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Master's Thesis

Academic Year 2018

ZONE:
Designing for Supporting Mindfulness Meditation Practice

Keio University Graduate School of Media Design

Xiaoyu Zhang

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
MASTER of Media Design

Xiaoyu Zhang

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Professor Kai Kunze	(Supervisor)
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Abstract of Master's Thesis of Academic Year 2018

ZONE:
Designing for Supporting Mindfulness Meditation Practice

Category: Design

Summary

Mindfulness meditation has significant benefits for health and well-being but requires practice and commitment. A wealth of mindfulness meditation products with technology use have been developed in the last years. However, there have various limitations for mindfulness meditation practice process to let novice meditators feel the essence of mindfulness.The design of ZONE" aims at supporting novice meditator how to cultivate their mindfulness through mindfulness meditation practice without instructor in a daily-life based scenario, given a non-invasive, non-verbal instruction approach and full-immersed environment to help meditators engage their both body and mind.

Keywords:

HCI, Mindfulness, Meditation, Interaction Design, Haptic Design

Graduate School of Media Design, Keio University

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As a visual designer before I started my graduate school at Graduate School of Media Design at KEIO University, I never thought that I could perceive hardware and software engineer knowledge, get involved to HCI field. I'm happy about my progression and willing to continue working in this field.

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Chapter 1
Introduction

1.1 Background: Mindfulness Meditation and HCI Design

Digital society impact, rapid industries changing, purpose-oriented lifestyle drastically affect mental health and subjective well-being. A high paced information overload environment that influences people psychological condition, even causes emotional distress such as depression, anxiety, insomnia that it is hard to know where to start. Adverse reactions, emotions, intentions naturally occur on a daily basis for any reason as long as information keep updating. In real-life and virtual society, people inevitably encounter numerous occurrence of unpredictable events every single day. It poses a serious problem that people get used to judging before thinking and feeling. In fact, the negative emotions come from the reactions and decisions based on how people process the non-stopping emerging events. The way that we perceive and define a particular "thing", or a specific "object" does a critical role that determines the emotion that we are going to have. Moreover, people worry about the future and the past at all time; it is difficult to require one to stop pursuing goals for a little while, sit down and pay attention to the present moment and appreciate what they have right now in this result-oriented society. One of the keys to achieving subjective well-being as well as mental health is to relieve one from an established thinking pattern that might cause an unpleasant experience. Converting the way of thinking is crucial to those who are struggling with the non-stopping negative emotions and stress. "Mindfulness" is concerned holding therapeutic effect which can lead those out of this situation.

In recent decades, the interest in the associations between awareness and the subjective well-being of health care professionals is growing. [24] Paralleling, mindfulness population and related scientific research keep increasing. As the emerging positive research evidence on mindfulness in this population, [13] mindfulness and

its effects on health and well-being at every level of biology, psychology and social connectedness. [18]It involves cultivating inner strength that already exists in one's capacity, self-regulation of paying attention to the experience of the present moment, being decentered, non-judgmental awareness, openness to one's internal experiences and external events. [16] [14]Mindfulness-based programs have been demonstrated to increase the clarity of values and ability to withstand exposure [4], to ones capacity to sustain openness to unpleasant/pleasant dynamics, without becoming cut off from awareness of the present moment. Mindfulness is not a goal; it is how we be. The vehicle to being mindfulness is to start cultivating it systematically. The most publicly accepted, scientific based methodology to develop mindfulness is by doing meditation practice [20], which is a form of meditation originally developed in Buddhist traditions of Asia. Currently, it is beyond religious principle, as a valid scientific method to achieve mindfulness state-being conscious of what takes you away from presence and peace. [1]

Meditation as part of the therapeutic process relates to spiritual growth and development; it is broadly utilized in clinic therapy, relaxation program,self-development, and so on. According to neuroplasticity research evidence, our brain develops based on how we use it [9] , when practice mindfulness through meditation, our brain develops its capacity to be mindful, compassion in it. Mindfulness is a practice, not a philosophy or magic, and it is accessible to everyone. Mindfulness meditation training produces demonstrable changes in subjective experience, behavior, patterns of neural activity, and peripheral biology. In Mindfulness-Based Stress Reduction (MBSR) [21] offered through the Stress Reduction Clinic at the University of Massachusetts Medical Center in Worcester, Massachusetts, the mindfulness-based programs conducted by them show the significant positive results from the participants who have been struggling with chronic disease, chronic pain conditions, and endemically stressful lifestyles, and progressions. MBSR is based on systematic training of mindfulness. The program leads the participants to seize high-quality life, satisfaction and stabled positive mental condition as well.

1.2 The Problem: Mindfulness Meditation for Novice Meditator

In these years, numerous people have made the inquiry on how to learn the self-oriented mindfulness training program, not only the people who have a severe problem. Since mindfulness training is meant to be a practical guide for anyone, well or ill, who seek to transcend his or her limitation and move towards a greater of health and well-being. Meanwhile, a huge number of programs, coaching services, and products that promote mindfulness meditation appeared. As for training service, over 778 mindfulness/meditation related institutions and program in New York, the United States only. "Mindfulness" gradually becoming an on-growing industry. According to the marketing research, $1.2 billion U.S. [1]meditation market grows strongly, following the path of Yoga studios. Paralleling, part of meditation population is finding a solution that could allow them to conduct self-direct mindfulness meditation on one's own on a daily basis without attending training courses. However, it is challenging for novice meditators who are lack of technique to implement this practice, regarding that meditation is an active training of the mind to cultivate mindfulness, compassion, concentration, and resiliency. It requires effort and commitment to transform the mind, ultimately to transform being. For many new meditators who do not realize what mindfulness it is, when they implement self-direct/self-oriented mindfulness meditation practice without guidance, their mind tend to wander or being empty which results in lack of ability being aware of the present moment. Thus, the problem with being fully present including building body awareness, observing mind-flow could be considered as the main pain point for the majority of mindfulness meditation beginners. Moreover, this group of meditator tends to pay too much attention to the physical sensation in a negative way which commonly due to the unfamiliar sitting posture over 20min - 40min mindfulness meditation practice. Eventually, it becomes another difficulty for them. Also, failing to stop thinking about the past events and future plans, which drag them out of the process of aware the present moment is another obstacle. These common mistakes an problems make mindfulness meditation more challenging for them to engage the mindfulness essence, especially under non-instructor, self-direct meditation practice condition.

1.3 Motivation: Mindfulness Meditation with Technology Use

To support meditators have better self-direct meditation experience in a daily life context, various meditation-based products that mainly focus on self-direct meditation practice keep increasing, which mostly presented some novice meditator friendly features mainly delivered by audio/verbal guidance. As result, meditation with technology use becoming prevalent this year, such as smart-phone application "Calm"[2], "Headspace"[3]. EGG(Electroencephalogram) monitoring brain sensing headband "Muse"[4]. "The Spire"[5], the waistband that connects to an app on smart-phone to monitor breathing. However, there has been limited academic work evaluating these technologies, providing limited insights into their design informed by mindfulness meditation literature. [6] In the current stage, meditation-based technology use product could be summarised into three major categories:

- ICT type: Remote teaching, training, community interaction.
- IoT type: the Sensor-based device such as EEG(electroencephalography), breathing, heart rate tracking with a recording system that provides physiological data and visualized data feedback.
- Application: Providing video and audio format introduction, varied course options, practice notification and schedule system.

Despite of the features including sensor-based physiological data tracking system, habit building strategy or community communication platform, specifically looking at how technology works with the process of meditation practice. Sensor-based devices show no introduction or direct involvement while meditating, which requires meditators to reach another solution to provide guidance. This type of supporting approach promotes and emphasizes the post-stage of meditation refers to self-evaluation after meditation session through checking physiological status as the "result" to help meditator do reflection. It holds limited ability to support new meditators for deeply engaging to meditation principle. ICTs provide remote training courses over internet which could be considered as a alternative solution of attending to real-life class. Emergent solutions focus on how video chat is used for meditation, and the quality of remote meditation teaching [10]. However, ICT is not a perfect solution for those who are willing to make flexible

meditation schedule. As for meditation-based website and application products, most features they obtain are verbal guided meditation training, sound relaxation therapy in audio or video format. Both audio and video guided meditation have potential to compel meditators to generate additional brain activities to perceive verbal information while meditating. A Research about meditation-based applications indicates guided meditation is the most popular one that people focus on, while providing limited support for monitoring the intrinsic meditation processes or for measuring the effectiveness of the training./citemeditationApp It also concludes with implications for design to address these limitations through novel tools supporting intrinsic meditation processes and bodily kinetic aspects fostering mindfulness, together with the call for developing guidelines for evaluating the effectiveness of such applications.

Although there isnt a right or wrong way to meditate, its important to find a teaching approach that meets one's needs and complements personality. This study aims at providing a solution that could help novice meditator who wants to cultivate mindfulness effectively at home through non-verbal guided mindfulness meditation at any time.

1.4 Hypothesis: The Solution

Mindfulness is moment to moment of awareness. It is cultivated by purposefully paying attention to things we ordinarily live with, the things that momentarily being around us. However people prone to neglect them. Whenever one brings awareness to what one's directly experiencing through senses, or to the state of mind through thoughts and emotions, aware the present moment, second by second, decentered, non-judgemental, then it is mindful. I assume if novice meditators have difficulties to be fully present and mindful at the early stage of mindfulness practice, they should be lead to the "ZONE" where their sensations can be stimulated, their mind-flow can be observed by their own. The gate that allows them to feel the mindful state should be opened. I assume haptics technology holds it ability to enable build body awareness and support mind-flow observation to lead novice meditator one step closer to be fully present while meditating, ultimately cultivate mindfulness.

The goal of this research is by creating "ZONE" to provide a new approach for mindfulness meditation training introduction, with HCI design theory that helps to lead novice meditator to do self-direct mindfulness meditation practice, engage

mindfulness principles. "ZONE" focus on mindfulness meditation-related values, capturing experiences for full immersion in the present moment through haptics interface in a non-invasive manner. By helping novice meditator for engaging both body and mind, "ZONE" is aiming to create an opportunity that allows them to develop the state of being fully present, discover and feel the essence of the mindfulness qualities through practice on one's own. "ZONE" allows meditator to have better self-direct mindfulness meditation practice experience, support individually catered interactions without additional meditation verbal guidance or other devices. This research aims to dig into the understanding in the area and contribute to the creation of new knowledge in the field of wearable haptics and techno-spirituality in HCI. The ultimate goal of this research is to invite more people to participate in the mindful mind transform program and create inner peace.

1.5 Contribution

When technology meets mindfulness meditation, either become distraction or important tools for meditators. Awakening for many meditators requires the ability to be present with however they are truly feeling, insight into principles, as described earlier, and finally, practice. It motivates the behavior described in each of these responses: rejection of technology. With this research's unique perspective on the interaction of human awareness and computer, think critically about the mindfulness principle compatible design for mindfulness meditation practice guide, seek to a solution with HCI design theory that helps novice meditator get to engage with mindfulness meditation essence and principle easier and direct, in order to provide a better mindfulness meditation practice experience by using technology . This research is to create a device set that consists of multiple components that trigger different parts of human tactile sense, as well as a mind-flow self-observing and logging system. A new approach associated with HCI technology, mindfulness principle for supporting and guiding novice meditators to cultivate mindfulness. If the design concept proves its applicable,feasible, mindfulness principle compatible, and meditator acceptable, it may establish a novel mindfulness meditation methodology by creating a new term of "awareness amplified mindfulness meditation." The research I conducted in this study hopes to offer evidence of the benefits that for mindfulness achieving.

Notes

1 https://www.webwire.com/ViewPressRel.asp?aId=214152

2 https://www.calm.com/

3 https://www.headspace.com/

4 http://www.choosemuse.com/

5 https://spire.io//

Chapter 2
Related Works

For the purpose of finding a solution to create a novel approach for non-verbal guided mindfulness meditation guidance, combining HCI design theory to create an opportunity that can allow novice meditator to conduct self-direct mindfulness meditation practice by following the introduction from haptics interactions. Through the psychological and physiological understanding of cultivating mindfulness, it has been proved that mindfulness practice needs to be developed in a systematical way. The design concept of "ZONE" is to stimulate meditator's sensations by haptics stimuli to make them aware of every single existence or event at the present moment. Moreover, a device with haptics interface that allows meditator to get into the mind-flow observation process. It can implicitly prevent novice meditator from wandering or empty mind, besides supporting them to reach a mindful state. In the pursuit of proposing an embodied mindfulness meditation introduction approach that supports novice meditators cultivate a mindful perspective to feel the physical sensation, thoughts, intentions, with a mindful attitude. Therefore, it is critical to examine these elements to further develop "ZONE" concept, prototype design and testing trails.

Section 1 of this Chapter demonstrates previous research to provide an overview of the field of the study and allow a deeper understanding of relevant areas and terms related to "ZONE."

Section 2 of this Chapter discusses related projects and research that provides necessary knowledge, insight, and inspiration.

Section 3 of this Chapter studies the methodologies of evaluating mindfulness through physiological monitoring and mindfulness self-evaluation questionnaire.

2.1 Theoretical Framework

Firstly, mindfulness meditation and body awareness will be presented to obtain the understanding of the context, to which qualities and design aspects the HCI technology could be related. Some of these qualities and terms were already mentioned in the introduction chapter, namely consciousness, non-judgemental, be in the present moment. This section will discuss more related theory along mindfulness qualities and mindfulness meditation training techniques. Secondly, theories and definitions of haptics interaction, techno-spirituality will be mentioned following. The understanding of these definitions and concepts will support "ZONE"'s design concept, protoype creation. Furthermore, in this section, the related knowledge about evaluation methodology will also be presented.

2.1.1 Mechanisms of mindfulness

An often cited definition of mindfulness - paying attention in a particular way: on purpose, in the present moment, and non-judgmentally [17] embodies the three axioms of mindfulness:

1. On purpose or intention,
2. Paying attention or attention,
3. In a particular way or attitude (mindfulness qualities).

Intention, attention, and attitude are not separate processes or stages they are interwoven aspects of a single cyclic process and occur simultaneously. Mindfulness is this moment to moment process. The study also presents the how mindfulness practice affects building actual mindfulness. As the conclusion, mindfulness practice continues and accelerates the shift of mindfulness building. It increases the capacity for objectivity in relationship to ones internal/external experience. Through the process of intentionally focusing nonjudgmental attention on the contents of consciousness, the mindfulness practitioner begins to strengthen what Deikman refers to as the observing self [8] . To the extent that we are able to observe the contents of consciousness, we are no longer completely embedded in or fused with such content. [4]

2.1.2 Mind of the Meditator

This research offers the cycle of events that occur in the practice of focused-attention meditation and the corresponding activation of specific brain areas. The traits and states of brains in different mind conditions. [15]

- Mindfulness: Also called open-monitoring meditation, mindfulness entails observing sights, sounds and other sensations, including internal bodily sensations and thoughts, without being carried away by them. Expert meditators have diminished activity in anxiety-related areas, such as the insular cortex and the amygdala.
- Mind Wandering: Meditator in the scanner illuminates the posterior cingulate cortex, the precuneus and other areas that are part of the default mode network, which stays active when thoughts begin to stray.
- Distraction Awareness: The salience network, which includes the anterior insula and the anterior cingulate cortex, underlies the meditators awareness of the distraction. The researcher of this study set a button, once cognizant that the mind has roved, the volunteer pushes it to let researchers know what happened.

2.1.3 Mindfulness Meditation

Mindfulness Meditation is a form of meditation designed to develop the skill of paying attention to our inner and outer experiences with acceptance, patience, and compassion. A reputable non-profit mindfulness community Mindful.org[1] summarized the essential points of mindfulness meditation practice in a comprehensive way. For "ZONE"'s research purposes, it is necessary to the main breakdown factors more specifically. Therefore, I re-construct the key points of mindfulness meditation practice, combining the knowledge and understanding from the Mechanisms of mindfulness as below

"Attitude" and "Intension"

- Observe the present moment as it is: Since the goal of mindfulness is not an empty mind, or attempting to achieve a state of eternal calm. It 's aiming to pay attention to the present moment, without judgment.
- Let judgments roll by: When we notice judgments arise during our practice, we can make a mental note of them, and let them pass. Return to observing

the present moment as it is. Our minds often get carried away in thought. Thats why mindfulness is the practice of returning, again and again, to the present moment.

