In-pocket Eyes-Free Touch Gesture System for Smartphone

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Abstract

People operate their smartphones everyday. They use them to send message, do phone calls, and use applications anytime anywhere. Smartphone takes a lot of advantage to us. However, there are also a lot of conditions that do not allow us to operate our smartphones in visual, such as when we are in meeting or just put our smartphones in our pockets or bags in the condition we can not take it out.

This system will let users do dialing, shuffle musics, and return fixed messages when users could not answer the phone call in eyes-free condition. In the function dialing, our system allow users operate with both user-defined gestures and system-defined gestures. Finally, we did the user experiment. Examined both user-defined gestures and system-defined gestures and made the comparison. We used SUS to measure users' satisfaction, and we measured the execution time and execution times participants complete the tasks, and the task success rate. We found that the success rate is quite high, and participants is necessary to learn how to use the system before they use it and participants are quite satisfied the functions our system had provided. We also found that the user-defined gestures will take little time than system-defined gestures, and the success rate is also higher.

Contents

List of Figures

Chapter 1

Background

The traditional computer, using desktop as interaction method, gives users perceptual intuition, distinct messages that meet the demand of everyone's life and work. With the development of mobile communication network, smartphones, tablets lead users in the man-machine interaction condition every time and anywhere. It meets the demand of information interaction when users are moving. Portable and intelligent become the key characteristic in the modern mobile computing interaction.

1.1 Eyes-free Interaction

[34] shows that the kinds of high-tech products had increased fast, the eyes-free interaction technology had been used in wider areas.

As [29] defined, eyes-free interaction is an interactive technology that is developed with the development of mobile and wearable computing, focusing on the interaction problem in the absence of vision (or minimal vision). [29] showed that current mobile interaction and wearable computing are dependent on visual attention during the interaction, but due to the characteristics of mobile, interactive scenes that could not obtain visual feedback often exist in the interaction process. For example, in the process of taking a phone call, people could not see the smartphone's screen (or people are in the condition that smartphone's display had automatically shut down due to proximity sensor), and at the same time you need to check some one's phone number immediately, this interactive scene is called the eyes-free condition. Obviously, if we take away the phone from ear to inquire the phone number and then put the phone back to ear, you can although complete the interactive process of taking phone call, but it will lead the interactive process fragmented. It will lead bad influence to the interactive experience [27].

[29] said that eyes-free technology is considered to be an important part of natural human computer interaction. Because the interactive process needs practical application demand (such as dialing in eyes-free condition, navigation information feedback, etc.), it also showed that a good eyes-free interactive interface can improve the efficiency of interaction, making the interaction process more natural and smooth.

There have been a lot of studies, such as [6, 10, 16, 23, 27, 35, 46, 48, 49, 54] of eyes-free interaction technology in mobile interaction and wearable computing environments. But overall, eye-free research works are still in a preliminary stage, the existing research is direct at the specific interactive scenes, or one specific movement or according to one specific wearable device, these research had not yet derive from human perception and cognitive theory [16, 54].The available interactive properties for eyes-free are comprehensive research [49], have no support of foundation interaction model, it restricted the interface between mobile devices and wearable computing technology development

It should be noted that the use of voice technology to achieve eyes-free interaction had a very significant development. There are a serious of commercial products, including Apple's Siri [1], in addition to the use of voice to achieve eyes-free research. But research also shows that the use of voice interaction is not easy to protect personal privacy. To address this issue, we will use gestures to execute smartphones' functions.

1.2 Current situation and development analyze of human-machine technology

Since the concept of pervasive computing had been put forward by Markeiser [9, 51], computer technology and computer equipment have been used in various fields in various forms and have achieved unprecedented results. But from the point of current technology development, it is considered that the human-computer interaction is still the key problem that is restricting the development of computer technology. Even, the pervasive computing interaction theory about human-computer is still in the technical direction stage. And the human-centered design or usability evaluation also remain in the prototype stage.

One of the fundamental problems of human-computer interaction research is to solve the problem that how to input into the computer easily. In this regard, the research carried out in this area and new concept had been updated. As the mobile devices and wearable computing devices have obvious characteristics, that is, the screen is small (or there is no screen), so that the output information is limited. And as the input bandwidth is narrow, the mobile devices are battery-powered, in the interaction, we have to minimize the energy interaction and we need to combine the interaction with social activities or rich interaction scenarios and so on. Therefore, the research on equipment in the human-computer interaction technology, to broaden the bandwidth of human and computer interaction is one natural interaction for people and computers' input.

1.2.1 Development of eyes-free interaction

[54] said that in human-computer interaction, visual attention is a limited resource, and it is also the largest interactive parameter in mobile computing environment. Using an alternative method (such as sound or touch) as an auxiliary method to interact, in order to minimize the use of visual feedback, is the so-called eyes-free interactive technology.

- Expand the input bandwidth.

  According to the specific business needs, Brewster et al. [10] proposed for the wearable computing two multi-mode eyes-free interactive technology. One is the use of 3D surround voice pie menu, and then use the head action to select the appropriate menu. The other is the use of a hand-tied PDA device to achieve the enhanced two-dimensional gesture recognition. The main idea of these two modes is that both of them achieve the functions through gesture control, and the voice feedback. Blindsight [27] is a system that major use of voice feedback of the mobile phone with mobile phone keyboard prototype, this study has found that the keyboard interaction accuracy is quite high when the mobile phone at the location of users' ears, but Blindsight adopted the mechanical keyboard. Kane use of multi-touch technology as input, using audio Ashbrok [6] and so put forward in the use of a finger ring interaction, through the rotation of the ring to achieve the menu selection, the use of the longitudinal direction of the ring movement Kajastila et al. [23] studied the method of gesture control on mobile devices. Ear-Pod [55] is a standard eyes-free example, in driving and other scenes have been applied.

Chinese eyes-free research, such as the iFLYTEK's work is at a very high level. Its function is quite like Siri which could achieve full voice eyes-free interaction on smartphone.

- Theoretical research and demand analysis.

  Yi et al. [54] studied the user motivation research combined with the eyes-free interface's research result. And in Alan Cooper's research [14]. The research adopted the method which was proposed by Alan Cooper, made analyze for users of eyes-free interaction in four aspects, resulting in a lot of useful results, such as the eyes-free interface have great relevance with people's social activities. But because of the interaction of different scenes, and the different interactive, it is difficult to form an unified technology. Dicke et al. [16] gave a complete design theory about mobile computing eyes-free interactive interface. In addition, on the basis of the application scenarios evaluation, Haitao Song proposed Fitts' Law to evaluate wearable computing interactive evaluation of the usability on mobile.

1.2.2 Development of man-computer interaction

Human-computer interaction models are generally divided into two types: descriptive model and predictive model. And descriptive model mainly provides a framework and scope [20, 30]. Prediction model mainly do the intitative analysis of people's operation behaviour and performance under a certain experimental condition which is generally said the 'Human Performance Model'. Research on this aspect had achieved great development, Particularly based on two models (The Fits rule of the task [19], and the Steering rule based on trajectory drag [4]) as the support, had become the core basic theory in the field of human-computer interaction.

Predictive models can be grouped into four categories according to the type of task (selection task and draw track task) and the nature of constraints (time constraints and space constraints).

- Target-based selection task model under spatial constraints [19];

- Time-constrained target-based selection task model [52];
- Spatial constraints based on a certain trajectory of the cursor drag (or draw line, etc.) task model [4];
- Based on the trajectory of the task line model.

Therefore, time constraints based on the trajectory line task model has been the blank of human-computer interaction model study. In addition, most of the current model is based on young man experimental data, and rarely consider the characteristics of the special user groups such as the elderly, children and people with disabilities, these studies are also one of the problems to be solved in the field of human-computer interaction [20, 30].

1.2.3 Development of touch technology

Touch technology is the most common in current eyes-free interaction technology [12, 17, 18]. Touch technology and keyboard, mouse, etc. are classified as haptics interactive technology. However, because of the development of multi-touch technology, the current touch technology has gradually become a major research hotspot in recent years, and became a representative of the natural human-computer interaction technology. It is widely used in the current electronic terminal equipments. Especially mobile terminal equipments. Modern multi-touch technology allows users according to the process of the operation to obtain more natural experience, which is very favorable for mobile interaction and wearable computing environment. With the release of iPhones and Microsoft Surface promotion, touch and multi-touch control technology is well known by the majority of users. [18] showed that some research results had shown that touch and multi-touch technology is one of the most natural human-computer interaction technology, therefore multi-touch technology may become an important part of human-computer interaction in the future.

Although, current multi-touch technology is still facing more problems in the rapid development. As multi-touch systems stand on previous single-point touch systems, multi-touch technology had been limited; the literature [11] shows that the current multi-touch system is more like a multi-coordinate (multi-point) touch system, rather than the real multi-touch technology, which leads to the situation where many operating technologies still remain in the traditional WIMP interface technology. Overall, the domestic touch and multi-touch applications in the ascendant, but the basic research on multi-touch is still relatively weak.

1.2.4 Development of touch auditory interaction

Touch auditory interaction is the development trend of human-computer interaction under the eyes-free interaction interface without thinking of visual feedback, which is a way to make human-computer interaction closer to nature, and reflects the constant concern for human factors. Touch, is one of the five senses of human beings. It has the characteristics that auditory and visual features do not exist. For example, all parts of the body could sense the tactile sensation. Contrast with the other four senses, tactile is the only two-way transmission channel. Tactile could not only output information through the control that brain to muscle, but also could take in information through the skin's perception from outside.

In recent years, the touch technology had get more and more attention of designers, it will certainly have a profound impact to human-computer information exchange; also, it had been widely used in home appliances and mobile communication products. In order to allow users to have better user experience, from the car window control buttons to the control panel on the microwave, had changed from the original button-type to today's touch design. The development of heat sensing technology, lens design provides the technical support to the progress of touch technology. Haptic feedback appears on headsets, mobile phones, toothbrushes, game pads, massagers and handheld PDAs, all of this had demonstrated that tactile feedback plays a significant role in contemporary mobile devices. In the interaction between human and mobile computing, the sharp increase of information, account for that to increase the haptic interface bandwidth and apply the tactile technology into digital home has broad prospects for development.

However, the current touch technology is based on the actual application scenarios, lack of the analyze and research of people (especially the blind) on the tactile control ability, that is, lack of the necessary usability analysis and theoretical guidance of the practical application guidiance. A preliminary study of haptics for the blind population included Balenger [7], which proposed the use of computer-assisted instruction systems to help blind people gain information through print, touch (Braille), etc. Rotard et al. [40] implemented a service for the disabled web browser; the set of hardware can convert the contents displayed on the web to a two-dimensional touchable plane, so that the blind people could obtain the content through the touch gesture. In addition to touch, the auditory feedback is blind access to information, Hubbel et al. [21] realized an eclipse development environment for programming for the blind by integrating IBM ViaVoice (a speech recognition system). Spalteholz et al. [45] implemented 'Key-Surf' technology that according to natural language recognition, with the assist of two or three keystrokes, users could a browsing operation.

1.3 Interaction technology based gestures

Because video information is a visual description of objectits, it is the most intuitionistic and concrete expression of information. For mobile devices and wearable devices, the use of gestures or body language is an effective method to input. For this purpose, in the new generation of man-machine interaction, the use of computer vision technology based on the man-machine interface is very valuable. To achieve the recognition of gestures, there are two main methods, one is based on the sensor, the other is man-machine interface which is based on the camera (CBUI). CBUI has obvious advantages, it has strong adaptability, and it is flexible and easy to use. It can meet the requirement of eyes-free man-machine interaction without wearing extra equipment or configuring expensive equipment, Especially with depth camera (such as the 'Time of Flight: TOF') had entered into the practical stage, TOF camera can reach the speed of 30 frames per second to receive the depth information and intensity information of the scene, coupled with the advantage it never influenced by light and no shadow phenomenon, the international research for TOF and CBUI had a very side rage.

1.3.1 Origin of gestures

The magazine Scientific American compared humans to the calories consumed by each of the different species of bears, orangutans, raccoons, fish, birds, and so on, to measure the movement efficiency of different species. Eventually the vulture won the first, As the human, ranked in the last few rows. But the magazine specifically measured the efficiency of human cycling, the results of the vultures far left behind, human is ranking far ahead. Yes, human beings are good at inventing tools that give us wonderful ability to change lives and create life.

The mobile Internet era, gesture interactive has also become a direct tool for people to obtain information. A few years ago, the majority of users can only manipulate the computer by clicking on the action or key or by using the scroll bar. Now, however, users are already familiar with gestures such as sliding, clicking, zooming, etc. Thanks to the popularity of touch-screen devices, people's fingers could instead of the mouse users and users could directly touch the screen and operation of the object, gestures gradually become popular and replace the original mode of operation. At the same time with the development of multi-touch technology, the advantages of gesture operation has become increasingly evidently.

1.3.2 Merits of gesture interaction

From the standpoint of product, the gesture opens up the information hierarchy. We can not render all the information at once, so we build information hierarchies and modules based on the front and back latitudes of the physical world, such as by swiping left and right to change to different pages, by pulling-down to call out the drop-down menu, so the existence of gestures will make the smartphone's screen to be more extended, finally, user can get more information within the limited physical space.

