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Author	赵, 家宁(Zhao, Jianing) 杉浦, 一徳(Sugiura, Kazunori)
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Master's Thesis
Academic Year 2018

Tangible Apps Necklace: Design Modular
Neck-Worn Digital Jewelry
for Augmenting Interpersonal Communication

Graduate School of Media Design,
Keio University

Zhao Jianing

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

Zhao Jianing

Thesis Committee:

Associate Professor Kazunori Sugiura	(Supervisor)
Professor Kai Kunze	(Co-supervisor)
Professor Sam Furukawa	(Co-supervisor)

Abstract of Master's Thesis of Academic Year 2018

Tangible Apps Necklace: Design Modular Neck-Worn
Digital Jewelry
for Augmenting Interpersonal Communication

Category: Design

Summary

Gustatory occupies a special position in the five senses. It follows you as your shadow, but also easy to be ignored. And nowadays, human beings are losing much of their ability to use it properly. At the same time, the problem of parent-child communication is presented as a new form in front of our eyes with the progress of the times. In response to this situation, I present a new type of smart necklace named Genki, which can be remotely controlled by an intelligent terminal to release different smells according to the needs of the user to promote communication between human beings, especially for elder parents who spend a great deal of time away from their children. This paper discusses the role of odor in pervasive system design. During operation, the initial prototype acts stable and easy to operate, well accepted by our subjects, especially for the elder users.

Keywords:

Odorant Interface; wearables; Behavior Change; Communication; Parentage; Elder Adult; Health - Wellbeing; Fashion/Clothing; Smell.

Graduate School of Media Design, Keio University

Zhao Jianing

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Chapter 1

Introduction

1.1 Background

Gustatory occupies a special position in the five senses. It follows you as your shadow, but also easy to be ignored. Because of the uncertainty of smell, olfactory is less developed than other five senses in the HCI field. However, this hidden treasure is gradually focusing the industrys attention upon. With the progress of technology, the olfactory system has been widely studied in the fields of psychology, neuroscience, chemistry and art. The importance of olfactory system has attracted more and more attention in personal technology area. Regrettably, most of the existing health promotion personal wearable devices such as fitness and sleep tracker, are still using visual, auditory and tactile stimulation. [1]

As it shows in Figure1.1¹In the perspective of adult children, what are the older parents looking for in their relationship with their children?² Recent study shows that they want not only to be independent but also establish close ties with their children. They define themselves as independent individuals, but when they need help, they also want their children to provide assistance timely. They are annoyed with the child's excessive protection, but at the same time appreciate the concern it expressed. They use a variety of strategies to deal with their ambivalence, such as minimizing the help they have accepted, ignoring or resisting their children to control the emotions, and these regrettable little problems have set a high wall between parents and children . This is a serious problem. We need to find an acceptable solution to improve parent-child relationship.

With the progress of technology, a lot of studies and researches have been developed to promote parent-child communication. Harmonious parent-child relationship is beneficial to human well-being in various ways. This led to more research on HCI to achieve the goal of supporting parent-child interaction.

1.2 Motivation

Back to 2016, I was graduated from my college in China, left my hometown to learn abroad in an unfamiliar country. I was born at my parents late thirties as an only child, that means basically all the classmates around me have parents whose 10 years younger than mine. This kind of situation enhanced our generation gap and caused various pressures. As a Chinese saying goes: children would like to support but parents cant wait. It would never be too early to treat your parents well.

During my first year in Japan, me and my parents suffered a lot from the communication problem, both of my parents didnt have a experience of living abroad or separate with me for a long time, and most of the time my parents live apart. So at first, I was very shocked to hear that my mother couldnt sleep at night because of the fears of being alone at a advanced age, she put a bicycle in front of the door inside our house and settled a kettle on it, because she thought when the bad guys broke down she could hear the installation fell down. This actually scared or housekeeper when she came to do the cleaning. After half of the year, she started to tell me about older adults living alone died for a long time but nobody noticed his disappear or the dead body for years. As for my dad, he is a traditional Chinese man who dont have habits to communicate with their children from his own initiative, so there is obviously a lack of communication between us, after seeing my update on SNS, he needed to talk to my mom and let her relayed it to me.

I actually felt ashamed and uneasy because of these, as a only daughter, I should comfort my parents and take care of their physical and mental health, but actually I cant even reply their text as soon as they wanted all the time because of the various factors which was no fault or wish of mine, sometimes I got Skype request in an inappropriate occasion because they couldnt count the time difference or I was too busy or just too enjoy the foreign life and forgot to reply, this actually made my mother called for police once and actually they didnt reply my contact timely either. Similar things kept happening on all of my foreign friends around me. We need a kind of product which children and their parents could share biometrics and daily rhythms and monitoring the health situation between each other to support parent-children communication, it should be universality, applied to elder adult and wont disturbing others in various environments. Existing products are unable to satisfy our needs.



Figure 1.1: Children and Aging Parents

1.3 Pre-research Study

The pre-research field trip have taken place in HeMei senile apartments, as shown in the figure 1.2³ a normal residential care institution for older person in China, on the 17th of February 2018. HeMei senile apartments is a normal senile apartments located in a prefecture-level city named TangShan in China. It is also the first unit in Yutian county to cooperate with the county hospital. At present, the facility has more than 100 beds and actively working on improving the core competitiveness of the elderly medical care system. As of January 2018, they had 106 elderly residents in total.

The objective of the pre-research is to observe what aging parents in senior home want from their kids, and what could be a solution to their communication problems. The senior home is selected in this pre-research because the elderly residents are basically my target age and most of them spent a great deal of time away from their children. Their living conditions and emotional factors make them vulnerable to psychological impact.

I distributed the questionnaires to them, collected the data, summarize and got the preliminary statistical results for my project.



Figure 1.2: HeMei Senile Apartments

1.3.1 Pre-researchs Find Outs

I put in questionnaires for elder parents and their children to get preliminary statistical data, in order to measure the feasibility of my project. I asked 10 elder parents who was basically around 50-65 years old and 10 of their children at their aged between 20 to 40 to answer the survey. The result shows as follows:

- 70 percent elder parents and 40 percent of their children feel a lake of communication with each other. Also, 60 percent elder parents and 50 percent of their children feel hard to ask for linguistic communication. There are obvious communication problems between adult children and their parents.
- More elder adult than I thought before are annoyed by the existing interaction ways and would like to try to get used of new technology. During the observation, profiting from wide use of communication methods such as WeChat, it is obvious that smart terminals was well popularized in China. Elder adult use tablet, smart phones, computers to communicate, do online shopping and play online board games, interaction had already been a part of their life.
- On the other hand, there are many elder adults who are willing to adapt to technology, but find themselves can not because of physical, perceptual and cognitive barriers. However, many others of them refuse to accept technology, but at the same time find themselves facing to a digitalized world. Looking upon this problem from only one perspective is unilateral and not

conducive to our research. Technology has fundamentally changed the way how society operates, conflict with technology may mean a conflict with society. Therefore, it is imminent to find out a solution to help elder adult adapt technology unconsciously. Also Harmonious parent-child relationship is beneficial to human well-being in various ways. So I think the market have enough requirement for this product.

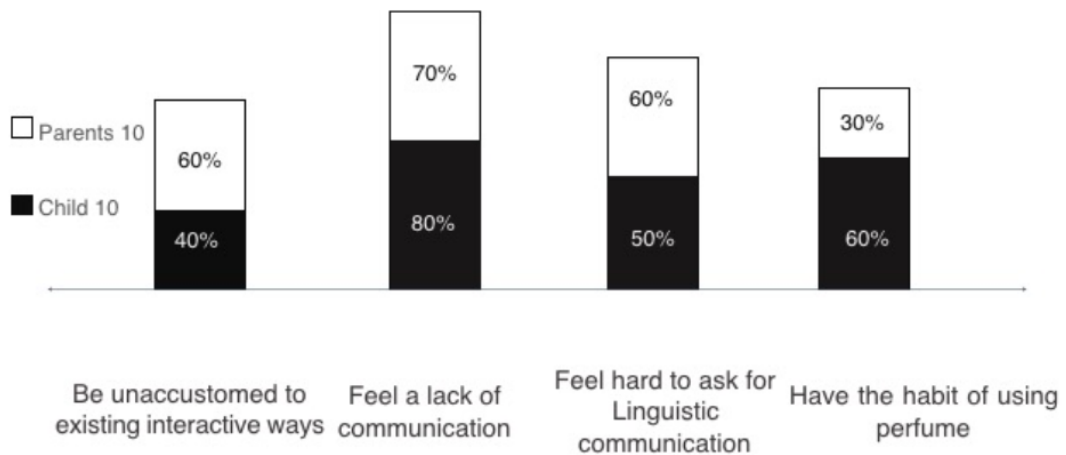


Figure 1.3: A Survey of The Status of Parent-Child Communication

1.4 Contribution

- The objective of this research is to understand if olfactory remote parent-child interaction through a device could have any positive effects on augmenting interpersonal communication, enhance mood and well-being.
- And could it possibly open up contributions in the promising area of olfactory devices for HCI systems.
- And could we overcome the uncertainty of odour and create an stable odour signal which is easy to be accepted and has no interference? After creating the signal, can it last long enough and dissipate on time when needed?

- How can we use smell-based technology to promote parent-child communication? Moreover, can the elderly overcome physical and psychological barriers, getting used to new interaction ways and enhance interaction with their adult children? Can adult children strengthen ties with their parents on their own initiative?
- This work conducted to analyze these problems and to provide an answer through the olfactory smart necklace, hoping to promote harmonious between parent-child relationship.

1.5 Thesis Structure

This paper is divided into 5 chapters.

