The Design Research for Personal Remote Communication

THESIS REPORT

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Vita

I am an international student from China. I was born in He Nan province, a middle district in China. I have achieved a Bachelor degree in Management Information System and a master degree in Industrial Economics in Xiamen University in China. Before coming to the U.S I have worked as a product designer for a while in the Internet Company. This job is related to user research, project management and interaction design. For developing my skills in product design and opening my eyes in HCI. I began my study at Tandon School of Engineering in New York University on 08/2018.

HUG-MUGs

A Design Research for Personal Remote Communiction

Contents

Abstract

Travel around the world and live far away from family members, close friends and lovers are so normal for people today. But the love among them never fades away. This is a natural emotion rooted in the soul, by connecting with each other, people get the power of support in daily life and heal hearts quickly when they experience changes. Therefore, personal remote communication becomes a basic need for people. However, the mainly present form of remote communication is the dialogue, and at the same time, no specific technology design is for personal remote communication. This largely limited people's capability to express their love and concern to each other.

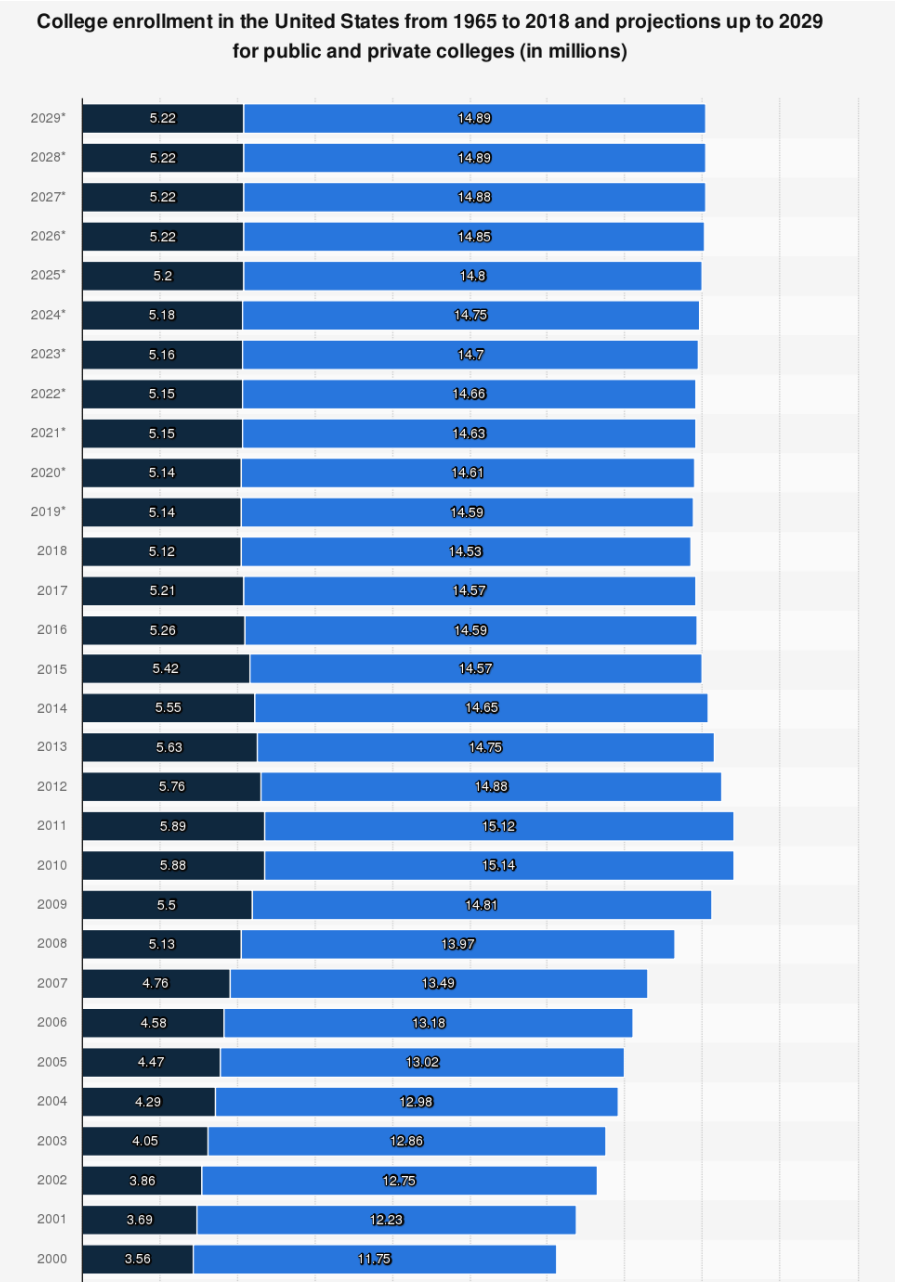
The purpose of this thesis is to explore and value the new interactive way for people, offering them a better experience in remote communication and have a strong emotional connection with people they love.

In the literature review and user research, I dig into people's cultural background to explore their behavior patterns and find out the overlap of daily routines between people separated with each other. Using brainstorming to redesign or design the tools can be used in their daily life for personal communication. In this process, I design a pair of cups as the interactive tools to show each other's presence and apply the water in the cup as an interactive interface for people to send emotion signals to each other.

Introduction

The background of Demand

According to the data report in America, roughly 35.5 million Americans move each year. In 2017, 11% of the US population moved[1]. This data only reports people who move home to different places. There is another large group of people--students in colleges and universities. According to the image1[2], by 2019, nearly 20 million enrolled college students. And the number of enrolled students keeps growthing[3], Among it, only at public colleges, about 40 percent of full-time students live on campus, 40 percent live in off-campus housing, and 20 percent live with their parents. This means nearly 10million~16 million young people just leave family and close family, but at the same time, they need a strong connection with these important people to help them adapt to social life. Personal remote communication should play a significant way to overcome the barrier of physical distance.



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This data in China is far over America, because there are three major reasons:

1. China has a large population in the world, almost 1400 millions by 2017
2. The fast industry development needs more human resources, which promote the population mobility
3. The speeding progress of urbanization leads growing people to move from small countries to towns and cities.

Because various measurements can show the population mobility in different angles. Here I chose the travel data during the Spring Festival travel season. The travel data is a representational data to understand the scale of population mobility in China. Spring Festival is a traditional festival and also the biggest party in China. People celebrate it for one week from the lunar New Year's Day, this is a public holiday for all the Chinese. In Chinese culture, this festival means the family members get together. People usually rush to go home where their original big family is before New Year's eve. The New Year will become incomplete for one person if he/she fails to celebrate this festival with his/her family members. The transportation system is the busiest during this season. In 2019, the railway handled 388 million people and civil aviation handled 73 million people. People who live or work far away from home usually use railway or aviation as their transportation compared to road trips considering the large area of China.

On another side, influenced by Confucianism for a long time, Chinese have lived in the form of the family and would like to show loyalty to their parents and friends. For juveniles, parents will pay much attention to their children's life and education, they present in every aspect of children's life. For adults, they take responsibilities to take care of their old parents. Sometimes, the family even includes uncles and aunts. Because of the close connection with each other, in history many famous writers left outstanding poetries, prose and novels when they were away from home to express how they miss their parents, wives, children and close friends. From Li Bai, Du Fu and Wang Wei in the Tang dynasty to Lu Xun, Lao She and Zhu Ziqing in modern China(1910-1970). This typical and important literary theme shows the deep love between family members rooted in Chinese blood. (related to chinese supporting old people)

In conclusion, the demand for keeping taking care of and interacting with each other is significant and meaningful, and continues to grow worldwidely.

The Remote Communication

Time has come to 21 century, technology has developed so fast and we can use different technologies to stay in touch with our parents every day. We can use phone calls, video calls or messages in remote communication. There are two reasons why we need to discuss personal remote communication:

1. Remote communication is a general concept. Actually according to the purpose or user scenarios, it can be divided into two sub-concepts: personal remote communication, in which two persons with close relationships but live in different places communicate privately with each other. Obviously communications discussed above related to children and parents, friends and lovers belong to this sub-concepts. Remote cooperation, this is information intensive interaction between public users, such as colleagues who need to finish a project together in different locations or clients use products under the guidance of remote service providers and so on. An essential difference is the message or information is the carrier of emotion communication in personal remote communication, but is the nature of remote cooperation---information share and exchange. In most situations, whether in the market or in academics, more attention is paid to remote cooperation. In the market, the products like Zoom or Polycom Trio, both aim to help staff realise team work in multiple locations. Not even mention the vast number of message applications on the smart devices. In academics, research keeps discussing the most natural and real time way to help efficient work by applying various new technologies. Recent 30 years, researchers in HCI area mainly focus on two ways--bring people together in a virtual shared space by applying tangible media design or VR/AR, which can be used in the industry model design or interactive meeting. Another way is to use physical agents to interact with people in distance and common in the research of Human Robotics Interaction, these physical agents can apply in remote medical assistance. I will unfold these research in the next section. However, compared to the attention on remote cooperation, which is an increasing explicit demand and closely related to social wealth and welfare growth. Personal remote communication is an implicit emotional demand and in most people's eyes it is about simply talking with others -- expressing their emotion via dialogs. Therefore, a few special topics in the product design industry or research are related to it.