- Observe the mind: Be kind to wander mind. NO judgment for whatever thoughts crop up. What makes it challenging is practicing how to observe and recognize when the mind has wandered off, also how to bring it back to the state of observing the present moment

"Awareness"

- Breathing: The physical sensation of breathing is always there, focusing on the breath is a powerful tool during the practice, whatever the mind goes wandering, come back again to the next breath as an anchor or reset bottom to the present moment. Throughout the breathing practice for tracking in thoughts, emotions, physical sensation.

- Body Scan: Another physical sensation oriented mindfulness practice technique, it requires to notice what legs are doing, what arms are doing, what the whole body is doing. Aware of the existence at the present moment, aware of the relationship with the body, and nature.

"3x3 Methodology"

This methodology created by Phil Boissiere who is an adult ADHD and couples counseling specialist based in the San Francisco Bay Area. "The 3x3 method", claims mindfulness and breathing simplified, by which 30 seconds to mindfulness.[2]. It demonstrated a minimized way to be mindful, also relieve the stress. This training model only consists of 3 steps:

1. Name a physical object
2. Take a deep breath
3. Repeat

It promotes a simplified way to achieve mindfulness, to give an objective a definition non-judgementally by which name it without any subjective descriptors or adjectives, then have a deep breath, and repeat it in a row. He's using this method to train people who are working in the high-intensity technology industry; it shows its beneficial to those people who participated in this program.

Since this method is easy for anyone in any circumstances, and it was proved the effectiveness it holds. 3x3 mindfulness technique gives "ZONE" inspiration. To combine this mindfulness practice method with "ZONE" concept in order to create a more comprehensive approach, "ZONE" is aiming to extend the model of " name an physical object and take a breath" and its application associate with haptics interactions.

2.1.4 Designing with Haptics Interaction and Techno-spirituality

Involving haptics in the design of the user interface, for raising human awareness and attention, has been presented in the literature. Traditional interface design involving human perception has mainly focused on vision and hearing. However, information overload might be caused when vision channel and audition channel are highly in charge. As previous research has addressed, to raise human attention, the additional use of haptic sensation holds potential capability for proving a supplementary level of awareness [25].

Previous research presented haptics interaction relates to all aspects of touch and body movement and the application of these senses to computer interaction. This involves not only sensation and perception, but also motor and cognitive aspects of active movement (self-initiated movement) for which detailed motor plans are created, stored in memory, and compared to receptor feedback from the muscles, joints, and skin. [12]

The surface area of the skin has enormous numbers of sensory receptors receiving stimuli of heat, cold, touch, pressure, and pain. Previous research indicates the importance in human behavior of tactile functions. [22] In "ZONE"'s design concept, utilizing the qualities and traits of those tactile sensations as one of the design factors to achieve the pursuing of supporting mindfulness meditation in non-verbal guided condition. Moreover, through this experimental design research to explore the possibility that haptics interaction it holds in mindfulness context.

Nowadays, spirituality has covered various platforms in computing and technology including HCI. This new form of interaction design has shown it's capability to support other activities which are mainly unrelated to productivity and efficiency such as exploring, wondering, loving, and worshiping [27]. Despite most of the research regarding this design category are related to the religious topic, it still provides valuable references to this study to discover techno-spiritual applications in mindfulness context. Mindfulness is considered as human consciousness,

it also associated with human inner strength cultivation that could lead one reach a greater mental, spiritual well-being.

2.2 Related Project and Research

In the current stage of HCI research and haptics interaction design, it states for integrating humans, hardware, software, it is necessary to incorporate a basic awareness of human capabilities and current device technology on the other. These projects represent the ongoing research associated with HCI technology and Mindfulness. They encourage redefining the approach of cultivating mindfulness during mindfulness meditation practice. Instead of the idea of delivering mindfulness principle through verbal guidance by accessing applications, "ZONE" assumes that through connecting human sensation to mindfulness meditation in a non-invasive way can raise meditator's awareness and attention to be fully present. Additionally, "ZONE" try to integrate mindfulness meditation practice method and mindfulness qualities, attitude into the its guiding system, in order to create a mindful state experience for novice meditator that is built upon a certain level of dependency between user and object.

Designing for Body Awareness - A Study on Enabling Body Awareness in Mindfulness Through Wearable Haptics Thermal Technology

This work explored how beginners in mindfulness experience the use of wearablehaptics technology in body scan meditation to investigate what potential possibilities that wearable haptics technology has in enabling body awareness in body scan meditation. It shows how to utilize thermal technology, implementation and evaluation of the wearable prototype HeatCue, with haptics thermal feedback. This study indicated to evaluate the interaction between technology and its user, HeatCue was implemented in the context of body scan meditation. There were five prototype tests, in two sessions, executed until theoretical saturation of data was achieved within the timeframe. They were done with one person at the time since there was only one prototype developed. The sample of the prototype testing consisted of four females and one male in the ages from 24 to 56. People in the researchers surrounding, in Malm in Sweden. They were also asked whether they had practiced mindfulness before. The prototype testing with each participant was divided in two sessions. One body scan meditation session without the prototype and one with HeatCue.The study has demonstrated that HeatCue provides an intimate, subtle and skin-close interaction, suitable for the context

of body scan mediation, without being invasive or obtrusive. This study has further shown that beginners of mindfulness experience that HeatCue enabled body awareness in the body scan meditation. The prototype was helpful as it acted as a reminder to the body part that allowed the user to easier identify the body part during the meditation, thus enabling body awareness. [5] conclusion of this research, it presented haptics feed back allows meditators easier identify body as well as engage to body awareness, which encourage "ZONE" to complete evaluation of its hypothesis,including haptic stimulus may allow novice meditator easier to feel and understand part of mindfulness essence.

Mobile Haptic System Design to Evoke Relaxation through Paced Breathing

This project refers there is evidence of the sense of touch being incorporated in traditional relaxation practices. Available paced breathing applications are also mostly non-interactive. The research explore the solution of tailoring the breathing tracking process into embodied experience to the user. This work develops a mobile paced breathing tool focusing on haptic cues and biofeedback to explore users' preferences between manual or biofeedback control, the efficiency is haptic guidance on its own, and how addition of haptic feedback enhance audio based guidance. The haptic guide was created using the Immersion Haptic SDK. It employs the phones motor to provide gentle vibrational pulses. The audio guide essentially plays a music file of a synthesized gong chime. Both of these prompts are looped according to a timmer interval determined by the target breathing rate. This creates a breathing guide to aid the user in pacing their own breath. If the user prefers direct control over the target breathing rate or wants to go straight into deep breathing, they may decide to use the manual interaction mode. However, if the user is unsure where to set the target breathing rate or wants to gradually fall into deep breathing, they may choose to use the biofeedback mode, so they can be guided to a slower paced breath from their current breathing state. [19] This project doesn't provide a detailed result of user test, but still, the design concept and the problems they are exploring provides "ZONE" reference value for the design ideation.

atmoSphere: Mindfulness over Haptic -Audio Cross Modal Correspondence

This research presented cross-modal correspondence between haptic and audio output for meditation support. They implement atmoSphere-a haptic ball to prototype several haptic/audio designs. It provides haptic and audio feedback

to allow users to experience instructing them in breathing techniques shown to enhance meditation.Through audio/haptic feedback design, it transmits breathing patterns to participants hands and ears, simultaneously monitor their natural breathing rhythm. The mechanism of atmoSpher works as while the participants have reached a state of mediation, the audio/haptic feedback will be tuned down in moments, when participant is being distracted then breathing pattern changes. This cross-modal feedback guide user to a more suitable breathing pattern for meditation. It demonstrates how haptic/audio feedback can shape user awareness and behavior pattern during meditation practice. [11]The positive results from this work provide "ZONE" tremendous inspirations to explore a deeper understanding of the collaboration among meditation and haptics technological artifact as well as it's application method.

Overall, the related projects show how haptics technology support body awareness along with mindfulness meditation practice guideline, which mainly presents the haptics designed artifact has the positive result in mindfulness body scan practice. "ZONE" want to explore more possibility that haptics interface it holds.As being presented, research mentioned mindfulness meditation practice requires not only paying attention to the body sensation but also thought, intention, engagement, and the way to observe and aware every event occurs at the present moment in a mindful way. How to integrate mindful thinking while body scan practicing; Can haptics designed artifact also help mind-flow observation? How to combine breathing practice to the utilization of haptics interface; How to cultivate mindfulness through sensation and awareness stimulus? "ZONE" aiming to find out these questions.

2.3 Research Methodology

To have a solid understanding of the evaluation and analysis method of mindfulness scale, physiological and psychological responses by using EMOTIV^3, Five Facet Mindfulness Questionnaire (FFMQ)and,Depression Anxiety Stress Scales(DASS). For the artifact design evaluation, participants will complete the evaluation survey, accept qualitative research including user interview, user observation. The related research will be presented below, which provide the references for "ZONE" project evaluation as well as its conclusion and discussion phase.

2.3.1 Physiological data Analysis

Quantitative change of EEG and respiration signals during mindfulness meditation

This research use EEG and respiration data, collected and analyzed on 34 novice meditators after a 6-week meditation intervention. Collected data were analyzed with spectral analysis, phase analysis and classification to evaluate an objective marker for meditation. As results, different frequency bands showed differences in meditation and control conditions. This study found the greatest accuracy using both EEG and respiration signals to discriminate between the meditation and control condition. Is also mentioned combined EEG and respiration signals may be a potential marker of meditation ability.

2.3.2 Mindfulness Scale and Stress Scale Self Evaluation

Five Facet Mindfulness Questionnaire (FFMQ)

Assessment of mindfulness by self-report suggests that it may include five component skills: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. These elements of mindfulness can be measured with the Five Facet Mindfulness Questionnaire (FFMQ). According to the conclusion and discussion of previous research, four of the facets that related to awareness skill were significantly correlated with meditation experience, and meditators scored significantly higher than in the sample group that not participated in mindfulness meditation practice . One of the high lights of this study is the "observing" facet includes attention to both internal stimuli (thoughts, feelings, sensations) and external stimuli (sights, sounds, smells). Both are higher in meditators. In addition, higher scores for the describing, non-judging, and nonreactivity facets in meditators suggest that meditators learn to respond differently to the internal stimuli they observe. [3]Because meditation teaches unbiased observation of all stimuli, it may reduce maladaptive forms of selective attention. Therefor, high scores on the observing facet in meditators may indicate a greater tendency to notice a wide range of internal and external stimuli, rather than focusing selectively on the threatening or unpleasant ones. "Observing" fact would be the main factor on which "ZONE" needs to focus.

Depression Anxiety Stress Scales(DASS)

In addition, Depression Anxiety Stress Scales(DASS) assessment will be conducted as part of "ZONE"'s evaluation for measuring participant's psychological

state changes. The DASS is a 42-item self-administered questionnaire designed to measure the magnitude of three negative emotional states: depression, anxiety, and stress. The DASS-Depression focuses on reports of low mood, motivation, and self-esteem, DASS-anxiety on physiological arousal, perceived panic, and fear, and DASS-stress on tension and irritability. Previous research refers to The DASS has excellent clinimetric properties and few limitations. DASS scores suggest that one has significant symptoms of depression, anxiety, or stress, then referral to a qualified colleague with experience in managing mood disturbance is required. [23] Instead of using the 42-item questionnaire(DASS-42) designing for clinical sample, "ZONE" use 21-item questionnaire(DASS-21) for non-clinical sample, considering most of the participants in "ZONE" evaluation session, have reported that they do not have mental disorder , physical physical disorder/disability, or chronic disease. Previous research test the construct validity of the short-form version of the DASS-21. The DASS-21 has been shown to possess adequate construct validity. The research conclude the results from the reliabilities of the DASS-21 scales are high.DASS-21 has a number of advantages over the full length DASS. It is shorter and, hence, more acceptable for clients with limited concentration, and yet still possesses adequate reliability. [7]

Notes

1 https://www.webwire.com/ViewPressRel.asp?aId=214152

2 https://www.calm.com/

3 https://www.headspace.com/

4 http://www.choosemuse.com/

5 https://spire.io//

Chapter 3
Zone

"ZONE" is a set of haptics output&input interface that designed for supporting novice meditators' to learn how to pay attention to the present moment in mindfulness protocol, cultivate mindfulness even naturally and constructively without the verbal instruction while meditating. User target is novice meditators, who only have theoretical knowledge about mindfulness but lack of practice and application. This design is aiming to prove valuable mindfulness cultivation support for these target segment. In this research, exploring a new approach combining the concepts of Mindfulness, Meditation, Haptics interaction, that can allow novice meditator to naturally conduct mindfulness meditation practice by following their awareness. To achieve this purpose, replacing verbal guidance through creating haptics user interfaces to generate tactile interaction including stimulation and user interface is one of the design directions. "ZONE" explore an approach to raise consciousness by creating "objects" that helps meditator get an immersive experience of being fully present and cultivate mindfulness thinking pattern along with this process. Thus, by achieving "ZONE"'s proposal, an experimental haptics interface set up will be build up and be evaluated by novice meditator and advanced meditator as well. Furthermore, this set up would help this research to have a further understanding of haptics technology associated with the concepts of body awareness, embodiment, as well as techno-spirituality in mindfulness context.

3.1 Field Work

For research purposes and personal mindfulness development, I have been participating in mindfulness meditation practice for over 1 year since Jun 2017. In order to experience different teaching approaches as well as self-direct practice, I took part in 3 different mindfulness meditation teaching studio and temple in

Figure 3.1: Research methodology

the US and Japan. Each institution represents different teaching method based on various traditions, philosophy. It should be mentioned that one of the meditation practice I had in Japan which combines Zen philosophy and Mindfulness. Sometimes these two terms are often used interchangeably, the fact is they are not the same. However, they still have some techniques that can be shared among these particular practices to achieve better practice experience which is mainly in postures and the teaching of how to deal with the distraction.

To categorize the major methods of mindfulness meditation teaching, there are two standard ways to guide this practice, verbal guided and non-guided. Non-guided mindfulness meditation can be conducted by the side of an instructor, or by oneself. In some cases, both ways can be with or without sound or music. It depends on meditators' additional requirements and preferences such as reducing stress and anxiety and instructors' teaching approach and philosophy.

3.1.1 Mindfulness Meditation Practice Experience

As being presented in the last two Chapters. The essence of mindfulness is to be present in our experience just as it is without judging ourselves. Mindfulness practice is a well-researched method that derives from Buddhism. The practice of mindfulness means gently attending to our experience and inquiring deeply into ourselves. It often considered the practice of being mindful of the breath, however, focusing on breathing is only one of the forms. It also contains other practices to build up awareness of body and mind such as body-scan, mind-flow observation.

General Way to Practice Mindfulness Meditation

- Relaxation Breathing: This step could be considered as an introduction to the practice, to activate the parasympathetic nervous system the relaxation response - involves regulating the breath to lower the heart right and blood pressure quickly and effectively. Which is a tool for those moments of panic and anxiety, relaxation breathing tackles physical responses to sudden, acute stress while buying us time to respond thoughtfully rather than react impulsively.

- Mindful Breathing Meditation: Mindfulness is the practice of awareness of the present moment, enabling meditators to disassociate with notions of past and future. With mindful breathing meditation, use the breath as an object of meditation, concentrating deeply on the rhythm and sensation of our most basic life force. Think of it as an exercise for your brain that strengthens your attention muscle by forcing your awareness inward and challenging you to stay focused.

- Body Scan Meditation: Build body awareness and ease tension after a long day or before falling asleep at night. A body scan meditation allows meditators to identify where unconscious holding patterns reside and help to release them with our awareness, enabling us to relax more completely.

