Investigating Hand Gestures as Additional Input in a Multimodal Input Interface

“DON’T TOUCH THE TOUCHSCREEN!”

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Abstract

At the time of writing, touch is revolutionizing the market with devices that have touch as the primary input modality. In this thesis we have been able to explore how another input modality, touchless, can complement touch in everyday applications. Touchless refers to an input method that is able to recognize hand gestures and act upon them. To investigate how these two input modalities can be combined, an Android prototype application featuring both touch and touchless was created. We chose to create a recipe reader because we found that a lot of people can relate to having soggy hands in the kitchen. The outcome of this thesis is assembled to form design principles that we find worthy to consider when designing multimodal input interfaces that includes both touch and touchless.

Tags

touchless, touch, feedback, multimodality, interaction design, swipe, gesture
Acknowledgement

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1 Introduction

“Everything is best for something and worst for something else.” (Buxton 2007)

At the time of writing, the market is exploding with devices that have touch as the primary input modality. Many laptops are equipped with touchscreens and computer tablets can be docked with keyboards. This provides a second and third input modality. These two components creates the common vision of a laptop and the way to interact with the system. Touch has already become a de facto standard for interaction with current phones and tablets. The ability to directly manipulate screen objects makes a tangible experience that is very satisfactory for people. As touch interaction has developed, several interaction design patterns have emerged.

An upcoming trend in Natural User Interface (NUI) research is touchless hand gesture recognition, which provides a three dimensional input modality. This area has been explored to some extent for entertainment purposes, whereas productivity uses remain largely uncovered. Touchless hand gestures are inherently contactless which makes interaction possible from a short distance. These interactions are also more hygienic.

In the near future touchless could complement other input modalities to provide people with novel ways of interacting with the technology around them.

2 Problem Statement

Hand gestures as an input modality are interesting for interaction designers since this sort of human computer interaction has begun to find its way into different digital artefacts. Gestural interfaces have historically been, and still is, an interesting input modality for Human Computer Interaction (HCI) to feature in science fiction movies. There is a popular scene in Minority Report (2002) where the actor Tom Cruise demonstrates this kind of interaction, from the scene:

“A man wearing special gloves stands in front of a large, translucent screen. He waves his hand in front of it, and objects on the screen move. It’s as though he’s conducting an orchestra or is some sort of high-tech sorcerer’s apprentice, making objects fly about with just a sweep of his arm. He makes another gesture, and a video begins to play. With both hands, he stretches the video to larger size, filling more of the screen. It’s like magic” (Saffer 2009, p. 1).

That was eleven years ago, yet today we have not reached that level of maturity to be able to make use of the technology in everyday situations. Major companies are investigating the possibility to integrate gestural hand input technology in digital artefacts. Samsung has recently released a smartphone, the Galaxy S4, which features hand gestural input. The product description reads: “Simply motion your hand at the Samsung GALAXY S4 to accept calls, change music, or browse the web and your photos with Air Gesture” (Samsung 2013).

“It is important to remember that a gesture interface is to be seen as complimenting or an alternative to existing interface techniques, such as the old desktop paradigm” (Nielsen et al. 2004, p.1).

Microsoft and Sony are two of the biggest actors in the video game industry. Each have their own ecosystem of dedicated videogame consoles, online services and games. Both companies have
explored how free form hand-gestures can be used to interact with games. To enable gesture recognition both companies make use of cameras, Xbox Kinect and Playstation Eyetoy. By adding a Kinect to an Xbox, users are able to control the console, play video games and access other multimedia features using touchless gestures.

Gesture recognition is currently an experimental way to interact with technology. The lack of tangibility and haptic feedback makes the design of touchless interaction a challenge. Where “...achieving accurate and meaningful gesture recognition and identifying natural, intuitive and meaningful gesture vocabularies appropriate for the tasks in question” (Sukeshini 2011, p. 821).

Although the technology for touchless gesture input has been explored, a lot of work is to be done in finding and investigating meaningful, practical and intuitive implementations for touchless gestures.

Throughout this report “touchless” and “touchless gestures” refer to an interaction method that recognizes hand gestures and responds to them. Considering our mobile context and intended use-cases, we delimit our definition of touchless to not include full body interaction such as Microsoft Kinect (see Chapter 3).

Since touchless is a relatively new interaction method it still hasn’t got its use cases and gestures well defined. This makes touchless interesting for interaction designers.