2. As the understanding of personal remote communication. The communication application or device in the market almost serves for remote conversation and no clear usage boundary between personal remote communication and remote cooperation. The major products are messages, voice calls and video calls. According to the rank lists in the App store, the instant messaging app like whatsApp, Messenger, Wechat and the smartphone native instant communication function all provide the basic and similar communication ways. But when I have a close look at these functions, I find that no matter messages, voice calls or video calls, they all help users to build the dialog between people in distance. The emoji or the video function just rich the user experience in the progress of dialogs, helping people express their emotion more accurately. And this dailog happens in real-time. These application designs set the personal remote communication only happens via the real-time conversation. But according to scenarios people stay with their loved parents or friends, conversation is not the only way for them to interact with each other in daily life. For example, everyday one father gives a big hug to his daughter when he comes home from work, in this scenario they have a very nice emotional communication without a word at all. The existing product or function limited the way and scenarios for people to express their emotions naturally in daily life.

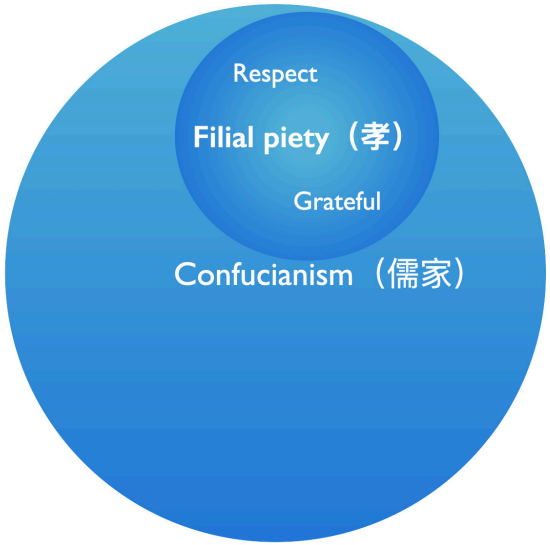
This thesis will explore people's behavior characteristics of personal communication with their loved persons in their daily life and propose a new interactive interface for personal remote communication. In this research, the user target is chinese international students and their parents. This community is far away from home and also needs strong spirit support from their family when facing a different culture and great pressure of study. Otherwise, the profound relationship between wanderers and their parents or old friends is a distinctive feature in chinese culture. Therefore, the thesis needs to combine this special cultural background to do research. In this thesis, the first chapter will show two parts of the literature review, one part is about the chinese culture research about emotion expression patterns. Another part is about the existing research of remote communication in HCI. The second Chapter is about users research and brainstorming the prototyping. The third chapter will introduce how to build the prototype, including the construction and the data sent progress. The fourth chapter includes the user test: how to design the user test, what the outcome of the user test and conclusions of the design.

Literature Review

The emotion expression pattern in China

In personal remote communication, people pay much attention to emotion expression, even conversation or sharing interesting stories is a way to communicate emotions. So for this research, it is significant to explore the emotion expression pattern in a special culture background before discussing the design solution. No matter in people's cognition or in the research, we believe that emotion expression in China is very different from other countries. On one side, the Chinese researchers(Liu Chao & Guo yongyu,2009)[4] study the difference and this expression pattern in the view of Confucianism. They believe that, for thousands of years, chinese people have been influenced by it since they were born. In this thought, "Xiao"--filial piety, which means respect and support your parents, is a core concept. Confucianism explains that "Xiao" is very important because it is the premise of domestic peace and national stability. At the same time, many famous literatures like poems using rich imagination and beautiful words to eulogize the love among family members and the concept of "xiao", gradually making "xiao" as a virtue grow deeply in people's hearts . The <The Analects of Confucius>B.C. 400) writes: "Those whose parents are still alive should not travel to far-off places. If they have to, then they should have a certain destination (instead of wandering around)." The poem<The Chant of A Wanderer>, written by Meng Jiao, a famous poetry in Tang dynasty:"Thread in the hand of a compassionate mother -, clothes on a wandering son; Just before his departure she sewed closely, in her mind worrying about his late return. Who would say that the heart of inch-high grass,could repay the sunshine of deepest spring?" Then the meaning of "xiao" expands to describe the relationship of people-homeland, brothers, monarch-subject. The growing importance of "Xiao" in the culture makes people set rules for people to follow and form a strict society hierarchy. To show respect to "parents", people should think twice before talking to their "parents", protect them and cannot go against them. The Classic of Filial Piety(B.C 221~A.D 8) writes: "Our bodies are given by our parents, we shouldn't destroy them", which even see children as the continuation of parents' lives. This lead to people have no idea of freedom and lost the opportunity to develop a unique personalities. Liu Chao thinks that the high emotional stability and Introverted personality in chinese formed from this cultural background.

"慈母手中线，游子身上衣。
临行密密缝，意恐迟迟归。
谁言寸草心，报得三春晖。"



There are also many western researchers exploring the origin and pattern of chinese emotional expression. Some researchers compared chinese emotion expression patterns with other nationalities'. For origin, Potter (1988)[5] mentioned collectivistic Chinese culture, proposing that emotions lack social significance since it may be more disruptive to social harmony. The interesting thing is this is consistent with the purpose of "Xiao", because people believe in collectivism, "Xiao" can work well to hold people together and keep national stability. For the emotion expression pattern, Michael Harris Bond(1993)[6] found that chinese culture is the lower frequency, intensity and duration with which emotions are typically experienced. José A. Soto(2005)[7] compared Chinese American couples with European American couples, chinese couples reported fewer periods of positive emotion and showed less viability in their emotional experience. These findings are also similar to the chinese researcher. Specifically, chinese prefer to hold their emotions in their hearts and show less emotional fluctuation in front of others. So when designing the medium of personal remote communication, we need to think of another suitable way to help users show their care to families. Obviously the language expression may be only one choice for us, but not the significant one.

Communication Study

Communication is the act of conveying meanings from one entity or group to another through the use of mutually understood signs, symbols, and semiotic rules. In the communication studies area, some models are proposed to explain the communication process. The following two models are representative ones: Figure 3, Harold Lasswell said that the communication process could best be explained by asking the following questions: Who? Says what? To whom? In what channel? With what effect? This model focuses on the subject of the information flow.

As the original model was designed to show the functioning of radio and telephone technologies. In the model we can see signals shown in the model. Besides, Shannon and Weaver argued that there were three levels of problems for communication within this theory:

1. The technical problem: how accurately can the message be transmitted?
2. The semantic problem: how precisely is the meaning conveyed?
3. The effectiveness problem: how effectively does the received meaning affect behavior?

This transmission or technical model clearly depicts the relationship between the communicator, message and recipient as a one-way process. And it begins to consider communication efficient in the view of technologies.

Figure 3 Lasswell's model of communication(Lasswell, 1948)[8]

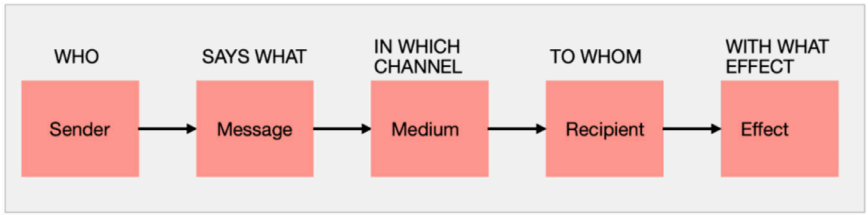
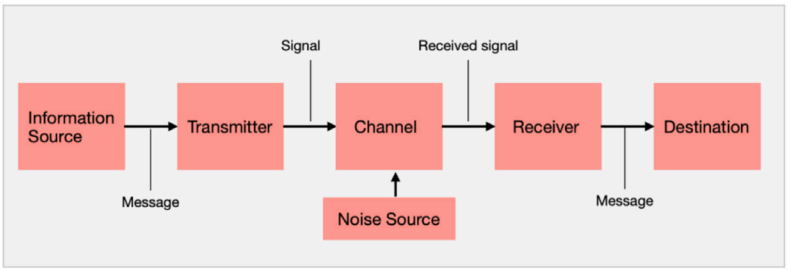


Figure 4 The Shannon and Weaver model(Shannon, Claude E. & Warren Weaver, 1949)[9]



Although the two models are proposed in different angles, they all mentioned the concept of Channel. According to Shannon, the channel could influence the message's accuracy. Therefore, verbal and on-verbal communication can be seen as using different channels to send messages.

Verbal communication, also called linguistic, is the spoken or written conveyance of a message. Human language can be defined as a system of symbols and the grammars or rules by which the symbols are manipulated. The word "language" also refers to common properties of languages. Non-Verbal communication, literally it means other ways of communication except speaking or writing. Examples of nonverbal communication include haptic communication, chronemic communication, gestures, olfactory, electromagnetic, body language, facial expressions, eye contact etc. Usually communication makes people think about verbal communication. Burgoon, J., Guerrero, L., Floyd, K., (2010)[10] said all non-verbal channels such as the body, face, voice, appearance, touch, distance, timing, and other environmental forces must be engaged during face-to-face interaction. At the same time, multiple channels can send simultaneous messages, which can strengthen the experience of communication. Mark and Judith(1997)[11] analyze the non-verbal communication systematically. They admit "Understanding and effectively using nonverbal behavior is crucial in virtually every sector of our society". Mehrabian(1972)[12] conducted a number of experimental studies of the behavior that indicate greater closeness or liking. The results showed that more direct body behavior, like touching or more facial expression means more intimacy between people. This work lends us a view here that the importance of non-verbal communication in close relationships.