- Mind-flow/Self observation Mind-Flow/Self-observation requires practice and being fully present. It also produces compassion for us and others in a non-judgmental way. Through identify with habitual ways of thinking, feeling and behaving that one normally unable to be aware and self-observant. Through this process, it shows the less likely to judge ourselves and others, thus, creating a more open, expansive inner landscape from which one can be engaged in the world but not totally of it because of the self-observing faculty. Monitoring thought-life enhances our experience of reality.[1]

Guidance Approach

Guided: I have been getting trained by guided mindfulness meditation at MNDFL, INSPACE in New York, the United States which are both in a group practice form with around 10 meditators. Also, I do practice by myself by using meditation-based apps such as Headspace and Calm on a daily basis. At MNDFL, the ambiance of the meditation room is bright, clean, and calm. Each of class is taught

by certified expert teachers in a variety of meditation traditions to support the practice; mindfulness is one of the favorite courses in this studio. The training session usually is 30min - 40min. Meditators no matter what level they are can choose different instructor by personal preference, or by the level of class. During the practice, meditators follow the verbal instruction without additional background music. Teaching contents and the pace of the introduction are various, which depends on the instructors' characteristics and training method. Despite there are normal and advanced level options provided, Meditator's level is often different in one class. Due to the course are in a pre-scheduled system, and part of the classes and instructors changed weekly; thus, some novice meditators have no choice to book the advanced level to match their busy schedule.

Another guided mindfulness meditation class I attended provided by INSPACE studio, which called "awareness: Mindfulness 35". This studio created a dome shape meditation room with dim light and lower ceiling. The atmosphere is lean to the purpose of relaxation. There's no human instructor at the class, but only one facilitator who takes in charge of the utilization of the meditation room. The verbal guidance is in audio format with background music, delivered by high quality surrounded speakers. This type of teaching can be considered as same as by using apps but with a better relaxation and immersive environment. There's no level distinction for mindfulness meditation class in this studio. The audio guidance are pre-recorded; thus, lack of variety, depth of teaching and humanity.

Non-guided: This type of mindfulness meditation practice is not beginner friendly. Most advanced meditator conduct this type of practice alone, it requires an adequate understanding of mindfulness essence and practice techniques, also the compatible inner strength. The most important trait of this type of practice is that meditator can entirely be in the present moment and be aware without additional compelling information. The pace of being aware, as well as the observation process, are under the mediator's control which depends on how better one is fully present. Although not every advanced meditator pre-determine the duration of the practice, there are some additional supports such as timmer which can notify them when to finish the practice and soundtrack. There is no right or wrong way to conduct a self-direct mindfulness meditation practice, as long as it provides a better experience.

Posture: The posture for mindfulness meditation practice is to ensure that the hips are several inches above your knees by sitting on a cushion or pillow. It helps to straighten the back, which keeps meditators aware, and mindful. At

MNDFL, A flat cushion and a mat underneath are provided, also meditators are free to have a thick blanket. As for the posture, there's no mandatory requirement though; instructors still provide sitting suggestions - Half Lotus position which can allow meditator to be grounded, stabled, and no hanging knees, in order to have a fully engaged practice experience. Thus, instructors suggest meditators get an additional blanket, put it under the knees to support Half Lotus position while meditating. For the most meditators who are lack of body flexibility, especially the beginners, it is challenging to consist half Lotus position through the entire practice for 30 or 40 minutes even with the assistance of the blanket. Part of the meditators choose sitting in a relaxation way or lying down as long as they feel comfortable. On the contrary, At INSPACE, another studio I attended, the mat it provided is far flatter and with waist support, yet, no knees support. However, because of the structure of the mat, some meditators chose to lie down and use that waist support cushion as a pillow.

ZEN Meditation Practice Experience

In Aoyama Baisouin Temple, Tokyo, Japan, my training followed by "ZEN" philosophy, this meditation practice called "Zazen". The essence of Zazen is to "not think", to go beyond thinking. Avoid having intentional thoughts and images in our head in a particular way. During Zazen, thoughts and feelings arise from the unconscious. Zen meditation requires not to become distracted or disturbed by these thoughts or being trapped by them, meanwhile, not pursue or try to escape from them, because the wandering mind is perfectly natural. Let them pass by effortlessly. Zazen is non-guided meditation; it can be concerned as a self-directed inner strength oriented method. What I've learned from Zen meditation is the way of acceptance, by which the attitude to never fights with the thoughts that might distract one. It complements mindfulness cultivation, especially allows the mind-flow observation process smooth and natural. The posture of Zazen is comparably restricted. Zen meditation is practiced on a special round cushion called a zafu in Japanese. The purpose of this cushion is to raise the hips, forcing the knees to touch the ground, which makes one's Zazen more stable, grounded, comfortable. Maintain a strongly grounded posture is important, it can make breathing naturally settle down because Zen masters never giving the introduction to guide meditator to do proper breathing during Zazen. They believe that it can be achieved through a correct posture, which refers to the Lotus position, or Half Lotus sitting position and "Zen mind" hands position. By doing

so, the mind will become tranquil, serene, and undisturbed. After several group Zen meditation training, the critical insights I realized is by sitting in half Lotus position, which forces the knees to touch the ground and consciously straight the back, meditators are more engaged to the practice and their mind and body. Besides, the way of acceptance followed by Zen philosophy also complements the mindfulness cultivation; it makes the process of mind-flow observation easier and natural than before.

3.1.2 Novice Meditator/User understanding

In New York, I participant in mindfulness meditation community events and workshops. The meditators in these communities are facing the same situation in their daily life, such as high pace lifestyle, intensive work, complicated social networks, some of them also have psychological or physical health issues. The motivations to start mindfulness meditation are mainly about changing the thinking pattern to reduce stress, pursue inner peace, and cultivating inner strength. More and more people join these communities because of the positive results and benefits have been shared by the advanced meditators which intrigue them to start meditating to open the gate to develop their understanding of mindfulness and how to implement practice in daily life situations. Taking mindfulness class and using apps are the main way to do the training. For the most novice meditator, following the verbal-guided mindfulness meditation is the popular choice. To understand the needs and pain points of novice meditators, I conducted qualitative research such as interviews, and questionnaires of the experience of mindfulness meditation practice and the attitude and expectations of meditation and technology use in this community. At meditation studio such as MNDFL, each class usually has ten meditators and one instructor. After the practice, meditators compare notes about the practice. It also has Q&A session between instructor and meditators. The studio holds mindfulness workshop monthly. These sessions and activities gave me a quantity of user studies opportunities for "ZONE" 's design ideation. I mainly focus on the "ZONE"'s target users, which refers to the novice meditators who have a couple of times of mindfulness practices, ideally, have both experiences on guided and non-guided. 20 novice meditators who are taking guided mindfulness meditation training at the studio followed by certificated instructors and having practice at home by using apps that contain mindfulness meditation course accepted my interview also filled out the questionnaire about the perspectives of mindfulness and technology use. They pointed out many problems and

difficulties they are going through at the very beginning of cultivating mindfulness:

For Mindfulness Meditation in General

1. For most of the novice meditators, the difficulty of holding an optimal mindfulness meditation sitting posture for the entire practice is a common issue. Some of the novice meditators are trying to stay in half Lotus position to meet the stander because this position can complement the training more effectively. However, after sitting in half Lotus position for proximately 15 to 20 minutes, they start to be distracted by the physical feelings and hard to get rid of it. Novice meditators have fewer abilities to face uncomfortable physical feelings mindfully at the initial stage, they usually end up turning these sensations into a judgmental way, subjectively, which causes them out of the mindful state.

2.Can not aware of the progress that has been made by themselves after every single practice.

3. Wandering mind or an empty mind.

For Guided Mindfulness Meditation

1. It is challenging to be aware of moment by moment and listen to the verbal instructions at the same time. Especially the situations where they need to perceive the verbal information that compels them to use additional brain activities.

2. When novice meditator is following by the verbal introduction, sometimes meditators' pace of meditating including experiencing, being aware and observing process has to match instruction, which makes them have limited experience in internal focus.

For Non-guided Mindfulness Meditation

Using apps and timer at home is the conventional way to do this practice. However, it is difficult for novice meditator starting with non-guided at the initial stage when they do not fully understand how to pay attention in a particular way to be fully present, non-judgment, awake. Mindfulness training is about learning how to observe, experience in a mindful protocol. Lack of techniques and practice makes them usually fail to do it only by themselves; however, the ideal way to be fully present and fully aware is through internal focus. Also, I executed the fieldwork at the Zen meditation class to observe the differences and similarities between these two groups. Zen meditation is non-guided meditation in general.

The differences between Zen meditation and mindfulness meditation are mostly about the attitude and way to see all the events, yet, they still share the similar meditation techniques. The novice meditators of Zen meditation group stated that through practicing Zen non-guided meditation, the understanding regarding how to accept physical sensation, thoughts, and feeling would gradually be enhanced. Moreover, Zen meditation is more like a real "practice" or "training" for most novice Zen meditator. On the contrary, some novice mindfulness meditators consider mindfulness practice more as a way of relaxation; In fact, mindfulness meditation is a constructive and systematic practice, like Zazen.

For Meditation and Technology Use

There are 40 participants filled out the survey, 30 people are the beginner of mindfulness meditation, 10 are advanced. After I present my proposal of "ZONE" project and the design direction, 95% of the participants show the interests and positive attitude of the combination of technology and meditation. Despite the amount of meditation-based app out there, the expectations of having more embodied interaction meditation experience are shown. I set the questions about which sensations they want to be stimulated or interacted during the meditation practice that can help them to conduct non-guided meditation practice on their own.80% of them chose haptics and auditory interaction support, olfactive in 50%, and only 10% chose visual. The result concretes "ZONE"'s experimental design direction, also, encourage me to keep doing this project. For the meditators who are doubt about "ZONE"'s approach state the hidden problems are how to make sure the interactions not to be another distraction, how to make these interactions to be supportive and functional, how to make them work as a real instructor. "ZONE" take all different opinions and perspective into consideration, to build a sound system and device to help novice meditator to start doing non-verbal guided mindfulness meditation, to have a deeper engagement to the present moment and internal focus.

3.2 Identify the Key Factor

According to the feedback, data, and insights of my fieldwork, I identify the key factors of "ZONE"'s initial prototype. "ZONE" promotes non-verbal introduction method, it is essential to get deeper insights into the process and experience of

mindfulness cultivation. The problems of mindfulness meditation for mindfulness meditation in general are:

- The optimal suggested posture-half Lotus makes novice have uncomfortable experience during the practice, lack of support of knees and waist is the vital issue.
- Novice meditator tends to doubt the process. Since meditation is not about doing it in a right way or not, therefore, novice meditators usually are not sure about whether they are in a mindful state and it is hard to tell which stage they are. As the result, the cultivation of mindfulness would become more difficult as long as they don't believe in the process, which also affects the insistence of the practice.

Since non-verbal guided mindfulness meditation is the best way to engage in one's meditation pace, internal focus, as well as the mindfulness state. For novice meditators, the difficulties and pain-points to conduct non-guided meditation could be broken down:

- Lack of abilities to naturally direct themselves to go through the practice, including breathing practice, body scan, and mind-flow observation. How to support them?
- Unconsciously let their mind empty or wandering. How to make them fully pay attention to the present?
- Have no techniques to experience some parts of body sensation, thoughts, emotions in a mindful way. How to teach them?
- Easily gets trapped by distractions and have the lack ability to drag themselves back to the present moment. How to guide them?
- Lack of experience and understanding of the "present moment", and the techniques to be aware of it.
- Enhance the overall experience

As far as I concerned, these are the current needs for novice meditators who want to conduct practice on their own to have a better understanding of the essence of mindfulness without any verbal instruction. To solve these problems,

"ZONE"'s initial prototype is consists of two parts that can support this group to have a better personal experience of mindfulness meditation which including breathing, body scan, and mind-flow observation practice. As I presented in the last section, breathing practice and body scan practice are the best objects that can be used to aware the moment by moment. Novice meditators need to build a conditioned reflex that can initiate these practices throughout the meditation. Besides, in the condition of non-verbal introduction, to support novice meditators have an activated focused mind is another key to the design of "ZONE", not only help them establish a better body awareness, but also provide a valid tool to support mind-flow observation process. After the first phase analysis completed, the next stage is to consider how to create the right interaction between meditator and the objects I'm going to develop. My fieldwork gave me an understanding that leads to well-founded choices of the focused body scan, mind-flow observation, and how to incorporate breathing practice throughout the practice. The second phase aimed to provide a groundwork for the choices of the hard and software of a higher-fidelity prototype, as well as the shape of it, and what haptic stimuli would be the best to fit the mindfulness context.

3.3 Target Persona

After analyzing the mental and behavior model of verbal guided and non-guided mindfulness meditation practice among novice meditators, create an ideal target persona in order to build a foundation of design proposal and prototype design process. Through the brainstorm and ideation process, this ideal user was used to help justify the reasoning for the addition or reduction of features. Users' pain points were presented in order to satisfy as many needs as possible while addressing their internal motivations.

Target persona Novice Meditator A is a 29-year-old American female who is working at a cosmetic company in social media marketing department as a manager. She works to pursue more exposure, followers, and engagement both on her company's Instagram and Facebook homepage. Her work requires the high intensity of contents creation and community maintenance including campaign conductions and so on. During her first year as the manager of the department, she founds that her current life is almost about chasing the numbers of likes, followers, and viewer engagement flow, she decided to try to pay more attention to her real life and surrounding events after work instead of checking social media

numbers monitor every 30 minutes. One of her friends recommended her to take mindfulness meditation training to cultivate a mindful mind and enhance inner strength to cope with the ups and downs of social media works. She downloaded several meditation-base apps and following the trial, but she confuses about the process of practice and the essence of mindfulness. Then she booked the class at meditation studio and attended several times which helps her get a better understanding than only using apps. However, the more practice she has done, the more difficulties she realized. On the one hand, verbal guided meditation practice did help her find the right way to get inner peace but still, it is hard for her to get into the mindful state. She feels it is challenging to perceive what introduction is saying and be fully present at the same time, besides, the posture of Half Lotus makes her lower back pain and also makes her consistently thinks about the physical unpleasant during the practice. Moreover, it costs plenty of money to take such training program, and due to her changing schedule, it is not easy for her to keep following the same class with the same instructor. Then she started trying non-guided meditation practice by only with the therapeutic soundtrack with relaxation position at home. However, it doesn't give the same experience as the practice that she has done at the meditation studio. She feels the dilemma, and both two different practice approach cannot satisfy her needs.

"Novice meditator B" is a is a 20-year-old Japanese male, he is a college student major in Phycology. He has a regular lifestyle; it is early for him to find an internship in this year; therefore most of the time he stays at college and broadens the knowledge. He is getting interested in mental therapy industry and started doing mindfulness meditation by using apps contents occasionally for a couple of months because one of his current assignments is writing a paper about the research on meditation and how it helps people get a relatively positive mental state. He usually uses the meditation-based app and follows the verbal introduction to do some general meditation practice in the morning before going to the class. Then he found there are so many types of meditation practices that he had never tried before. After he finished the trail training programs on the apps for several genres of meditation, he decided to focus on mindfulness meditation for a while since it has more scientific evidence-based research. B doesn't have any part-time job, taking mindfulness meditation class at the meditation studio or any training institution is not a practical option for him. However, after repeating follow the apps' same free verbal introductions many times, he is getting familiar with the introduction even unconsciously recites it in the mind while doing med-

itation practice, which causes a not ideal experience for him. In order to get rid of the voice in his mind, he decided to try non-guided mindfulness meditation, but the experience has not changed better. Due to the verbal introductions still affects the way of his practice which makes him consistently think what to do next instead of being fully present. He felt that he lost his inner focus and hard to have a quality self-direct mindfulness meditation practice.