From the user's perspective, good gesture interaction design shortens the distance between the user and the target, and improves the efficiency of the operation task. Gesture operation for physical keyboard, reduce the operation steps or let complex operation becomes easy to use, also, it is less impact on the user's normal activities, so that users could operate it anytime and anywhere. Therefor it will let complex operation faster and more efficient. And it happened lots of the new gesture research is in order to improve the efficiency of the user operation, so that users could complete more things in a short time. For example, video sites add node on the play slide to give a introduction of the video, allowing users could quickly locate the time point they want to watch.

From the view of user experience point, gesture interaction is the natural and intuitive interactive way which could form a smooth user experience. User gestures are based on the cognitive operations of daily life, complete the user needs a variety of tasks without increasing the burden on the user memory. Such as flip gestures, that is, from the metaphor that turn pages of books. At the same time, gestures are belong to the category of interactive design, innovation in the interaction will left a deep impression to users. Such as Apple has been the official recommendation of the excellent application ‘To-do Clear’. All of its interactive operations are using gestures to complete, and it also has a clear interactive architecture. In the touch screen era, you can only use your finger to do the operations, then you can explore everything. To give up the blunt keyboard, mouse, sliding, staggering, aggregation and expand the integration of operation, human-machine communication has been profound and deep, this change also constitutes a final experience for the products.

1.3.3 Development of gesture interaction

Gesture interaction and touch-screen devices are inseparable complement for each other. On the one hand, touch-screen device is the carrier of gesture interactive, on the other hand, gesture interaction becomes the present way of touch-screen devices. Here, according to the development of touch technology, gestures can be classified into three stages of interaction, single touch, multi-touch, and 3D Touch which Apple called the new generation of multi-touch technology.

Gesture typed in the development of touch-screen

Not long ago, Apple released the new function in iPhone 6s, it is called 3D-Touch. It had opened a new direction of gesture interaction. It can be said gesture interaction and touch-screen devices are inseparable complement each other. On the one hand, touch-screen device is gesture interactive carrier, on the other hand gesture interaction is a presentation touch-screen device presentation. According to the development of touch technology can be divided into three phases of gesture interaction, single-touch, multi-touch, and by Apple, it is called a new generation of multi-touch technology 3D Touch.

- Single-point touch technology

  The initial products of touch screen only supports simple manipulation, which is, one finger touches a point on the screen to achieve control. The main interactive gesture is click. Such as self-service terminals in banks, the previous device is controlled by the mechanical buttons around the screen, while the single-point touch screen to achieve the user’s direct operation of the machine. Basic gesture interaction is to click on the operation object once or twice to complete the click and double-click operation to select. As long as the the menu or button appearing at the touch screen, you can click immediately, no longer through the navigation buttons and function keys in the phone’s hardware and no more other operations. Single-touch technology limits the user’s interaction with one finger single-click action. Why is the user’s interaction with the device limited to one finger. Apple lead human-computer interaction into a new area of multi-touch technology.

- Multi-touch technology

  Multi-touch technology adds a directional dimension that identifies the direction of the finger relative position when the gesture is manipulated. According to the different mode of operation, it is divided into single-point gestures, multi-point gestures and other input gestures. Gesture interaction variables involved in the number of contacts, the number of clicks, speed and time, direction and so on.

Single-point gesture is the most basic common gestures, including click, press, drag, swipe and other operations. Click gestures are the most common and original gestures, it is divided into clicks, double clicks, and triple clicks, depending on the number of clicks. Press: touch and hold a region of your hand for a period of time; drag: hold your finger down and slide in the direction of your target; stroke: fingertips quickly paddling. Multi-point gestures are: rotate, zoom, press and click, press and drag. These are the completion of a target object on the screen operation, such as adjusting the location of the object, size, delete or move a file. At the same time to complete the view guide, such as switching screens, scrolling screen, zoom pages, exit and so on. Input gesture refers to that use hand or input pen to write the corresponding symbol on the multi-touch screen, the system will identify the gesture in order to complete the task. Such as Samsung Note4 with S Pen, it could sketched out any area on the screen for the screenshot, you can cut the picture as the same as editing one brief report. In addition, there are some other new interactive gestures, such as shaking, turning the angle used in order to switch modes, lay out mode, icon mode, etc. And the shaking gesture had been used for some small innovative applications, such as finding friends, changing background, shuffling music and so on.

- 3D touch

  Multi-touch had changed the way we browse and experience the digital world, but Apple is not just satisfied with this. The new release of 3D-Touch iPhone6s pressure touch technology will operate to expand to three-dimensional level, the pressure sensing layer under the phone's screen will identify gestures of pressure to complete the operation command. This means that you can open a shortcut bar by re-pressing any application icon. The shortcut bar will provide these frequently used functions (which is you just click on the shortcut bar function, you can go directly to the application of the internal module, greatly cut down the distance between the user and the operational objectives). Because the difference of the finger press strength, the touch screen can be activated at different levels to achieve different functions.

1.3.4 The designation principle of gesture interaction

Each new technology, new tools are in the public life for more convenience and pleasure. Gesture gestures bring simple, efficient interfaces and naturally interesting operations, and how to design gestures that make it easier for users to understand the interaction is a key element of a good experience [22, 24].

Natural principle

Natural communication: people naturally communicate through language, gestures, emotions, movement to complete the transmission of information; Norman had said that in the future of human-computer interaction, one of the design principles is the use of natural correspondence, so that interaction can be easier to be understood, making interaction more effective, that is, ‘metaphor’ concept which had been emphasized in the human-computer interaction. Metaphor is the visual form or visual interaction which will change people’s familiar concept or phenomenon to the user interface concept, and use the concept into the interface, such as the desktop in the graphical interface is the metaphor of the real world and so on. The metaphor is more vivid, the more well known to users, often means that the interface is more natural. The fact that the interaction that is retained and used repeatedly is a logical extension of what people often do, based on everyday cognitive habits and rules, and those are relevant with the virtual world. While establishing the mapping relationship, breaking the limitations of the corresponding rules of thinking, although the gesture is origin of the replacing the operation of click button, but we have to consider more that we should be combined gesture with real-life tasks and user intuition response.

Target oriented principle

The core of UCD’s user-centered thinking is that it is the understanding of the user’s needs. The user must be in a particular situation in a scene environment when using the gesture to operate the touchscreen device, and the gesture is exactly the direct form of completing the user’s goal.

3D Touch essence is to increase the ‘level’ of this dimension, we can also comprehend the level as that users’ needs which at specific moment and in specific scenario. The feedback obtained by performing the pressing operation on different pieces of information is different. For example, the feedback obtained by pressing a plurality of pieces of information is the detail of the information will be showed. But long touch the information with location, it will show the map suspended page. The goal-oriented design philosophy is to understand user’s goals, needs, motivations, and contexts better, and how they can help design appropriate interactions. So the real task of interactive gestures here is to shorten the target process so that users could quickly navigate to the level or function they want to use.

Metaphorical matching principle

The metaphorical matching of gesture interaction refers to the use of the appropriate conceptual model and the user’s mental model to match each other to reduce the interaction costs of gesture interaction and improve ease of use. Conceptual model: refers to the designer through the design of things, and then expressed to the user out of things and the control of the match between the operation. Psychological model: refers to the people through training, experience and teaching, and then for themselves, others, the environment and access to things to form the inherent pattern. Systematic representation: the external form of the conceptual model.

When the user interacts with each other, the process of pattern matching, which is the process of establishing the mental model, is stimulated by the appearance of the system. If the system representation can make the user’s mental model and conceptual model match each other, the usability will be very high. If the stimulation of the system appearance makes the concept model and the user mental model can not match, then we believe that the user's intention has gap between the operation, which is the so-called implementation gap. If users want to do the correct way to interact, they need to repeat the complex reason and other cognitive activities which will waste more psychological resources, and also easy to cause frustration.

Therefore, the design of gesture interaction need to use cultural standards and physiological level, so that the design of the gesture interaction model and the user's mental model could match each other, this will reduce the user's cognitive burden.

According to the cognitive psychology: When people are cognizant matching new things, they always look for the closest model in the past experience and map the past experience to the present. For example, in the past we use the mouse gesture interaction, pen interaction and gesture interaction of different platforms, that lead users will try whether those gestures also existing in the touch-screen mobile phone, this is called the gesture interaction inheritance. So in the gesture designation, we need to inherit the gestures users always use on computer or on web to smartphone, in order to reduce the operation and learning costs, and also could enhance the corresponding gesture interactive learning.

The visibility principle

- Gesture combined with controls

  Designers can design a large number of external knowledge for users to help users recognize memory. Through the interface controls to guide the user to use a certain gesture, which is the combination of gestures control. The adjustment of the gestures: iOS, Android and Windows Phone are used Picker control. When users see this control implied, will naturally be guided up and down sliding to adjust, greatly reduce the cost of learning. If there is no control implied, the user may difficult to understand how to adjust. So that users will find it difficult to adjust the gesture of time, need to try and think again before operation, usability will not good.

- Gestures combined with interface scenes

  The most important thing while let the user remember the outside world knowledge is the situational effect, for example, the same thing under different scenarios will have different meanings, an object in which the scene can make the memory easier or difficult.

  Gesture interaction design is also the case, put the same gesture in a different interface scene, the feedback may not the same.

  For example, use the pull-down gesture to bring up the status bar at the top of the smartphone, and in the specific interface, the gesture is to adjust the list position. At the top of the drop-down, the status bar design hierarchy for the top level, the main metaphor similar to real-life curtains, so in this scenario, the pull-down gesture is bound to open the status bar. Put down from the top of smartphone, account for that the status bar is list is at the top of designation hierarchy, it could be considered metaphor the curtain in real life. In this scenario, the pull-down gesture must open the status bar. But in the list, list is the currently operation layer, so the pull-down gesture is the directly operation in the interface. The pull-down gesture here is like the pull-down action in real life. Therefore, this time pull-down gesture will move the list position. In summary, the gesture design should also be combined with the scene, the different gestures of different scenarios, the use of gesture types will be different.

Anti-failure principle

According to cognitive psychology, users in the long-term memory of the encoding process will be subject to a variety of interference and therefore will lead to fuzzy memory. The main reason is that the storage of information into the long-term memory, the encoding process needs to extract a clue and the target memory interconnected, when the subjects in the long-term memory for the target memory request, simply find the relevant clues can catch the corresponding target memory.

The storage mechanism of memory is: when the target memory features are obvious, the corresponding extraction clues tend to correspond to only one target memory, and when several target memory features are not obvious, multiple target memories may correspond to the same extraction clue. When the subjects in the reading memory, separate clues corresponding to a single memory is relatively easy to catch. A single clue corresponding to multiple target memory then it is not easy to crawl, this time there will be memory confusion, it is prone to misuse.

Cognitive psychological measurements show that: the object to be stored in the larger differences, the characteristics of the user to stimulate the obvious clues to the more easily extracted.

Therefore, gesture interaction design need to have a more obvious characteristics of each other. Such as the example that iPad let users use five fingers pinch to close application gesture is very special to other sliding gestures, the user is easy to remember as obvious characteristics. The Nokia N9 slide gesture to give too many operational tasks, give too little clues for the user in when they memory the gestures, so that the probability of occurrence of fault operations is very high.

Chapter 2

Gestures we use to operation and how will it be used in our system

2.1 Gesture Types

[15] shows that the smartphone capabilities have been increasing in the last years, and many applications have been developed in order to take advantage of these capabilities. A lot of smartphone users take their smartphones close by any time any where. They use smartphone applications to do SNS, listening musics or just play a game. Mobile phones have become essential to people's equipment. Mobile phones are so popular today, we can say people almost could not be separated from their phones. The way people interact with the phone is seriously affect the user experience of using mobile phones.

The human-computer interaction has experienced the stage of manual operation, the command language stage, the graphical user phases and multimedia multichannel intelligent human-computer interaction. At present, we are in the stage of multi-channel human-computer interaction, gesture interaction had been more and more popular because of its intuitive and convenient features. Because of the combination of mobile phone and the internet, the condition of using mobile phone had being varied. The portable of mobile phone determines the size of the mobile phone screen, and mobile phone applications require a variety of personalities, the complexity of mobile phone operation is growing. This contradiction is expected to design a more convenient and more pleasant way to solve the human-computer interaction. Intuitive, natural human gesture interaction just could ease the contradiction between them. Gesture interaction is an interesting, easy to use, and with great scalability and plasticity of human-computer interaction, it could ease the mobile phone screen size and complexity of the contradiction between the operation, and could also help users more quickly complete the operation, and simultaneously lead interesting and relax experience to users.

Then we will talk about the gestures we used to operate the mobile phone.

2.2 Introduction of smartphones' touch mechanics

The current mobile platform gestures are divided into multi-touch gestures, strokes gestures and combination gestures [2]. The details are as follows.

2.2.1 Multi-touch gestures

Click gesture

Click gesture is the most common and the original gesture, click gestures according to the number of clicks can be divided into click, double-click and three-hit, used the number of 1-5 fingers.

Click gestures that belong to the basic operation category are mainly used for selection and open the corresponding item.

Long press gesture

Using the number of 1-5 fingers, long gesture based on the operating category, it always used to open the context menu.