Remote communication research in HCI

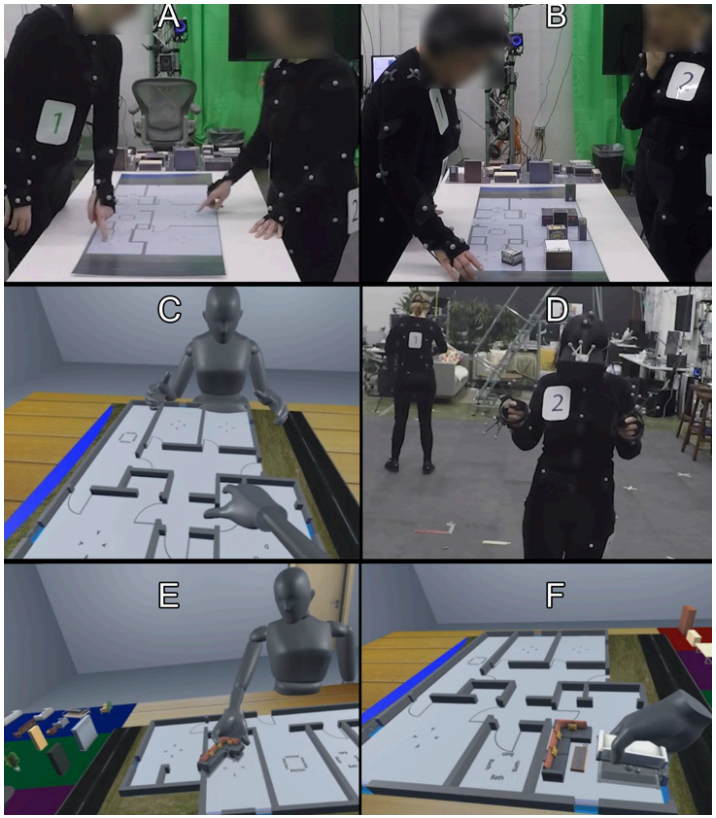
Nowadays, remote communication is to transfer people's speaking or writing or images to digital signals and then send it to people in the distance. According to the communication studies, this remote communication mainly takes the verbal way as the main channel for people to change information, and non-verbal communication is missing in this process. So researchers in HCI area continuously try to bring non-verbal communication back to remote communication. They use different views and technologies to do design research. In this process, "presence" is proposed as a core concept in remote communication research. Because the source of all the difference remote communication from traditional communication is lack of people's presence. James S. Tittle(2002)[13] specifically discusses the function and importance of presence in remote communication. From this view, researchers, especially those who are in the area of HCI, explore new technologies to compensate for non-verbal parts in remote communication. First, compared with the traditional face to face communication, the physical presence is missing, which is the carriers of many non-verbal communication, so some researchers think about the physical agent, the development of robotics give them a new view: Eric Paulos and John Canny(1999)[14] projected human beings' presence into a tele-robot instead of an avatar in remote communication. The robot even can perform users' activities, like wandering around, pointing, conversing with people and so on. By user research, they found that in remote communication, people show the willingness to browse and explore the space, also the physical presence can improve the length, quality and priority of one-on-one group interactions. Later this telepresence design is usually discussed in two sides: Embodiment and immersion, Embodiment refers to the level presence that people interacting with the robot experience, immersion refers to the level of engagement or involvement the operator experiences. Sigurdur Orn Adalgeirsson and Cynthia Breazeal (2010)[15] built a Mini Robot-MeBot, which communicates more than audio or video but also expressive gestures, body pose and proxemics, bringing people more engaging and enjoyable interaction. Hideyuki, Kazuaki and Yuya(2014)[16] made a robot hand, which can simulate partner's hand movements and even temperature. They explore adding a touch channel besides audio and video attendance in the remote communication. Then their analysis revealed that robotic design can enhance the feeling of being close to the partner. Here the HRI design is to add more physical channels in the remote video and more design in the background of public remote communication, because physical cooperation can improve the work efficiency.

Adalgeirsson, S. O., & Breazeal, C. (2010, March)

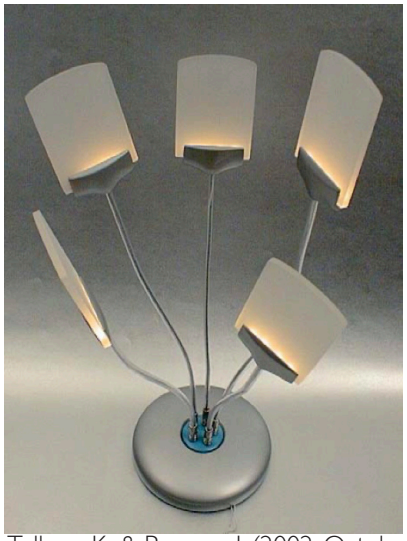
Nakanishi, H., Tanaka, K., & Wada, Y. (2014, April)

Besides, some researchers make extensions of the existing smart communication device by using tangible elements. This tangible design usually sends an emotional message or it is a physical compensation of the message sent on the phone. Usually the size is smaller. Angela, Sile, Rob, Eric, and Hiroshi(2002)[17] designed a ComTouch, a device which can convert hand pressure into vibrational intensity between users in real-time. Joohee, Young-Woo, and Tek-Jin(2014)[18] developed Wriggle, a shape-changing "tentacle" attached to a smartphone. Users' can send their emotional states by performing different gestures on receivers' phones. Masaru, Shuhe,and Takuya(2016)[19] proposed a novel augment mobile interaction with hair-like shape-changing interface, based on the concept of context-aware interaction. Marc, Gilles, Catherine, and Eric(2018)[20] made an augmenting Mobile device with a robotic limb. One limitation of these research is they all depend on the smartphone-a specific device instead of the different forms of communication itself, such as real time or non-real time communication, which will lead to these creation lack of adaptability.

Another research direction focuses on how to offer the virtual presence in a shared space, in this space people can use non-verbal communication with verbal communication, such as facial expression and body language, which can send more accuracy information to each other and enhance user experience in intimate communication. VR/AR technology brings people this unprecedented immersive experience. In remote communication, this technology can let people share a virtual space and more interaction can happen between people. Harrison and Michael(2018)[21] compared three ways of communication in two user tasks, which needs a shared virtual space: face-to-face, embodied VR with visible full-body avatars, and no embodiment VR, where the participants shared a virtual space, but had no visible avatars. The research shows that the Embodied VR provides a high level of social presence with conversation patterns that are very similar to face-to-face inter- action. Based on this view, the research scenario is usually related to 3D Collaborative Virtual Environments, in which people cooperate with each other to finish a task in a separate work location. There is little paper that talks directly about remote communication itself.



Smith, H. J., & Neff, M. (2018, April)



Tollmar, K., & Persson, J. (2002, October)

The third research direction focuses on the essence of remote communication in the view of Ethnographic Research and design some natural interaction based on the existing items in life. Konrad and Joakim(2002)[22] use ethnographic study methods to exam family communication and the role of artifacts in supporting emotional closeness. They use observation to watch people's daily communication with their families and also how they behave everyday, whether there is an artifact that exists at home can connect each other well in the distance. The results show that every artifact at home attaches people's emotion. In some scenarios, people can connect it to family members. They build a prototype by redesign the daily item at home--the lamp, which displays the sense of presence in remote communication. Based on this study, Melissa(2008)[23] designed a BuddyWall that served not only for presence detection and communicating emotional content but also engaged users in voice communication. Those are different ways to send abstract messages to friends or families. These non-verbal messages are related to people's emotions directly and attach to a culture which roots in the long history of the whole society.

Conclusions & insights

The first two research directions tend to improve the accuracy of information transmitted by using advanced or new technologies to explore a new way to bring people back to face to face communication virtually or physically. Most of them are technology applications. They focus on technological execution and require a high level of technical design. This form of research actually brings many new design patterns for remote communication. However, since these research pay attention to the underlying element of communication--information itself, so the design in these research is used to a general scenario, just like you can use any phone call in any remote communication scenario. They discuss little about emotional connection with each other in remote communication, which is a key point in the design for personal remote communication. The third research direction is to take the method of ethnographic research or cultural background research to look for the emotional symbols that exist in people's daily life, and discuss the possibility of these emotional symbols used in personal remote communication. Compared to the first two research directions, it does not give a specific design solution for personal remote communication but try to find the principles to design for the emotional symbols. This research doesn't stop at the stage of discovering more useful emotional symbols, but uses this research concept--by using ethnographic research to redesign the items in life to strengthen people's emotional connection, the thesis will finally give one or two specific design solutions by applying some useful advanced technology.

User Research

The target user

This research targets are International Chinese students and their parents as mentioned in the first chapter. The emotion expression in Chinese culture is very different from it in American, South American or European. So this research will be more persuasive and rigorous if only one kind of person is chosen. As I am more familiar with Chinese culture, I set this research in the background of chinese people. International Chinese students are those who are away from parents and live outside of China, They and their parents are typical research targets. Most of the International Chinese students have just left their parents for a short time, they face a very different culture and living environment. At the same time, they need to handle the great study pressure. Therefore, they have a very strong emotional demand to connect with their parents in daily life.