3.4 Design Concept

To pursue the goal of "ZONE" - designing a non-verbal instruction tool to support mindfulness meditation. Initial "ZONE"'s prototype is consists of two parts, "the Ground" and "the Mind". Two parts are haptics interface by utilizing haptics electronic components and pre-designed interaction model to replace verbal instruction implicitly. "ZONE" is a design method for initial stage prototyping that is applied to inform the design of systems incorporating technology components which do not yet exist. The purpose of the "ZONE" is in this study to simulate physical sensations by using haptic feedback to gain the insight of the users reaction to the feedback in the context of body scan, mind-flow observation, and breathing.

3.4.1 Body Scan Support: "The Ground"

"The Ground" is the instructor of body scan practice. The shape of it is a body fit meditation cushion mat to support the optimal mindfulness meditation posture - Half Lotus. "ZONE" promotes this posture to let novice meditator sit more grounded and more comfortable, "The Ground" is the solution. Its squared-off shape offers the greater support by keeping cushioning where meditator needed most, which is the knees and waist Microbeads filling offers a high degree of softness and support. The sand resists crushing over time to offer durability. "The Ground" intends to provide a more comfortable sitting experience to build a greater foundation of mindfulness meditation practice, it is designed to allow meditators sat firmly and wrapped with cushion mat from waist to knees.

For haptic feedback body scan instruction, "The Ground" with haptics components inside, the position of each stimulus are right underneath meditator's hips, legs and knees, which can stimulate body sensation implicitly to build meditator body awareness. The haptic stimuli are vibration with small vibrating ampoule

Figure 3.2: Sketch of The Ground

and thermotic with cooling and heating feedback. The stimuli of vibration motors are comparably direct, yet it could be considered as a distraction challenge to cultivate mindfulness by integrating "ZONE"'s user-guided which would be presented in the next section. On the other hand, thermotic stimuli are more intimate and subtle, which could allow meditator to keep the internal focus. The rhythm and timing of incentives, the subtlety of feedback are the design requirement.

3.4.2 Mind-Flow Observation Support: "The Mind"

"The Mind" is designed as a tool to help novice meditation log their brain activities during mindfulness meditation practice. It is a handful size in a ball shape with a soft resistant texture which is easy to hold and make meditators feel weak. "The Mind" has three interactive buttons, "Thoughts" and "Feeling", which are on the top left and top right of the ball, meditator can use their thumbs, give it a gentle push to complete the mind-flow record task. The third one "Intention" is down to the bottom of the ball; it is a special key that only be used in a specific situation, meditator is required to use little finger to reach this button "intentionally" to prevent the miss operation. The main function of these three buttons is to categorize and label the basic mind activities objectively and without judgment. "Thoughts" represents daydream, future plan, memories and so on.

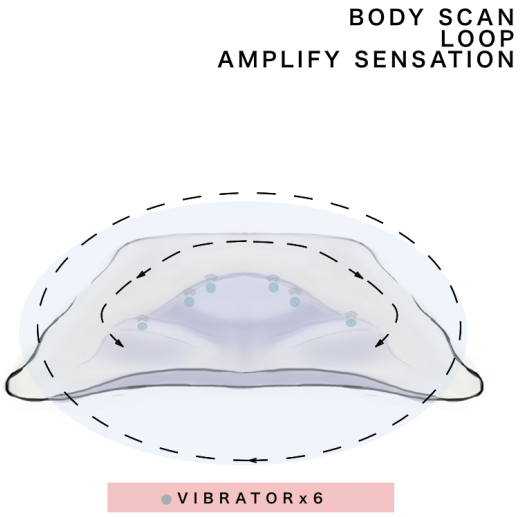

Figure 3.3: Feature of The Ground

"Feeling" includes physical sensations and emotions. Meditator needs to record these mind events appearing in mind and let them naturally pass away then back to aware the present moment. "Intension" is the special one, it is only used when meditator get caught in specific "Thoughts" or "Feeling" which ends up being the distraction. In this situation, meditator is required to force oneself to generate strong brain activity and inner strength to bring one back to the present moment, intentionally, let the distraction go or let it be. "The Mind" intends to provide greater support to cultivate novice meditator's ability that not subjectively define anything is happening in their mind at the present moment, prevent one from keeping thinking of one event gradually deeper that might cause one out of the present. By labeling the happening in one's mind with simple "terms" which help them to practice mind-flow observation smoothly and effectively. Through this process, the mind-flow record will be recorded and shows on "ZONE" application to allow meditator to do reflection. After mind-flow observation practice, "ZONE" app would suggest meditator pay attention to the record of "Intension" to think the reason why they got trapped, what happened at that moment.

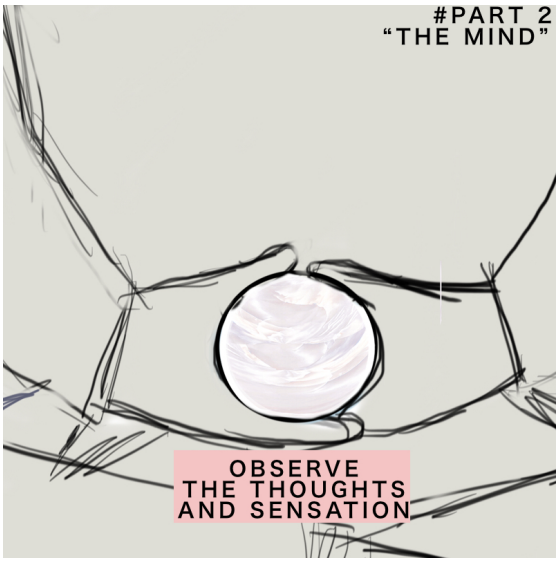

Figure 3.4: Sketch of The Mind

3.4.3 Combining with Breathing Practice

The last section introduced the essential functions and the form of devices, in this section, the complete user flow will be presented. Meditator can choose to meditate with sound therapy or aromatherapy, and they are optional. Besides, ”ZONE” will keep creating more related features, integrate them into ”The Ground” cushion mat to cover all the needs in the future. In this research, ”ZONE”’s initial prototype intends to concentrate on the haptic feedback and interaction with novice meditator.

User Flow and ”Three-Step Method

The user guide will be demonstrated on the ”ZONE” app in video format for the first time use. Meditator is requested to check the user guide carefully and patiently. The user guide will demonstrate the feature of ”The Ground” and ”The Mind”, the most important part is how to work with these two components to get a better experience and understanding of mindfulness meditation. ”ZONE”’s ”Three-Step Method” is vital for the whole non-verbal introduction mindfulness meditation experience, this method is based on the ”3x3 method” which have been mentioned in Chapter 2, ”ZONE” upgraded it to make it can be used while meditation. ”Three-Step Method” represent the order of a sequence of activities

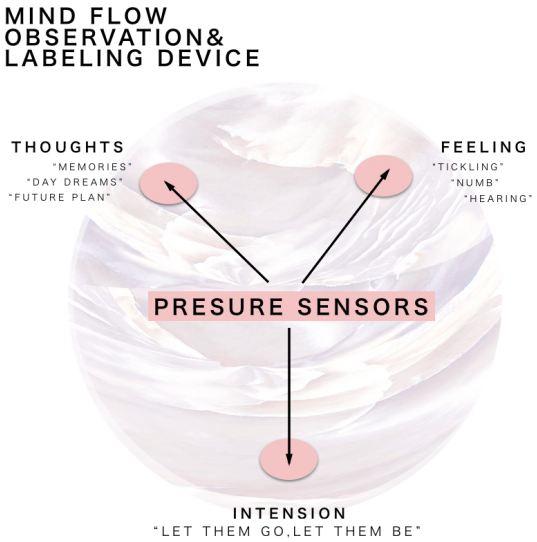

Figure 3.5: Feature of The Mind

while meditating: Aware and Define then Take a Deep Breath. It is the foundation of the practice and a vital tool to cultivate mindfulness which can highly be integrated into the haptic interaction based meditation guide. The purpose of this "Three-Step Method" is to introduce a concrete method of how to be mindful and how to face every single event that might happen in the future without adding the adjectives or having a strong subjective reaction.

10 Minutes Body Scan with "The Ground"

To work with "The Ground" instruction, it asks meditator to complete the "Three-Step Method" every single time when one's part of body is being stimulated.

1. Aware of the sensation.
2. Define the sensation absolutely objectively in one's mind as "This is my left leg " or "I feel my leg".
3. Take a deep breath after the definition of sensations is done and back to the moment.

This process will be iterated along with the stimuli working pattern. The process of "define" and "deep breath" is crucial for this practice, which could establish

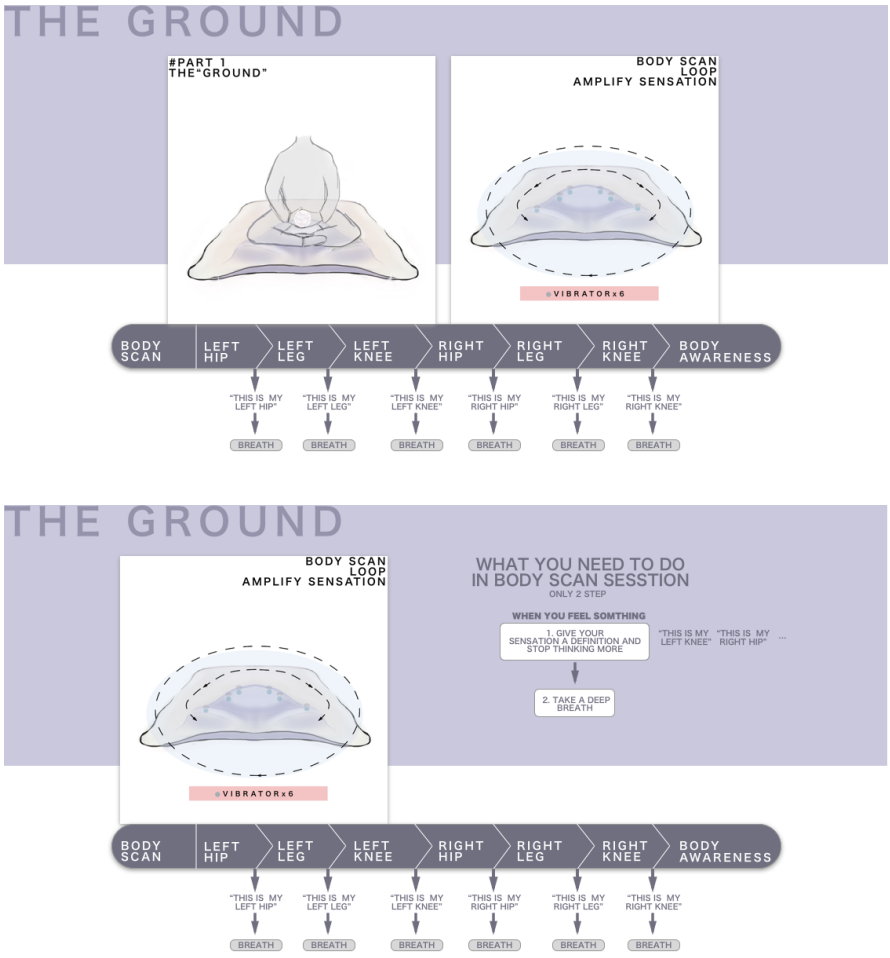

Figure 3.6: User Work Flow with "The Ground"

a mindful thinking pattern that follows the mindfulness principle. By doing this iteration several times, meditator might be familiar with the procedure being aware of the body in a mindful way. In this session, "The Ground" guided Body Scan for five minutes at the very beginning of this practice. Stimuli start working after one's one-minute meditation preparation. After the preparation, stimuli will generate haptic feedback in the first route, from left hip, left leg, left knee, right hip, right leg, and right hip. Then starts with the second route in the order from the left hip, left leg, left knee, right knee, right hip. The final round will generate two stimuli at one time, starts from the left and right hips, left and right legs, and lastly the left and right knees. Each simulation with 30 seconds interval, to create

a period to allow meditator to focus on internal body awareness and combine the breathing practice which has been introduced the "Two-Step Method" to ensure one can back to the present moment successfully. After following the haptic introduction for five minutes, meditator needs to finish the body scan meditation on one's own for the rest of the time by using the same technique which is "Three-Step Method". The rest of five minutes would provide an opportunity to novice meditator utilize the constructed non-judgment thinking pattern, being the fully present behavior mode into the practice, to seek more internal focus.

10 Minutes Mind-Flow Observation with "The Mind"

"The Mind" is a mind-observing recorder; it helps meditator initial the observation mode to see what is happening in one's mind at the moment, as well as to see the changing of the brain activities. Using "The Mind" requires meditator to combine "Three-Step Method" through the entire ten-minute mind-flow observation practice. As mentioned in the feature description of "The Mind", meditator needs to record what is happening in their mind in the present moment by labeling them into three categories, "Thoughts", "Feelings", and "Intention".

1. Aware of the mind
2. Define what happens in the mind, meanwhile pushing the specific record button to match the categories, and let the thoughts or feelings naturally disappear. When it is hard to get rid of one particular thought or feeling, meditator needs to use strong brain activity to let it go or let it be, pushing "Intention" button same time, intentionally ignore or accept this situation.
3. Take a deep breath and back to the present moment, keep observing.

"The Mind" provides a greater tool to help novice meditator to know one's thinking pattern which is usually being ignored in general by most of novice meditators, keep one's mind stay in concentration, prevent wandering or empty mind. This session is a self-direct practice, it supports novice meditator to have a better experience of non-verbal introduction to mindfulness meditation.

3.5 Design Summary: ZONE

The initial design of "ZONE" is combining body scan instructor "The Ground" and mind-flow observation tool "The Mind", two artifacts that work separately

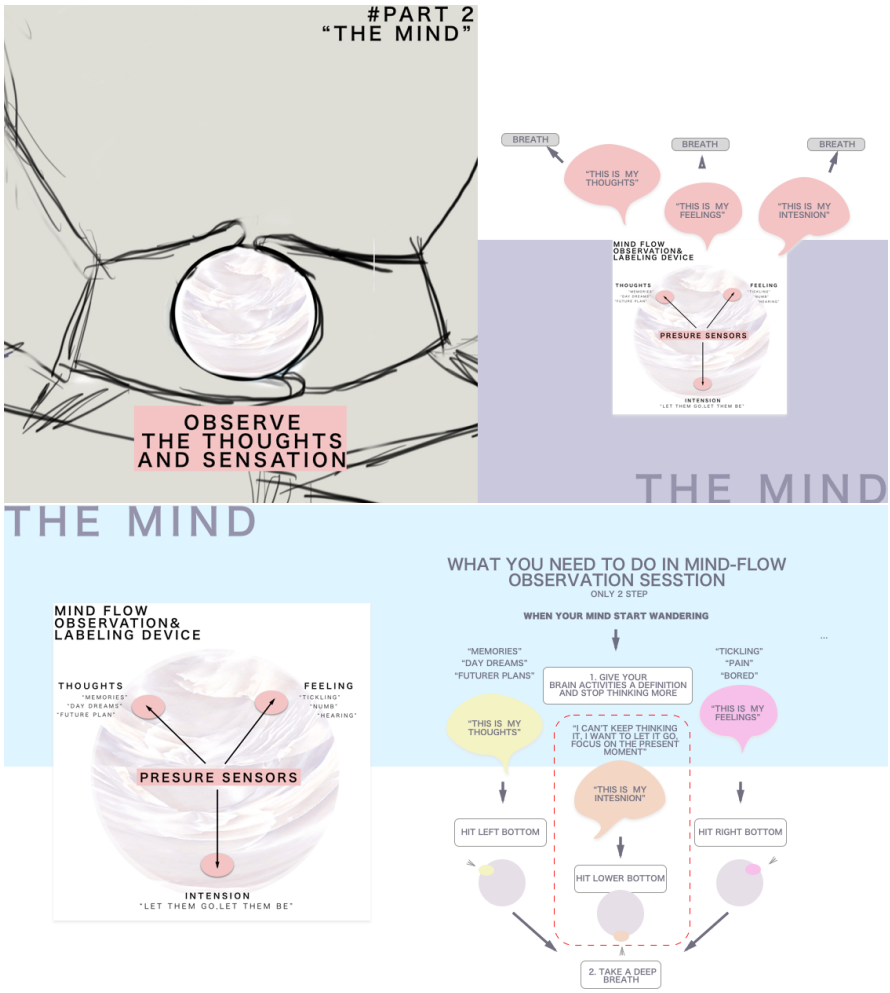

Figure 3.7: User Work Flow with "The Mind"

in a customized order that depends on novice meditator how they build up their mindfulness meditation practice routine. In "ZONE" 's user guide, it provides suggestions that help meditator to do conduct self-direct practice. At the initial stage, novice meditator will be suggested to stay in a calm and peaceful state for at least 5 minutes before starting the following practice with "ZONE"'s artifacts use. When they feel the timing is right and ready, they can choose start body scan practice with "The Ground" for 10 minutes to enhance body awareness, through this practice, meditator's body awareness and concentration would have gradually become sensitive and stable. Then using "The Mind" to observe mind-flow till the end of practice, the optimal duration of mind-flow observation is 10