Rotation gesture

Using the number of 1-5 fingers, the more common for the two-finger rotation. Rotating gestures that belong to the category of the object's actions, mainly with the rotation of the object.

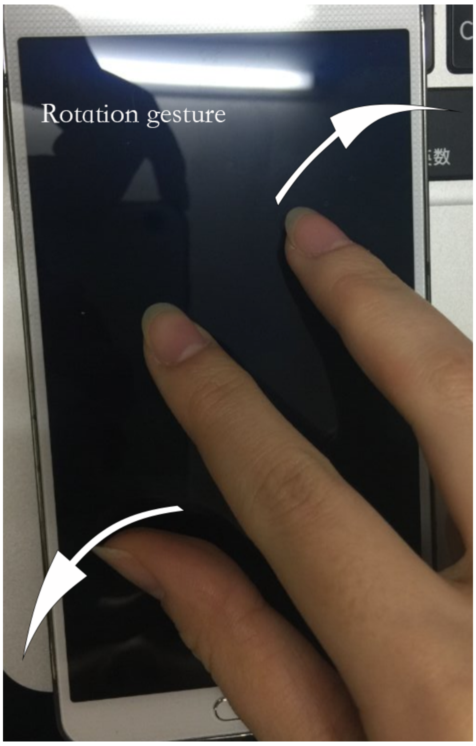


Figure 2.1: Rotation gesture

Zoom gestures

Using the number of 2-5 fingers. Commonly used for the two fingers and five fingers. Zoom gestures are gestures of the object's action categories, primarily with object scaling.

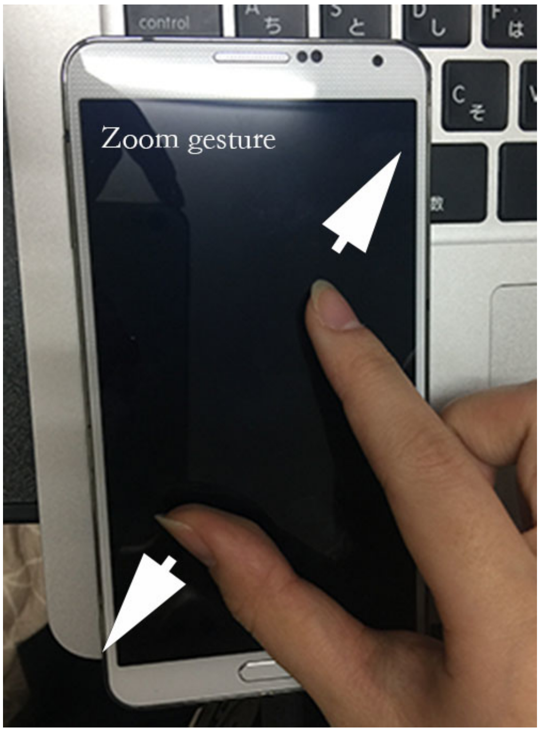


Figure 2.2: Zoom gesture

Swipe gesture

Swipe gesture is divided into fast sliding and slow sliding gesture, both of them are navigation gestures. It is mainly be used to move the objects or rotate the objects and so on.

Split gestures

This gesture mainly use both hands and mainly be used to edit the status of objects.

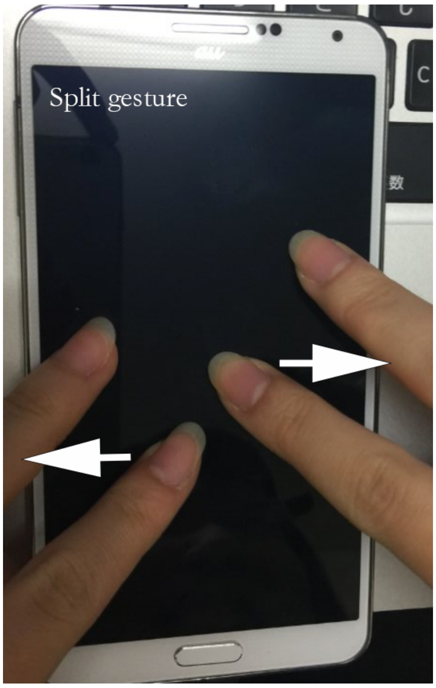


Figure 2.3: Split gesture

Drag gestures

This gesture will use the number of fingers used 1-5, belonging to the object operation class, it may used for the object position changes and control adjustments.

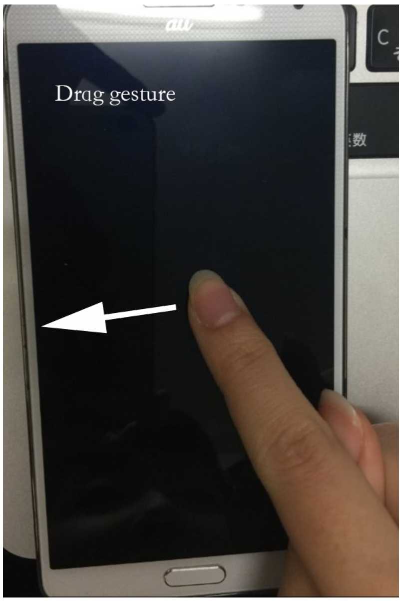


Figure 2.4: Drag gesture

Press and slide gestures

This gesture generally requires both hands to operate, which is, one finger is used to long press, and then the other one slide to enter the command.

2.2.2 Strock gestures

This gesture is now a more advanced gesture, as multi-touch gestures could be identified in order to complete the task. For example: the depth of integration of the operation of the mobile browser-Skiipir browser, compared with other mobile browsers, Sleipnir gestures are more directly. if you draw the appropriate strokes on the screen, you can complete the appropriate action.

In addition, Microsoft will release the new search engine, which joined the new ”lasso” strokes gestures, users only need to draw a circle on the side of one word or plural words, it could let users search the word on the internet. And ios [1]comes with copy and paste function compared to Microsoft's new program can save up to nine steps. The existing gestures can be divided into alphabet gestures, Greek alphabet gestures, digital gestures, shape gestures, symbols, gestures these categories.

Alphabet gestures

Alphabet gesture is, the finger on the touch screen to write 26 letters in English, you can perform the appropriate tasks, such as dolphin browser, writing B can enter Baidu, write G can enter the Google search and so on, the letter has a certain gesture , But the metaphor of the letter gesture is not strong enough, and the mapping between letters and tasks is too much contradiction.

Shape Gesture

Draw various lines and shapes on the touch screen to complete the command input.

For example, draw a circle in the page, then select the contents of the box, painting on the greater-than sign and the less-than sign to return to the previous page and flip to the next page. Draw a figure cross and a figure check will start the function canceled and determined, or deleted and retained. Sketch is cut, draw the question mark is to help the function and so on.

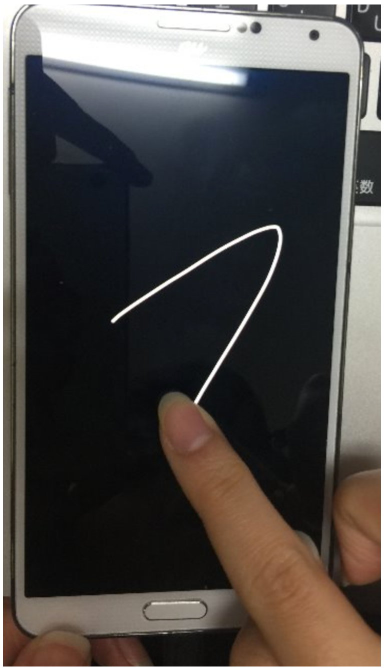


Figure 2.5: Shape gesture

2.2.3 Combination gestures

Combination gestures is that combine single gestures together. Combination of gestures with high forward-looking, such as the new google gestures. It could combine the gesture double touch and drag, touch and drag an so on.

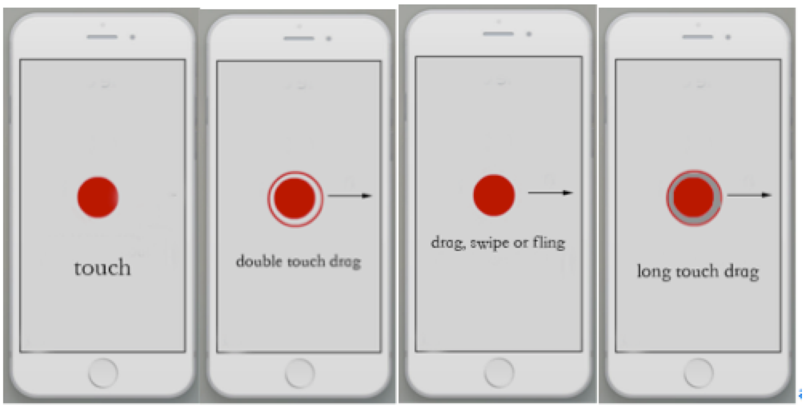


Figure 2.6: Combinations gesture

2.3 Gesture applications for smartphone

There are a lot of existed software that use gesture. Then I will introduce some of them and find the difference between our system and them.

2.3.1 Control smartphones with gestures

'SideControl'

SideControl is an Android application which could let users control their smartphones with gestures. With the help of this Android application, users could set gestures by themselves. Users could speed up their phone handing, such as lock smartphones, kill running applications, switch to recent application or even shortcut to launch applications you want with swipe, slide that the gestures you like. This application provide the functions similar to the one we complete in our system, but our system is not only use the gestures swipe or slide, we also complete it with other gestures, such as circles or regular triangle, which I will introduce later for detail.

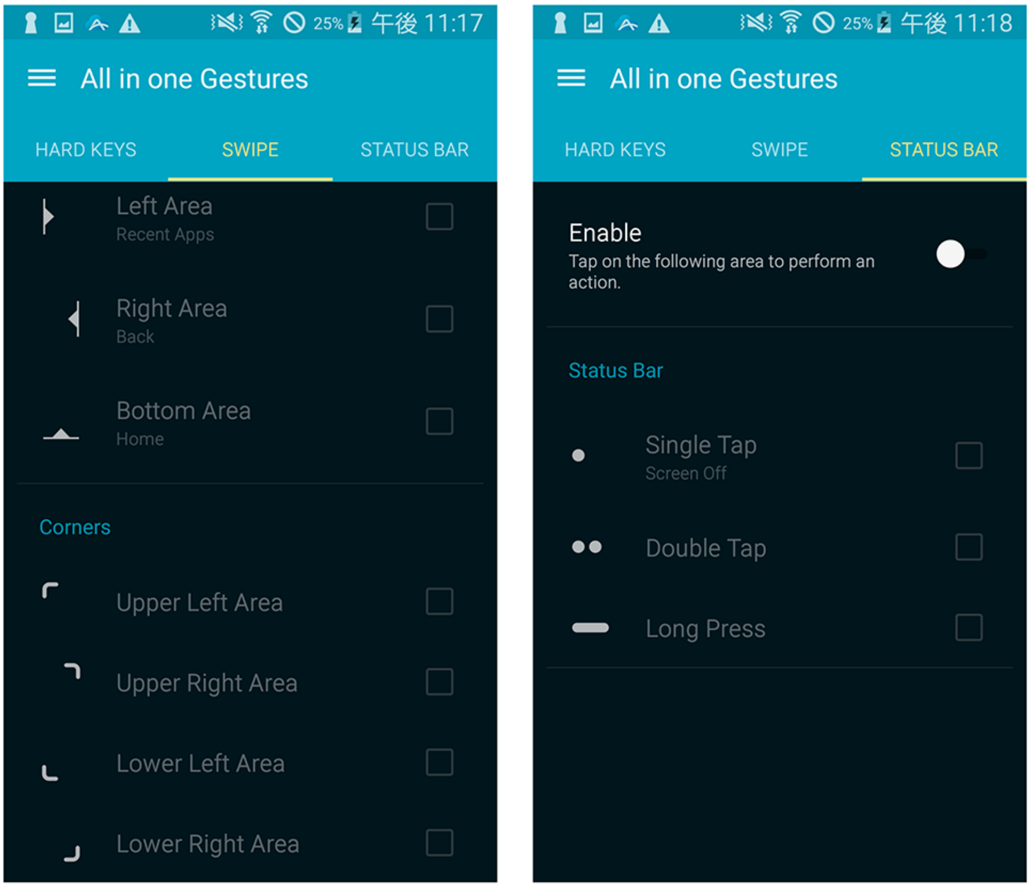


Figure 2.7: Screen shot of SideControl

There also another application just like the application 'SideControl', the difference between them is that the gestures they used in their system just the gestures which operate smartphone on the side, the application 'All in one Gestures' gives users more choice to the gestures.