- Chapter 1: The first chapter generalizes the background, motivation and preparatory work of this thesis. Talking about the contribution that the author can make and explaining the structure of whole thesis including this chapter.
- Chapter2: Following the introduction chapter, this chapter mainly discusses about literature review and related works. As for the related work part, I separated it into two sections and describes them greatly. The first section talks about the related works in digital communication area. Nimesha Ranasinghe, Feather and WeLight are mainly studied in this section. The second section discuss about the related works in fashion and personal technologies area, Scented Pebbles and tangible apps bracelet are mainly studied in this section. Aiming to summarize the research results so far, learn from the experience of the predecessors, identify deficiencies, analyze the current market situation, and separate my work from existing related projects, locating innovative points and advantages.
- Chapter3: This chapter elaborates the design conception and steps of this thesis in detail.
- Chapter4: This chapter proves the feasibility and value of this thesis by setting up a preliminary model for user testing. Then collect data from the test result for analysis and comparison. And adjust based on user's feedback.

- Chapter5: This chapter summarizes and analyzes the whole thesis, the future direction of this project is also put forward.

Notes

- 1 http://blog.sina.com.cn/s/blog_5ce46d060102wcaz.html
- 2 <https://www.theatlantic.com/health/archive/2016/03/when-youre-the-aging-parent/472290/>
- 3 <http://www.yanglao.com.cn/resthome/228024.html?ly=yanglao>

Chapter 2

Literature Review and Related Works

2.1 Human-Computer Interaction

Human-Computer Interaction, as shown in the figure 2.1¹, which is called HCI for short, is a research to plan and design the ways of cooperation between users and computers. It includes three constituent parts: user, computer and cooperation ways between the two parties

Humancomputer interaction (HCI) mainly focus on planning and design ways of cooperation between computers and users. Concentrated on the study of the interface between people and computers. The study of the interface between people and computers is the concentrated expression of HCI study. Observe, explore and discover new ways to interact with computers, is the major topic of the researchers in this domain. HCI is in the intersection of digital media design, behavioral science research and many other fields. This means, As an utility, computers have extensive application area and limitless possibilities, In order to help understanding the concept of HCI, the industry generally compares human-machine interaction with human to human interaction, its flexibility and practicability can be seen from it.²

2.2 Olfactory Sense

2.2.1 Smell Triggers Memories and Emotions

How smell triggers memories and emotions [2]? Smell has a peculiar magic that it could bring people back to a scene deep inside their memories. Then why could smell easily awaken peoples memories and emotions? As shown in the Figure 2.2³, analyzing the structure of human brain may help us find an answer. When the

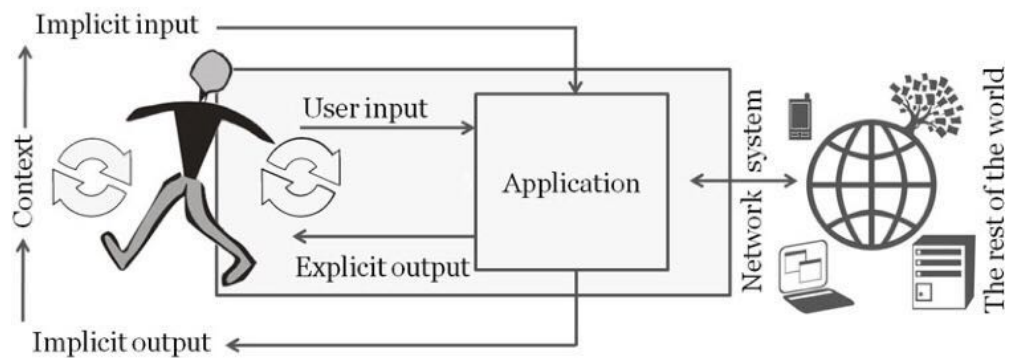
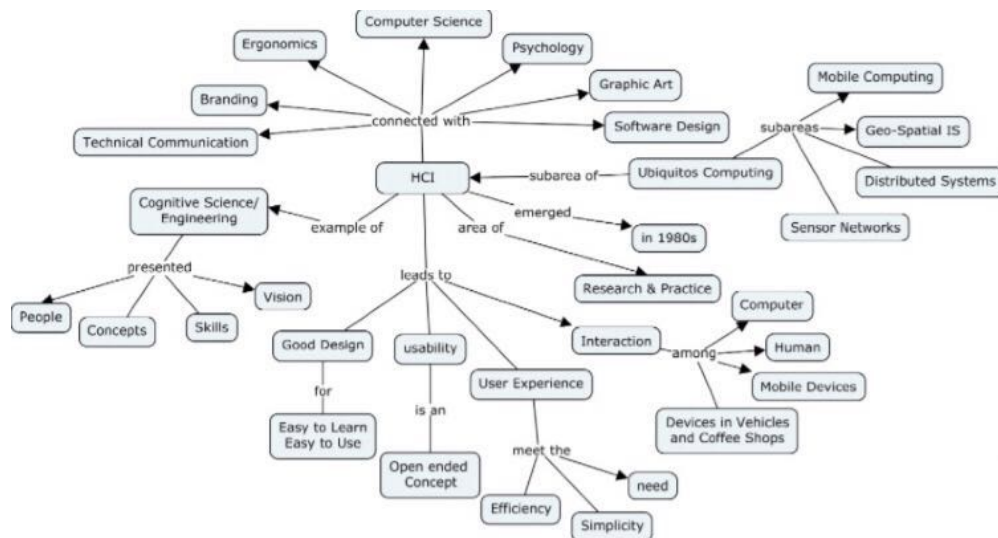


Figure 2.1: Concept of HCI

smell exported into human body, olfactory ball is the first thing to deal with it. It extends from the inside of the nose to the bottom of the brain and continues to

move and operate. The two regions in charge of memories inside human brain are amygdala and hippocampus, The arousal of human emotion and memory is closely related to these two regions. However one of the nervous structure connects these two regions directly is precisely the olfactory bulb we mentioned above. The more convincing fact is that none of visual, auditory and tactile information passes through these two brain regions. From this point of view, smell can stimulate human emotions and memories stronger than any other sense. Based on this fact, my thesis tries to help parent-children communication by using smell as a carrier to transfer information and emotional trigger.

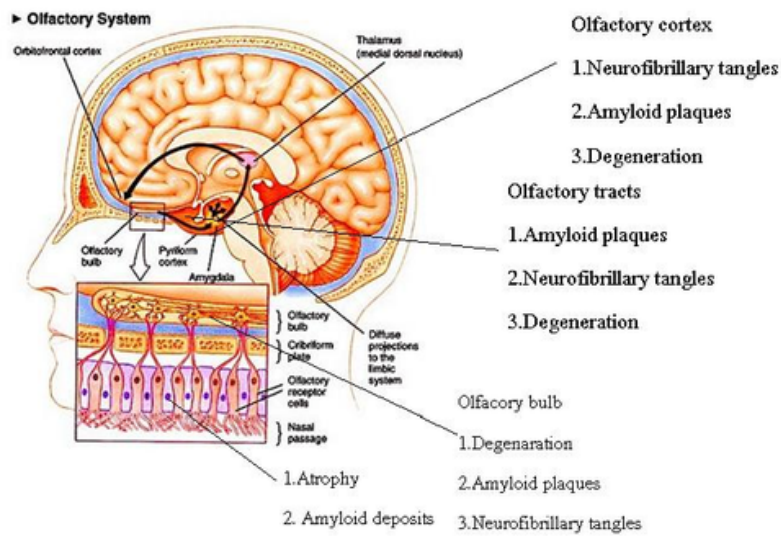


Figure 2.2: Smell And Memory Brain

2.2.2 Sense Degradation

The growth of age can affect all the senses. But generally hearing and vision are most severely impaired. The advantage of olfactory sense in this aspect provides convenience for us to design interactive systems for the elderly.

As you grow older, your senses (hearing, vision, taste, smell, touch) would gradually change the way you perceive the world. Your feeling may gradually become dull. When we perceive a feeling, we have actually accumulated a certain amount of stimulation, the minimum level that can be perceived by us called threshold, aging will increase the level of threshold, and the usual amount of stimulation

would be insufficient to trigger your feelings, which may make it difficult for you to concentrate and pay attention to the details. The enthusiasm of the feeling will completely change the way a person lives, and may bring bad effects to elder adults such as reduce the quality of life and prevents interpersonal relationships. Which could lead to the isolation of the society.

As shown in the figure 2.3 ⁴ although olfactory sense acts better than other sense in degeneration, but the sense of smell also decreases, especially after the age of 70. This may be related to the derogation of nerve endings and the decline of ability to secrete mucus in the nasal cavity. These mucus can help prolong the time of smell storing to provide chances for the nerve endings to detect and fully reacted the smell. Also, it can help to eliminate odor remained in nerve endings. On the basis of University of Chicagos research findings, the degradation of smell could even be a sign of death. Up to 39 percent of the test objects who failed in the olfactory tests died in five years period. It means that the loss of smell can be used as a "early warning" for the deterioration of health, and this fact provides our research a possibility of using olfactory to monitor and record health conditions or early warning of critical diseases.



Figure 2.3: Sense Degredation

2.3 Related Works

Because of the uncertainty of smell, olfactory sense is less developed than other five senses in the HCI field. However, this hidden treasure is gradually focusing the industry's attention upon. With the progress of technology, the olfactory system has been widely studied in the fields of psychology, neuroscience, chemistry and art. The importance of olfactory system has attracted more and more attention in personal technology area. Regrettably, most of the existing health promotion personal wearable devices such as fitness and sleep tracker, are still using visual, auditory and tactile stimulation. The HCI research field has also begun to develop and research some odor-based technology in designing HCI systems, and expand the apply styles of smell in HCI. [9]. HCI research attempts and breakthroughs have focused on the use of odor as a carrier for digital transmission. [5] [11]. Most project is still focusing on the research of the device itself. On the basis of the system prototype, they choose to use existing odor, instead of the research and creation of the odor itself.