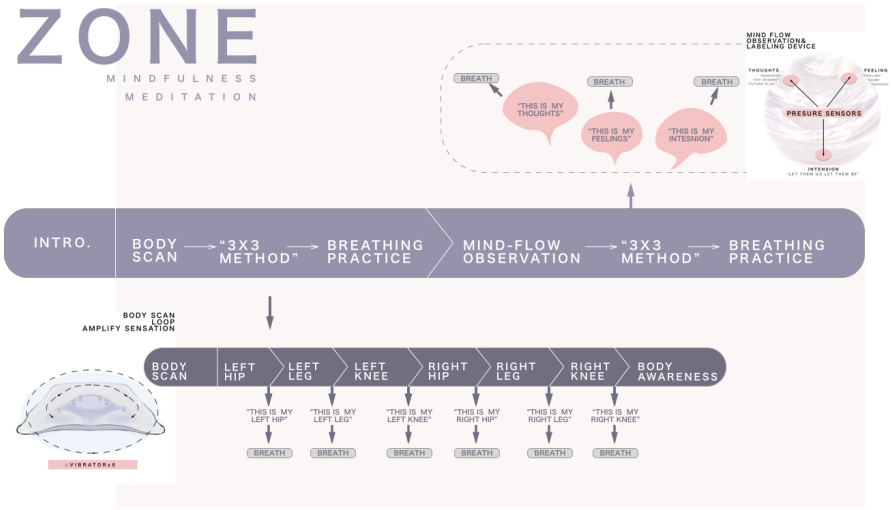

Figure 3.8: User Work Flow with "The Ground"

minutes in minimum. Two artifacts can be used separately for different purposes. "The Mind" in a portable version that allows novice meditator to do mind-flow observation everywhere in anytime.

3.6 Prototype Design

The basis of designing the "ZONE" prototype was aiming at using it to gather supporting evidence that it can deliver its value through functioning, meanwhile providing novice meditator a solution that can support them to conduct self-direct mindfulness meditation to achieve the optimal inner focus and being fully present. This prototype would be tested through various perspectives: Is it valid as a novel approach of non-verbal guided mindfulness meditation introduction? How much can it help novice meditator cultivate mindfulness scale? Additionally, the interaction between "ZONE" and user's physical sensation, emotion, brain activity and so on, which can be summarized as the overall user experience is also being crucial criteria for creating this prototype. Following mindfulness principal is the foundation of the design, it is important to guarantee the minimum interruption that might be caused by haptic interactions during the practice. Beyond

this baseline, maximize the capability of cultivating mindfulness understanding through this approach is the goal. After compiling the data from the fieldwork, user understanding, key factor identification phases, using the target persona to predict possible outcomes for user experience flow. It provides the direction of prototype creation and the basic guideline of utility and experience design.

First time using full set up of "ZONE" UX logic Flow

1. User sits on "The Ground"
2. User check the basic introduction and mindfulness meditation tutorial on "ZONE" application
3. User presets the "The Ground" and "The Mind"'s interaction manner and duration as the introduction on "ZONE" application
4. User holds "The Mind"
5. User starts non-verbal guided self-direct mindfulness meditation
6. User starts to calm down and be peaceful until whenever it is ready
7. "The Ground" Starts introducing body scan practice by stimulating user's body sensation in a preset manner and duration.
8. User feels physical sensation, defines it as "This is my leg" in make, then take a deep breath.
9. User iterates this practice by being interacted with "The Gound"
10. User is getting familiar with this cognition and action pattern
11. "The Ground" finish the body scan introducing at the timing of the preset duration
12. User starts doing the rest of body scan practice driven by one's inner focus and the cultivated cognition and action pattern.
13. User gets further enhanced body awareness, the basic understanding of non-judgmental quality, and how to focus on the present moment.
14. User starts doing mind-flow observation and holds "The Mind".

15. User is aware that something is appearing in mind, which is the memory of yesterday's party, push the "Thoughts" button to record it, then take a deep breath.

16. User is aware that something is appearing in mind, which is the feeling of tickling on the face, push the "Feeling" button to record it, then take a deep breath.

17. User cannot stop thinking about the tickling, generate strong brain activity to let it go, presses the "Intention" button to record this activity, taking a deep breath after it.

18. User iterates the same cognition and action pattern during the mind-flow observation practice.

19. User finish the mind-flow observation practice

20. User knows how to conduct mind-flow observation practice, a better understanding of non-judgmental quality, how to deal with the distractions, how to focus on the present moment.

With skills in Arduino, hardware, videos, application development, interaction design, visual design, I am capable of creating a complex prototype to meet the design requirements. A fidelity prototype was developed. I created the hardware circuit on circuito.io[2]which made the wiring process much clear and perceivable.

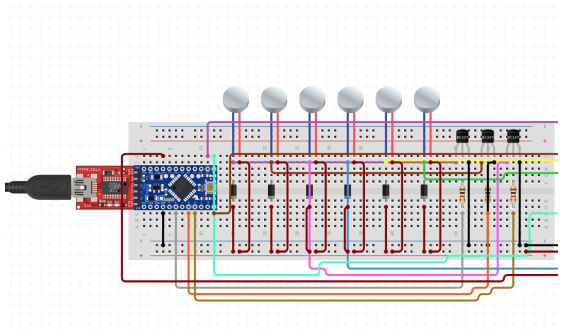

Figure 3.9: Circuit of "The Ground"

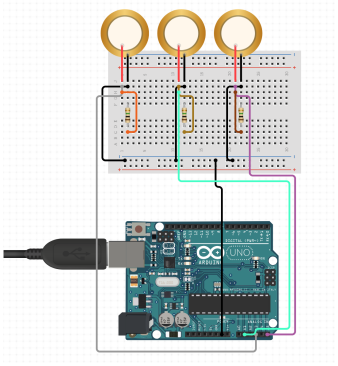

Figure 3.10: Circuit of "The Ground"

Figure 3.11: Hardware of The Ground

Hardware and the initial experiment version of "The Gound"

For the initial prototype, I decided to use the vibration motor as stimuli to test the body scan introduction ability and the bias of potential distraction quality of vibratile interaction in meditation context. Previous research has mentioned that vibratile stimulation might be too strong for the medication use. However, for the very initial evaluation of "ZONE", it is crucial to evaluate whether the haptic interaction approach can be an alternate of verbal body scan introduction. Thus, the direct stimulation solution was being considered as the first choice at the very beginning stage. Meanwhile, I was trying to weaken the "side effect" that might be caused by the strong vibratile interaction which may potentially kick user out of the mindful state. I started by creating the sketches of the circuits,

the hardware of "The Gound" consists of the following components:

Primary Parts:

- Arduino Pro Mini 328 - 5v/16MHz
- SparkFun FTDI Basic Breakout - 5V
- USB Mini-B Cable - 6 Foot
- 6 Vibration Motor

Secondary Parts:

- 6 1K Ohm Resistor
- 6 Transistor - NPN BC337
- 6 Diode Rectifier - 1A 50V
- BreadBoard
- Jumper Wires

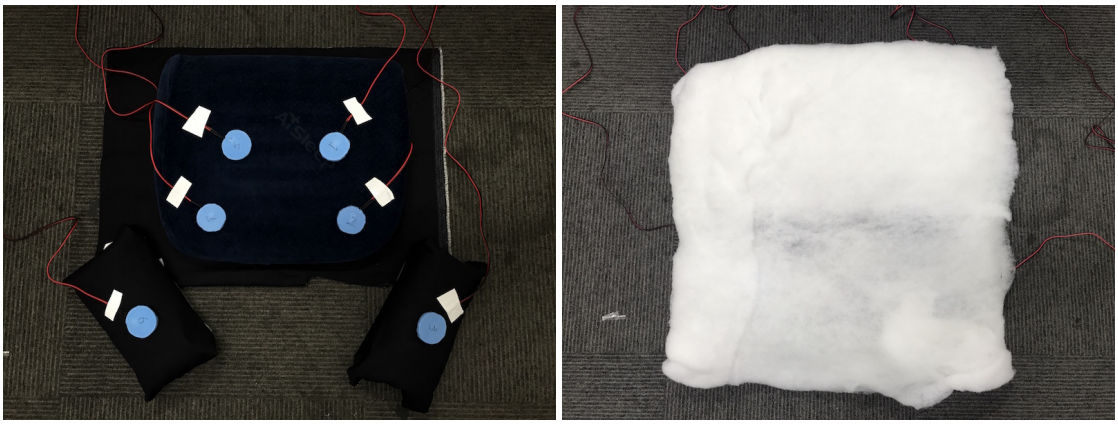

Figure 3.12: Hardware of The Ground

I chose Arduino Pro Mini 328 - 5v/16MHz to drive six vibrators since it has more available pins to work with. I started by soldering Arduino Pro Mini 328 and SparkFun FTDI Basic Breakout together. Then ss the circuit design, I wire the secondary parts together which is including the six vibration motors, then

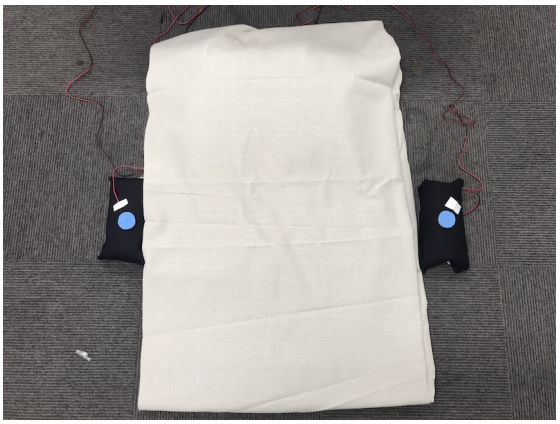

Figure 3.13: Prototype of The Ground

connect to the Windows Arduino text editor, wrote the testing code to test if everything is connected and work. Then I wrote the code for "The Ground" body scan introduction purpose, following by the manner that is presented in the design concept section. The vibration motors are going to be put underneath meditator's hips, legs and knees, it is necessary to coat the vibrators with bendable, soft material to make the existing of the six vibrators more non-perceptible. I use Ethylene-vinyl acetate plastic board in 3mm thick version, I cut it into six rounded shape pieces, the size is two times bigger than the vibrator's, after that, I split each rounded piece by half and insert the vibration motor into it. To make the experimental prototype more close to the final product ideation. I choose a regular cushion, and my two handmade knees cushion as the base, then I placed six vibrators in the right position, cover the whole sitting cushion by 10cm thick cotton to make it more comfortable to sit on, finally I put 3mm thick linen fabric over the whole set up in order to make it as close as design sketch.

Hardware and the initial experiment version of "The Mind"

"The Mind" is an input interface device without output feedback, the basic idea of it is to provide a natural hand position and still can be used as an interface that anyone can work with effortlessly. The hardware of "The Gound" consists of the following components:

Primary Parts

- USB Cable A to B

Figure 3.14: Hardware of The Mind

- Arduino Uno
- 3 Piezo Element

Secondary Parts

- 3 1.0M Ohm Resistor
- BreadBoard - Half Size
- Jumper Wires

Initial prototype "The Mind" consists of one handful ball in 8cm diameter size, which can be entirely held by two hands, three Piezo Elements (pressure sensors) were placed on the position as the design concept sketches. As the same approach that I had done with the vibration motors of "The Ground", I made 3 rounded pieces as cover and while working as fingertips size button for each Piezo Element (pressure sensor). I attached them on the ball firmly, tested by code to make sure the circuit is working, then I started writing code for each sensor to create the mind-flow recording function. For the mind-flow recording data, I combined the Arduino Serial board and software Tera Term software which can monitor the results on Arduino Serial board, and convert it into CSV file with logging time. It helps the evaluation and data analysis process.

Figure 3.15: Prototype of The Mind

Notes

1 https://www.webwire.com/ViewPressRel.asp?aId=214152

2 https://www.calm.com/

3 https://www.headspace.com/

4 http://www.choosemuse.com/

5 https://spire.io//

Chapter 4
Evaluation

This research aims to prove the utilization of haptic interactions based mindfulness meditation practice introduction can guide novice meditator to conduct self-direct practice, cultivate mindfulness scale with a qualitatively positive interaction through customized experiences in daily life scenario. The concept and approach of "ZONE" to reach this goal by (1) Utilizing and exploring the feasibility of haptics interaction to guide body scan which is part of mindfulness meditation practice. Expanding research on meditator's physiological and psychological responses during mindfulness meditation as they relate to haptics output; (2) Utilizing and exploring the feasibility of how haptics interface supports mind-flow observation practice during mindfulness meditation. Finding more insights and feedback through physiological and psychological responses; (3)integrating with traditional mindfulness meditation breathing practice methodology and mindful principle and attitude with the haptics interaction based meditation guide to enhance the experience; (4)creating a set of artifacts that can deliver "ZONE"'s proposal which can be used by novice meditator on a daily basis. This research focuses on these three areas, the initial prototypes were tested and updated in order to obtain more insights and understanding to create the final product in the future.

The prototype for experimentation used the vibratile output as body-scan guide and haptics input as mind-flow observation support, combining the breathing practice technique and mindful attitude, in order to purposefully cultivate mindfulness scale and support non-verbal guided mindfulness meditation for novice meditator. Each participants electroencephalography(EEG) data was monitored in real time in order to observe the physiological feedback during meditation practice with "ZONE"'s support. Before and After participants completed "ZONE" supported mindfulness meditation, they were required to assess mindfulness scale that reflected on five facets of mindfulness, which are Observing, Describing, Acting with Awareness, Non-Judging, Non-reactivity. On completion of the testing,

the participants completed a follow-up survey that reflected on their experience by using "ZONE" and also verbal guided mindfulness meditation. Comparing the mindfulness scale and the experience of non-verbal guided mindfulness meditation both with and without the use of the "ZONE". In order to obtain more sample EEG data when meditator's following verbal guided mindfulness meditation introduction, participants were also required to do so and completed the evaluation survey afterward.

The experiment design aimed to assess and evaluate: (1) "ZONE" prototype did or did not add additional distraction or disturb meditator during mindfulness meditation; (2) the usability of "ZONE" protoype to support and enhance non-verbal guided body scan and mind-flow observation experience for novice meditator; (3) the changing of mindfulness scale after being supported by "ZONE" ; (4) meditator found the form and interaction experience positive and beneficial; (5) the overall user experience of "ZONE".

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4.1 Methodology

Through user testing by using the "ZONE" prototype, the evaluation consisted of experimentation with participants in a controlled setting through the sessions below: Stress level testing for obtaining mental state reference, 10 minutes of verbal guided mindfulness meditation (Emotiv equipped) Verbal guided mindfulness meditation experience evaluation survey and interviews; First-time mindfulness scale assessment; "ZONE" supported mindfulness meditation (Emotiv equipped): 10 minutes body scan practice using "The Ground"; 10 minutes mind-flow observation using "The Mind"; Second-time mindfulness scale assessment"ZONE" evaluation survey and interviews.