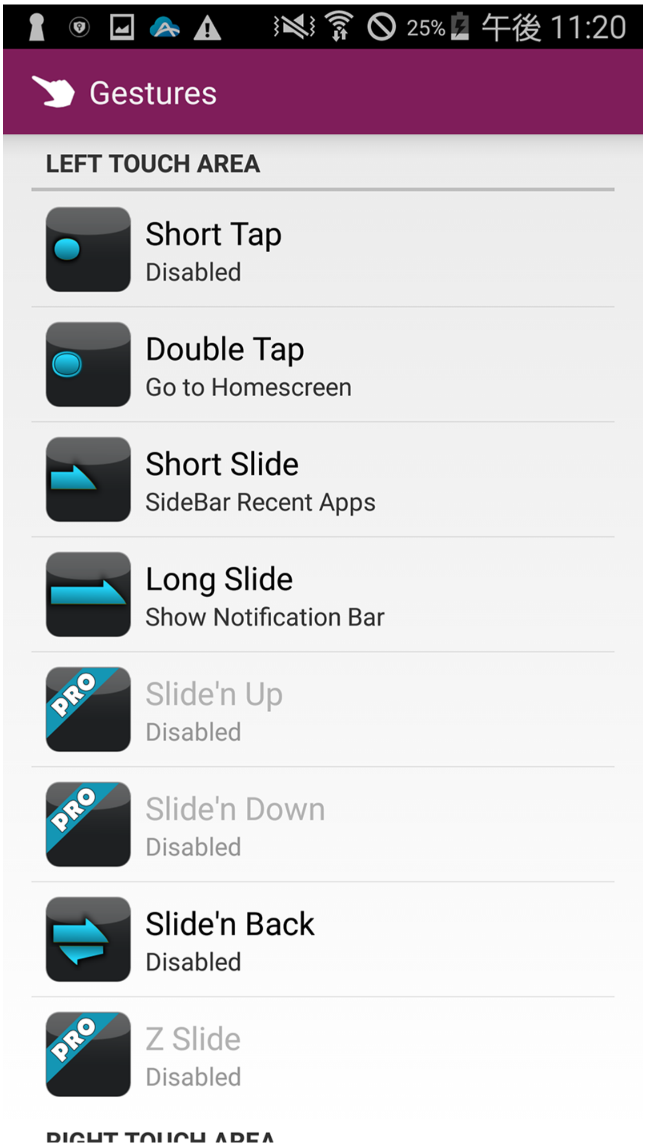


Figure 2.8: Screen shot of All in one Gesture

2.3.2 'Xposed gesture navigation'

With the help of this gesture control application, users can control the android navigation with the multitouch gestures. This application will work on top of any applications and users could completely get rid of using soft keys or hardware keys.

Figure 2.9: Screen shot of Xposed gesture navigation

2.3.3 Operate smartphones with body movement

'Air Call-Accept, Hovering Controls'

It is a Android application that let users operate your smartphone with body movement, we also could call it gestures here. With this application, users could reject your phone calls without touch it. For example, as the figures shows, users could set the gestures 'move over' to set function reject phone call, when users driving a car or in the condition that difficult to reject phone calls with touching on the smartphone's screen, just set it and then move over of the device, it will reject the phone call automatically. This application is specially useful when users driving cars with a Bluetooth headset.

This application using the movement of users, and also could say it used in the eyes-free condition as users could use it just using body movement without seeing the screen. Our system lay emphasis on the condition that users put the smartphone in their bags or pockets (eyes-free condition).

Referring to this application, I think we may also develop the software that operate smartphones through pockets or bags. The application hovering controls is also the application like air call-accept.

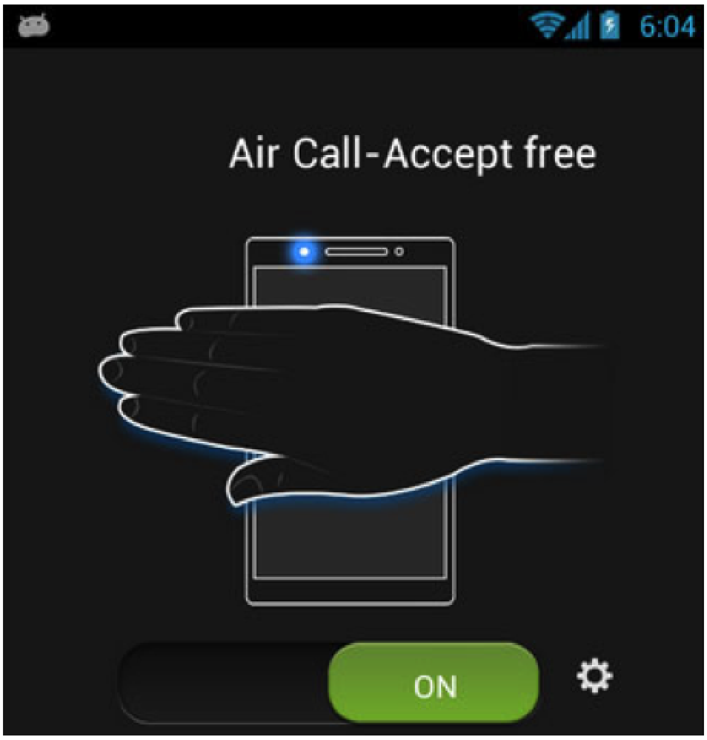


Figure 2.10: Screen shot of Air Call-Accept

Figure 2.11: Screen shot of Hovering Controls

2.3.4 Approach and Goal

As the conditions I had introduced before, to solve the problems that when people in the meeting, in the rush hour bus and subway, when they put their smartphones into there pockets or bags bring in the problem that they could not see the smartphone's screen, we will use gestures to solve the problem. And with uswing gestures to let users could answer the phone call with fixed messages, shuffling music, dialing when putting the smartphone into their pockets or bags. Our purpose to work out this system is to let users operate their smartphones more convenient in the invisible condition.

2.3.5 Dissertation Organization

The rest of this dissertation is organized as follows. In the next chapter we will introduce the reference of our study. Chapter 3 will introduce the reference about our research. The reference will introduce why we design the gestures in our system, how to use gestures to unlock smartphone in our system and so on. Chapter 4 will introduce the designation of our system. It contains how we will unlock our smartphone to launch the software, gestures will be used in our system, and the introduction of the system function for detail. Chapter 5 will introduce the user experiment we did. It contains the introduction of participants, the introduction of the device and the applicant we provided, and the designation of user experiment, the proceed of the user experiment for detail, the result of the user experiment and the discussion of the result. Finally we will give the conclusion of this paper and the work we have to do in the future.

Chapter 3

Related work

3.1 Eyes-free interaction

As our system will be used in the eyes-free condition, the most important thing is to study the literature about eyes-free [5, 13, 31, 33, 39, 41, 42, 47], how these research do in eyes-free conditions and what functions they complete.

There are a lot of study that use gestures on smartphones to complete some functions. Such as avoiding of shoulder seeing, Chen C. et al. had the study 'Eyes-free gesture passwords' [13].

As development of using smartphone, people always use smartphone applications to do a lot of things such as chatting with friends, do online shopping, booking hotels and so on. Of course it is very convenient for people, but it is not difficult for the peep of one's password input. There are methods could avoid the peep from others such as input the password inside pockets or bags. So in [13], they designed, prototyped and evaluated four eyes-free password entry methods (Number pad, Wheel, Stroke, and Scroll) on the iPhone.

The system designed four prototypes. Each is input with a number panel, input with a wheel panel, input with a stroke, and input by sliding in four directions. This system conducted subject experiments in four methods.

And another research from Negulescu et al. [33] . In their research, there are two ways to enter modern smartphone devices. The user taps on the screen or detects the movement of the smartphone by the user with an accelerometer or a gyroscope. This research is particularly interested in the physical exercise benefits and costs of smartphones as an input method. The main point of this paper is to compare how much touch concentration and human gesture power consumption the touch input and motion gesture input consume. Compare motion gesture input and touch input (tap and swipe) under two experimental conditions. The first condition is to have the user walk on a predetermined route and take a light one (wallet, bag). The second condition is to make the smartphone invisible when the user operate it (eyes-free condition). Measure and compare each reaction time, walking speed and attention (visual focus). As a result, they found that both cognitive costs can not be distinguished statistically. As a result, motion gesture input is considered to be a method that can be input in the eyes free situation.

In these two research, it remind me that what we should do to meet user's needs. What function we need to design in eyes-free condition. And what is the eyes-free condition exactly. Of course, there are a lot of research about how input gestures, and applications using gestures to operate smartphones in eyes-free environment, this research is a good reference to our system designation.

3.2 About how to unlock

In our study, we designed the system that let users dialing, shuffling music, and answering phone call with fixed message. But to complete these functions in the eyes-free condition, nowadays, people always lock their smartphones for information safety. That means we have to considering the condition that the smartphone had been locked. So there are problems have to be solved that how to unlock our smartphone in eyes-free condition [44].

I had read research that related to the problems like this. M shahzad et al. had the study 'Unlocking of Mobile Touch Screen Devices by Simple Gestures' [44] gave me the reference. In [44], they explore a system named GEAT, a gesture based user authentication scheme for the secure unlocking of touch screen devices. It is different with the existing authentication precept that using users' inputs as the authentication secret for touchable devices. Their system will give the authenticates depend how users input, they used the distinguishing features such as finger velocity, device acceleration, and stroke time. The merit of the GEAT is that even the one want to do shoulder surfing to the user, they could not reproduce the gesture the user did.

And quite similar with our system. Benjamin et al. had the study:Understanding Shortcut Gestures on Mobile Touch Devices [37]. In [37], they thought that compared to traditional user interfaces, gestures have the potential to lower cognitive load and the need for visual attention. They studied unistroke touch gestures for instant access to mobile phones' key functions. In their study, they design their apparatus which could complete the user training and could recognize custom gestures on Android phones.

Samsung developed the function 'Gesture Lock' in the recent released smartphones. It will allow users to unlock their smartphones and even could launch applications by inputting the English characters. However, it is just could let users write english characters to achieve the functions, one function in our system could let users define gestures by themselves.

The way this research did, could protect the users' privacy, it also a good reference for our study. This research let users could accessible from the lock screen, so do our application. As people always lock their smartphones, so we have to unlock it when screen is been locked.

3.3 About user experiment

Not only the gestures applications on smartphones, the user experiment also have to study, as our system is quite complex, there are a lot of influence factors we have to have attention [53]. As I had never do the user experiment before, so made this study as the reference [8, 38, 50].

Here I would like to talk about the S Vidal et al. had the study [50]. [50] reports initial pilot evaluation comparing three different methods for dialing a simple phone number with a touchscreen device in an eye-free interaction. Their proposal which is said named oPhone, they complete the gesture recognition with sound elements and to get an audio validation as the feedback [50].

And Yudai tozawa ect. had a study that aim to verify usability such as efficiency by using gesture control, ease of gesture remembrance, etc. by implementing and evaluating shortcut function by gesture using touch panel device on Android.

In their user experiment, they aim to obtain the knowledge of the optimum combination by grouping the gestures to be used for each function. The volunteers that participant the user experiment are about 20's, men, right handed. (In those ten volunteers, they had selected and separated by whether they had touch panel devices). In the subject test, the task of performing the task prepared for each application is performed 5 trials, ask them to do the functions in 5 permanent orders.

It is same with our user experiment, their system also had complete plural functions, so in the user experiment, they had let users do each functions by different combinations. That is a good study to me.

Yuma MIKAMI etc. had the research that they create a music player for verification with an Android application and examine what kind of eyes-free operation method is easy to handle. Their system will complete the functions below. When launching the application, it displays a list of sound sources stored in external memory. By selecting a song from among these, the screen shifts to the player screen that plays music.On the song list screen, the song title/artist name/playing time is read and displayed on the player screen from album name/artwork from a music file. On the player screen, a seek bar indicating the current playing time, a pause button and a button for sending to the next song are displayed. In their user experiment, they will do the repeat operation between A and B in this study indicates the following three operations.

- Designation of point A
- Designation of point B
- Start of repetition between AB Stop repeat between A and B

Changing the operation method specified between A and B can be done on the player screen. For the designation between AB and Android, use sensors that are supported, angle sensor to designate by angular velocity, acceleration sensor to designate by acceleration, and proximity sensor to specify by proximity. After selecting the operation method, these operations can be operated on the player screen or on the lock screen in the case of locking on the player screen. Also, because of poor tactile feedback on each action, vibrations are played.

The experiment result showed the accuracy and the easy degree. As our system also reference with music player, this study is the guidance of my designation of user experiment.

3.4 About user-defined gestures and pre-designed gestures

[32] said that in general, it has been found that pre-defined gestures are difficult than memorize than user-designed gestures. It has found that in participatory design studies, user-defined are easier to be recognized [25,26,43,52]. In [52] research, they first showed the influence that each gesture would cause and then, they required users to define gestures by themselves. They recorded the gestures and executed it. They found that users prefer to operate the smartphone on one hand and without caring which hand and how many fingers they will use. Seyed et al. applied a similar approach for multi-display environments [43].

Li et al. [28] had a research that allows users to operate their smartphone with letter-shaped stroke gestures. Thereby, users could complete a lot of functions with gestures, e.g., camera access, open menu or shuffling musics. The research focuses on how the recognition of gestures could be combined with traditional user interface elements. They found that gesture research may be a very quick way to access smartphone's applications and data.

Ouyang and Li had the study user-defined gesture shortcuts on mobile phones to find the system of gesture recognition [36]. They explored user-defined gesture shortcuts with 26 participants who are all android users. The user experiment result found that about 72 percent of all gestures were of alphanumeric nature, i.e., a character or letter. They found that for different action, users always define the same gestures. It made that their system difficult to recognize those gestures and the decrease of recognition rate was about 70 percent. Also, they found that the gestures user always do is limited. Therefor, we could say that in most cases, the gesture definition that users do is have a lot of personality.