2.3.1 Digital Communications

- Nimesha Ranasinghe

Nimesha Ranasinghe [10] explored the digital transmission of odors. By decomposing odors into another form of data, it realizes the spread and sharing of odor on interconnection network.

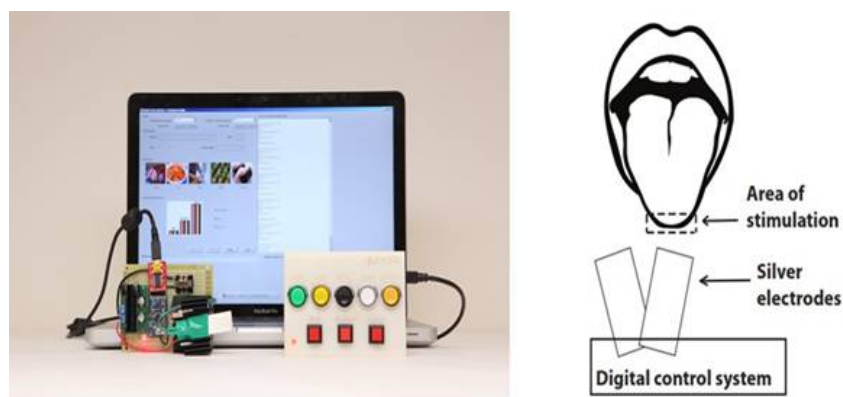


Figure 2.4: Portfolio of Nimesha Ranasinghe [10]

- Feather

Feather is a system used to promoting communication and mind sharing between travelers and associates who cant come along with them, It uses odor as propagation medium.as shown in the Figure 2.5⁵, is a variation part on feather system . The specific usage mode shows as: when one person goes on a journey and another need to stay at home, in order to express the traveler’s yearning to the other, travelers send out pictures and request to get to know their partners’ activities now. Meanwhile, the object which is in charge of image processing triggers the heater in the aluminum bowl device at home, evaporate the pre-selected essential oil at the bottom. As a result, a smell carrying specific message will spread around the home.

The disadvantage of this system is that the speed of image processing and aroma heating in the feather system is different, and the duration of the feathers is more lasting. This asynchrony causes even the associates in the closed space could miss the signal easily.

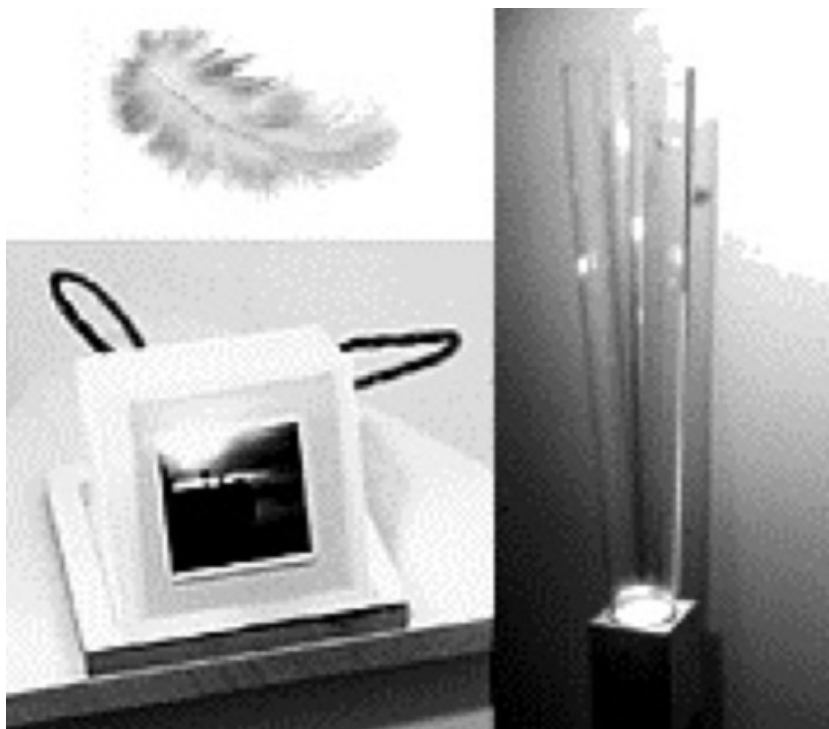


Figure 2.5: Feather

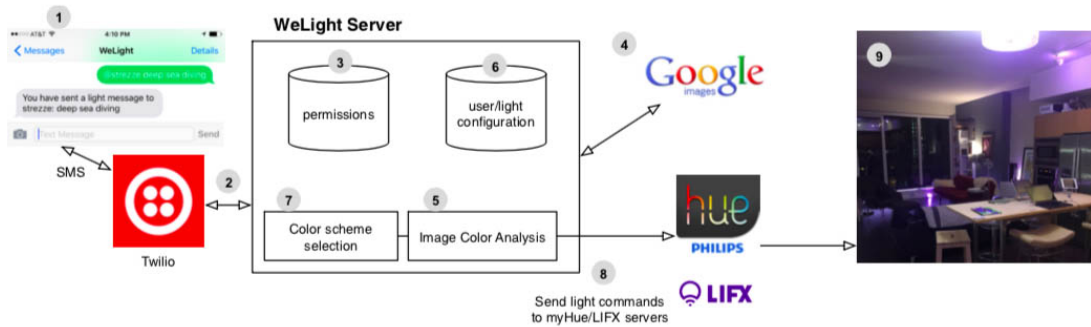


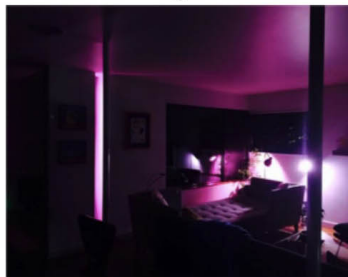
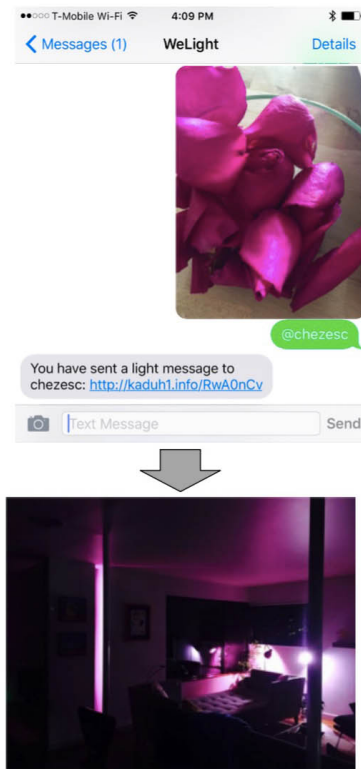
Figure 2.6: WeLight Server [7]

- WeLight

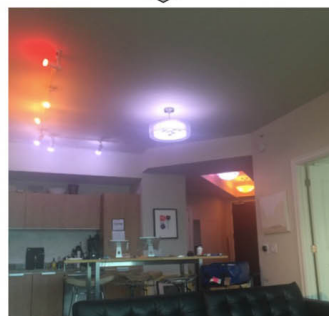
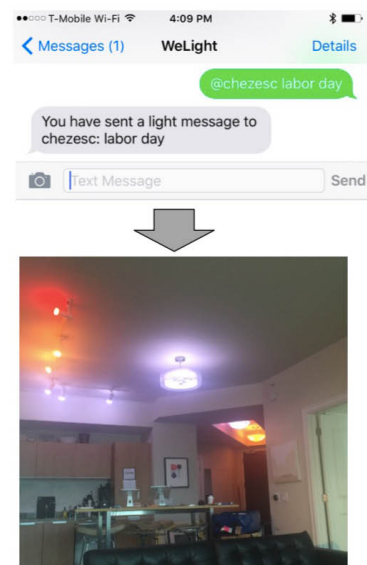
WeLight [7] is a system that uses light groups to promote communication between people. That is to say, the utilize of vision atmosphere brings out an impact on human behavior. By connecting the light system between families, people can smoothly control the light groups of others' families and create the atmosphere they want to convey emotions for communication. In order to reduce communication barriers between families and reduce operational difficulty, the research team created the linked lighting group, especially the Philips Hue and LIFX. At the same time, using messaging services such as SMS for technical support. For promoting spontaneous communication inside and between families, they enhanced natural language processing and voice search capabilities to increase the representability of scene creation. Meanwhile they focuses on developing special features to enhance oral communication, especially those can be controlled by voice and emotion.

In this project, the researchers chose to support communication between people with intimate relationships, which means they could have familiar or similar emotional expressions, this situation provides a viable environment for the transmission of visual signals. Otherwise, these signals may be confusing and disturbing.

As for system design, the goal of this project is to enhance the representability of scene creation, create a light union which is safe and easy to operate. The whole system was built in Python which includes about 2,000 lines of code



(a) Scene creation using an image



(b) Scene creation using English text

Figure 2.7: Examples of WeLight algorithmic scene creation. [7]

2.3.2 Fashion and Personal Technologies

- Scented Pebble

Scented Pebbles [3] is a luminescent tool with interactive function, It could use lighting and odors releasing to stimulate the feeling of many senses so as to enhance the ability of imagination, expand the mind and reach the goal of increase the quality of life.

Scented Pebble integrates peoples behavior into the change of the environmental atmosphere, prompting them to explore and understand the environment spontaneously. There are multiple preinstall specific subject scenes including Hawaii sunset and so on. In the process of using this product, users will launch various senses to perform scene experience, when users use touch, move and other interactive ways to simulate natural phenomena such as tilt and jitter, the product will continue releasing various odors which matches the scene, thus improving the theme impression.

Scented Pebbles is a collection of lighting modules and odor diffuser, it provides various ways of interaction to trigger the function, such as touch and shake. While sensors are embedded in each of the unit to collect and record users data. They can capture and record these data sensitively for reproducing user behavior.