Research topics

The user research aims to find the different behavior patterns between when they lived with their parents and now when they live alone in a foreign country. The difference can guide the research to explore the missing parts in remote communication compared with the traditional family life or face to face communication.
Thus, according to the above purpose, this user research can be divided into two scenarios: the daily life before they left home and daily life now they live in a different country. The key part of this observation is how they communicate with their families.
The interview will try to explore the following topics in each scenario:

The interview will try to explore the following topics in each scenario:

1. The daily life before they left home
- Do users and their parents often express emotions or feelings with each other? How do they express these emotions?
- What is the daily routine between you and your parents?
- What kind of emotions users would like most to share with their families? And under which circumstances?

2. Communication with families now
- What applications do users usually use when they communicate with their families?
- Which kinds of ways do users use most? Message, Voice, Video or others? Why this way?
- How long do users call their parents every time?
- What kind of content do users usually communicate with their parents?

As the region limitation for me and the user's privacy. I only interview Chinese students and let them narrate their daily behaviors in different scenarios.
For this purpose, I have interviewed 9 Chinese international students. They are all NYU students, whose parents stay at home in China. All of them keep in touch with their parents at least once a week. The interview for each person lasts 1~2 hours.

In the first scenario---their daily life at home before. For all the interviewers, a father usually shows less emotional expression than a mother. This also matches the theory in Chinese culture this thesis discussed in the second part--In the concept of "Xiao", a father should have the authority, which doesn't allow him to show sensibility in front of other family members too often. He is always busy working and tends to give materially care, like money or gifts. So a mother plays an extremely important role in emotional care. In my user research, most of my interviewers have shared the sweet memory about how their mothers look after them physically and emotionally. Two important conclusion:

1. In the past, parents helped their children keep good living habits, such as reminding them to drink water, eat meals when it is warm, and eat breakfast, which shows parents care about children's health in detail.
2. Companionship is a very important concept in family life. Everyday family members sit together at a fixed time, just talking or watching TV. Usually it happens during one meal. This is the most memorable time and nice memory for them now.

http://www.996pic.com/sucai/442840.html

For the second scenario, our talk mainly focuses on communication by using smartphones, because this is the most frequency device people used to contact with the outside world after World War II. Before the development of signal and image processing, the phone itself was a communication device, people call and text to others. Now in the smartphone, we can use video calls and send pictures with each other. Of the users I interviewed, all of them use Phone as the medium of remote communication. The most used APP is WeChat. It is a Chinese instant messaging app with 1100 million monthly active users by 2018. Except **WeChat**, sometimes people would use iMessage and Facetime on the iphone.

In WeChat, people can choose to use three ways to connect with each other: message, voice, video. The interviewers all use it frequently. The following is the scenario analysis according to user research:

1. Message-- Left some use or interesting information, not harry for reply
2. Voice call--Most interviewers use it as the major channel for personal remote communication , the content can be everything, such as things happen in daily life and study contents; It usually takes about 1 hour every time
3. Video call--Used among very closely person, the content is similar with voice call

- Advantage, offer the feeling of sharing the same time and space with people in distance;
- Disadvantage, the performance of communication immensely depends on the condition of Internet; users cannot move around during talking

Compared with the past life with parents, now the communication on the phone is almost the only way for them to interact with their parents. The phone call plays the role of companionship with each other. Most of the time, they just need to know each other's presence at the other side and don't need many conversations in the phone call. According to the research, half of them are used to using video calls with their mother during one meal. Two purposes for interviewers contact with family via phone are discovered: share emotions and keep companionship.

Findings

Combining the findings in two scenarios, this research finds that "Companionship" is the core concept no matter in the past or now. Another common is parents care about children's health too much and help them to behave healthily. While the present personal remote communication is mainly in the form of dialogues, that is verbal-communication. However, in Chinese families, more emotions and love are covert in their daily life. They are just expressed in many life details in silence.

Ideation

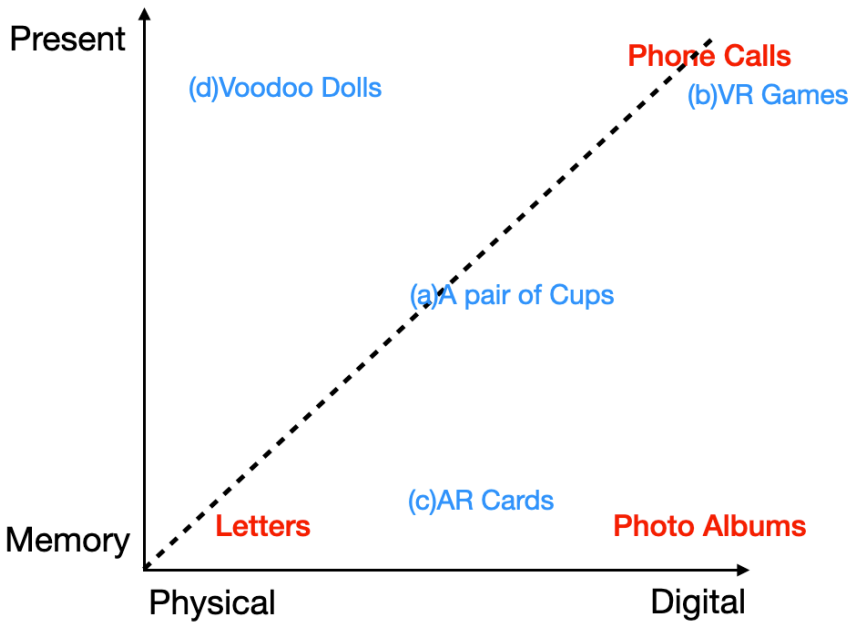
A large gap of the communication way between past daily communication at home and the present personal remote communication. According to the user research, the missing part is non-verbal communication. However, as children become independent they won't choose to talk about everything with their parents, at the same time, the environment now is very different from family life, for example, people will separate in different time zones. So the research will not try to recover the communication path users applied when they live at home. Therefore, this research set a few design principles:

1. Design for the communication channel--non-verbal path. The signal and image processing is well developed, so most of the remote communication tools use this technology to bring better user experience, but the core concept of this technology application is still "conversation".
2. Add the Daily routine elements: Many communications between Chinese parents and children are just simple actions without a word.
3. Usability: Different from the dialog, which can be understood by everyone using the same language. The non-verbal communication will have very different meanings under different backgrounds and sent by different persons. Thus, the design should be usable for all the users.
4. Feedback: The design should consider whether the feedback should be instant, which will decide the notification mechanism and its form. While users lived at home, some interactions with parents were instant, such as doing some cooperation; However, most of the time, the feedback was lagging, like a mother preparing the lunch for her child in the morning. The notification mechanism should have no great pressure for users to respond.

Brainstorming

The brainstorming analyzes the possible ideas from two aspects: the channel type and timeliness. These two dimensions consist of one coordinate system, respectively represented by X axis and Y axis. Different ideas are deconstructed in this coordinate systems, the applications---Phone calls, Letters and Photo Albums are reference in the coordinate system :

1. A pair of cups: Drinking water is very important in China, people believe drinking enough water everyday is a good habit. In China, parents usually monitor how much water their children drink everyday and remind them to drink. This behavior is a love carrier for both of them. The cup can work in pairs. They can pass the information of people's presence, behavior of drinking and emotion signal of love via the each other's cup. The cups will let people know these signals by changing their surface or status.
2. VR Chess game: Recently years, researchers explore the possible design of VR in remote cooperation by taking the advantage of sharing the same virtual space. This thought also can be used in personal remote communication. In our daily life, the family game is a relaxing entertainment which family members can sit together to enjoy the happy time and also it is a kind of companionship. Using VR games, parents and children can share the same virtual space and engage in the same tasks.
3. AR postcard: This idea tries to combine virtual and physical together, which is the advantage of AR. The postcard keeps its traditional meanings. People can add memorable moments using video to the photo in the postcard and send the postcard with their writing words. Using this form, family members can share the experience with each other, the touchable paper and handwriting can enhance the receiver's experience.
4. Voodoo Dolls: This is a tangible design expressing each other's emotion by physical touch. The research shows that tangible or haptic elements can enrich the experience of communication since it adds non-verbal channels of communication. People can send their present feelings to others by sending the command to the toy, and others should hold the toy by their hands. Then the toy will take action according to different feelings. For example, if children miss their parents, the toy held in parents hands will rub parents' hands by using the toy hands.