2.1 Problem Area

Windows, icons, menus, pointer (WIMP), is a style of computer interaction that makes use of graphical elements to drive interaction. Many of the interfaces that are built on the WIMP style of interaction are based on the “desktop” metaphor that first saw light at Xerox PARC in the 1970’s (Moggridge 2007). This design pattern is based on analogies between real world office items and virtual ones. The computer screen as a whole, resembles a desktop on which files depicted as documents (commonly referred to as icons) can be placed by the use of a pointer which can be moved across the screen along the X and Y axis. Apart from being moved around, documents can be selected and opened inside windows, which just like icons can be rearranged using the pointer. A menu is a selection of contextual or categorical options and actions that can be selected or performed, again, with the pointer.

As described above, one of the four pillars of a WIMP interface is the pointer. The pointer is the main input method in a WIMP interface which means it has a wide influence on the design and layout of interactive interface elements. The most commonly used input device for controlling a pointer is the mouse which gives the user the ability to control the pointer with very high precision; a gaming mouse may have a precision as high as 8200DPI (Razer 2013). What this means is that an interface can rely on the pointer’s accuracy to be precise enough for enabling a user to access every pixel on a screen. WIMP interfaces are developed for use with high precision pointers which enables having a lot of buttons in a physically small area. The feedback that is provided in WIMP interfaces is often objects changing color as they are hovered over or clicked on by the pointer.

With the introduction of touchscreen input devices, interfaces have gradually started to challenge the established WIMP interaction style. Apple’s iPhone can be considered to have set a design paradigm for touch interfaces. A main difference between a traditional WIMP interface and a touch interface is that a touch interface’s pointer is replaced with the user’s finger. This allows for a very direct interaction where a user’s finger directly manipulates virtual screen objects. However, a human finger is considerably larger than a mouse pointer and combined with the comparably low precision of a
finger touch input lacks the same level of control that a traditional pointer offers. To accommodate the loss of precision, touch interfaces commonly have bigger touch targets. However since touch offers a much more direct manipulation of screen objects combined multi-touch gestures such as zoom, some functionality can be offloaded from dedicated buttons and instead be utilized almost subconsciously anywhere.

Feedback from touch interfaces often make screen objects bounce, squeeze or be distorted in other ways to simulate being physically touched.

Touchless input provides even less precision than touch. In addition to this, touchless, like a mouse pointer, manipulates screen content indirectly. Because of this, touchless requires a different interface - an interface that doesn’t need the same level of accuracy and precision as touch-based interfaces. Touch interfaces made screen objects larger and more tangible than in previous WIMP interfaces.

<table>
<thead>
<tr>
<th>WIMP</th>
<th>Very high precision, Indirect manipulation</th>
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<td>Touch</td>
<td>Low precision, Direct manipulation</td>
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Future implementations of touchless might evolve from being a low precision input method, as described and experienced in this thesis, into a direct input method with very high precision. Display technology will also evolve and might evolve into 3D displays which would make touchless interaction every bit as direct as touch currently is on 2D displays.

As was previously mentioned, the market is currently experiencing a large increase of smartphones and computer tablets. Because of their portability, people tend to bring these devices along with them almost anywhere they go.

A lot of people prefer to use a tablet form-factor device instead of a laptop form-factor device for reading lengthy texts. A survey made by Gartner Inc. shows that “… more than 50 percent of media tablet owners prefer to read news, magazines and books on screen, rather than on paper” (Gartner Inc. 2012). A reason to this may be a tablet’s “book size form-factor” and lesser weight compared to an ordinary laptop.

Usage of these devices is growing as they are used by people of all ages in a wide variety of places and situations. From casual media consumption at home to professional uses at work. Because mobile devices are used by a large variety of users in a possibly even larger variety of places, there are a lot of important things to consider. It is challenging to design for a broad spectra of users because they all have specific goals and needs. Alan Cooper says in his book *The Inmates are running the asylum*:

> "Whenever I hear the phrase “the user,” it sounds to me like “the elastic user.” The elastic user must bend and stretch and adapt to the needs of the moment. However, our goal is to design software that will bend and stretch and adapt to the user’s needs" (Cooper 2004, p. 127).

A persona can be used to specify the purpose of the prototype application and may thereby make the design process more focused.

As touchless is a new interaction input modality on mobile devices, a persona that is interested
in technology and likes to explore new features and artefacts before they are available on the market, might be suitable to design for.

2.2 Goals and Purpose
The authors of this bachelor thesis are Malin Olofsson and Hampus Söderberg, two interaction design students at Malmö University. We have worked together on a slightly related project in the past, a project called “The Chosen One”. That project consisted of a digital table top adventure game that featured physical play pieces (see Illustration 1: The Chosen One). We built the game using a borrowed touch-table, also known as “Rosie” (Barrajon & Göransson 2009). Touch input was recognized by a camera that was able to track two dimensional movements and objects on a diffuse glass surface. The project allowed us to explore how digital and physical elements can be used together and augment each other. Specifically we took the tangibility of physical play pieces and combined this with the dynamic possibilities of a digital playfield.