Figure 2.8: Scented Pebbles [3]

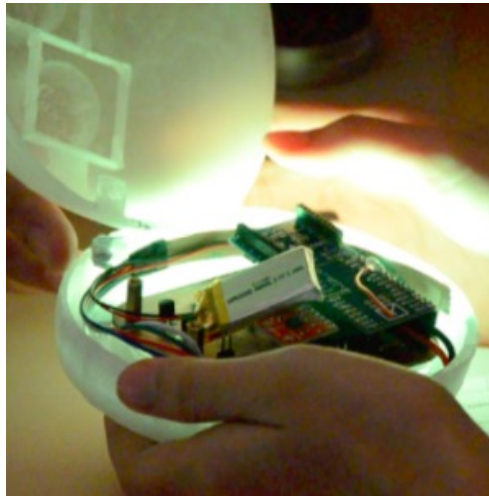


Figure 2.9: Scented Pebbles [3]

- Personal Branding [4]

By letting users wearing a device called sound-producing perfume system, which composed with a series of sound generating devices and odor diffuser, to build and express personal image, Remain unforgettable impression and experience. By the sound and smell created by the embedded sound generator and odorant releaser. The autograph of user's personalities has come into being. This commodity can be used for the establishment and promotion of personal brand, annotate the concept of brand from a new perspective.

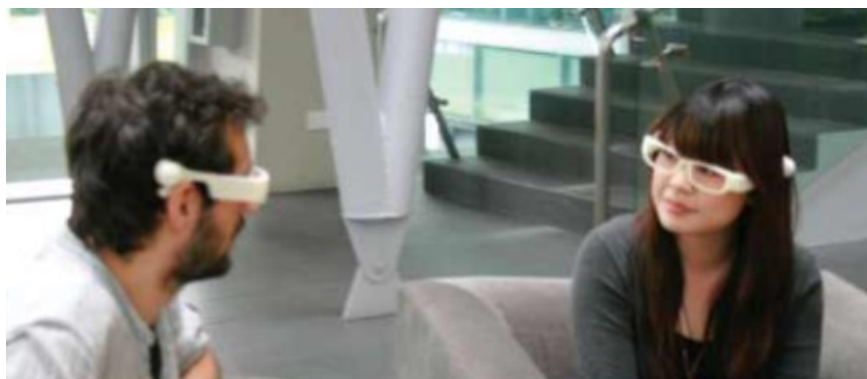


Figure 2.10: Personal Branding [4]

- Tangible Apps Bracelet

The Tangible Apps Bracelet [6] is an intelligent digital bracelet with a variety of uses, this kind of multi-function smart wearable product is quite common in the market today. The unique feature of this product is it attempts to enhance its appearance and trying to simplify the system. The idea of design is to enhance functionality while enhancing products attractiveness. Make the product easy to understand, management and operate. The author team set up a tangible application bracelet, and completed the test in the laboratory, then collected data to do the evaluation. The Tangible Apps Bracelet is made up by several applications, each single threaded element is connected to strings orderly and dexterously.

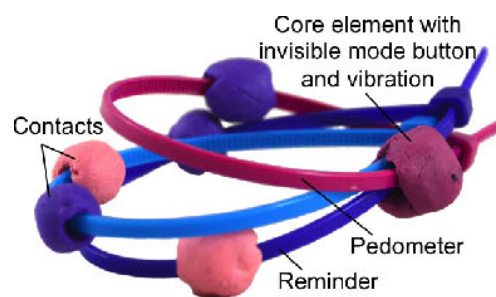


Figure 2.11: Design Concept A [6]

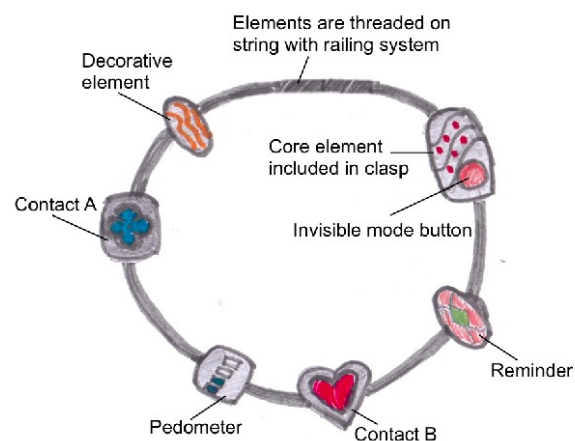


Figure 2.12: Design Concept B [6]



Figure 2.13: Demo Tangible Apps Bracelet [6]



Figure 2.14: Prototype of the Tangible Apps Bracelet. Each element is made up by plastic material, and they release lights under mounts of LEDs. These LEDs are moulded into various aesthetic styles, glued on the buttons, painted and decorated with propylene. The author team wound the silver thread around the copper wire to form a plasticity bracelet to make the appearance more beautiful. Right: the user realizes input by pushing the element. [6]

functionality

- It could afford 3-6 applications
- Available applications now involves communication, alert and Physiologic regularity measurement three aspects

Notes

- 1 <https://mubashariqbalhci.wordpress.com/2015/09/06/hci-concept-map>
- 2 <https://www.igi-global.com/dictionary/human-computer-interaction/13413>
- 3 <http://suesturos.com/2011/05/smell-1-fastest-way-to-absorb-essential-oils/>
- 4 http://www.6a8a.com/2017/0308/297387_4.html
- 5 <https://people.cs.vt.edu/~wangr06/touch%20review%20organization/StrG96.pdf>

Chapter 3

Design

This chapter describes the ideation of this study, and the selection of sent based on the data collected in the ideation. Then expounds the operation of the whole system and the design theory included. Finally, in order to help understanding, I provided a case of user scenario. 1. Ideation

2. Sent Selection
3. System Description
4. User Scenario

3.1 Ideation

The derivation of the project's name: Genki is a Japanese word means healthy or vitality. Families and acquaintances use as How are you? while they meet each other , It shows concern and careness at the same time. In general, with bright and brisk meanings, it relieves people's pressure and burdens while using it. So I think its an appropriate name for this project.

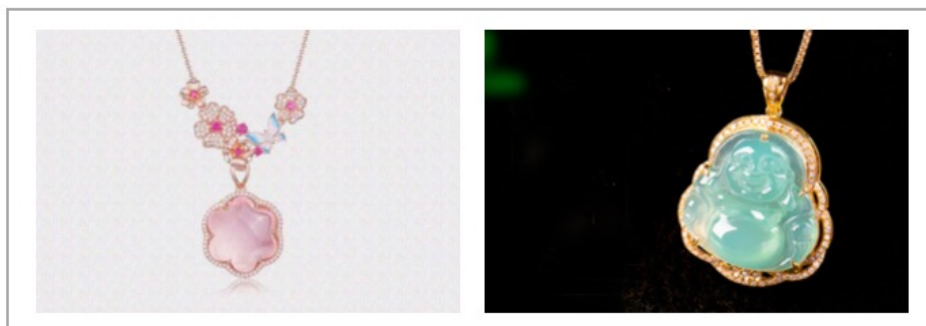


Figure 3.1: Necklace and Jade Buddha for Female and Male

In China, as shown in the figure 3.1¹, both men and women have a habit of wearing necklaces, especially for adult males they wear the Jade Buddha for a long time to bless themselves they don't even take it off when they are taking a bath, this provides a chance for children to interact with their male relatives by using our neck-worn product. [8] [12] As it is shown in the Figure 3.2², to make the released odors more easily to be smelled, considering to make a practical and pleasing product and providing personal space without disturbing others, a neck-worn digital jewelry using smell-based technology was finally determined.

According to the pre-research study, in order to ease communication pressure, reduce the disturbance to the surrounding environment, and considering about elder adults' interaction habit, passive interaction is a better design solution.



Figure 3.2: Personal Space

3.2 Sent selection

I designed 2 surveys about sent selection, the result shows as follows: obviously even the totally same sent symbolized different meanings all over the world, for example the ocean smell represents positive and gentle meaning to western respondents and totally opposite as negative and melancholy to Asian respondents, it is precisely that because of the uncertainty of smell this kind of particular answer varies from person to person. So I screened out some sent with stronger common views all over the world from the questioners to reduce the confusion and interference of sent signals.



Figure 3.3: Different Types of Scents

As the graph shows below: I asked 20 parents at their age of 40-60 all over the world and sorting out the answer the first question is to showing up the sent I prepared and ask them the meaning of each smell, I prepared 6 kinds of different smells and finally determined to use honey vanilla smell as the signal of I love you peppermint as rejection not an appropriate time to getting connection and Johnson and Johnson baby oil smell as I miss you (a request for liaison). There is an interesting situation in my second survey: What kind of smell make you think of your children? Basically over three-quarters of my respondents think Johnson and Johnson baby oil smell is a symbol of family and children because they have an experience of using Johnson and Johnson as their or their children's baby oil, these kind of situation provides opportunities for the promotion and branding of this products.

As for the selection of sent material, I choose natural essential oil commonly used in aromatherapy (vanilla, peppermint), and Fragrances, perfumes and diluted oils (Johnson and Johnson baby oil), because their smell acts strong and stable in the experiment

Table 3.1: Is this Prepared Sent Symbolized Positive or Negative to You

Sent	Vanilla	Peppermint	Baby oil	Ocean	Musky	Jasmin
Positive/Negative	15/5	4/16	18/2	10/10	8/12	12/8

Table 3.2: What kind of smell make you think of your children

Baby powder	Perfume	Condiments	Flower
16	8	6	3

3.3 Wireless Communication

As it shown in the figure 3.4³⁴, in order to control the necklace by using smart-phone applications implemented on an Android platform, make sure the necklace can have the ability and capability to communicate, a technology of microprocessor was implemented to necklace and a technology called Bluetooth Low Energy (BTLE) was used and applied the smartphone for control the necklace remotely. The microprocessor be used in this prototype is ATmega32u4, and to empower the system, a 3,7V Lithium Battery was also connected and implemented to it. As the battery was connected, the system can be used in a certain time without using chargers or wires to bring powers to it. Also for better use the system, there was a mini USB micro connector on the necklace, so that users can charge the necklace at whatever time they want. While using the system, there was a switch on the necklace, firstly user can turn on and activate the necklace by push the switch to turn-on mode. As a result, the necklace will continually boost the scent for 1 second of every 20 seconds. They frequently is adjustable so that user can drag the necklace to lower position so that to send signal to the necklace, and extra boost of scents will be released.