	A pair of Cups	VR Games	AR Cards	Voodoo Dolls
Timeliness and communication channel	It is not a instant communication.Especially the presence of a status, which can last one minute or two hours.	It is an instant interaction, the communication happens in the form of playing game together; It is totally digital communication.	It is a logging demand. Communication builds up via a memory; It combines physical card and digital video.	It closes to an instant communication***
Verbal communication in the phone	Interaction is related to sender's behavior and doesn't need to talk	Talk in the shared Virtual space, it mainly related to the Game contents	No conversation. The message left in the form of handwriting	The interaction is the signal of users' emotion
Overlap of daily routine elements in the past	Parents remind children drink water every day, the cup is a carrier of this action	Family members sat together in a fixed time every day	Sometimes users write letters and postcard to people in the distance	Users expressed their feelings by body movement. For example, children rub parents' arms or parents hug children
Usability	No matter stay at home or live alone, users own a private cup and use it everyday	Players need a set of VR device and learn how to use VR rightly; Family members need to have a shared game	Users need to use an App to add an video to a fixed image; Users should send postcard internationally	Users need to use smartphone along with dolls. The APP in the smartphone will control the doll remotely
Feedback	No feedback mechanism	Feedback is similar to video game, players also can have direct feedback by talking with each other	No feedback mechanism	No feedback needed
Technology	Internet of Things(IOT), Physical computing	Virtual Reality	Augmented Reality	Internet of Things(IOT), Physical computing

*** :The doll has specific actions when receiver the remote command. Since the action is instant, if users cannot see the action immediately, the signal is meaningless.

Analysis of ideas

Among four ideas, VR Game's performance is not good in the view of "Usability", because people need to prepare devices and have basic knowledge of VR, which sets a high entry threshold. In China, VR is not a very usual technology for the ordinary family. The heavy headset is not an ideal tool for a long game with family during one leisure time.
The AR game isn't environment friendly since postcards are made of papers. Another problem is the international mail usually needs a very long time and users need to take the risk of losing the postcard. There is a doubt that how valuable the video showed on the phone compared to the video people send by the instant communication application, like Wechat.
The one problem of Voodoo dolls is people need to have an instant perception to the signal. And the design of the doll's appearance would be a big issue since people will have various feelings when facing the same kind of dolls, some think it adorable, but others think it horrible. Not to mention the doll can move. In essence, this new interaction is not so natural for people to use.

A pair of cups–"Hug-Mugs"

The literature review makes it clear that presence is a very important factor in remote communication and many daily items in our daily life attach people's emotional connection with their loved persons in the distance. Through studying people's daily life and the possible items they used everyday. The user research found that drinking water is a daily routine that happens between Chinese parents and children. When children lived with their parents in the past, their parents prepared hot water or reminded their children to drink enough water. When they live away from home, parents still usually remind children to drink water in a phone call. Because in parents' eyes, drinking enough water everyday, especially hot water, can keep people healthy. So drinking water can be seen as the emotion link between parents and children and it shows the infinite love between them. The cup and the water in the cup is the emotion symbols this thesis discovered. According to user research, users reflect that phone calls take too much time and many times they have not so muh things to talk, they call just for companionship. Therefore, this design reduces the stress of talking something by just displaying people's state.

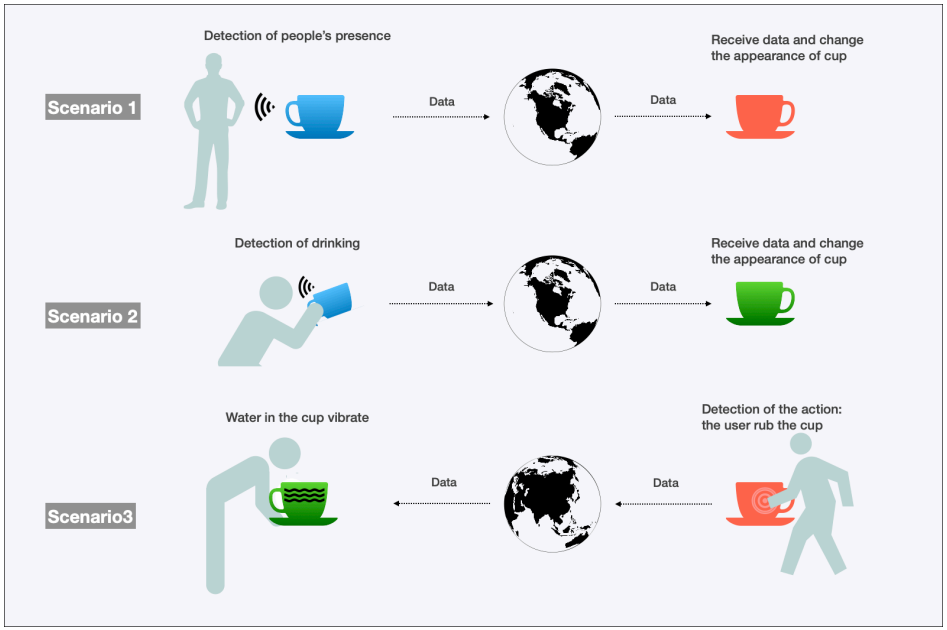
Usually a cup is a very private item people use everyday. So it is easy to redesign the cup as a personal communication tool. Further, non-verbal communication proved in previous research and user research plays a significant role in Chinese daily family life. This redesign for the cup is in the form of non-verbal way. As they transmit the love between parents and children, which is similar as one hug every time they give to each other. So I named my new cup design of cups--"Hug-Mugs".

Prototyping

This prototyping will realize three functions, each function is one user scenario. The Hug-Mugs always works in pairs:

1. Hug-Mugs A at one side can detect its user's presence when the user is near it, no matter the user is in the movements or just sit still. Then Hug-Mugs A sends the information of "presence" to Hug-Mugs B, which works at the other side in the distance, Hug-Mugs B receives this information and changes its surface color to Hug-Mugs A. The user of Hug-Mugs B now know that the user of Hug-Mugs A shows up around the cup. As knowing the presence of the user of Hug-Mugs A, the user of Hug-Mugs B feels relieved and peaceful in the heart.
2. When the user picks up Hug-Mugs A to drink, Hug-Mugs A detects this action and sends this information to Hug-Mugs B, Hug-Mugs B receives this message and changes its surface color to Color B. This change lets the user of Hug-Mugs B know that the user of Hug-Mugs A is drinking water. It is a good and healthy signal for the user of Hug-Mugs B.
3. When the user of Hug-Mugs A misses the user of Hug-Mugs B or wants to express his/her love and care to the user of Hug-Mugs B, they can simply touch or rug one fixed area on the surface of Hug-Mugs A. Hug-Mugs A sends this message to Hug-Mugs B, the water in Hug-Mugs B will vibrate five times at the speed of human's heartbeat to let its user know. That this water vibration stimulates the heartbeat of human beings is to try to concrete the love of the person in the distance whose love is so deep and fresh.

To finish this prototyping, the first stage focuses on how to make the cup work. The following image shows the three scenario in the design:



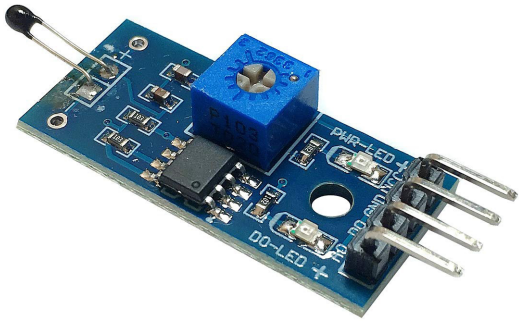
The introduction of sensors and computer processor

Human presence detection:

In this project, the detection is to use a range of technologies and methods for detecting the presence of a human body in an area, the presence means the user just needs to show up near the cup. No matter if users are static or move around. The detected area is a circle, the cup is the centre of this circle. Its radius is 0.5mile to 1mile. If the radius is too small, many presence will be missing, since now most of the length of a table is over 1mile and people don't allow the cup to be too close to them if they are working with a lot of things. While the radius should not be too large, because the status will always be present when people stay in the house but they cannot sense the water vibrate if it happens in a long distance.

Considering the size of a cup and the detect requirement. The sensor which can sense a human being's presence should not be small enough to be embedded into the cup and can set the detect size. In physical computing, some sensors are good options. Like thermal sensors, which work by detecting the variation in temperature in the body; Infrared sensors,which detect people's presence or movements by either emitting or detecting infrared radiation; Chemical sensors, work based on chemical concentrations.

This prototyping will use a high sensitive thermal sensor--Thermistor module. It is highly sensitive to ambient temperature, detects the temperature of the surrounding environment and converts the output signal to temperature value. The size is 3.2cm*1.4cm, which is small enough to integrate into the cup.



Detection of drinking:

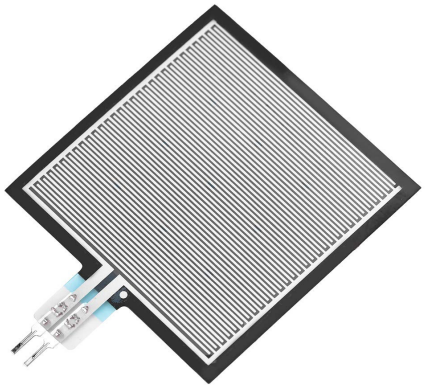
For convenience to track people's behavior pattern, a handle is designed in this cup. When people drink water, their behavior pattern is to pick up the cup by the handle. So the handle is a key point to sense people's motion of drinking. A force sensor can be embedded inside the handle since people's fingers will press the handle when picking up the cup. Because this sensor is plastic and its size is small (the thickness is less than 0.25mm), and it can bend easily which fits the shape of the handle well.