Illustration 1: The Chosen One

A shared interest in cutting edge technology and experimental interaction design have led us to work together again with this thesis.
We were inspired to explore the touchless interaction field by a Swedish company called Crunchfish. With their Touchless A3D software, Crunchfish aim to provide a more intuitive human-computer interaction: “Crunchfish mission is to simplify interaction with mobile devices by providing a more intuitive touchless interface” (Crunchfish AB 2013).
At a presentation event, Crunchfish demonstrated a couple of prototypes to illustrate what possibilities their Touchless A3D™ platform could provide.
The first prototype they showed was based on ID Software’s classic videogame, Doom. By tracking head movement, users were able to control the onscreen point-of-view by tilting their head. To fire a gun, the user tapped the screen.
The second prototype demonstrated how users were able to rotate a colorful 3D cube by gently waving their hands in front of the screen.
Crunchfish envision touchless interaction to be integrated and used with any device as long as it has a camera.
The main goals of this thesis is to explore touchless hand gestures and how these can be implemented alongside other input modalities, such as touch. We have decided to use a scenario that puts the fictive persona in a kitchen context with the task of cooking dinner.

2.3 Questions
What visual feedback will users require when interacting with software in a touchless setting and how can this be implemented?
How can touchless hand gestures be combined with touch gestures in one user interface on everyday devices?

2.4 Delimitations for this thesis
We have chosen to delimit our focus to mobile devices. The mobile operating system (mobile OS) Android has been chosen as a prototyping platform, as it is the platform of preference for our partner Crunchfish, and also because we are familiar with developing applications for Android devices.
It is important to know that within this thesis there is no room for altering hardware designs. The key is to provide intuitive touchless interaction without having to change existing hardware designs.

The focus will be on human-computer interaction. Therefore, the application’s actual content will not be thoroughly researched in terms of how to efficiently display a recipe or how the cooking guide should present its recipes. Similarly, concepts in the project will mainly be targeted at single user activities.

2.4.1 Hypotheses
To guide and keep our effort focused, these hypotheses were formed:

- An icon that indicates the currently available interaction mode can be helpful in making users understand how to interact when several interaction modes are present.
- A visual feedback in the shape of a frame that activates when a touchless interaction is detected can make users’ touchless experience more satisfying.
- A semi-transparent overlay that appears on first-use only to instruct users how to use touchless interaction is a fast and efficient way to introduce new users to touchless interaction.
- A touchless gesture may advantageously derive from an existing touch swipe gesture.

2.4.2 Technical boundaries
Technical difficulties that are experienced in this project are due to inconsistent hardware, such as cameras and sensors that are positioned differently from device to device. Because of this, it is challenging to design an accurate touchless input modality as hand tracking can easily become offset. This affects the users’ intuitive understanding of how to interact touchless as users need to first locate a device’s camera before they can start their interaction.

2.5 Document Layout
Chapter 3: Related Work will show related work within the field of our investigation and introduce three research themes: multimodality, touch and touchless.
The next chapter, Chapter 4: Methods, will present and describe the methods that were employed in our design process.
How these methods were actually applied will be detailed in the subsequent chapter, Chapter 5:
Design Process. This chapter will take you through our entire design process, starting with the conceptualization stage leading all the way to final user tests of the prototype application. In Chapter 6: Summary and Analysis, we will summarize the work that has been done, as well as describe individual research outcomes. The final chapter, Chapter 7: Conclusions and discussion, will concretize the outcome of the thesis and provide answers to our research questions. This chapter will also discuss how we reached our results and what these results mean. Lastly we will point out some further research topics for other researchers and interaction designers to investigate.

3 Related Work

In this thesis, we present a study of multimodal interaction that focuses on the novel input modality, touchless, and how it can be implemented alongside traditional input modalities. Within this field of multimodal interaction, previous work have predominantly been focused on sensor-based gesture interaction. Specifically on mobile devices with built-in sensors like accelerometers and what forms of interaction these sensors can enable.

To get a thorough understanding of the research area, we studied how touch-based interaction has evolved and what others have previously done in the area of touchless interaction.

3.1 Touch

Touchscreens have existed since the 1960’s and one of the earliest incarnations was created by E.A Johnson. In 1965, Johnson wrote an article where he described how a frame of conductive wires could be attached to the front of an, at the time, ordinary cathode-ray tube computer display and form a novel input/output device (Capacitive touch). Johnson presented his input/output device as a new kind of keyboard whose keys are changed according to what keys are needed (Johnson 1965).