- Fundamental support to make the system works

There are several ways can support the system to learn so that to boost and release different smells. One possible way is based physiological data and support, which some tests were done before to test if it really works. There are several directions under physiological researches, for example like heart rate, electrodermal records or activities and records from brain. For the heart rate and electrodermal ways, a tested is done by using the E4 Wristband ⁵. And for the other two ways, another test was done by using the the EEG MUSE Headband ⁶. These tests

were all designed to see and compare the focus and concentrate level, base on the comparisons of different frequencies of the brain. From these experiments, some interesting and useful result was observed. One interesting data is that the user was observed as their brain doing some peak performances, the Gamma brainwave was also activated and sent, at that time the user was preferred to act as more concentrate or more focus. Especially when the user extremely focused on something or try to guide himself attention to a more focus level, those values such as Gamma waves increased. The data collected from these related experiments were drawn and mapped so that to be applied onto the scent boosting frequency.

- APPLICATIONS
- Sleep and Memory

Its already been identified and stated that sleep will actually help with the combination and consolidation of humans memories. Some studies were done under a laboratory environment by scientists. While participants were sleeping, scientist tried to release and give smells from a previous setting of learning environment to users. And as a result, because users knew the smells, which reactivated their memories, so that old and new memories mixed and combined with each other, memory consolidation were observed in users sleeping period.

Also base on these medical researches results, it is said that during the Slow Wave Sleep and Rapid Eye Movement period of sleep, humans memories are at the most effective learning period. In order to apply these knowledges to the system, its important to detect users situation from a more biometric direction, so that to contribute to find out the special moments of user that can boost the scent.

But as more experiments or tests were conducted under a laboratory environment, actually to gain a more realistic data and feedback, designer and researcher have the need of using normal target user to use the device under a more natural environment, like users homes. And by using this carry-on size system, both the device and smartphone, as its easy to carry and can be used almost anywhere, its not hard to tell that this system will really help to collect much more users feedbacks from a real living space, so that real biometric data and results can be gained from these tests conducted in a real environment.

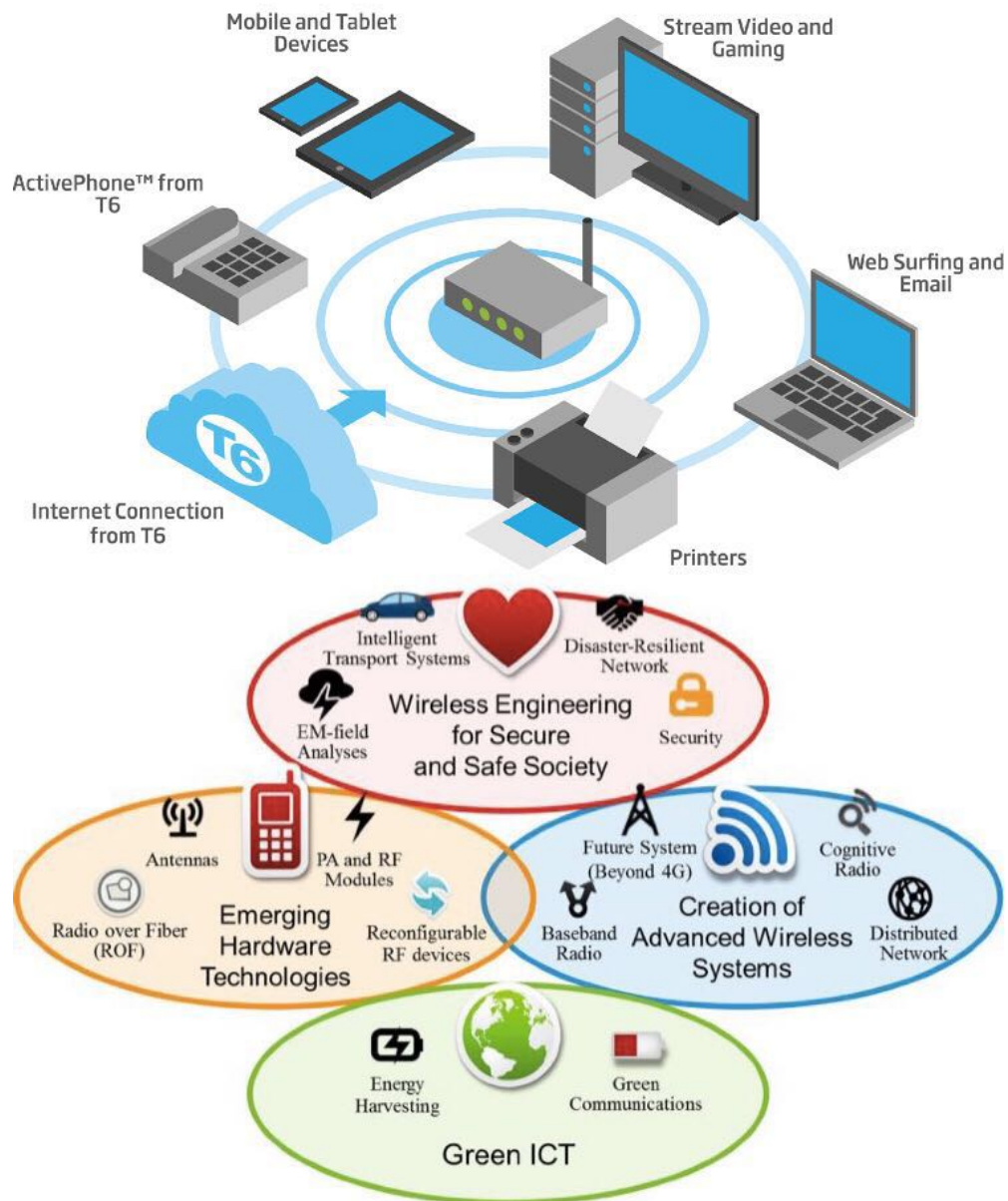


Figure 3.4: Wireless Communication

3.4 System Description

The whole system should work in 2 directions, serves parents and children st the same time. But we mainly focus on the elder parents side at present. The whole

system is separated into four sections: children, network system (smart terminals), digital necklace and elder parents. It works like this, children send requirements to the network system from the application they installed in their smart phone, then the digital necklace wearing by their elder parents which is connected to the Internet receive the request and transfer it to the diffuser installed inside the device, and set out the smell which their children was chosen just now as a signal, then the elder parents could perceive their children's emotions in real time through the smell released by children now. In the other hand, elder parents could also send requirements to their children by pushing the button which is connected to the digital device installed inside the necklace.

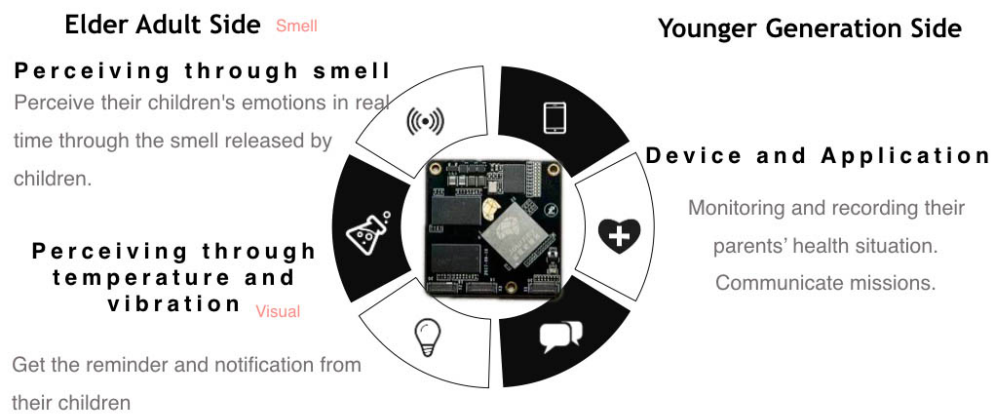


Figure 3.5: Structure

3.5 User Scenario

- To be able to produce a impressive simulations and help understanding, I created a scenario of using Genki. As it shown in the Figure 3.7⁷, Our target persona are Linsy's parents who were at their age of 50, both retired and spent most of their time at home. The father is a traditional tough guy who felt shame to express emotions. Their daughter Linsy is a 27 years old business woman works abroad. She has a weak and sensitive heart but she

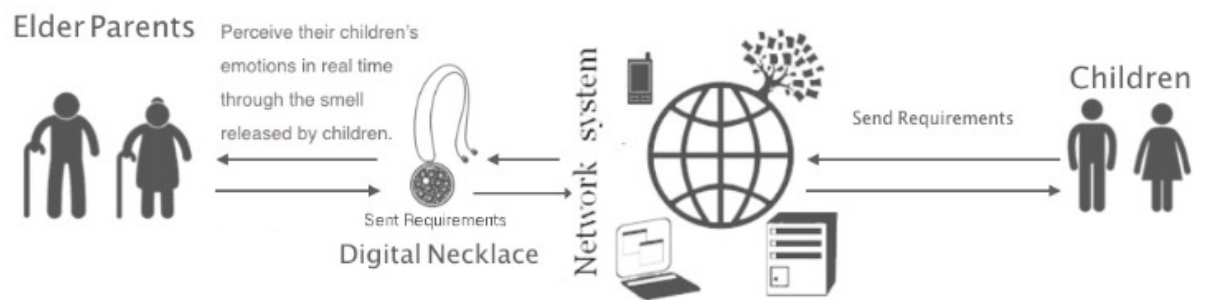


Figure 3.6: System Description



Figure 3.7: User Scenario

is always so busy. Although she always miss her parents, it is still difficult to find an appropriate time for both her and her parents to communicate.