4.1.1 Participant

There were 12 participants in total, 10 Participants I chose were mostly novice mindfulness meditator, who had limited knowledge of mindfulness or meditation techniques either. The rest of 2 had experience on mindfulness meditation and other meditation genres, and also had experience of the meditation-based app using and meditation training at related studios. These 2 participants were vital to provide the deeper user experience feedback for this work. The critical tasks

for this experimentation which were to compare and observe the physiological and psychological responses and overall practice experience under two different conditions, verbal guided mindfulness meditation and using "ZONE" including "The Ground" and "The Mind". Besides, to assess the possibility of cultivating mindfulness scale by practicing with "ZONE" approach. It was important to control the content, duration, and the environment of two practices as identical as possible.

4.1.2 Controlled the variables of contents for mindfulness meditation practice

In order to limit the variety of the comparison between two different approaches. The content of verbal guided mindfulness meditation guidance was chosen close to "ZONE"'s pattern as possible. One needs to be mentioned is that the method and timing of the introduction for breathing practice might be slightly different, due to the original breathing practice methodology "Three-Step Method" is based on the haptics interaction system model. But the body scan and mind-flow observation parts were kept both similar. Which means participants followed the same practices on mindfulness protocol and principle, the differences are the way to instruct by two different approaches. "ZONE" tried to convert verbal guidance into haptics interaction as being presented in chapter three. The point of this comparison is to give more understanding and explore the effectiveness and feasibility of "ZONE"'s concept.

4.1.3 Controlled variables of contents and scaling system for the evaluation questionnaire

Self-evaluation for performance, overall opinion and user experience of two different guidance methods through questionnaire were conducted right after each session. The design of the questionnaires pursued to keep the same format and same questions and scaling system including Scaling questions, Multiple choice questions. The contents of each questionnaire consist of three dimensions, self-evaluation, the effectiveness of the approach, user experience and satisfaction.

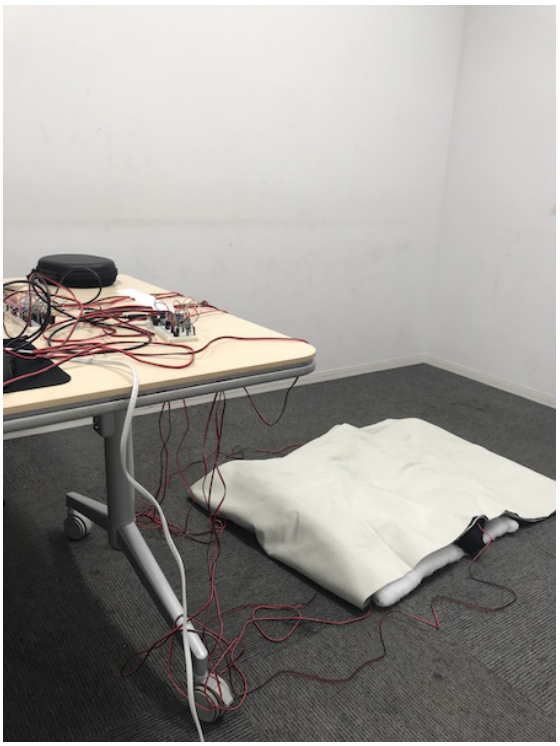

Figure 4.1: Experiment setting

4.2 Experiment Setting

The experiment was conducted in a controlled environment within an isolated room in order to provide the ideal meditation conditions and reduce the variables. During the meditation, the lighting was adjusted to the dim light, the temperature of the room, and the positioning of set up was maintained as similar as possible for each examination. The experiment set up consisted of the following items: A chair for verbal guided mindfulness meditation, "The Ground" prototype, "The Mind" prototype, a Emotiv, evaluation forms, a Mac book Pro for tracking and recording real-time EEG data and play the verbal guided mindfulness meditation introduction, a Windows laptop for driving "The Ground" and "The Mind" prototypes and tracking and recording the real-time mind-flow observation data, a meeting table with two chairs to place the computers and conduct the evaluation session for participants. An audio recorder for user interview. For each participant, an Emotiv was equipped on one's head during verbal guided mindfulness meditation practice, and non-verbal guided mindfulness meditation by using "ZONE", EEG

raw data was recorded by paired software Emotiv Pro in 200(uV) Channel spacing, -100(uV) Amplitude min, 100(uV) Amplitude max scale, also performance metric evaluation including: stress, engagement, interest, excitement, focus, and relaxation .

4.3 Experiment Flow

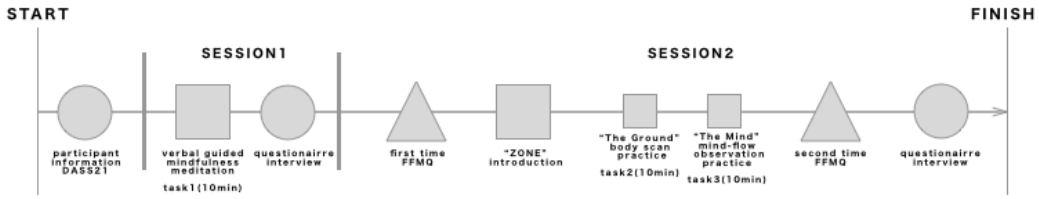

Figure 4.2: The experiment procedure

4.3.1 Participant information

The form consists of three parts, first, the basic questions about the age, gender, background, occupation. Second, participants were required to finish the scale questions which were designed from one point to five points for assessing mental health, physical health, and one point to ten points for assessing the general stress level. In the third part, participants were asked to leave the details of information relating mindfulness meditation experience, simply scaling the current knowledge about mindfulness and mindfulness meditation from one point to ten points. Then, participants completed the simple self-evaluation by scale questions from one point to five points, to estimate the following questions: how often pay attention to the present moment, how often think about the future plan or past events. And the last question is have ever observed the mind-flow. The third part is specially designed to obtain the general overview of where each participant was relating the basic facet of mindfulness of each participant at the first place.

4.3.2 The stress test

To clarify each participant current mental state more specifically considering it would be an additional variety for this experiment, each participant were required to assess the stress level at the very beginning of the experiment by complete the DASS21 assessment.

4.3.3 First Session: Verbal guided meditation practice session

Figure 4.3: Verbal Guided Meditation Practice Session

1. In order to represent the scenario how novice meditators start doing mindfulness meditation by using the meditation-based app at home, participants were required to sit on a chair in a relaxation position following the verbal guide mindfulness meditation for ten minutes mindfulness meditation practice. The audio resource is from a responsible mindfulness education organization-Mdiddleway Mindfulness Centre : Guided Mindfulness Meditation-10 Minutes[1], which includes

breathing practice, body scan practice, and mind-flow awareness building. For each participant, an Emotiv was equipped during this session.

2. After the practice, participants moved on to complete the verbal guide meditation self-evaluation questionnaire including the performance and user experience, also the interview was coming after which including the following topic: overall experience; The pain points, the hardest part.

4.3.4 Second Session: The utilization of "ZONE" prototype

1. First-time mindfulness scale assessment Participants were required to take the first Mindfulness-Five Facet Mindfulness Questionnaire(FFMQ) after the first session. The reason why the first FFMQ wasn't designed before the verbal guide mindfulness meditation session is that the purpose for eliminating the influence of the first session. Participants would redo FFMQ after the second session: the utilization of "ZONE", if I put this assessment before the first session, it might create an additional variety of evaluating the viability of cultivating mindfulness scale by using "ZONE", especially for the data comparison before and after using "ZONE". Furthermore, to explore the effectiveness and influence of the verbally guided mindfulness meditation to build mindfulness qualities for novice meditator is also another reason.

2. The introduction of "ZONE" After the first-time FFMQ mindfulness assessment, participants were instructed how to use "ZONE" including "The Ground" and "The Mind" as the tool to practice non-verbal guided mindfulness meditation. Participants started by watching and reading "ZONE" user guide to obtain the general idea of the artifact, as well as the mindfulness principle and attitude which were delivered by video. Also, participants were taught to how to combine "Three-Step Method" which had been introduced in chapter three, the method to work with the haptic output based interface as body scan guidance by "The Ground", and input interaction based interface as mind-flow observation assistance by "The Mind". For each participant, an Emotiv was equipped with both "The Ground", "The Mind" testing.

3. "The Ground" body scan Participants were sitting on "The Ground" cushion mat in half Lotus position for ten minutes. For each participant, an Emotiv was equipped on one's head during this session for recording and tracking EEG data. Six vibration motors to guide body scan practice were mapped underneath

Figure 4.4: "The Ground" Testing Session

their hips, legs, and knees. In the first one minute and a half, participants were allowed to get into the meditation mode without vibration stimuli guidance. The stimuli started guidance with implicit motion after the preparation, a feed forward system was built with a pre-set frequency and motion. Each stimulus was activated twice between 0.2-second delay in 0.5-second duration in an implied manner. The order of six stimuli was pre-set based on the design concept which has been mentioned in chapter three. In the first round, stimuli were generated separately with a 30-second interval in a clockwise direction. The second round was in a counterclockwise direction. This enables the meditator to identify subtle feedback on the certain part of the body. When participants aware of the sensitive tactile feelings from the lower body where attached to the ground, they did self-initiate "Three-Step method", define the feeling with a simple word non-judgmentally in mind, and take a deep breath. This action was iterated every time they felt being stimulated. After the guidance, participants were provided self-direct body scan to repeat this behavior pattern without tactile guidance until the end of practice.

4. "The Mind" mind-flow observation

Participants kept sitting on "The Ground" mat cushion. "The Mind" testing session was last for ten minutes. Since they were already taught to how to use

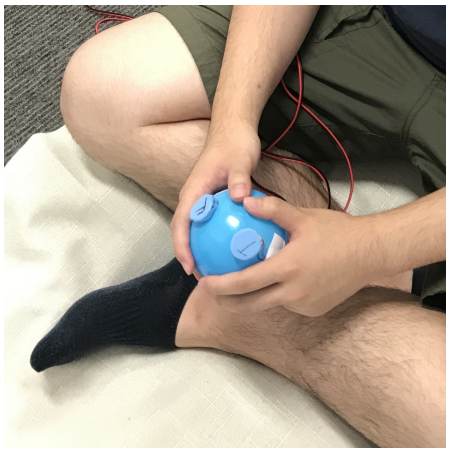

Figure 4.5: "The Mind" Testing Session

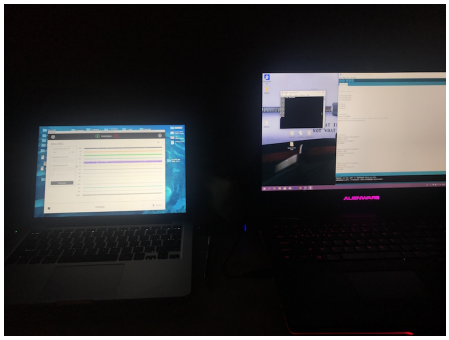

Figure 4.6: Recording the EEG data and Mind-flow

"The Mind" haptics interface to recording their brain activities and how to categorize and label them into "Thoughts", "Feeling", "Intention" non-judgementally, participants began to observe their mind following the instruction by the examiner. Participants were instructed to start holding "The Mind" haptics interface. Once participants push one of the buttons on "The Mind", their mind-flow would be shown on the Tera Term monitor Fig.4.6 which was connected to the Arduino serial board. The log data were converted into CSV and TXT format including date and time and were presented to participants right after the practice.

5.Second-time mindfulness scale assessment When the "ZONE" testing session had done. Participants accepted the second time Mindfulness-Five Facet Mindfulness Questionnaire(FFMQ), to evaluate their changing before and after using "ZONE".

6. "ZONE" evaluation and interview Participants completed the evaluation for "ZONE" concept and product, as well as their performance and experience while using "ZONE". The interview session was held for thirty minutes. The interviews included the use of "The Ground" and "The Mind" in general; The completion of the tasks. Overall user experience and usability; The pain points, the hardest part, motivation and interest. For the script of interviews, to dig more information from each participant, it was designed to avoid "yes" and "no" questions as much as possible to make the discussion and conversation go through smoothly.

4.4 Study One: Evaluation of Usability, Effectiveness of "ZONE"

4.4.1 Comparison of audio guided and "ZONE" guided mindfulness meditation

The evaluation of self-evaluation for performance, overall opinion and user experience of two different guidance methods through the questionnaires which were controlled the question variation and format as mentioned before. Besides, further information from the participants was obtained through interview sessions which were conducted right after the evaluation questionnaire. The questionnaire consists of three dimensions, self-evaluation, the effectiveness of the approach, user experience and satisfaction, broke down into "Self-performance(concentration and engagement)", "Understanding of Mindfulness", "Fully present", "Body Awareness", "Mind-flow observation", "Non-judgement". The chart fig.4.7 presented the average points of each trait that being considered as the mindfulness quality were scaled by 12 participants. It could be perceived as the metric to judge the performance under two guidance. According to the chart, it shows the result of the questionnaire among two different approaches. For self-performance(concentration and engagement), "ZONE" shows the higher points in terms of the concept of "ZONE" is to encourage inner focus that drives self-driven mindfulness meditation by following the haptics guidance and assistance. Through "ZONE" haptics interaction guided practice, participants average points on "Understanding of Mindfulness", "Fully present", are also higher than verbal guided guidance. "ZONE" aimed to provide more flexible space to maximize meditator's internal concentration that

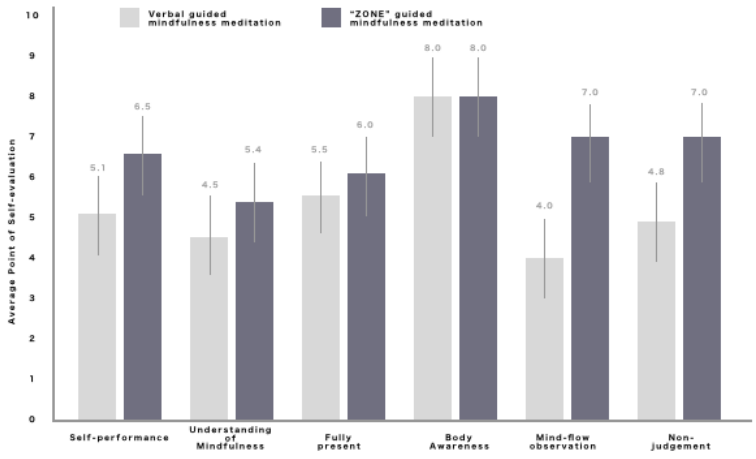

Figure 4.7: Self-evaluation Average Score

can help meditator take mindfulness principles into the real practice, and feel the present moment, the changing of the everything that happened at that specific moment concretely. The chart also shows the significant inequalities on the average point of "Mind-flow observation" and "Non-judgement" features. It indicates that the concept of "The Mind" and "Three-Step Method" might perform more supportive for the cultivation of these qualities. For the "Body Awareness" feature, the self-evaluation questionnaire doesn't show the difference between two approaches, which could be considered that "The Ground" might not perform the efficiency of as the expected based on the design concept.