3.5 In-pocket condition

[42] said that Pockt-touch is a capacitive sensing prototype that enables eyes-free multi-touch input on a handheld device without having to remove the device from the pocket of one's pants, shirt, bag, or purse.

T.Scott Saponas et al. had the study 'PocketTouch: Through-Fabric Capacitive touch input' [42]. They showed that how strokes could recognize the text or the characters that be written on the same area and how touch strokes can be used to initialize the device for interaction.

[42] also contribute a comparative study that empirically measures how different fabrics weaken the touch inputs. Their results suggest that PocketTouch could prove effective with a lot of different fabrics which are used in clothes people always wear, and it is a viable input method of touch devices in pockets in eyes-free condition for quick operation.

This study did the system could complete functions in the same eyes-free condition, however in their study, they could let users operate smartphones through fabrics. It is quite different from our system, but it is also could let users operate smartphones well in eyes-free condition.

Chapter 4

System Designation

4.1 Scenarios

Let us think about the scenarios below.

- Considering the condition of at the meeting, you are waiting for the very important phone call, and also this meeting is very important to you, what will you do to be gentle in meeting and also be gentle to the one who take the phone call to you.
- You are in the bus or the subway, in the rush hour there are a lot of people there, it is very hard to take out your smartphone from your pocket or bag, what will you do if you want to shuffling the music.
- You are go back home by yourself, it is dark and silent, if you meet the dangerous condition, what will you do. You will just screaming or just do nothing. Of course you may take out your smartphone to call the urgency number, but the phone may be taken by the bad man, what will you do to guarantee your own security.

  Let us assume the condition we could do all those things in the eyes-free condition.

4.2 About gestures in our system

First, I had thinking about that typing, you often operate smartphone with both hands. However, there are cases where you may want to operate in an invisible place. For example, during a meeting or in a crowded train, there are cases where it is desired to operate a smartphone even while it is in a pocket. So I wish to develop various commands with gesture and develop an eyes free gesture system to deal with this kind of situation. Considering that it may start a command by mistake as an ordinary gesture, as a gesture of this system, I thought of a way to slide from a fixed point 'S' in four directions and return to 'S' . After touching, I slide it for a sufficiently long time to some extent, then slide it in four directions and activate the corresponding command for each. The figure shows a pulling action in one direction from 'S'.

But thinking about the condition that when we put the smartphone in the place that we could not see the smartphone's screen, we had thinking about the gesture symmetry figures. For example, the figure circle and the figure regular triangle.

And in the seminar discussion, I got the advise that using gesture like double tap to complete the functions. As my considering, I think in our scenario, like in the meeting, first, if user had put the smartphone in their bags, double tap may play a part, but if user put it in their pockets, their may no enough space that let users do the double tap. second, if do the gesture double tap across the clothing materials, it may also make noise that may let others attention to you, or it is difficult to improve the accuracy.

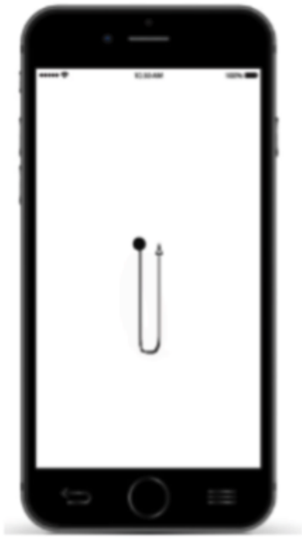


Figure 4.1: The prime think of gesture

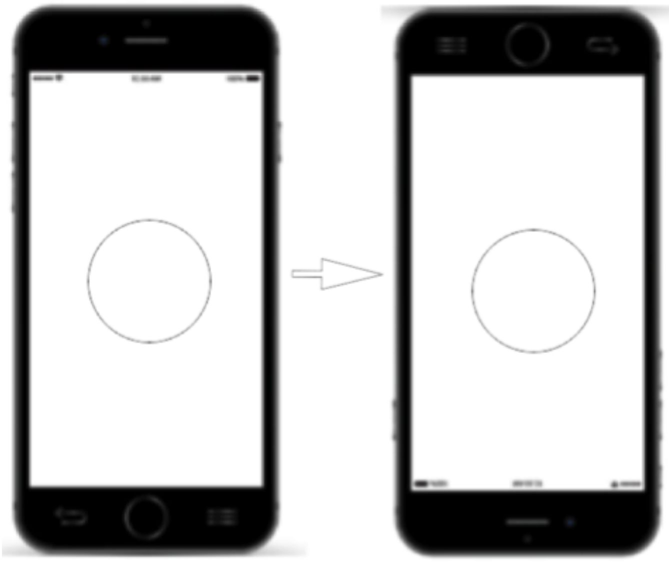


Figure 4.2: Using figures like circle as the example

4.3 Introduction the system in detail

So in this paper, we design and made a software may let users do shuffling music, answering the phone call with the fixed message and make phone call in the eyes-free condition which we means here is that do the functions in users pockets or bags with gestures.

First of all, we also need to open the software in the eyes-free condition, that means we need to do design gestures, and need to let users use gestures open the software while the smartphone unlocked. In our software, we could let users design the gestures they like by themselves in the function dialing. Also I had designed gestures in the software.

About the gesture designation, we could like the symmetry figures to be used as the smartphone may be upset down. But in the condition listening music (as the ear phone had been insert), the problem will not be considered. So in the function shuffling music, I had considered the gesture that what always users would do to shuffling it, so chose the gesture left arrow and right arrow. The detail I will introduce it later.

4.4 Gesture in detail

Considering of the gestures will be used, as we will use the software in the eyes-free condition, we would like to use the symmetry figures to complete the functions. Because of in the eyes-free condition, people will not know whether the smartphone is upset down. Of course we will complete the software to allow user define gestures themselves.

About the user-defined (user do the designation themselves) gestures, we may make conclusion in the user experiment. Here we will introduce the figures we had considered. For example, we considered here is to use circle or regular triangle for avoiding unconsciousness of smartphone upset down.

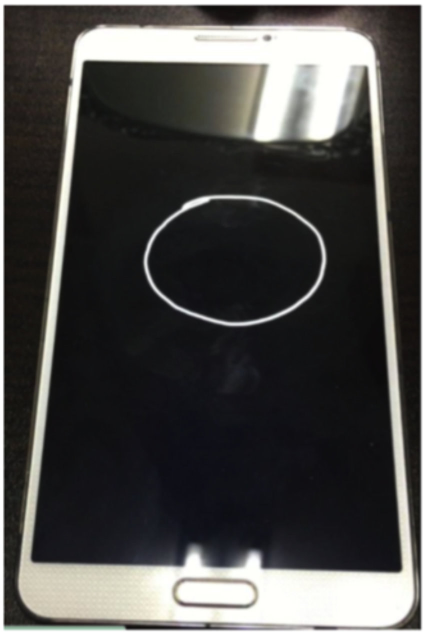


Figure 4.3: Using gestures to unlock when screen is locked

4.5 Functions of the software in detail

4.5.1 Using gestures for dialing

First of all, we have to unlock the smartphone in the eye-free condition. So we let users do gestures on the smartphone, and unlock it automatically.
Secondly, we made the software complete the function blow:

- Shuffling music
- Dialing
- Return phone call with fixed message

All of these functions will complete with gestures. Gestures we used will be user defined gesture or system gestures.
User defined gestures are users define the gesture themselves. The function will related with each gesture. Let us look the figure below. In this figure, it shows that how users could define the gesture. For example, we define the regular triangle as the function dialing, the figure heart as the function message. Then users could do the gestures on the smartphone

to make phone call or launch message. There also could let users define much more gestures they like.

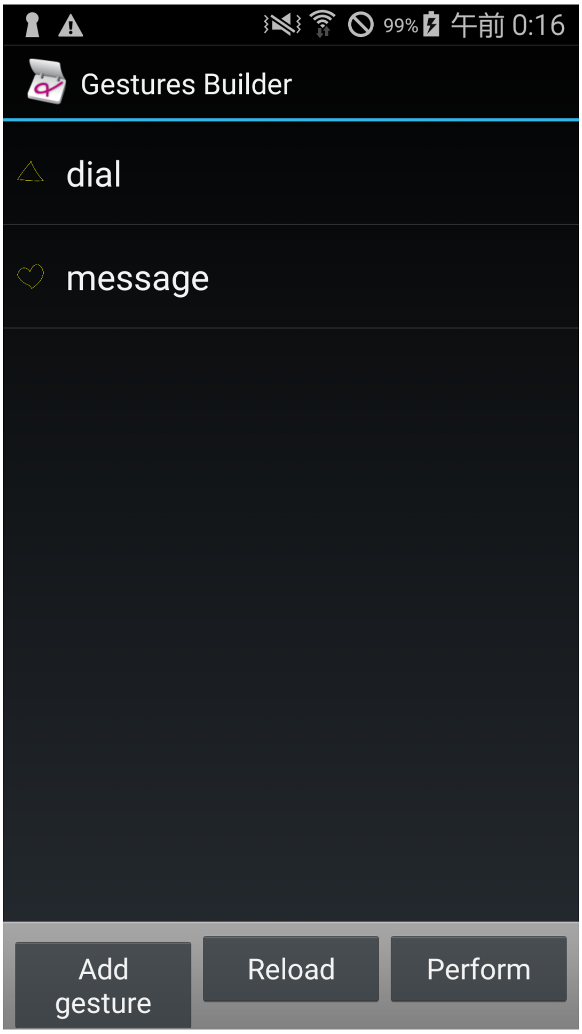


Figure 4.4: Example of user-defined gesture

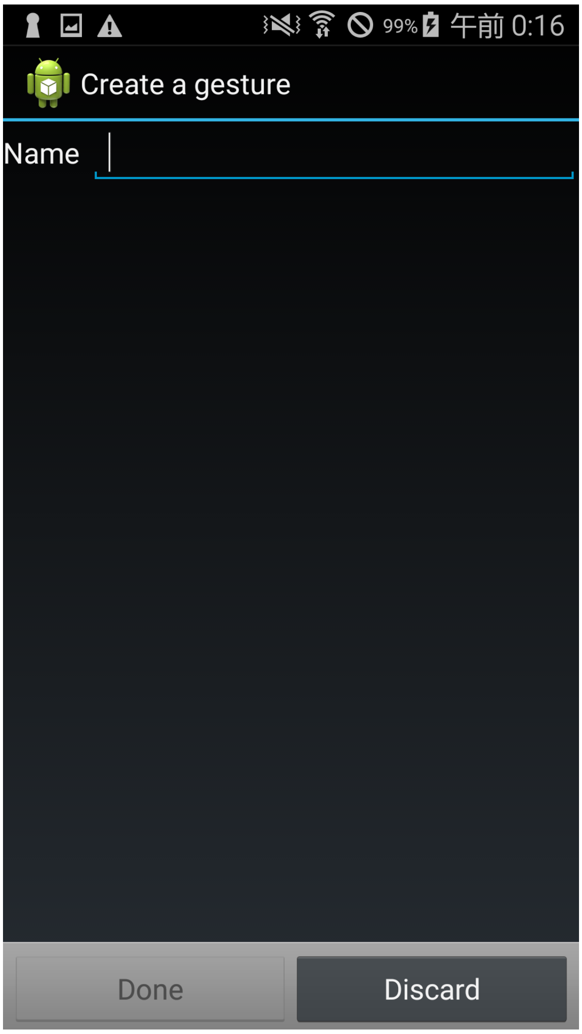


Figure 4.5: The user interface for users to define gesture

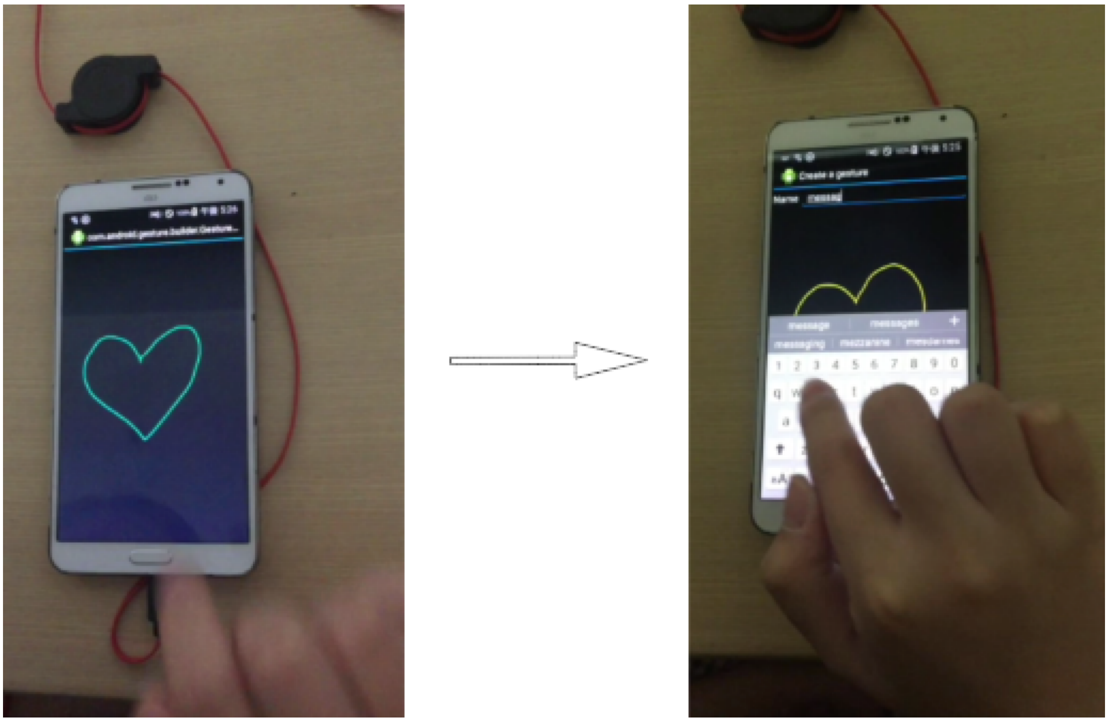


Figure 4.6: User is making a gesture by using a heart

This figure shows that the function we do for real. After we defined the gesture regular triangle as the gesture we will use to dial, we could write it on the smartphone's screen. After we do the gesture, it will recognize the gesture and we could dial it to the number we want. Of course we set it here is the emergency number as we think about the condition as somebody had met the dangerous things.