- One day in the evening , the father came back after exercising, the little girl he met on the way to local primary school made him miss his baby girl very much in a sudden. Linsy is his only daughter and he haven't seen her since the last Christmas, it's about a year. He sat on the couch and kept watching TV with his wife, he tries to forbear his own feeling because he feels shy to express his yearn to Linsys mother, because he thinks as the owner of this house, he shouldn't express weak feelings, his wife will laugh at him. Finally he thinks out a solution is to use Genki, which is hanging on his neck. So he press the button on the necklace furtively to sent the miss you smell through Genki as a requirement for communication. His wife didn't find out that.
- On the other hand, because of the time difference, it is 10:30 in morning in Linsy's city. Linsy is having an important meeting in her company, everyone is so tense because of the most important customer, she kept tortured by the slides and data for hours and feels very depressed. Suddenly she got the miss you smell from daddy, he favorite smell spreads in her private space without disturbing others, make she feels comfort and thanks to Genki, his father didn't connect her by phone as usual, her boss will kill her if her cellphone rings now. So she send inappropriate situation smell back as a rejection.
- While after a long day Linsy went back home, felt really tired and need comfort. She miss her parents so much and sent out the I miss you smell through Genki system and both of her parents received it , then they connected her on skype and had a warm coversationwhat a lovely day with Genki's accompany.

Notes

- 1 <http://www.nipic.com/show/4/79/9477687.html>
- 2 <https://ecofriend.com/what-s-next-outdoor-air-purification-systems.html>
- 3 <http://www.synfrait.com/wireless-communication.html>
- 4 <https://www.uec.ac.jp/eng/research/researchcenters/awcc.html>

- 5 <http://www.smell.dating>
- 6 <http://www.choosemuse.com>
- 7 <https://usafootball.com/parent/>

Chapter 4

User Test and Evaluation

4.1 Ideation

4.1.1 Qualitative data

As it shown in Fig.4.1, the first paper prototype of Genki shows the scenario of how the device works. By using Figure 4.1 as a Paper Prototype to explain how's the whole smell based communication product works, I organized a seminar with 8 participants in total. The main topic of this meeting is: what kind of smart necklace (feature) would you like. We launched a enthusiastic discussion and collected a lot of effective suggestions.

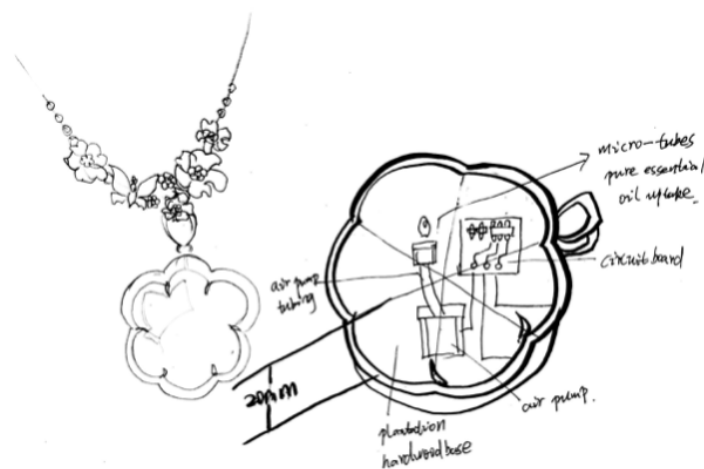


Figure 4.1: Paper Prototype of Genki



Figure 4.2: Qualitative Data

4.1.2 Result

The result show as follows:

- I should hide the device of the necklace at the back and make it as light as possible.
- The feature design of the prototype should be neutral.

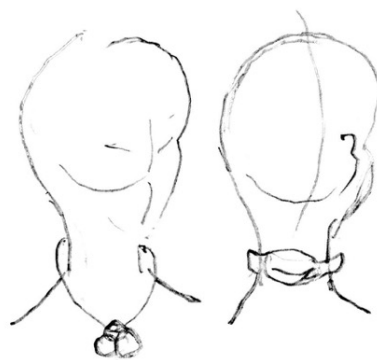


Figure 4.3: Result

4.2 Prototype

4.2.1 Scent Release

The internal structure of the diffuser shows as follows:

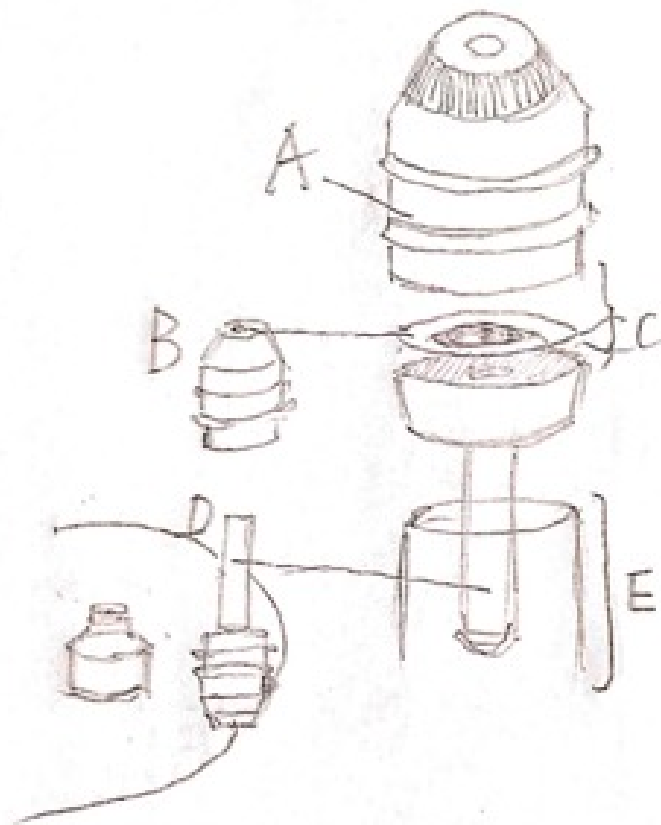


Figure 4.4: The Internal Structure of the Diffuser:

A) Plastic cover for protection (B) a piezoelectric transducer, with a small metal plate that vibrates at high frequency to release the fragrance. The piezo is connected to the rest of the electronics through the thread. (C) GND and Vcc cables. (D) Water absorbable filter paper rod (E) vessel.



Figure 4.5: Filter Paper Rod Drowned in Scents

The main part of the necklace consists a fragrance diffuser, which is connected by two cables. Inside the fragrance diffuser, there is container with a piezoelectric transducer for fragrance storming , and the piezoelectric transducer could be used to release the aroma. Inside the piezoelectric transducer there is a small lamellule that which could vibrates at high frequency to produce ultrasound, it is hardly to be perceived by human beings, but it can efficiently decompose perfume into tiny granules and become water mist, release aroma instantaneously in the private space around the necklace. This diffuser can hold 5ML fragrance and keep effusing for 18-20 hours.

4.2.2 Prototype

The prototype consists of five parts:

- Plastic cover
- Piezoelectric transducer
- GND and Vcc cables
- Water absorbable filter paper rod
- Vessel



