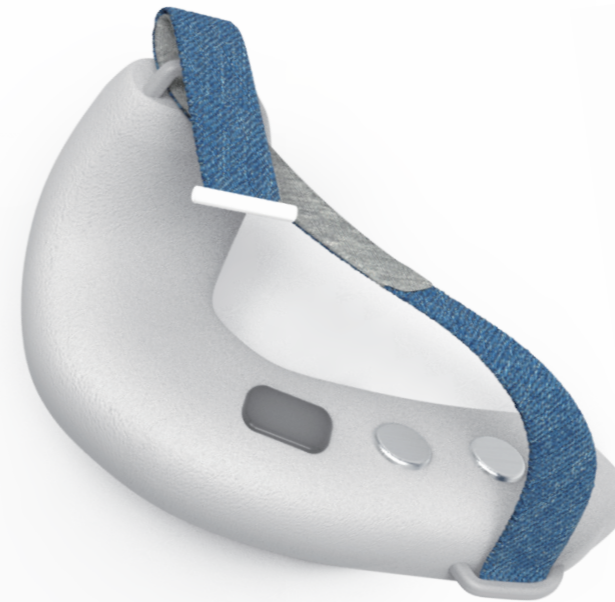
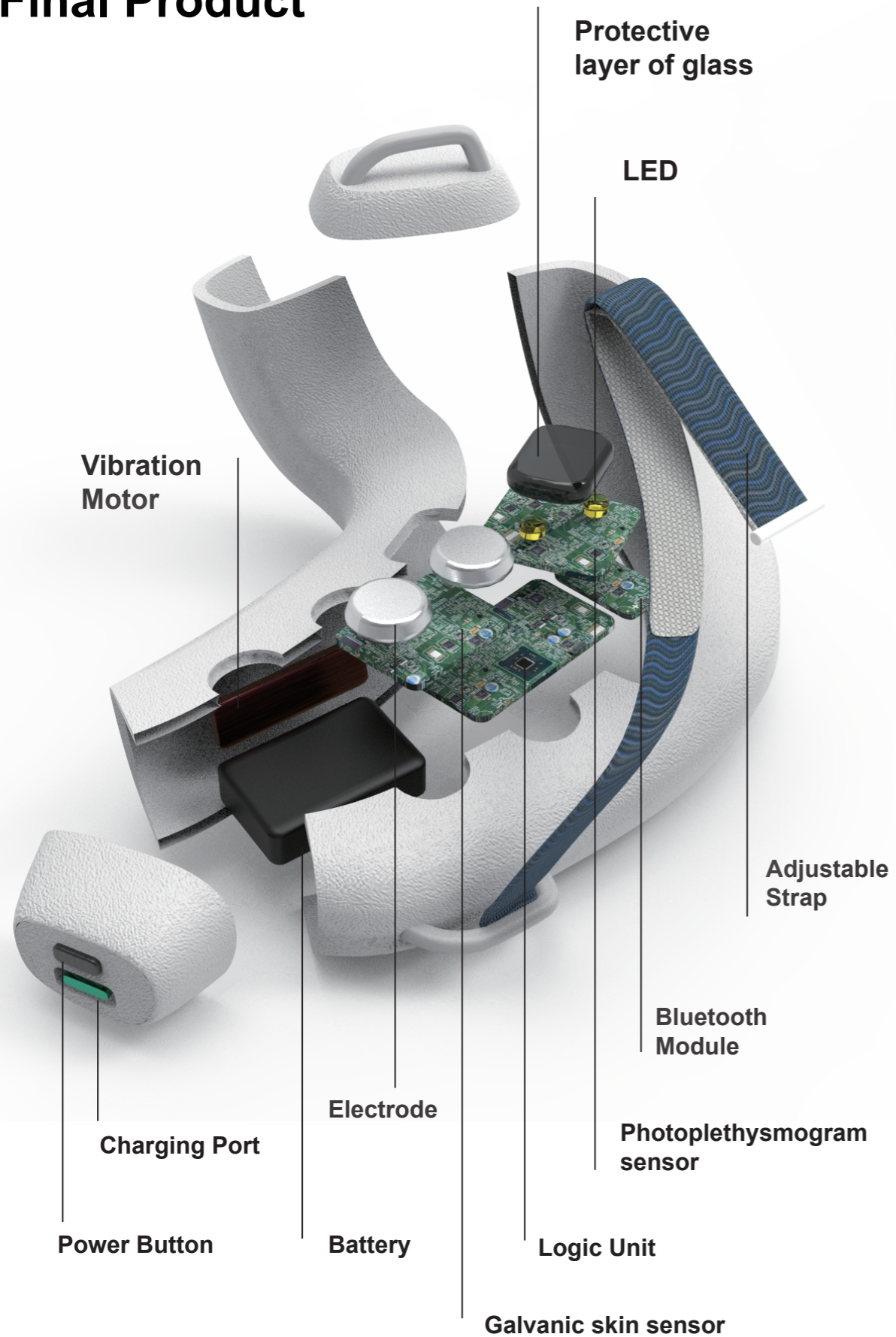
The shell part chooses to use ABS plastic injection moulding with low price, light weight, and good strength. In addition, the surface of the shell is frosted, so that when the user holds the product in the hand, the skin and the surface of the product have a certain friction, thereby providing a better grip.



The strap part is used to help the product to maintain a better fit with the palm during use. Therefore, the strap part uses elastic nylon woven material, which can fit the skin comfortably and rely on elasticity to help the product fit to the palm. A Velcro covering the outer layer of the band allows the user to adjust the band and hold it in place according to the size of their hand.



Final Product



The user holds the product in his hands during meditation, feels the vibration in his hands to adjust his breath and know if he is in a effective meditative state. After meditation, users can check their biological data to know how long they really reach the effective meditation state during the entire exercise.



Conclusion & Future Work

After research, ideation, developing and testing, the final design can be helpful for beginners to overcome the difficulties they face and practice better meditation. Through the relevant man-machine engineering test, the design and application of internal components, the product can meet the functional application of the design concept in the technical level.

On the design process, the downside here is that there is no physical testing and simulation of the sensor. Although technically sensors and other components enable the detection of heart rate variability and electrodermal activity. But it still needs to be further optimized in practical application. For example, the stability of the sensor in the use environment, anti-interference, accuracy, etc. In addition, the design concept of vibration-guided breathing to help users meditate is not difficult to realize functionally, but how to use vibration to bring users a better breath-guided experience is still worth further discussion. For example, in addition to considering different rhythms and vibration intensity, it is possible to combine space aspects, such as whether it is possible to use different directions of vibration and rhythm for a better experience. Finally, as a product that needs to be used with mobile phones, the related software requirements of mobile terminals also need to be further improved.

In conclusion, the design concept of the project has been basically realized, which can achieve the design goal of helping beginners practice meditation, but it still needs to be further improved in practical application.

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