The summary of the information from the interview as fig.4.8 The participants were asked more specific details about each feature from the questionnaire, also including the overall experience of practices. Concerning the Self-performance(concentration and performance) reflection, ten novice meditator participants stated, being practice with verbal guidance, the relaxation effect is more significant, but it also caused their mind started wandering at a various level. Sometimes they found themselves lost engagement to the extent that ignored the introduction and let the mind wander for a couple minutes. On the contrary, the self-performance review on the practice guided by "ZONE", most of the participants gave comments including, "highly concentrated and engaged", "even hard to get time to let brain wander". One of the novice meditator participants also mentioned, after "ZONE" guided meditation, she felt that this practice requires much energy, which means the "ZONE" has limited relaxation outcome; however,

	10 Novice Meditator		2 Advance Meidtator	
	Verbal Guided	Zone Guided	Verbal Guided	Zone Guided
Self-performance	"Calm" "Relax" "Sleepy" "Sometimes lost focus" "Stress reduced" "Paid to much attention to the verbal guide"	"Fully engage to the practice" "Know how to not be distracted" "Put much energy into practice"	"Good for relaxation" "Stress reduced"	"Fully engage to the practice" "Higher internal focus" "Better performance"
Understanding of Mindfulness	"Not really sure about what mindfulness it is"	"Got the concpet of mindfulness"	"Maybe there's another way to build mindfulness"	"Felt more about what mindfulness it is"
Fully present	"Hard to process the guidance and be fully present at same time" "Tended to wait for the next introduction or couldn't catch up the introduction which cause not be present"	"Did pay attention to the moment by moment" "Did aware there were too many things happended in just one second "	"Sometimes the internal focus that was on the present couldn't match the pace of instroduction"	"Did pay attention to the moment by moment at my pace" "Percieve things more subtly"
Body Awareness	"Did feel the sensation of body much sensitively"	"Did feel the sensation of body but too directly"	"Did feel the sensation of body much sensitively"	"Did feel the sensation of body but too directly"
Mind-flow observation	"Not sure wether I was doing right"	"Did understatnd how to observe mind-flow" "Interesting practice, really did focues on the ovservation"	"Only followed what introduction ask to imagine"	"Percieve mind-flow more subtly" "Hard to get trapped into one specific thougts"
Non-judgement	"Didn't know what specific objects need to be non-judged"	"Did feel how to see and perceive the things in a non-judgemetal way"	"Only followed what introduction ask to imagine"	"Got how to be non-judgemental during the practice"

Figure 4.8: Comparison of Verbal-Guided and "ZONE" Guided Mindfulness Meditation Interview Summary

the positive emotional change was significant. When the conversation topic moved on to "Understanding of Mindfulness", 8 of them gave the responses which mainly refer to the limited understanding of the concepts of mindfulness by following the verbal guidance, but after using "ZONE", 10 novice meditator participants related the growth of mindfulness knowledge especially on the concept of aware of present moment and non-judgement attitude and indicated the contribution of the combination of "ZONE" and its "Three-Step Method" . This group of participants also discussed that compare to the verbal guidance, the experience of being fully present by following "ZONE" guidance is more distinct and concrete in terms of the given opportunity to pay attention to the "things" that happened at the present instead of forcing themselves to comprehend and catch up the verbal guidance. According to the response, the body awareness was build up by each approach, yet, "ZONE" 's "The Ground" protoype was consists of vibratile stimuli, which affect the ideal practice experience in terms of the direct stimulation that might take the existing sensation away from participants' body. For this feature, 5 participants of this group showed the more satisfaction on verbal guided body scan practice. 8 participants in this group also talked about that there were notable memories about whether they did mind-flow observation or not when they were doing verbal guided practice. 10 of them mentioned that "ZONE"'s "The Mind" protoype did support them to conduct mind-flow observation practice notably. Furthermore, 2 advance meditator had the similar opinions, they also provided an

interesting view that the verbal guided mindfulness meditation practice confused them which should be the evaluation object for the performance of concentration during the practice, it could be paying more focus on the guidance or themselves or the present moment. The advanced group said they are satisfied with the self-driven practice that supported by "ZONE" system which provided more internal focus space to them that helped to enhance the mindful state.

4.4.2 Effectiveness of Haptics Interaction Based Body Scan Introduction and Mind-flow Observation Support

	REACTION TO FEEDBACK/INTERACTION		USABILITY	USER EXPERIENCE
	EEG RESPONSE	INTERVIEW		
"The Ground"	10 participants had stabled reasponse 2participants had fluctuate reasponse to the stimuli	"It helped to build body awareness" "Tickled" "A little bit direct" "Lack of preciseness and implicity" "Intentional"	All participants completed the task "Easy to use " "Easy to feel " "Cushion should be more fit to the body "	"Got the concept of body awareness" "Know how to deal with distraction from unpleasure physical sensation" "Didn't pay too much attention to the upper body " "Want self-initiate body sensation awareness simulator"
"The Mind"	All participants had stabled reasponse	"It helped the mind-flow observation practice" "Subtle" "Comfortable " "Intimate " "Approporate" "Nice " "Like it"	All participants completed the task "Easy to use " "Easy to reach the button unconciously " "Like the form of device" "Like the handful size" "Like the feeling of pressing button" "The feature of each button is lack of affordance for first time use"	"Felt secure" "Highly engaged to the ovservation practice" "Unique and interesting experience" "Didn't want to stop the practice" "See world in another way after practice" "Less anxiety and stress"

Figure 4.9: User Reaction, Usability, User Experience Summary

To have the understanding of how "The Ground" and "The Mind" performed, more specific questions and discussion about the usability and user experience oriented talks were conducted. As the fig. shows, I summarised the keywords from each interview that could clarify the information from the feedback. Also, the EEG responses from 12 participants during the test could provide some related information on the reaction to the haptics interaction based mindfulness meditation guidance toon on the physiological aspect. Since high-temporal-resolution techniques are well suited to capture the fast, dynamic and temporally sequenced cognitive events.

"The Ground"

To figure out how does the haptics based body scan guidance affect meditator, the evaluation of the reaction to the feedback and the form of interaction design is important. Since the initial "The Ground" prototype used vibration motors as stimulation for building body sensation, it is obvious that participants could fully sense the stimuli caused physical feeling on certain body area through the pre-designed haptics feedback pattern, yet, in mindfulness meditation context, in order to follow the mindfulness principle, the design of the tactile interaction becomes extremely difficult. Thus, using vibration motors make this evaluation easier to find out the feasibility and limitation of this approach. It should be mentioned that since I put a thick cotton barrier over the vibration motors to make the cushion mat more comfortable to sit on, which reduced the power of the original (vibration motors driven by 5V pin, 450 mA). The examination of "The Ground" mainly focus on participants' responses to the stimuli as well as the user experience. After reviewing the EEG recorded during the test group of participants, it shows various EEG responses. All participants closed their eyes during this session, hence the variation happened at the moment when the vibrator started the motion. 10 of the participants had stabled EEG sequence during testing, 2 female participants had notable movement when the vibratile stimuli were generated as the fig.4.10, these raw EEG data were selected in the same period of time when the stimulus was generated.

Combining the feedback from the interview session, these 2 participants mentioned, the noise of the vibrator was the main reason why they got disturbed at that moment, not due to the power or motion of the vibration. Interestingly, this group said that through "Three-Step Method", they just defined this "unexpected" event as "I heard something" "This is my right leg" and take a deep breath, which dragged them back to focus on the present moment. Besides, according to other 10 participants, the vibratile feedback didn't cause the distraction to the mindfulness body scan practice, it could be considered as part of the training that how to deal with the unexpected situation. They also mentioned the understanding that stimulus was only one of the elements to build the whole "The Ground" training concept. Also, they talked about the usability of "The Ground" was straightforward and easy to understand, as well as the capability to build body awareness. There was no complain and negative comments on vibrators' motion pattern. However, 8 participants mentioned, vibration feedback was not the ideal interaction to build up body sensation due to the user experience

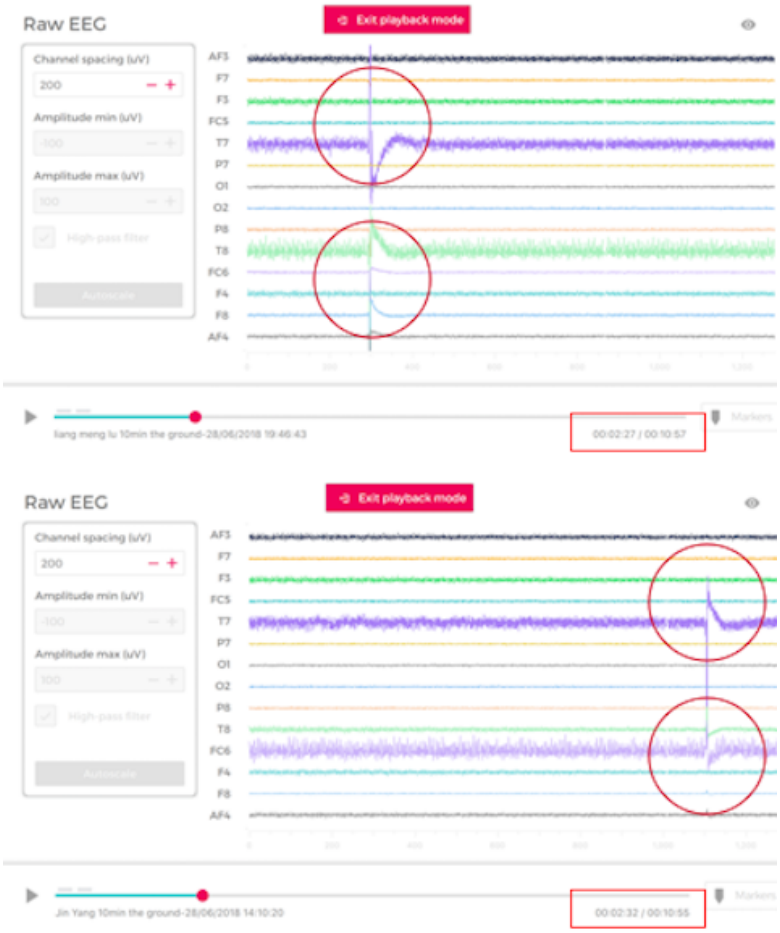

Figure 4.10: Selected EEG Data When Participants Had Strong Response

during the testing session was not as calm and comfort as they expected. Due to the noise, tickle feeling, lack of positioning preciseness, implicitly and intimacy which caused the interaction felt to "Intentional" and "Unnatural". Also, the participants stated that they put too much attention to the lower body where the stimuli were so that ignored the upper body.

"The Mind"

All participants completed the mindflow observation practice supporting by "The Mind" haptic interface. They expressed a positive experience with the interaction such as " It was subtle and comfortable", "Interesting and creative", "The form

of interaction was appropriate and supportive". Reviewing the raw EEG data recorded during this session, all participants showed the steady response, yet, due to the fact that all participants closed their eyes during this session, the data shows the similar results which can not be considered as the valid data to interpret. Through the interview, all participants showed the interest in "The Mind", which helped them conducted the mind-flow observation that they had never done before. In terms of the usability of "The Mind", the comments on the hand size, ball shape, the position of the button were positive. During the test, all participants didn't show difficulty to reach the button, press the button, or miss operations. Besides, participants emphasized that during the mind-flow observation practice, they didn't feel the interfering from the interaction with haptics interface. Specific about the feature of "Intention" button, 10 participants used this feature and mentioned that it helped them get out of the certain thoughts or feelings and pay attention to the breathing and continuing the observation. 9 participants had over 10 times interaction with the device during the 10-minute practice, they mentioned that it was too focused on observation of the current state in the mind to let the mind wander. However, a participant who has an engineering background pointed out that the haptic interface lack of affordance for the first time use, yet, it didn't require a long learning curve which fixes this problem at some level. The feedback about user experience was also positive, all participants commented that they had high engagement and concentration during the practice. Furthermore, regardless of the interaction design, the artifact itself made them feel more secure and calm compared to the practices that conducted before. 7 participants said the idea of "The Mind" is interesting and unique, they want a portable version to carry on with them on a daily basis. 2 participants who had high-level stress index regarding the results from DASS21 said that the assistance of the "The Mind" allowed them to take mind observation into practice in a mindful way which means just simply define any event appeared in their mind, they felt relief and the changed mindset that might be the reason caused on overthinking.

4.5 Study Two: The Viability of Cultivating Mindfulness Scale by Using "ZONE"

I administered the user study to investigate whether the proposed haptics interface would enhance mindfulness cultivation effectively. Twelve subjects (eight females, four males, age range: 20 to 30) participated in the study. All participants complete 10-min verbal guided mindfulness meditation, 20-min "ZONE" guided mindfulness meditation (10-min "The Ground" guided body scan practice, 10-min "The Mind" supported mind-flow observation practice) using the same guidance. I introduced Mindfulness-Five Facet Mindfulness Questionnaire(FFMQ) to assess the mindfulness scale for each participant before and after using "ZONE". FFMQ served as the measure of trait mindfulness. FFMQ has several strong psychometric features. The measure includes 39-items that are rated on a 1 to 5 point Likert-type scale assessing five facets for Acting with Awareness, Describe, Non-judge, Non-react, Observe, and total scores respectively. All five subscales, as well as a total score composed of all items, were used in analyses. A higher score on the FFMQ indicates higher levels of mindfulness. [2] [26]

FFMQ
5 facet mindfulness questionnaire

	AVERAGE SCORE BEFORE USING "ZONE"	AVERAGE SCORE AFTER USING USING "ZONE"
Observing	2.3	3.4
Describing	2.1	2.2
Acting with Awareness	2.8	3.5
Non-judging	2.7	3.3
Non-reactivity	1.8	2.2
TOTAL FFMQ:	109	115

Figure 4.11: The Comparison of MMFQ Score

The results are shown in Fig.411 The total average score before using "ZONE" was 109 points, after using "ZONE" was 115 points. In terms of "Observing", 0.9 points increased, "Describing", 0.1 points increased, "Acting with Awareness "0.7 points increased, "Non-judging" 0.6 points increased, and "Non-reactivity" 0.4 points increased. According to the result of the assessment, it shows the improvement in mindfulness scale after using "ZONE" for each trait, especially

for the "Observing", "Acting with Awareness", and "Non-judging" facets, which could be considered that haptics guiding approach of "ZONE" has potential for the cultivation of mindfulness.

4.6 Concept Reversion

Mindfulness meditation is advocated for reducing reactions to stress by inducing the relaxation response to lowering the heart rate, reducing anxiety, and encouraging positive thought patterns and attitudes. Meditator of mindfulness meditation aims to cultivate self-awareness and a nonjudgmental, loving, kind, and compassionate feeling toward themselves and others. By suggesting "ZONE", this study provided an understanding of designing for techno-spirituality and how to support novice meditation to practice non-verbal guided mindfulness meditation. The study promotes that haptics interaction can enable novice meditator to cultivate mindful thought pattern without the verbal guidance. It also suggests that haptics interaction could be considered as a suitable approach for different practical purposes on mindfulness protocol. Thus, the study advocates the importance of the haptics interaction design which could provide the positive effect in mindfulness context. In addition, this study implies that to support body scan practice and mind-flow observation for cultivating body awareness, mindful though pattern. The limitation and validity of this research are obvious, considering the small number of participants, the limited testing duration, times, and subject sample group to investigate the process of mindfulness cultivation. Lack of multi-dimension mindfulness scale assessment is also a problem. The interpretation of haptic stimulation and haptic interface is contextual depends on individuals. Overall, mindfulness context in association with human interaction design and its methodology, the complexity of a human consciousness and the uncontrollable circumstances is the vital factor to take consideration for better user experience design.

Notes

1 https://www.webwire.com/ViewPressRel.asp?aId=214152

2 https://www.calm.com/

3 https://www.headspace.com/

4 http://www.choosemuse.com/

5 https://spire.io//

Chapter 5
Conclusion

The purpose of this research is to design a novel approach "ZONE" that can support novice meditator practice non-verbal guided mindfulness meditation in order to allow them to experience internal focus that can lead them to cultivate mindful thought patterns and qualities. In addition, "ZONE" aims to explore the potential possibility of haptics interaction utilization in mindfulness meditation context. To find out the appropriate solution to this question. Combining the design of haptics interaction based artifacts 'The Ground", "The Mind", as well as traditional breathing practice methodology, and mindful though pattern, which constitutes the idea of "ZONE". To evaluate this concept, fieldwork, user research, prototype creation, implementation, and examination was conducted. The study has demonstrated that "The Ground", which with vibratile stimulation feedback provides an effective body scan introduction, however, through evaluation, users have shown lower satisfaction on the vibration stimuli which causes the unnatural user experience during body scan practice. "The Mind" with haptics interface enables novice meditator to practice mind-flow observation concretely as well as the sustained attention and engagement without being invasive or interfering. "ZONE" enhance novice meditator's capability on self-driven practice and the cultivation of mindfulness, which encourages this group to spend their time aware of the precious present moment. By providing the solution to help novice meditators who are trying to reach the mindful mind for overall well-being, "ZONE" assists in non-verbal guided mindfulness meditation without interfering. Novice meditators are able to conduct practice on a daily basis. The study has also shown the potential possibility concerning the cultivation of mindfulness through "ZONE" assistance, which is fitting to the mindful context and principles. Through this research, it could be reflected in the feasibility which by enhancing novice meditator self-awareness, guiding them to think in a mindful thought pattern. In conclusion, this study provides a solution "ZONE" with haptic feedback and interaction design to support novice meditator conduct mindfulness meditation including body

scan, mind-flow observation, breathing practice by one's own. Furthermore, the results of the study indicate that haptic technology is also beneficial in mindfulness meditation context. The study has contributed to the knowledge in the field of haptics interaction design, user experience design, techno-spirituality in HCI.