Figure 4.6: Fragrance Diffuser

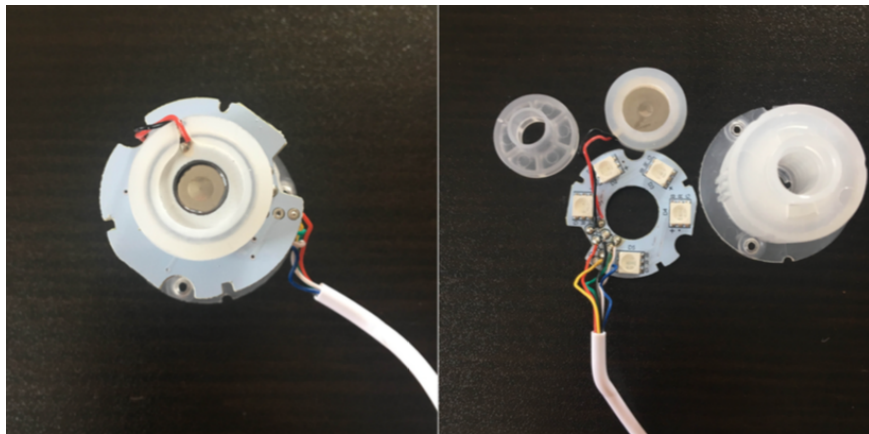


Figure 4.7: Internal Structure



Figure 4.8: Working Prototype

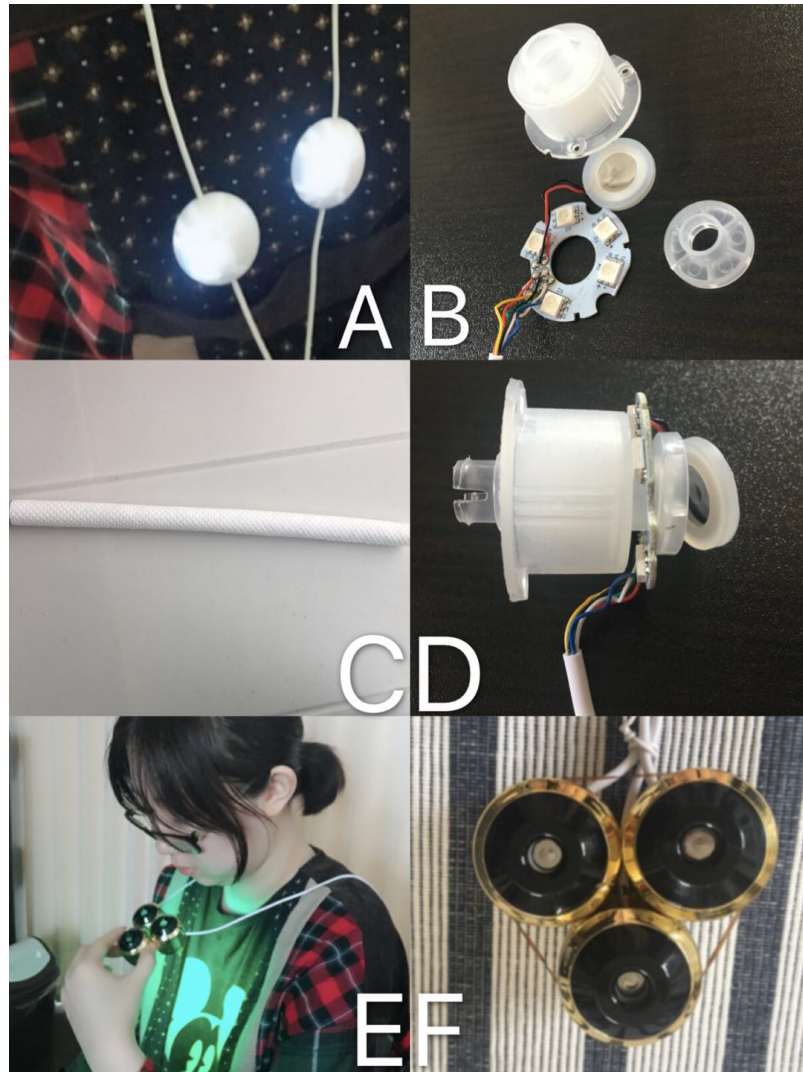


Figure 4.9: Elements(A)Back device(B)Internal structure(C)Filter Rod(D)Permutation structure(E)Luminescence mode(F)End product

4.2.3 UI Design

The main using group of this application are young adults with elder parents, so we dont need to consider too much about aging factors, as long as the style of UI design could be concise, practical and simplicity of operator, wont cause boredom and resistant from users, then it would fit our project very well.

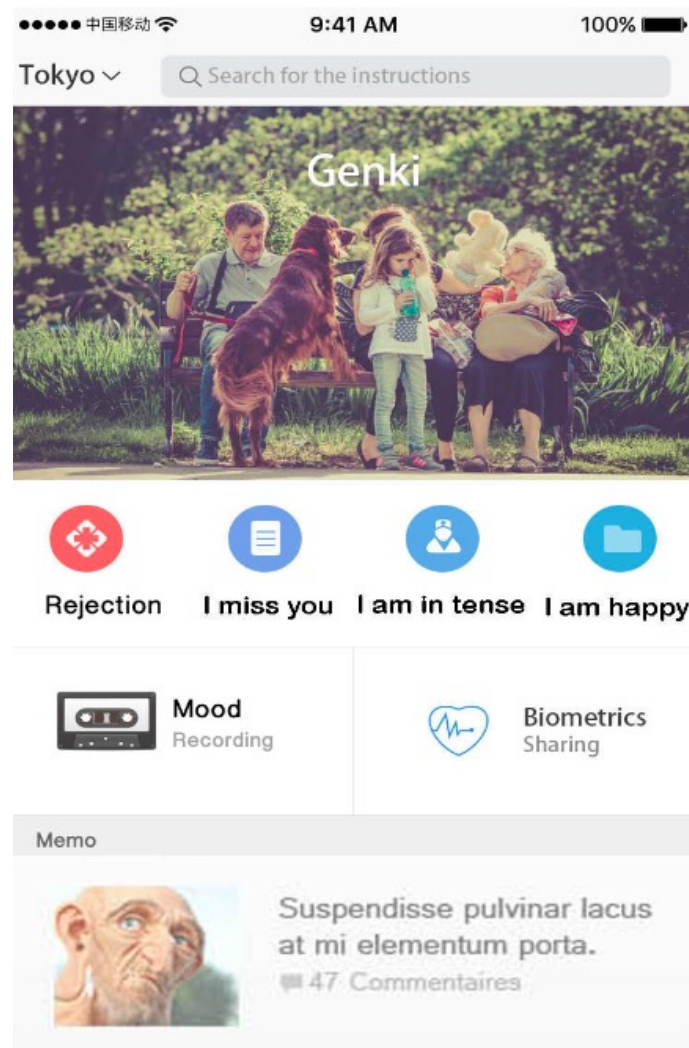


Figure 4.10: UI Design

4.3 User Test

In this user test, we have 5 participants, 3 of them are women, 2 men, with a mean of 49 years old. They are 3 elder parents and 2 children who spend a great deal of time away from their children/parents. They were asked to use the necklace during 3 days in 3 different locations (2 indoor and 1 outdoor). The type of scents they used were baby oil, peppermint and vanilla. The smell selection was based on previous studies.



Figure 4.11: Outdoor user test

4.3.1 Questionnaire and Survey

For the sake of statistical and analysis data, I distributed questionnaires and survey to understand users' sense of use and degree of satisfaction to this products. After finishing the experiment, users need to fill in a satisfaction questionnaire of wearing Necklace in different environments. They need to rank easy to operate, sufficiency, comfort and communication augmenting of this product. The other survey asked the normal frequency they communicate with their parents/child to compare with the result after using Genki.

4.3.2 Feedbacks

- It seems that there was still some space to develop the prototype, interaction and feature design, etc.
- Didn't prominent the advantage of using smell-based technology to support interpersonal communication
- Lack of interactive design aiming to the characteristics of the elderly
- Need to decide what and how many kind of smell can be released by Genki.
- It's more realistic to do one-direction HCI

4.4 Result

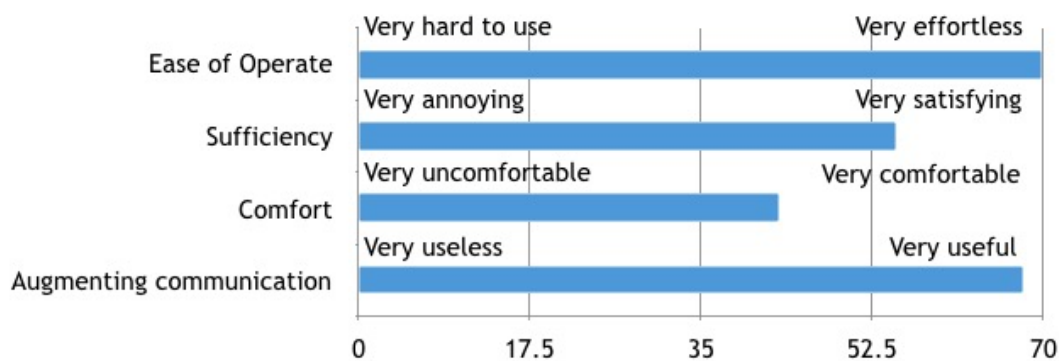


Figure 4.12: Questionnaire Result

- Users' average number of communication with their relatives in 7 days increased by 3.7 times.
- Participants ranked the experience of wearing the Essence necklace very positively.
- The Essence prototype is usable enough to be used for augmenting interpersonal communication and works in long periods of time in multiple environments .

Chapter 5

Conclusion

5.1 Proof and Concept

Gustatory occupies a special position in the five senses. But because of the uncertainty of smell, olfaction is less developed than other five senses in the HCI field. The importance of olfactory system has attracted more and more attention in personal technology area. At the same time, parent-child problems becomes a serious topic. Harmonious parent-child relationship is beneficial to human well-being in various ways. This led to more research on HCI to achieve the goal of supporting parent-child interaction. Because smell triggers memories and emotions and olfactory sense presents better than other senses in resists aging degradation , so I choose smell as a media to transmit signals to promote communication between parents and their children.

To summarize I present Genki: an olfactory smart necklace that can be remotely controlled through a smartphone and release different sent for multiple purpose based on users actually intended, to facilitate communication between human beings, especially for elder parents who spend a great deal of time away from their children.

5.2 Limitation

- Some people do not usually wear necklaces in public.
- Older adults arent that interested in computer technology.

5.3 Future Work

At present, the product is still a device to smart terminal interaction device, but actually the original motivation of this service is it should serve the elder parents

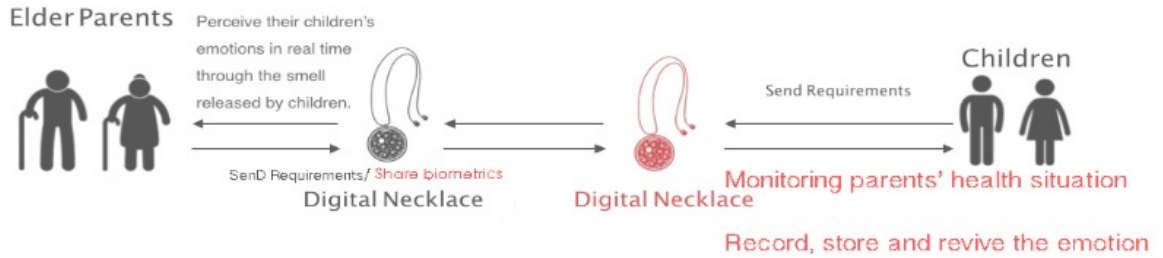


Figure 5.1: Future Work

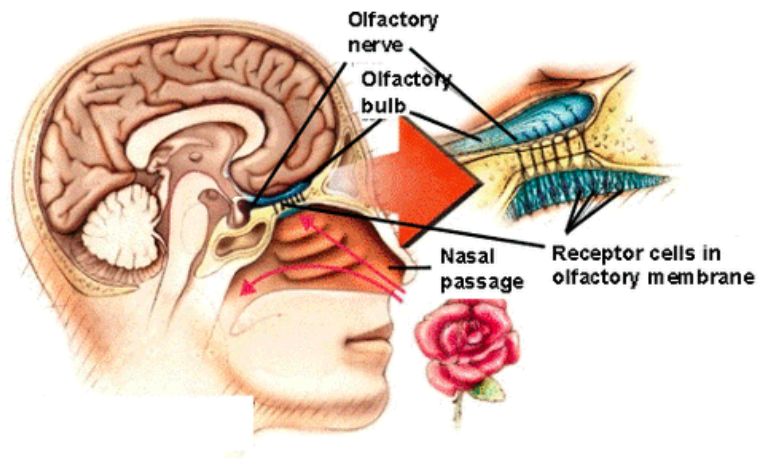


Figure 5.2: Psychic Trauma Healing

and their adult children together. With the advantage I've listed in the research before, Children should also benefit from this smell-technology based device, so the final form of the product would be a device to device interaction system as I labeled red in Figure 5.1. Also I would like to deploy several of the Genki prototypes so we can conduct user studies in different environments, such as talent developing and psychic trauma healing, as it shown in the Figure 5.2¹. Perhaps Genki will encourage discussion within the community and open up contributions in the promising area of olfactory devices for HCI systems someday.