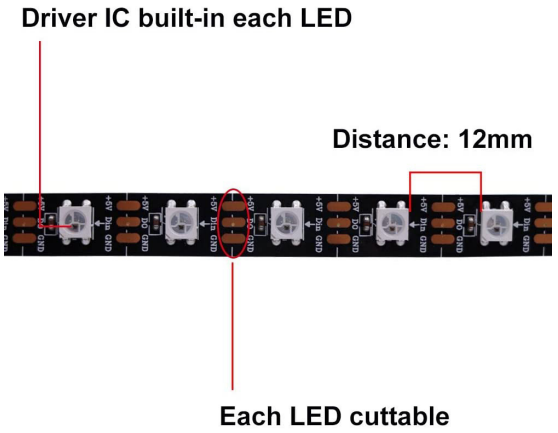
ing environment and converts the output signal to temperature value. The size is 3.2cm*1.4cm, which is small enough to integrate into the cup.

Detect the action of rubbing the cup:

In the past daily life, parents could show their love to their children by rubbing children's head, hand or back. Identically, children also use this behavior pattern to express their feelings to parents. This behavior is a natural sign of love and care between parents and their children. For this reason, this cup will lend this rubbing mechanism. The difference is this behavior is used between people and the body of the cup. Since in daily life, when the cup is close to one's hands, sometimes he/she rubs the cup for no reason, so this interaction isn't expected to be strange or weird. The prototyping fixes an area on the body of the cup and also uses a force sensor. And set a much lower threshold value than the force sensor in the handle to make sure even a slight rub can be detected.

signal to temperature value. The size is 3.2cm*1.4cm, which is small enough to integrate into the cup.

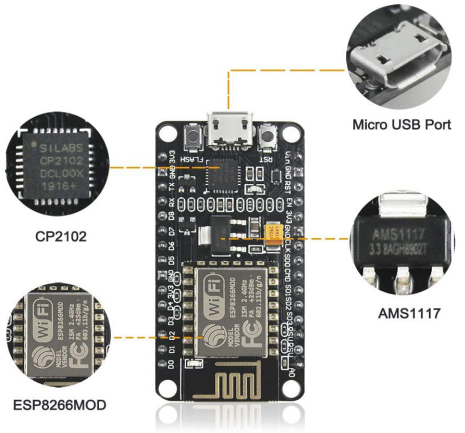




Change the appearance of the cup:

When one cup received data from the other cup remotely. The cup shows a signal of the status of the other side to users. Different statuses match different signals. Usually the color change is an obvious signal for people to perceive and often used in the interaction design. As easily controlled by a microcontroller and conveniently adjusting the size to match the cup's, the led strip is used here.

Vibrate the water:
Water in the cup vibrates when receiving a rubbing signal is one scenario related to instant communication. Therefore, the vibration of water should satisfy two requirements: the vibrate can be noticed when people nearby and the vibrate should not be too strong otherwise the water will splash everywhere. Compared with a turbine motor and a vibration motor, the amplitude of the mini vibration motor is small. Besides, it will make a gentle voice in case the scenario that people ignore the signal or no water in the cup.

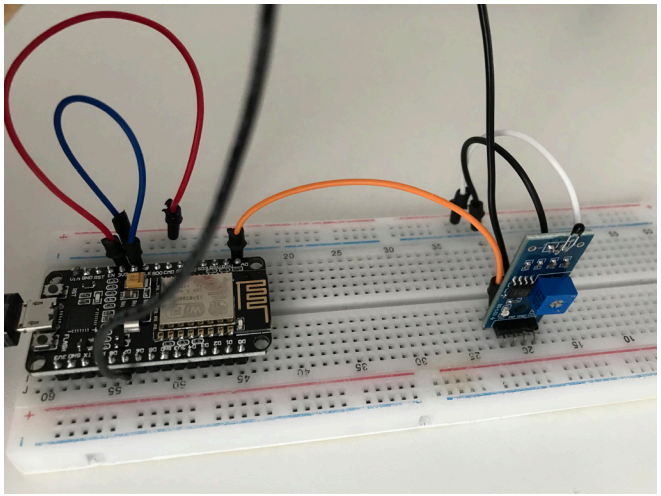


Send and receive data in different locations:
According to the schematic diagram above, this is an issue of the Internet of Things. For the data transmission, two parts need to be figured out: which microcontroller can use to process data remotely? How to save the data in the process of transmission? For the first question, ESP8266 is the best choice. Because ESP can send and receive data through WiFi without assistance of the computer and its size is smaller than the size of an arduino. For the second question, this prototyping will use the real-time database in Firebase. That is, in the process of data transmission in a different network environment, the data will be saved in the cloud.

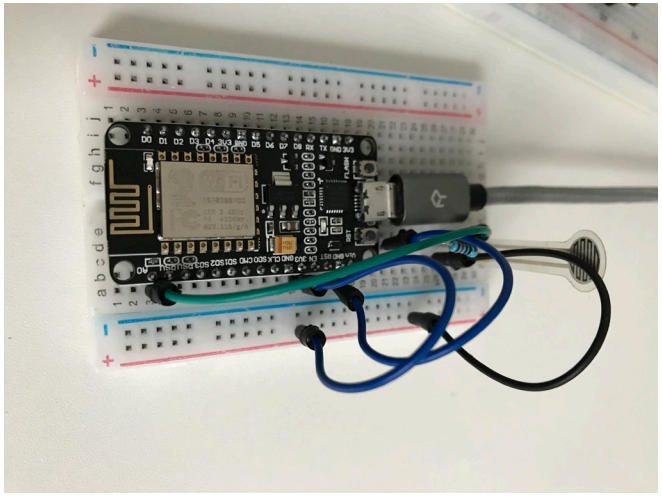
The circuit schematic and related coding

In conclusion, for each cup, I will use one thermistor sensor to detect users' presence; Two force sensors, one detects people's behavior of drink, one detects people's behavior of rubbing; One led strip is to show the presence and drinking behavior of the user at the other side. One mini vibration motor vibrates the water in the cup. The following the circuit connection and the video of data send and receive in the end of microcontrollers and in the cloud:

1. The Thermistor sensor circuit (see coding in Appendix A)

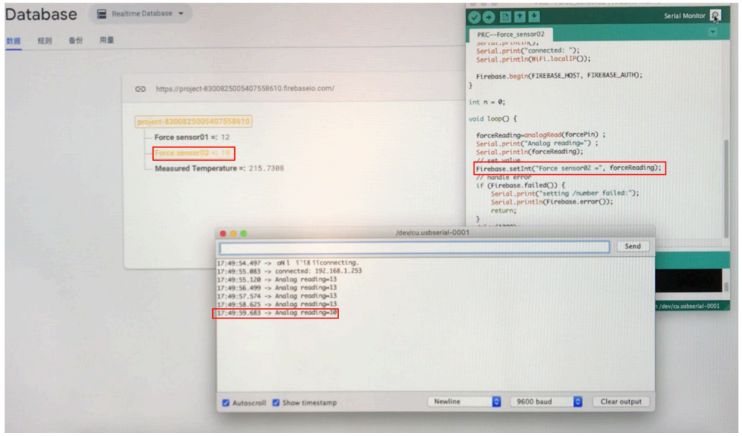


2. The force sensor circuit(see coding in Appendix B)

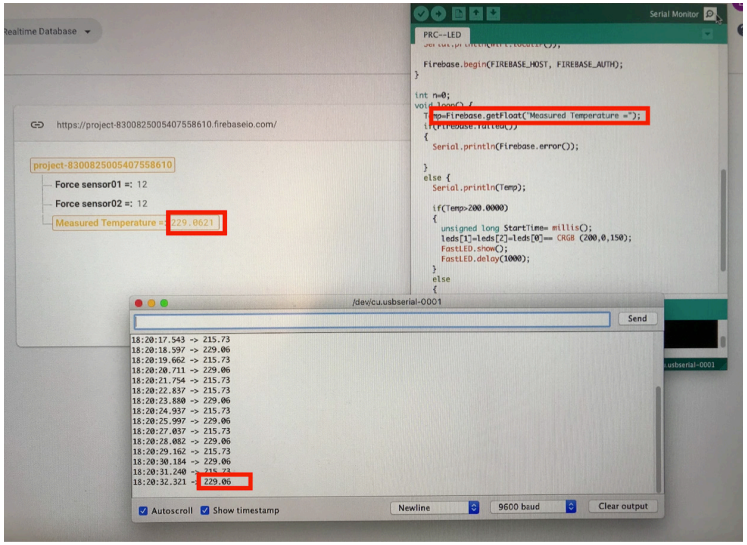


3. The circuit of the LED Strip and the mini vibrate motor(see coding in Appendix C)

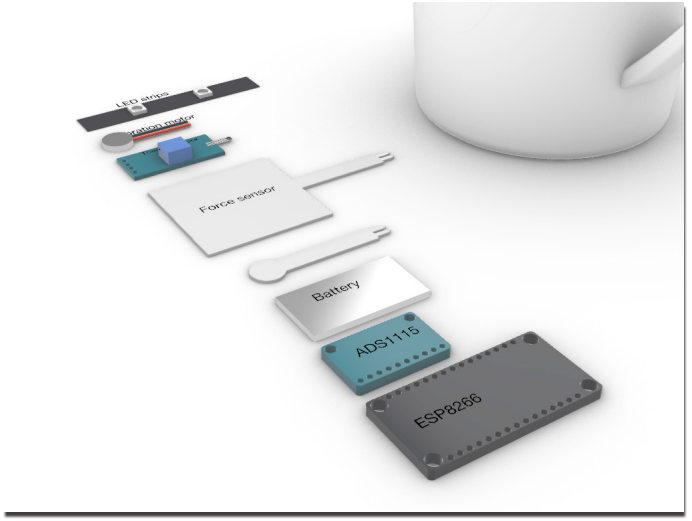
4. Force-sensor send data to Firebase in real time