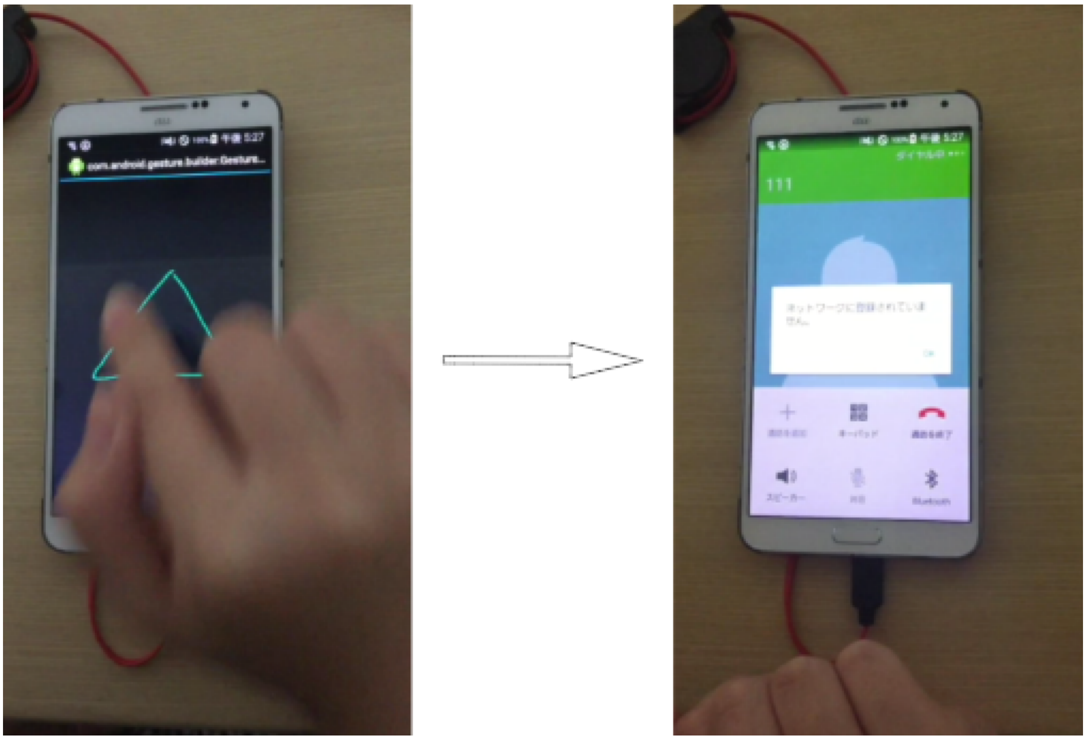


Figure 4.7: Recognize gesture and make phone call

4.5.2 Music shuffling function

Considering of the condition when we listening the music, we insert the ear phone on the smartphone, in this condition we could avoid the smartphone upset down. So we chose the gesture arrow to shuffle music. When user do the gesture right arrow, it will play the next music, the same do the gesture left arrow, it will play the music before automatically.

Figure 4.8: Write right arrow to turn music after

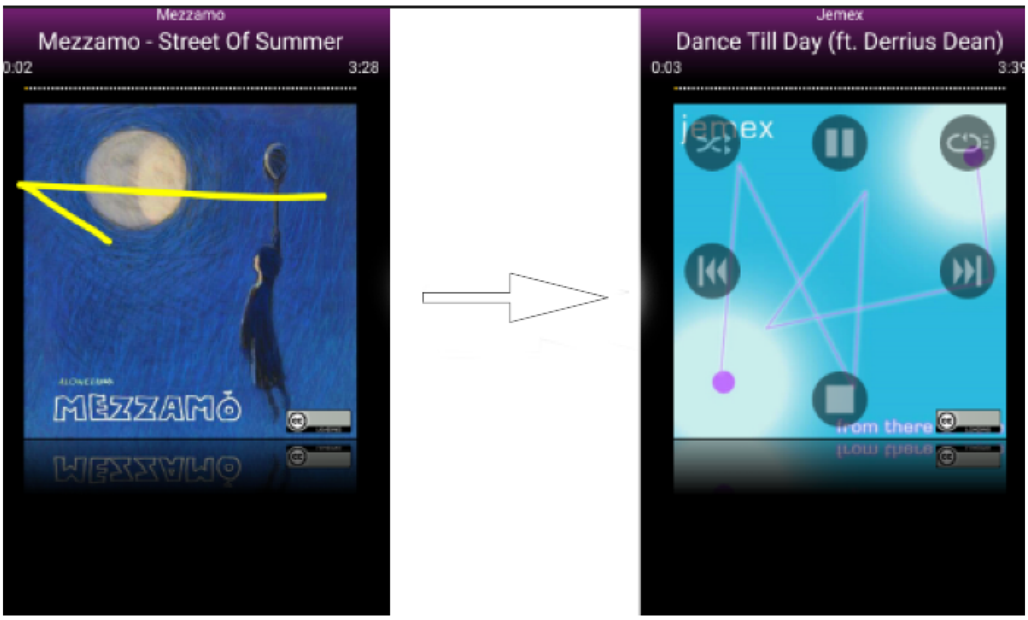


Figure 4.9: Write left arrow to turn music before

4.5.3 Answer the phone call by fixed message

When we in the meeting, there comes a phone call, we could not take out it in that condition. The same, if the phone call is very important, we need to tell the person who gave the phone call that you are in the meeting. So we could use gestures to return a fixed message. In our system, we could let users set the fixed message, and if there comes a phone call, it will return the fixed message automatically. The picture will show how we could set the fixed message users set up by themselves.

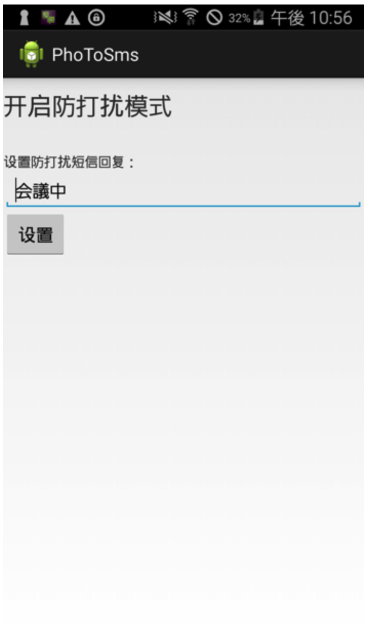


Figure 4.10: Using figures like circle as the example

4.6 Method of unlock in eyes-free condition

4.6.1 About the problem that smartphone is being locked

In the semi-term presentation, professors had asked me about how the software will be used in the environment that the smartphones have been locked. As I have never thought of the problem before, this time I would like to discuss about the problem of how to use the software in the locked environment.

4.6.2 Unlock methods of smartphones

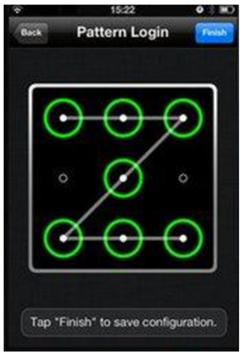
As our software will install into the android smartphone, I will discuss the methods that how to unlock the android smartphone. While there are various ways of unlocking:

- Slide to unlock

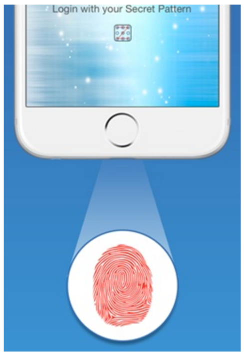
- Face unlock
- PIN pattern and password
- Fingerprint scanning
- Shake to unlock
- Continuous touch to unlock
- Circular screen unlock

Slide to unlock

Face unlock



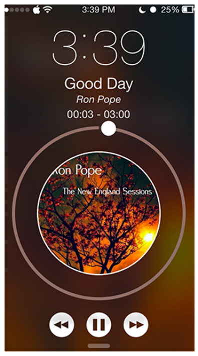
PIN pattern unlock



Finger print unlock

Shake to unlock

Continuous touch unlock



Circular screen unlock

Figure 4.11: Unlock methods of smartphones

4.6.3 Think of solution

As the software will be used in the eyes-free environment, I thought the solutions below.

Change the pattern of unlock

Users could change the unlock method that could be used in the eyes-free environment.

Add the unlock function into the software

As the software use gestures, there is a way that add the function into the software, while use the software we could just unlock the device's screen by using gestures. after researching, I found a lot of methods that could unlock the android smartphone in the eyes-free environment such as use the gravity and swipe to unlock or lock.

Set the smartphone for automatic unlock

In the swipe up to unlock environment, the user could unlock their devices exactly in the eyes-free environment, but this will indicate that our software have the fetal defect.

Launch the application in the eyes-free environment

And finally, we chose the way to launch the application in the eyes-free environment. As the scenario we talked before, users might not open the application rightly. After unlock the smartphone we need to launch the smartphone use gestures in the same way.