Notes

- 1 <http://www.ptsdessentials.com/psychology-of-smell.html>

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- [3] Cao, Y. Y., and Okude, N. Scented pebbles: Interactive ambient experience with smell and lighting. In *Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction*, TEI '15, ACM (New York, NY, USA, 2015), 409–410.
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- [10] Ranasinghe, N., Karunanayaka, K., Cheok, A. D., Fernando, O. N. N., Nii, H., and Gopalakrishnakone, P. Digital taste and smell communication. In *Proceedings of the 6th International Conference on Body Area Networks, BodyNets '11*, ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering) (ICST, Brussels, Belgium, Belgium, 2011), 78–84.
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- [12] Zhou, R., Wen, Z., Tang, M., and DiSalvo, B. Navigating media use: Chinese parents and their overseas adolescent children on wechat. In *Proceedings of the 2017 Conference on Designing Interactive Systems*, DIS '17, ACM (New York, NY, USA, 2017), 1025–1037.

Appendix

A Pre-Test Questionnaire

Form description

Thank you very much for your cooperation. Please answer the following questions.

1. Do you feel unaccustomed to existing interactive ways?

Yes

No

2. Do you feel a lack of communication with your parents/children?

Yes

No

3. Do you feel hard to ask for linguistic communication?

Yes

No

4. Do you have the habit of using perfume?

Yes

No

5. Do you have the habit of wearing jewelry?

Yes

No

6. Are you suffering from a sense degradation?

Yes

No

7. If so, what kind of sense degradation are you suffering from? Short answer text

8. What kind of smell would make you think of your parents/children Short answer text

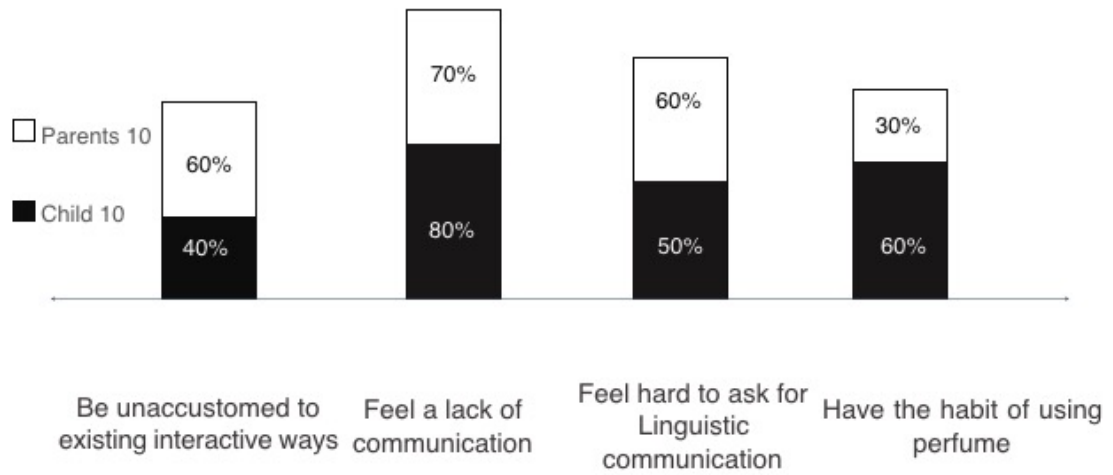


Figure A.1: Survey 1

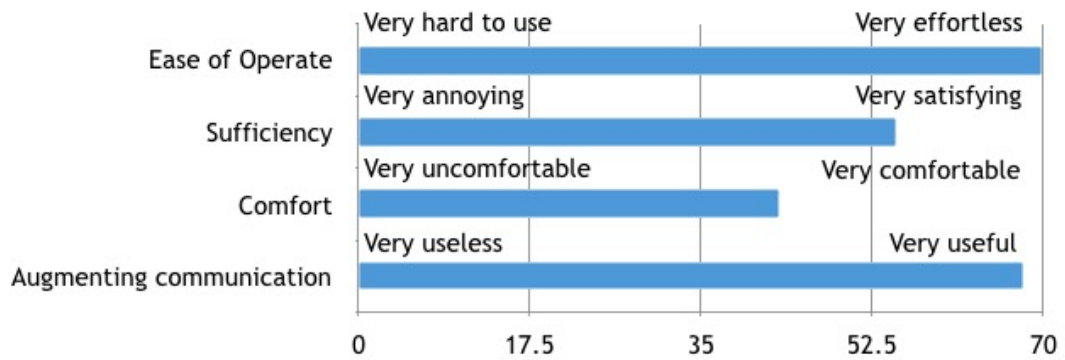


Figure A.2: Survey 2

Table A.1: What kind of smell make you think of your children

Baby powder	Perfume	Condiments	Flower
2	3	1	1

Table A.2: Is this Prepared Sent Symbolized Positive or Negative to Yyou

Sent	Vanilla	Peppermint	Baby oil	Ocean	Musky	Jasmin
Positive/Negative	15/5	4/16	18/2	10/10	8/12	12/8

B Scent Selection Questionnaire

Is this prepared scent symbolized positive or negative to you?

1. Vanilla

Positive

Negative

2. Peppermint

Positive

Negative

3. Baby Oil

Positive

Negative

4. Ocean

Positive

Negative

5. Musky

Positive

Negative

6. Jasmin

Positive

Negative

7. What kind of smell would make you think of your parents/children Short answer text

C Pro-test Questionnaire 1

Thank you for your participation, before you leave, please fill in the survey for our future improvement

1.How many times do you connect your children/parents spontaneously a week before using Genki?

Short answer text

2.How many times do you connect your children/parents spontaneously a week after using Genki?

Short answer text

3.If it increases, how many is it

Short answer text

D Pro-test Questionnaire 2

Thank you for your participation, before you leave, please fill in the survey for our future improvement

1.During using Genki do you feel it easy enough to operate? 0 means very hard to use, 70 means very effortless.

0-17.5

17.5-35

35-52.5

52.5-70

2.During using Genki do you feel it acts sufficiency to you? 0 means very annoying, 70 means very satisfying.

0-17.5

17.5-35

35-52.5

52.5-70

3.During using Genki do you feel it comfortable? 0 means very uncomfortable, 70 means very scomfortable.

0-17.5

17.5-35

35-52.5

52.5-70

2. During using Genki do you feel it acts sufficiently to you? 0 means very annoying, 70 means very satisfying.

0-17.5

17.5-35

35-52.5

52.5-70

3. During using Genki do you feel it comfortable? 0 means very uncomfortable, 70 means very comfortable.

0-17.5

17.5-35

35-52.5

52.5-70

4. During using Genki do you feel it useful in augmenting communication? 0 means very useful, 70 means very useless.

0-17.5

17.5-35

35-52.5

52.5-70

5. What's your favorite level of odor intensity?

1

2

3

4

5

6. Any other suggestions?

Short answer text

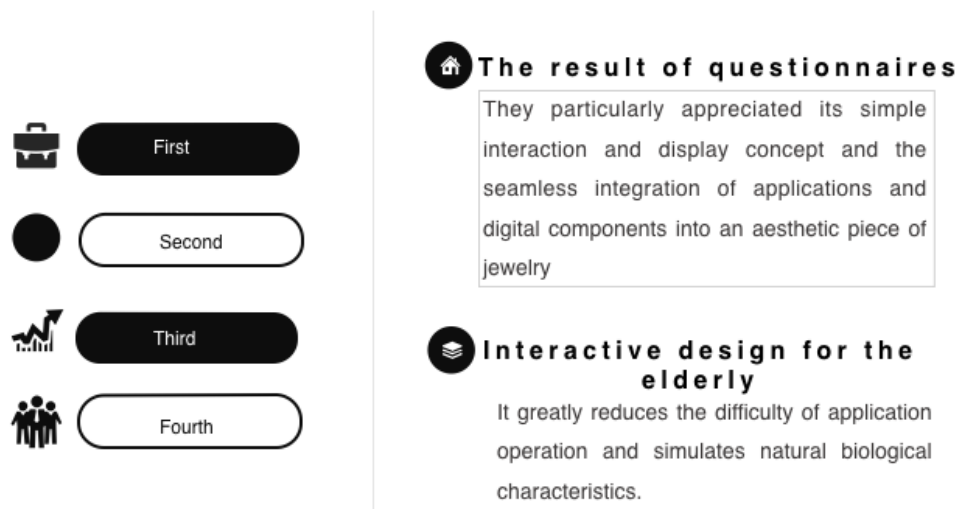


Figure D.1: Result