In the following years, Johnson set up his touch display for use with an air-traffic control. Johnson believed this to be a given use context for his touch display as air-traffic operators traditionally had to enter large amounts of text to amend air traffic. He reorganized the workflow and created a sequential user interface with dynamic buttons that changed labels and functions based on the current situation. By combining the sequential workflow with the touch display he managed to greatly simplify the complexity of amending flights (Johnson 1967).

During the 1970’s, Sam Hurst from the University of Kentucky was a key player in the advancement of touchscreen technologies. During 1971 he formed Elographics Inc. who, in 1977, developed a touchscreen based on a different technique where the screen itself consists of two layers making contact if touched (Resistive touch). They continued working on the technology and showcased 33 touchscreens to the general public at the 1982 World’s Fair in Knoxville, Tennessee (Elo Touch Solutions 2013).

In 1983 HP released their “HP-150 Touchscreen” PC which is considered to be one of the world’s first computers that came bundled with a touchscreen. The computer ran MS-DOS 2 with touch compatible versions of that time’s popular productivity applications: MultiPlan, Graphics, WordStar, Lotus 1-2-3, dBase II, VisiCalc and others (HP).

Apple announced the iPhone in 2007 which was a time when touchscreen equipped phones were relatively rare and touchscreen interaction most often required the use of a stylus. Tapping with a
finger was either impractical due to small GUI’s or wasn’t technically supported by the touchscreen. The iPhone reimagined the way a touch interface can look and behave by designing a GUI that considered the finger to be a user’s primary input method. “We are all born with the ultimate pointing device—our fingers—and iPhone uses them to create the most revolutionary user interface since the mouse” (Apple Inc. 2007). The iPhone was created with this in mind and thereby featured an interface that leveraged many of the possibilities that touchscreens provided. With the iPhone Apple has propelled the development of touchscreen based interfaces and set general expectations of how touch interfaces should look and behave.

3.2 Touch User Interface
Designing for mobile devices is challenging because of the wide range of various platforms and device form factors that exists; from the smallest phones to the largest tablets. Different software and hardware designs are created and combined to adapt to various usage patterns (Nudelman 2013). There are three common operating systems for mobile devices (mobile OS) which all have touch optimized user interfaces: Android, iOS and Windows (Windows 8, Windows RT and Windows Phone). The user interfaces in these OS’s varies but some design patterns can be recognized and the design principles for those patterns are often similar.

Different navigation features that have similar patterns have emerged as the touch interface has become more common. Examples of those are menus that appears from the side of the screen, in some software in all four sides (Canonical 2013). These can be reached with different gestures, to mention two common gestures, swipe in to the middle of the screen from the sides or tap a button that will activate a menu. This feature is integrated and well used in both the Facebook application and also in the Spotify application.

Illustration 2: to left: Facebook to right: Spotify
The menu in these applications is there to hide unnecessary information that the user doesn’t need at the moment. This way of hiding information makes more room in the GUI for content that is more relevant in this particular place in an application.

“People feel great when they figure things out for themselves. Make your app easier to learn by leveraging visual patterns and muscle memory from other Android apps. For example, the swipe gesture may be a good navigational shortcut” (Android Developers 2013a).
Swipe gesture is a well-integrated pattern within the touchscreen interface on various mobile devices. Most of the applications on a device doesn’t take advantage of the space when the screens gets larger than average size. When navigational components are hard to reach by holding the device with one hand, a swiping gesture can reduce these difficulties (Nudelman 2013).

“This is similar to Drag to Move Object, but this pattern, sliding a finger on the screen in one direction scrolls the screen or a list of items in that direction” (Saffer 2009, p. 52). Slide to scroll is commonly used when the screen can’t hold the content. The pattern of slide to scroll is similar to another pattern, Tap-and-hold on the screen, to select an object to move. This activity is usually confirmed with some sort of feedback, haptic or audio to indicate for the user that they have started the pattern to move an object. “Utilizing some kind of feedback, such as a visual bounce, haptic buzz, or sound when the user reaches the end of a scroll, is a good practice” (Saffer 2009, p. 52).

### 3.2.1 Feedback

According to Dan Saffer (2010, p. 39) feedback is “…a message about whether or not a goal was achieved or maintained – whether or not an error was detected.” When a tap action is confirmed the user is shown a hint or confirmation that an interaction has been recognized. It is equally important that when the user wants to perform an interaction such as tap, flick or drag, that the affordance is presented according to “…common visual design techniques to indicate controls” (Neil 2012, p. 259). The visual appearance alters to show that something is interactive. A common design pattern for this involves beveling and shadowing screen content to make the element seem clickable. The user flow must not be disrupted by either one of these visual cues; it is important not to exaggerate the usage of these effects (Neil 2012).