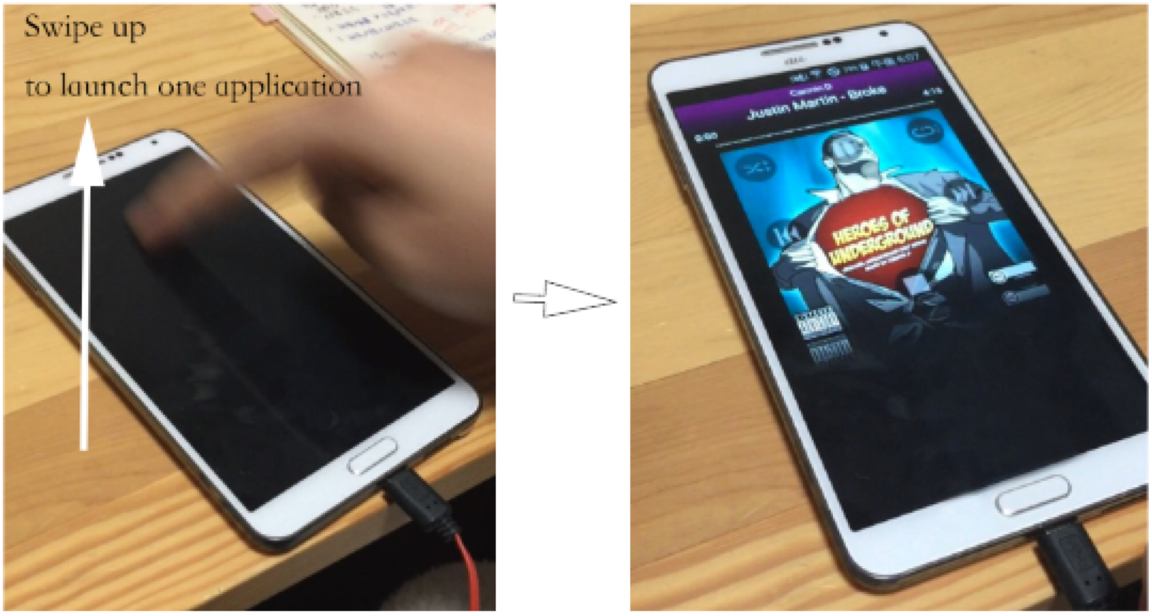


Figure 4.12: Swipe gesture to launch application

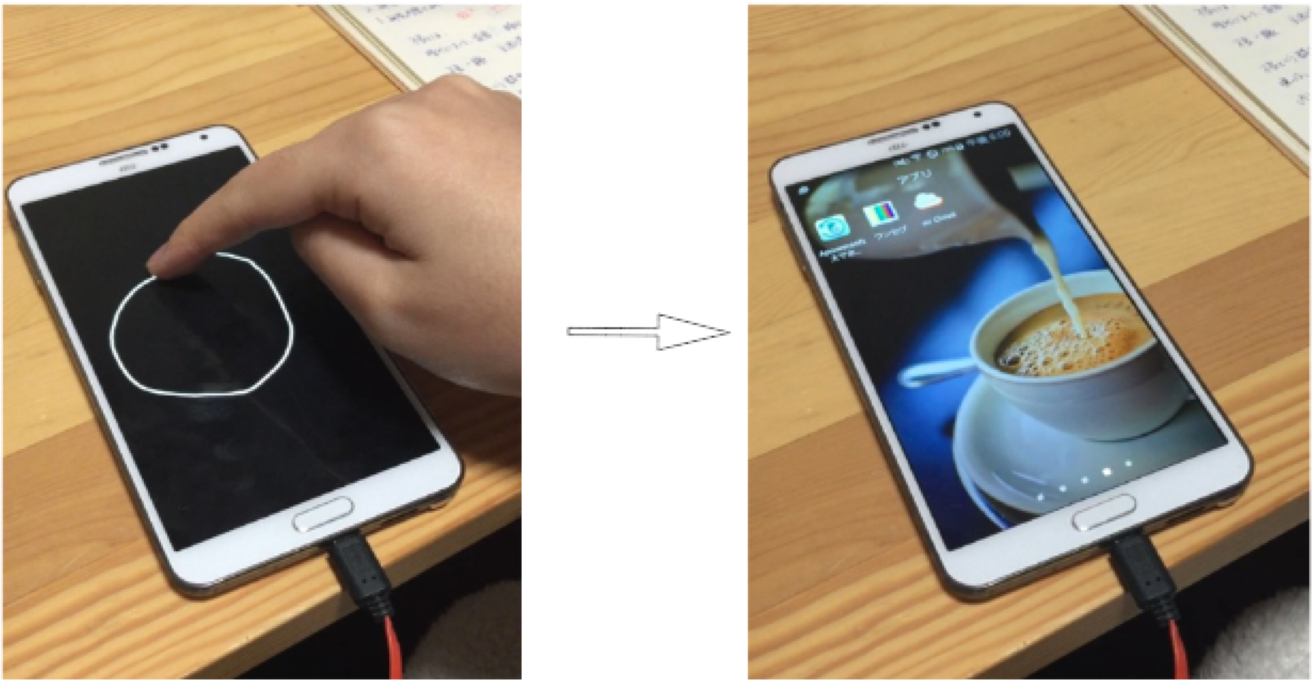


Figure 4.13: Draw circle to unlock smartphone

Chapter 5

User Experiment

5.1 Designation of user experiment

5.1.1 Setting up

To test the effectiveness of our software, we conduct this experiment let participants do the experiment below. The software will be used in eyes-free environment. The software will achieve the three functions.

- Shuffling music
- Dialing
- Answering phone calls with fixed messages

In the user experiment, participants need to do all of these steps in eyes-free conditions, so while participants do the gestures, they have to do it by putting the smartphone in pockets or in their bags.

- Measurements

  In the experiment, participants are asked to do selection tasks and we measure the execution time, execution times, success rate and practical level of each other.

- Execution times

  For each function, we have to record how many times will each user could complete the function correctly.

  Here we use a timer in smartphone to measure tim.

- Execution time

  First, we should record the time each participants could complete each function.

  Second, we have to record the time each participants complete all the experiment.

- Success rate

  Measure whether the software could operate successfully. Here we will record that how many participants could complete the three functions finally.

- Practical level

  It will record how participants think about the software, and for each function how comfortable (by using percentage) the participants feeled.

5.1.2 Steps

First of all, let participants be familiar with the software as by using this software, gestures could be set by participants themselves.

- Let participants set the gestures they like.
- Let participants do the functions below.
- Dialing while put the smartphone in the pocket or bags.
- Shuffling music in the pocket or bags.
- While receiving a phone call, by using gestures refuse the phone call and replying a fixed message.

Because of the implementation of function sequence can affect the experimental results, here as we have three functions need participants do, we will arrange all there three functions to 8 orders.

- Shuffling music → Dialing → Answering phone calls with fixed messages
- Shuffling music → Answering phone calls with fixed messages → Dialing

  ...

- Answering phone calls with fixed messages → Dialing → Shuffling music

5.2 Hardware introduction

The installation of our software, we will use the hardware below.
Developing Environment:

- Programming language: Java
- Smartphone system: Android
- Device: Smartphone (galaxy Note scl22)

Figure 5.1: The hardware used in our user experiment

5.3 Paticipants introduction

Volunteer (Academician or master student of our school) as users to do the task we designed before. The volunteers will be both women and men. The number of people is 10.

All of those people was right-handedness. All of those volunteer had use smartphones for over 60 months (for average).

Figure 5.2: The user is familiar with the system installed in the device

Figure 5.3: Using the same bag to simulation eyes-free condition

5.4 Result of user experiment and discussion

5.4.1 Customer satisfaction degree

To examine the system's costumer satisfaction degree, we asked some questions to the participants. Here we used the SUS to examine the satisfaction degree of each function.

The System Usability Scale (SUS) provides a 'quick and dirty', reliable tool for measuring the usability. It consists of a 10 item questionnaire with five response options for respondents from 'Strongly agree' to 'Strongly disagree'. Originally created by John Brooke in 1986, it allows developers to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications [3] .

Benefits of using a SUS

SUS has become an industry standard, with references in over 1300 articles and publications. [3]

[3] showed that the noted benefits of using SUS include that it:

- SUS is s a easy method to control participants [3].
- SUS could be used on small scale user experiment and could get reliable results [3].
- SUS could judge whether the system is usable effectively [3] .

How to use a SUS

[3] tell us that when a SUS is used, participants will be asked 10 questions and participants need to score them from point 'Strongly agree' to 'Strongly disagree'. The questions will explore that whether users will use this system frequently, whether the system unnecessarily complex or not, whether the system is easy to use, whether user need technical person to teach them how to use the system, whether the various functions in this system were well integrated, whether there was too much inconsistency in this system, whether the operation of the system is easy to learn, whether the system is hard to use, whether users have confidence to use the system, whether user needed to learn a lot of things before they use the system.

Strongly Disagree 1	2	3	4	Strongly Agree 5
○	○	○	○	○

Figure 5.4: The SUS form

In our user experiment, we also give users question to answer, and using SUS to give the result of the customer satisfaction degree. Then we will give the user experiment questionare we used in the final.

In the end, we gave the result below. As we gave 10th questions to 10 volunteers, the result will be not easy to read, so I write the result in three figures to show the result.

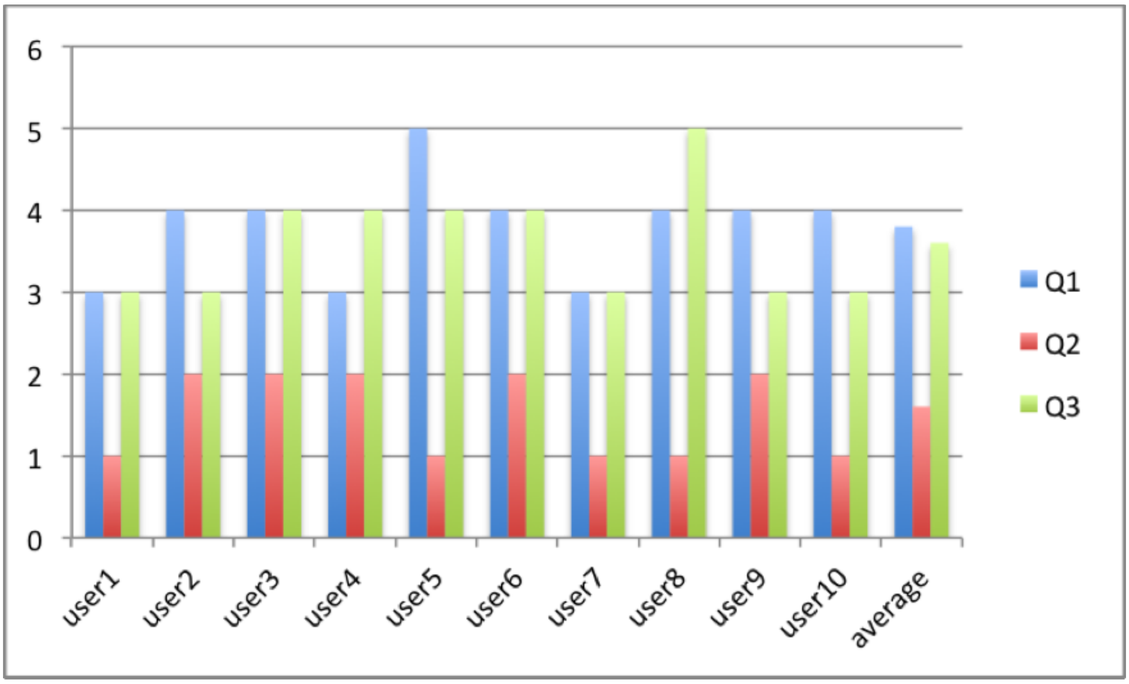


Figure 5.5: Users' answers for first 3 questions

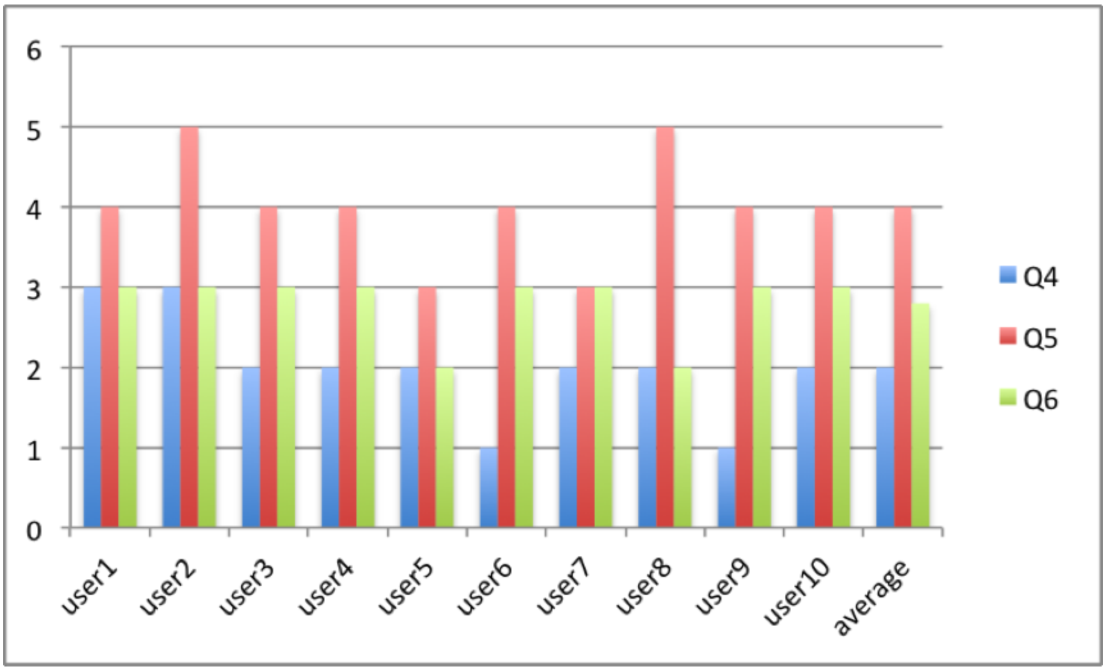


Figure 5.6: Users' answers for first 4-6 questions

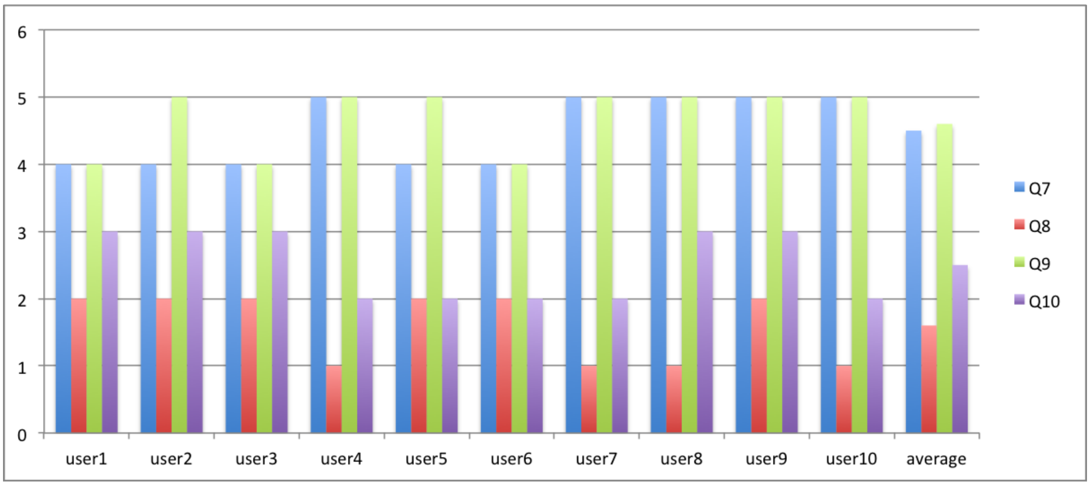


Figure 5.7: Users' answers for first 7-10 questions

The average point of each question is 3.8, 1.6, 3.6, 2, 4, 2.8, 4.5, 1.6, 4.6, 4.5. The average point shows:

- The frequency wiill volunteer use the software will be 76%.
- The difficulty of using the software is 32%.
- The easness of using the software is 72%.
- The degree that this software need technical person 's help is 40%.
- The degree that thinking of this software have various functions is 80%.
- The stability of this system is 56%.
- The degree that agree this system will let user easy to use will be 90%.
- The degree that thinking the system very cumbersome to use. Is 32%.
- The degree that have confidence to use the software is 92%.
- The degree that thinking needed to learn a lot of things before using the system is 90%.