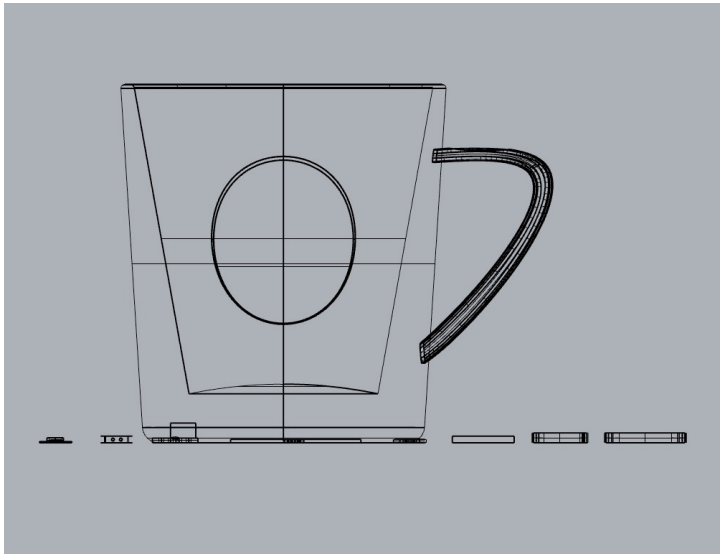


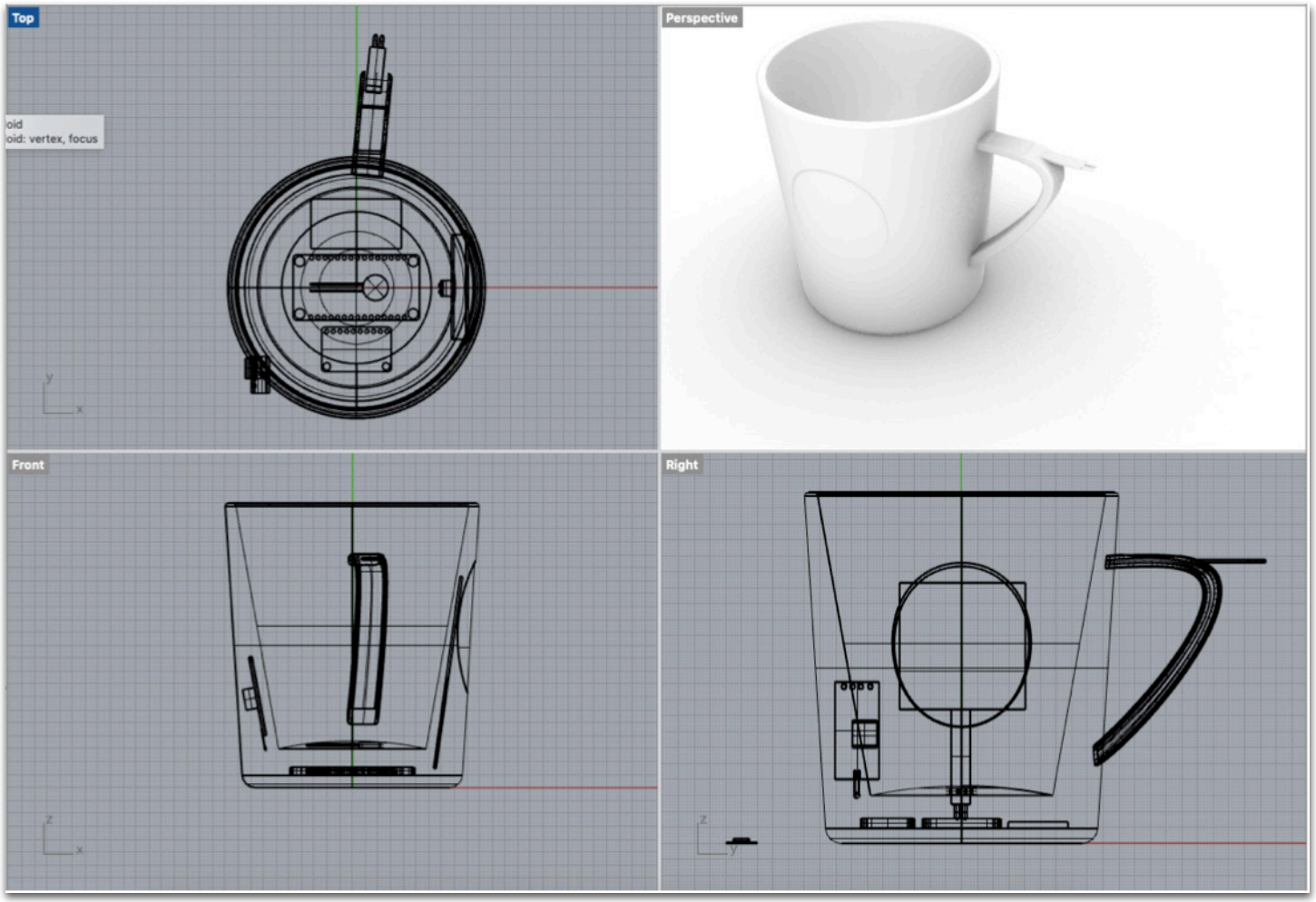
5. Firebase sends value from Thermistor sensor to the LED strip



6. Use Rhino to make the 3D model






Top
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oid: vertex, focus
Perspective
Front
Right

User test

Research topics

This research explores a new interaction way to enhance people's emotional experience in personal remote communication. The prototyping redesigns the cup---an item in the daily routine. The user test pays attention on two topics:

1. Whether the new type cup could be useful in the personal remote communication
2. The understanding of the water vibration

Study design

The usual user research methods include: Observation, Think-aloud protocols, Video observation, Eye-track, Skin Conductance, and etc. In this user test, I combine "Think-aloud protocols" and "Video observation" as the user research method. The reason why I use these two methods at the same time is:

1. This research studies a natural interaction way for people, so users should not be disturbed by others. According to the features of this prototyping, users don't need to take many actions in this test but the length of test time should be long enough for the natural behavior to happen, like a working afternoon. Taking video can record how users interact with the Hug-Mugs.
2. Another advantage to apply the "video" is that some details can be studied carefully. For example, the distance between users and Hug-Mugs, how they hold the cup and how long they discover the signal after it is received. This data can be used to adjust the design in the future. These details help to design a usable and appropriate industrial structure.
3. "Video" can show users' faces in the whole process and give information about their feelings in case that they ignore speaking it out.
4. Since Hug-Mugs focuses on emotion connection or mental activities, no feedback or outcome we can watch through video directly. "Think aloud" can let users talk about their feelings' change in the process of the test and how they think about different interactions in Hug-Mugs.

The environment variables

For achieving the accurate data from this user test, the environment variables which related to the characteristics of the test environments, such as the test environment is quiet or noisy, must be considered. Here four environment elements will be clarified in the test: female or male, parents or children, working or leisure time, users from other cultural backgrounds.

1. This test will invite 16 Chinese people. Ten of them are students and the rest are parents. Since parents and children play different roles in this daily routine which may lead them to generate different attitudes to this design. At another side, young people and aged people have different cognitive levels facing novel interfaces, so they may have different feelings about the design. The possible feedback:

- Parents think the water vibration is weird or they feel confused about the new interface.
- Parents will pay much more attention to the Hug-Mugs's states than their children since compared to children, parents care more about their children's health.
- The design changes parents life more than children

2. Half of the parent group and half of the children group will be female, the rest are male. This classification supposes that female and male will act differently, because maybe the female is more sensitive to the notification of the Hug-Mugs.
3. The test environment will be divided into studying or working time and leisure time. Usually people have a high cognitive load when they process the task which needs to be paid much attention to, like studying or working. In this circumstance, subjects are supposed to easily ignore the state's change in the Hug-Mugs. On the contrary, people are supposed to be very sensitive when they have a low cognitive load, like do something relaxing, like read a book or watch a funny video.
4. The design is based on the cultural background of Chinese. However, for exploring the usage extension of this design and finding out the difference of behavior patterns among different cultures. This test will also involve people from other countries: three people respectively from Brazil, America and Japan.

The process of the test design

As the design is for the remote communication and the mugs always work in a pair, so the test will need two persons once a time. Considering in this test people in different time zones need to coordinate one available time, 3 groups of parent-child will play the test. I will let them respectively record the video in that shared time. To collect data quickly in a short time and also make the test controllable, the rest of testers each will use one mug and imagine the user at the other side is one of their parents. I will simulate the behavior at the other side by changing the sensor's value via google firebase.

Instruments & Measures

Preparation

1. One digital camera needs to record. In the screen, the upper parts of the body, especially the face should be seen and also the desk with the Hug-Mugs.
2. A note and a pen, take some important information at the whole process
3. I will show the animation about how to use the cup first, let them know what message they can receive and send through the Hug-Mugs.