5.1 Limitation

The subject of this research associating the complexity of mindfulness, consciousness, psychology, which not only requires a deeper knowledge in each field but also the application in human-centered design, which demands the dedicated localized support system that "ZONE" can function as part of but not an ultimate solution. By tracking only one form of biofeedback data through EEG, and FFMQ mindfulness scale assessment test, the best estimation that this research can do is measure mindfulness scale in relation to "ZONE"'s artifacts functionality and user experience. EEG data didn't show the significant result in this context, it was only applied to judge whether the interaction design is appropriate that followed mindfulness meditation principle. It is important to recognize the importance of the impact of biofeedback to refine haptics interaction, user experience design. Furthermore, there was no real-time reflection of the actual emotional state of the participants during "ZONE" guided mindfulness meditation. The evaluation design was not ideal for assessing long-term mindfulness cultivation, due to the duration and times of testing on one subject was relatively short. Lastly, Mindfulness principle does not suggest to make a judgment of correct or wrong way to meditate, either the good or bad performance during meditation. Mindfulness meditation experience is contextual depends on individuals and the personal purpose and desire. evaluation

5.2 Discussion and Future works

In the reflection of the data gathered through research, user testing, user reaction observation, survey response, which provided the opportunity for improvements in the concept of "ZONE" and its interaction design. The limitation and shortage including the inappropriate interaction design and the form of the artifact were identified through exploration of novice meditator's difficulties and uncomfortable points in the "ZONE" prototype experience. Regards to the utilization of the vibratile stimulus in order to guide body scan practice, it was determined

that alternative haptic feedback and the manner of interaction design should be explored and examined in the future. To reach the goal of "ZONE", one of the tasks that supporting body scan practice need to explore more variations of interaction form driven by different types of stimuli, as well as the shape of the artifact is very crucial to the way to deliver the introduction naturally and subtlety. The positioning of the stimuli should also take reconsideration, due to the upper body is the certain part that meditator can not aware directly. Thus, type, motion, and the trigger of haptics feedback would be regarded as the most important elements of this research. Mind-flow observation assistant "The Mind", the portable version is required regarding the users' feedback, it shows the unexpected beneficial in mindfulness cultivation and positive emotional changing. To enhance its functionality and user experience, following user-centered design principle that promotes iteration of design and testing to make "ZONE" a better-shaped design concept.

References

[1] Atanes Andreoni, H. M. e. a. Mindfulness, perceived stress, and subjective well-being: a correlational study in primary care health professionals. *BMC Complementary and Alternative Medicine*, 15 (2015), 303.

[2] Baer, R. A., Smith, G. T., and Allen, K. B. Assessment of mindfulness by self-report: The kentucky inventory of mindfulness skills. *Assessment 11*, 3 (2004), 191–206. PMID: 15358875.

[3] Baer, R. A., Smith, G. T., Lykins, E., Button, D., Krietemeyer, J., Sauer, S., Walsh, E., Duggan, D., and Williams, J. M. G. Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment 15*, 3 (2008), 329–342. PMID: 18310597.

[4] Benedict, S. S. C. L. A. J. F. Mechanisms of mindfulness. *Journal of Clinical Psychology 62*, 3 (2006), 373–386.

[5] Brolin, L. Designing for body awareness - a study on enabling body awareness in mindfulness through wearable haptic thermal technology. *Malm hgskola/Teknik och samhlle* (2017).

[6] Claudia Dauden Roquet, C. S. Evaluating mindfulness meditation apps. *CHI 2018* (2018).

[7] D., H. J., and R., C. J. The shortform version of the depression anxiety stress scales (dass21): Construct validity and normative data in a large nonclinical sample. *British Journal of Clinical Psychology 44*, 2, 227–239.

[8] Deikman, A. *The Observing Self: Mysticism and Psychotherapy.* Beacon Press, 1982.

[9] Demarin, V. Neuroplasticity. *Periodicum Biologorum 116*, 2 (2014), 209 – 211.

[10] Derthick, K. Understanding meditation and technology use. *CHI 2014* (2014).

[11] Fushimi, H., Kato, D., Kamiyama, Y., Yanagihara, K., Minamizawa, K., and Kunze, K. atmosphere: Designing cross-modal music experiences using spatial audio with haptic feedback. 4:1–4:2.

[12] Hale, K. S., and Stanney, K. M. Deriving haptic design guidelines from human physiological, psychophysical, and neurological foundations. *IEEE Computer Graphics and Applications 24*, 2 (March 2004), 33–39.

[13] Irving, J. A., Dobkin, P. L., and Park-Saltzman, J.

[14] Jon, K. Mindfulnessbased interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice 10*, 2 (2003), 144–156.

[15] Jon, K.-Z. Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice 10*, 2, 144–156.

[16] Kabat-Zinn, J. An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results. *General Hospital Psychiatry 4*, 1 (1982), 33 – 47.

[17] Kabat-Zinn, J. *Wherever You Go, There You Are: Mindfulness Meditation in Everyday Life*. Hachette Books, 1994.

[18] Kabat-Zinn, J. *Full Catastrophe Living (Revised Edition): Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness*. Random House Publishing Group, 2013.

[19] Leanna Bumatay, A., and Seo, J. Mobile haptic system design to evoke relaxation through paced breathing. 1–1.

[20] Marlatt, and Kristeller. Mindfulness and meditation. *Integrating spirituality into treatment: Resources for practitioners.* (1999), 67 – 84.

[21] Marlene Samuelson, James Carmody, J. K.-Z. M. A. B. Mindfulness-based stress reduction in massachusetts correctional facilities. *The Prison Journal 87*, 2 (2007), 254 – 268.

[22] Montagu, A. *Touching: the human significance of the skin.* Harper & Row, 1971.

[23] Parkitny, L., and McAuley, J. The depression anxiety stress scale (dass). *Journal of Physiotherapy 56*, 3 (2010), 204.

[24] Richards, K., Muse-Burke, J., and Campenni, C. Self-care and well-being in mental health professionals: The mediating effects of self-awareness and mindfulness. *Journal of Mental Health Counseling 32*, 3 (2010), 247–264.

[25] Riener, A., and Ferscha, A. Raising awareness about space via vibro-tactile notifications. In *Smart Sensing and Context*, D. Roggen, C. Lombriser, G. Tröster, G. Kortuem, and P. Havinga, Eds., Springer Berlin Heidelberg (Berlin, Heidelberg, 2008), 235–245.

[26] Taylor, N. Z., and Millear, P. M. R. Validity of the five facet mindfulness questionnaire in an australian, meditating, demographically diverse sample. *Personality and Individual Differences 90* (2016), 73 – 77.

[27] Wyche, S., Caine, K., Davison, B., Arteaga, M., and Grinter, R. Sun dial: Exploring techno-spiritual design through a mobile islamic call to prayer application. In *Conference on Human Factors in Computing Systems - Proceedings* (2008), 3411–3416.

Appendix

Appendix A
Example Codes

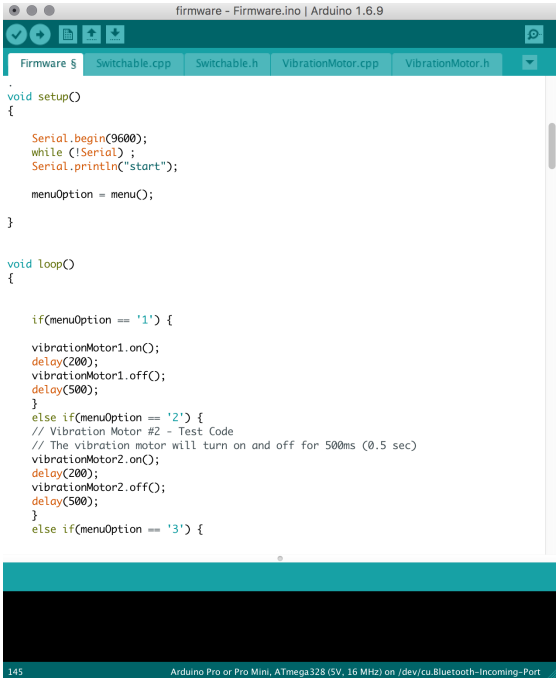

Figure A.1: Arduino code for "The Ground" prototype

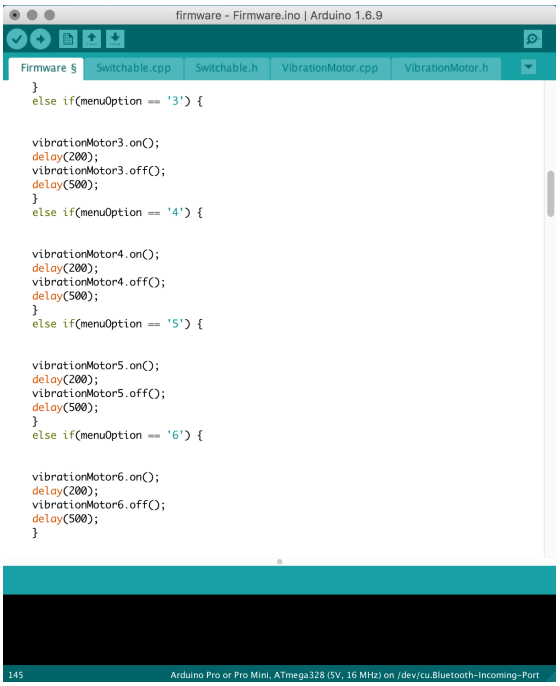

Figure A.2: Arduino code for "The Ground" prototype

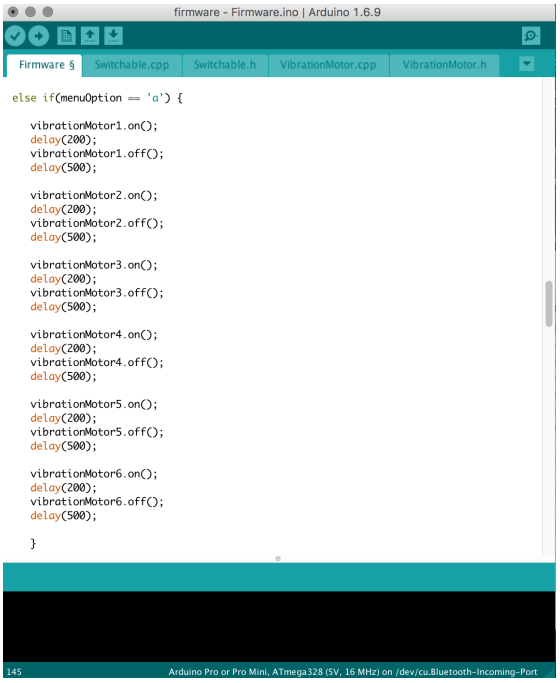

Figure A.3: Arduino code for "The Ground" prototype

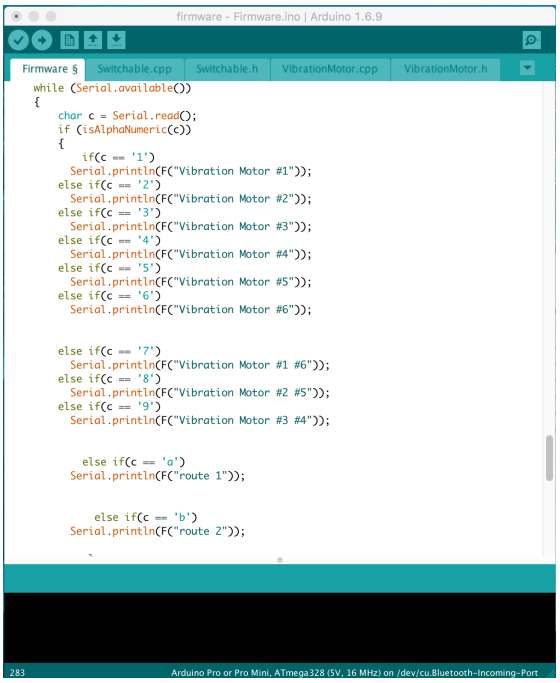

Figure A.4: Arduino code for "The Ground" prototype

```
[2018-06-30 11:23:11.774] Feelings
[2018-06-30 11:23:33.093] Thoughts
[2018-06-30 11:24:27.770] Feelings
[2018-06-30 11:25:08.547] Thoughts
[2018-06-30 11:25:47.525] Thoughts
[2018-06-30 11:25:49.815] Thoughts
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Figure A.5: Mind-flow observation record

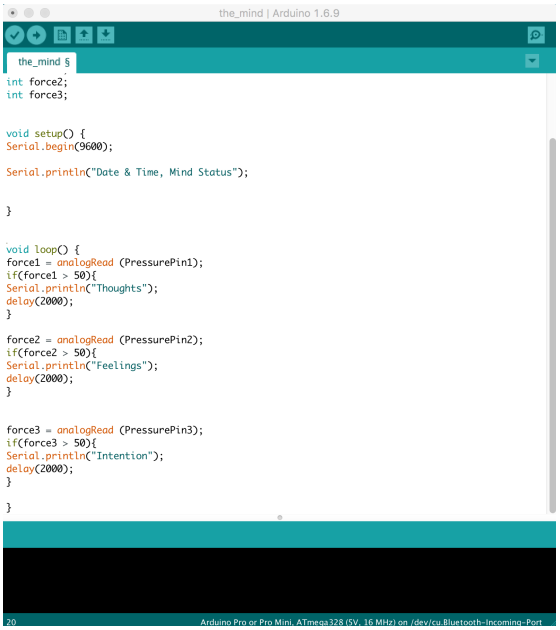

Figure A.6: Arduino code for "The Mind" prototype

Appendix B
Initial Design Sketch

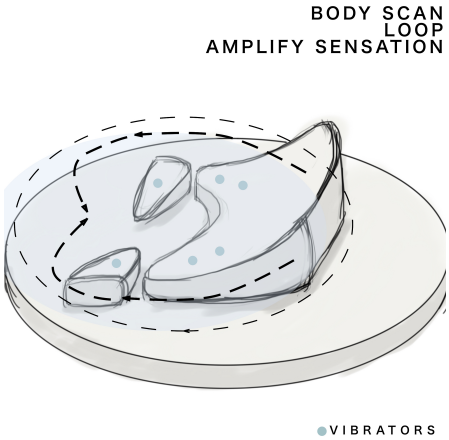

Figure B.1: Initial Design Sketch

Figure B.2: Initial Design Sketch

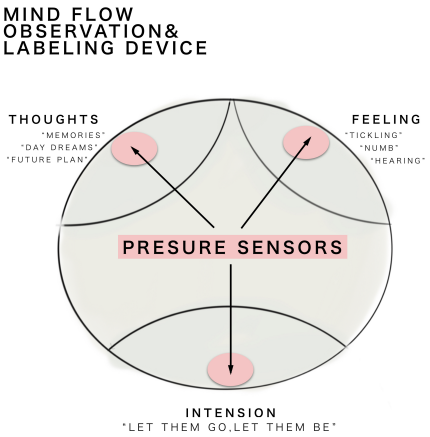

Figure B.3: Initial Design Sketch