On the basic of the result of costumer satisfaction degree, we find that it is necessary to learn how to use the system before we using it, and it is better to have some on to give a teach. It is a bit difficult to use the software. Volunteers are quite satisfied the functions this software had provided.

And then we give the SUS score of the user experiment. The average of SUS score is 74.2. As the mean of SUS score/related adjective is: 92=best imagination, 85=excellent, 72=good. We could know that our average had over the meaning of good. But it hadn't achieve the excellent. From the figure we could know that, our system have so many gestures could be use and also include the function may use user-defined gesture, user have to be familiar with it, it will take some time. It tells us that we still need to work on the aspect of making system clear and easy to understand.

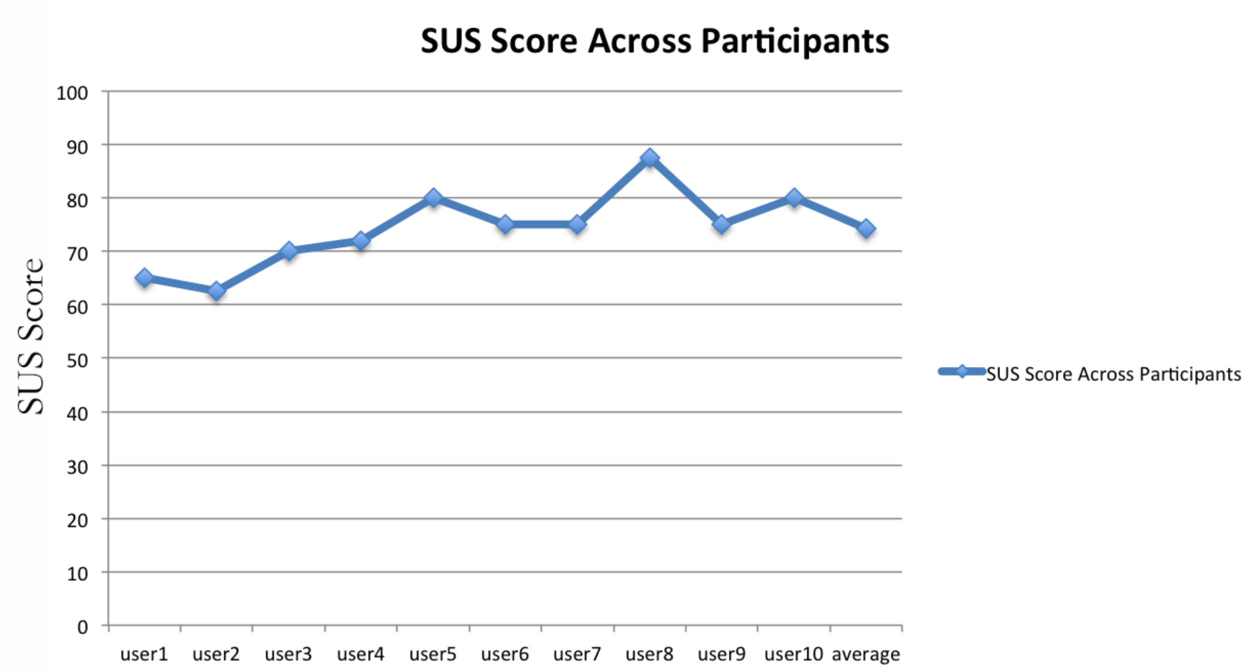


Figure 5.8: SUS score across participants

How many time will participant complete the tasks

The figure shows the time that experiment participants complete the mission had asked. According the result, we find that system defined gesture will spend more time than user defined gesture. The influence factor may be that system defined time may take participants more time to think out of which gesture could do which function. By contrast, user may recall the gesture quickly they defined by themselves.

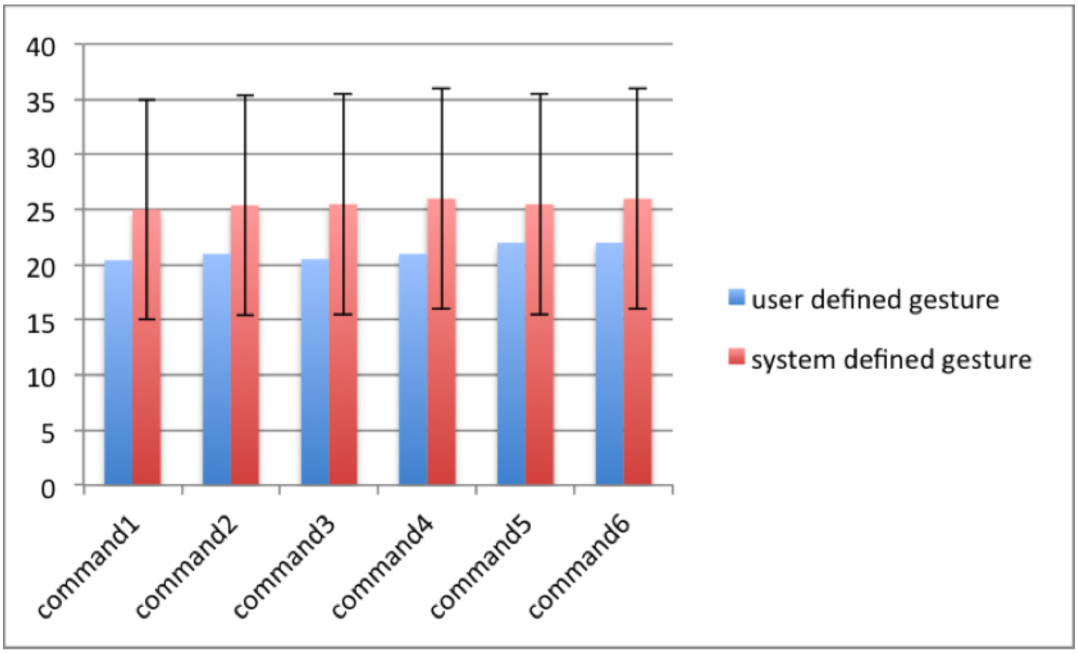


Figure 5.9: How many time will users do the user-defined gesture and system defined gesture still succeed(s)

Success rate of each command

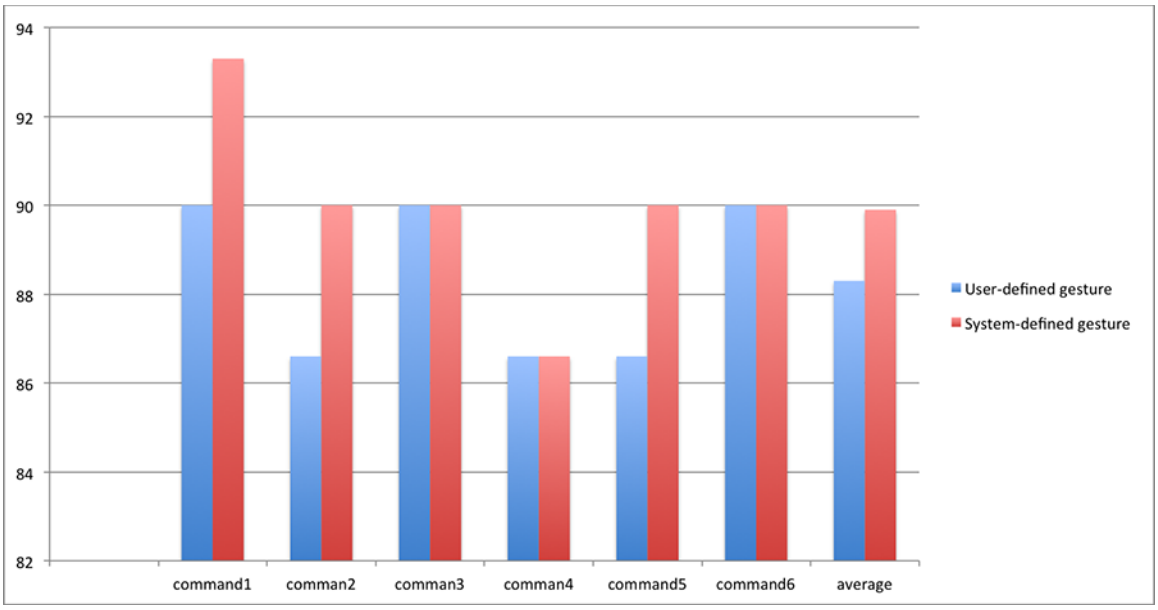


Figure 5.10: Success rate of each command

How many times will user complete the task

This figure shows that how many times participants do the gestures before they complete the commands.

The first participant had done the demo for presentation, she is more familiar than other participants, that is why she did obviously less than others. For the average result, the times of participants do user defined gestures is less than system defines gestures. This shows that user defined gestures is easier to complete the functions than system defines gestures. I think this result is also have relevant with the degree of the familiarity that using the software.

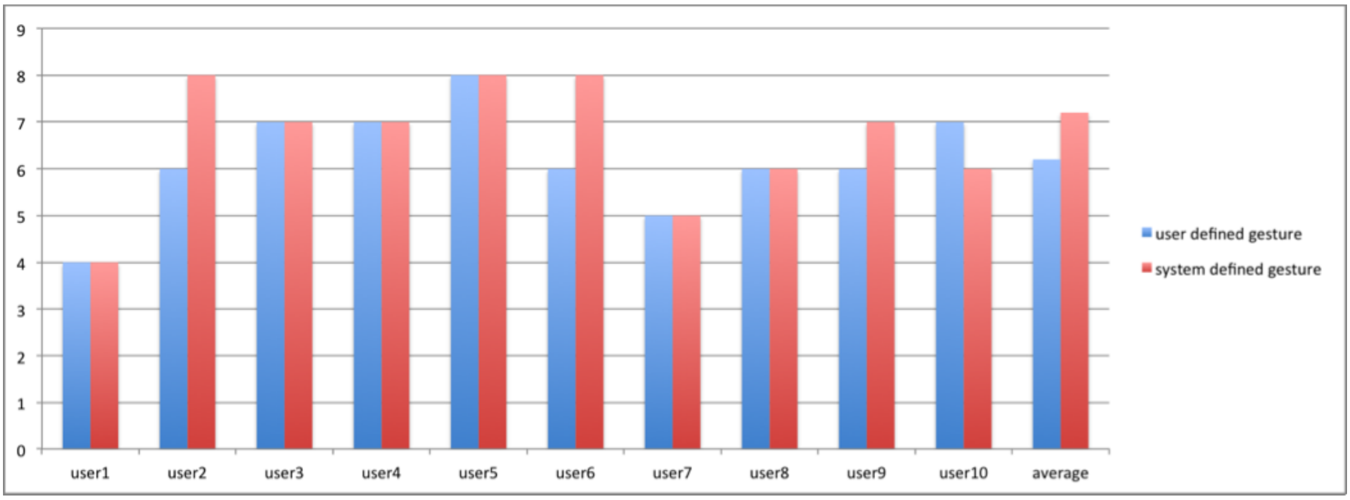


Figure 5.11: How many times will users do the user-defined gesture and system defined gesture still succeed

Chapter 6

Conclusion and future work

6.1 Conclusion

This research is an attempt to work out a system that would make users do dialing, shuffling music, return phone call with fixed message in the eyes-free condition with using gestures. The gestures will be both system-defined and it also could be user-defined. We recommend to use the symmetric figures, and we also set the system will allow users to define the gestures they like.

The user experiment is based on the system we had worked out, in the user experiment, we tried to find out whether this system will easy to use. We found out the costumer satisfaction degree, success rate, how many time and times will user could complete the command we require them to do. In the conclusion of the user experiment result, we find that this most users are willing to user our system.

6.2 Future work

The system we had worked out still have some limitations and shortage. The third function, return phone calls with fixed message is still not perfect. Because in our system, we just complete the part that it may return the missed call, but not all of the phone call. That is to say, our system could not answer the phone call that dialing to us immediately, this function need to be perfect. Also, as the user experiment result showed that the study of our system had spent some time, so to easy our system operation is also very important.

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User experiment questionare

User Experiment Questionare

About the experiment, please answer the questions below.
Please check the check box which appropriate best.

Questions	1	2	3	4	5
I think that I would like to use this system frequently.					
I found the system unnecessarily complex.					
I thought the system was easy to use.					
I think that I would need the support of a technical person to be able to use this system.					
I found the various functions in this system were well integrated.					
I thought there was too much inconsistency in this system.					
I would imagine that most people would learn to use this system very quickly.					
I found the system very cumbersome to use.					
I felt very confident using the system.					
I needed to learn a lot of things before I could get going with this system.					

Name____________________
Age ____________________
Handedness ____________________
Execution time ____________________