According to the topics, I design the specific research requestions which can be used in the test:

Topics	Research questions
Whether the new type cup could be useful in the personal remote communication	• Can you understand the interaction easily? • What's your feeling when you see the status of the cup change? • Do you think that the notification works well? Whether you always miss it or you think it is suitable, not too pressure or too invisible? • Whether you would use it in your daily life? • If you would like to use it, who do you want to share with?
The understanding of the water vibration	• What's your feelings when you see the water vibrate? • What do you think the vibration means?

Usability Set-up & Procedure

1. Train users to apply the "Think-aloud" method in the process of the test: they need to keep talking at least when they interact with Hug-Mugs, and use less vague words to describe their mind activities.
2. In the group test, let every pair of users stay in the comfortable place. Talk about some interesting things between each other before the test begins.
3. The task of this user test is to use every type of interaction Hug-Mugs---presence, drinking or touch the fix area on the Hug-Mugs.
4. The duration of time will according to users themselves, or when finished working or watching video, they can stop the test.

Conclusions

Personal remote communication is very different from the general remote communication, people's emotional demand is obvious in this type of communication. According to the prior research in this thesis, the communication of close relationships largely builds on the interaction in daily life, and the way is not limited only to verbal communication. Especially for Chinese, nonverbal communication plays a very important role. However, the current instant communication applications focus on creating dialogs between each other, leading something is missing in today's personal remote communication compared to the traditional personal communication. The thesis tries to make up the missing elements by redesigning the daily items people used--the private mugs, when they lived with each other in the past. Because this research found that usually daily items attach people's memory or strong emotion, such as love and care, which can provoke emotional resonance deeply with each other.

In the future, the design research will be developed in 3 directions:

1. Improve the Hug-Mugs performance by change the way of design
   Now the Hug-Mugs stays in the early design stage. There are simple features and user paths included in this prototype. But for better user experience and obtaining accuracy feedback from user tests, more scenarios need to be included in the design, and some design elements should be improved .

- One scenario is the parent can control the water's temperature to make sure their children can drink warm water since Chinese parents believe the hot water can help people keep healthy. A saucer can be added to the mug, which can be a holder for the heater part.
- At this stage, I just choose LED strips to show the state's change in the Hug-Mugs, it is not good enough for a well designed project. More importantly, the light change is only partial, it may not be attractive enough for people, especially when they focus on one stuff at hand. Now in the market, many cups use the thermo-chromic material, which can change its color with the ambient temperature. It can substitute the LED strips in this design. The technological key point is how to let the materials change 2 different colors to show the two different status of the Hug-Mugs---presence and drinking. And at the same time, the material can only detect temperature changes of the heating pad embedded in the Hug-Mugs, this heating pad supposes to change its temperature by the command from the other mug in the distance. The water temperature change will be shielded.

2. Develop other possible daily items and explore the design principle about this kind of design
   Nowadays some research proposes the concept of everything is computer. They aim to embed computers into every element in our daily life. This research applies a similar thought to do the design research of personal remote communication. Therefore, in the future, this design research can discuss more items that emerged in people's daily routine, which are important and rich in emotions and memo ry, and try to redesign them as links between people and their loved person in the distance. Further, the research can figure out some com mons among these redesigned items. For exploring this issue, the next possible step is to redesign one or two or even more daily items used for personal remote communication. Using new designs, the research can continually study the feedback and the usability of these rede signed items and figure out the principle of this kind of redesign for personal remote communication.

3. Aiming to different designs, this research can use affective computing to study people's physiological signals, different design elements will bring different signal changes. Therefore, this research can only control people's one emotion or mood change by designing one special element.

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Appendix A

```
// #include <Wire.h>
// #include <Adafruit_ADS1015.h>
#include <ESP8266WiFi.h>
#include <FirebaseArduino.h>

// Set these to run example.

#define FIREBASE_HOST "project-8300825005407558610.firebaseio.com"
#define FIREBASE_AUTH "Nx0r27SAx5EzmmHE0BTidtL5RJ47ti3BDQZd7QtW"
#define WIFI_SSID "FiOS-CLABM"
#define WIFI_PASSWORD "XXXXXXXXX"


#define DIGITAL_INPUT D7                    // defining digital input at pin 3
#define ANALOG_INPUT  A0

int    digital_output ;                      // This will read the digital value
int    analog_output ;                       // This will read the analog value
int    revised_output;                      // variable to store the corrected value

float  temp ;
float  temp_C ;                              // Variable for storing the temperature

void setup() {
 Serial.begin(9600);

 pinMode ( DIGITAL_INPUT, INPUT ) ;          // declaring pin 3 as input

 pinMode ( ANALOG_INPUT, INPUT )  ;

 // connect to wifi.
 WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
 Serial.print("connecting");
 while (WiFi.status() != WL_CONNECTED) {
  Serial.print(".");
  delay(500);
 }
 Serial.println();
 Serial.print("connected: ");
 Serial.println(WiFi.localIP());

 Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
}

int n = 0;
```

```
void loop() {
  // set value
  analog_output = analogRead ( ANALOG_INPUT ) ;
  revised_output= map ( analog_output, 0, 1023, 1023, 0 ) ;
  temp_C = Thermistor ( revised_output ) ;
  //digital_output = digitalRead ( DIGITAL_INPUT ) ;

  Firebase.setFloat("Measured Temperature =", temp_C );
  // handle error
  if (Firebase.failed()) {
     Serial.print("setting /number failed:");
     Serial.println(Firebase.error());
     return;
  }
  delay(1000);
}

double Thermistor ( int RawADC )

{

  double Temp ;

  Temp = log ((10240000 / RawADC) - 10000);
  Temp = 1 / ( 0.001129148 + ( 0.000234125 * Temp ) + ( 0.0000000876741 * Temp * Temp * Temp ) ) ;
  Temp = Temp - 273.15 ;            // This will Convert Kelvin to Celcius
  return Temp ;

}
```

Appendix B

Since only the threshold is different between two force sensor detection. Here I post code of presence status :

```
#include <ESP8266WiFi.h>
#include <FirebaseArduino.h>

// Set these to run example.

#define FIREBASE_HOST “project-8300825005407558610.firebaseio.com”
#define FIREBASE_AUTH “Nx0r27SAx5EzmmHE0BTidtL5RJ47ti3BDQZd7QtW”
#define WIFI_SSID “FiOS-CLABM”
#define WIFI_PASSWORD “XXXXXXXX”
//#define ANALOG_INPUT  A0

int    forcePin=A0 ;                                    // The input pin
int    forceReading;                                  // the value of force input value
// Variable for storing the temperature

void setup() {
  Serial.begin(9600);
 // connect to wifi.
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print(“connecting”);
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(“.”);
    delay(500);
  }
  Serial.println();
  Serial.print(“connected: “);
  Serial.println(WiFi.localIP());

  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
}

int n = 0;

void loop() {

  forceReading=analogRead(forcePin) ;
  Serial.print(“Analog reading=”) ;
  Serial.println(forceReading);
  // set value
  Firebase.setInt(“Force sensor01 =”, forceReading);
  // handle error
  if (Firebase.failed()) {
      Serial.print(“setting /number failed:”);
      Serial.println(Firebase.error());
      return;
  }
  delay(1000);
}
```

Appendix C

```
#include <FastLED.h>
#include <ESP8266WiFi.h>
#include <FirebaseArduino.h>

// Set these to run example.

#define FIREBASE_HOST “project-8300825005407558610.firebaseio.com”
#define FIREBASE_AUTH “Nx0r27SAx5EzmmHE0BTidtL5RJ47ti3BDQZd7QtW”
#define WIFI_SSID “FiOS-CLABM”
#define WIFI_PASSWORD “signs889pry84basis”

#define Motor_PIN D4
#define LED_PIN D1
#define NUM_LEDS 3
CRGB leds[NUM_LEDS];
float Temp;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  pinMode(D4,OUTPUT)
  pinMode(D1,OUTPUT)
  FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);
  // connect to wifi.
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print(“connecting”);
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(“.”);
    delay(500);
  }
  Serial.println();
  Serial.print(“connected: “);
  Serial.println(WiFi.localIP());

  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
}

int n=0;
void loop() {
  Temp=Firebase.getFloat(“Measured Temperature =”);
  Pressure1=Firebase.getIn(“Force sensor01 =”);
  Pressure2=Firebase.getIn(“Force sensor02 =”);

  if(Firebase.failed())
  {
    Serial.println(Firebase.error());

  }
```

```
else {
    Serial.println(Temp);
    Serial.println(Pressure1);
    Serial.println(Pressure2);

    if(Temp>200.0000)
    {
      unsigned long StartTime= millis();
      leds[1]=leds[2]=leds[0]== CRGB (200,0,150);
      FastLED.show();
      FastLED.delay(1000);
    }
    else
    {
     leds[1]=leds[2]=leds[0] = CRGB::Black;
     FastLED.show();
    }
    if(Pressure1>20)
    {
      unsigned long StartTime= millis();
      leds[1]=leds[2]=leds[0]== CRGB (0,255,255);
      FastLED.show();
      FastLED.delay(1000);
    }
    else
    {
     leds[1]=leds[2]=leds[0] = CRGB::Black;
     FastLED.show();
    }
    if(Pressure2>5)
    {
      digitalWrite(D4,HIGH);
    }
    else
    {
      digitalWrite(D4,LOW);
    }
  }
}
```