Today touchscreens don’t have tactile feedback. On several mobile devices physical buttons are replaced with touch buttons. The feedback given is an indication in the form of light or a vibration (Saffer 2010). On mobile devices that don’t have physical buttons it becomes more important to use other channels to inform the user that the device has responded to their action or input.

“Use color and illumination to respond to touches, reinforce the resulting behaviors of gestures, and indicate what actions are enabled and disabled” (Android Developers 2013c). It is important to show the user that the application is listening and recognized the object that was touched. Google have published guidelines that they would like to have implemented in the applications that people around the world are making (Android Developers 2013b). As mentioned before, when physical buttons are removed from the touch interface it becomes more important to give the user feedback when tapping on a touch button, which they cannot feel, if there isn’t a haptic feedback in a form of vibration. Otherwise commonly used feedback in this situation to let the user know that the application is listening are audio or visual feedback.

The application that is built by us will have an overlay tutorial that is the same color as the feedback frame. Even though a tutorial are annoying and can interrupt the user flow in the application it can be necessary to show an introduction on how to use the application or how to interact with it. Trying not to annoy our users, the tutorial is an overlay that is added on top of the screen content. The strength of the overlay tutorial is that the user is free to ignore it if they want (Nudelman 2013).
Even though haptic and audio feedback can increase the user’s performance on a mobile device, for the chosen context where it can become very noisy during preparation of a dinner, we fall back and rely only on visual feedback for this project (Hoggan 2009). When looking at the touch design patterns for visual feedback, a frame appears when there is a boundary, buttons become blue if they are tapped. The chosen theme was the default Android Holo Theme, which provides the feedback in the color blue (Android Developers 2013b).

3.3 Touchless
Although touchless is yet to be introduced in personal computing contexts such as those involving mobile phones, tablets or computers; touchless interaction has been explored in the context of entertainment systems and hygiene sensitive environments.

3.3.1 Sony EyeToy
In 2003 Sony released the “EyeToy” which essentially was a webcam that was connected to a PlayStation 2 console and placed on top of a television. The EyeToy was developed by astronautical and aeronautical engineer Richard Marks who wanted to take advantage of the PlayStation 2’s hardware capabilities and create a supplemental input method to complement the traditional Dual Shock controller (Robischon 2003). Since the EyeToy didn’t replace the traditional controller, games had to be developed specifically for the EyeToy in order to take advantage of the added possibilities. At launch, Sony released the game “EyeToy Play” which was a collection of minigames designed specifically for the touchless EyeToy interface. Not only the mini games but also the menus of this game was controlled by hand gestures, enabling the user to exclusively use the EyeToy for interaction. Users interact with the menus by gently waving their hand at a button, making sure a button-“press” was intentional.

The minigames were relatively simple and were designed to mimic common physical activities such as sports and household chores. One of these minigames was “Wishi Washi” which was a game where the users were supposed to clear the screen of fog. Users could use their arms or grab a real sponge to more efficiently remove the fog. Another game was called “Boxing Chump” and was a boxing game where users got to deliver, as well as dodge, incoming punches from an opponent visible on the screen.

3.3.2 Nintendo Wii
Sony and Microsoft both focused on delivering consoles with cutting edge hardware performance that supported the next generation of graphics. With the Wii, Nintendo chose an alternate approach to differentiate themselves on the gaming console market. Instead of packing high performing components, like Sony and Microsoft, they built the Wii with relatively low performance parts and put their focus on how the user was supposed to interact with the console. Therefore the Wii’s game controller is different than Nintendo’s earlier controllers, and different than most others that had previously been seen on the market. The Wiimote is a candy bar form-factor controller that features a speaker, an IR camera and most prominently an accelerometer for enabling gesture recognition. The Wii was released in 2006 (Nintendo n.d.). One of the first games released to Wii is “Wii Sports”, a collection of mini games based on different sports. With the use of the Wiimote users get to play baseball, golf, tennis, bowling and more. Physical accessories for transforming the Wiimote into rackets, golf clubs and steering wheels have become available to further improve user immersion (Nintendo 2013).
3.3.3 Microsoft Kinect
Microsoft released the Kinect in 2010 as a peripheral device for the Xbox 360 and has later been made available to Windows as well. The Kinect itself is a USB connected device featuring microphones and three cameras, two 3D depth sensing cameras and one RGB camera. The interactions supported by the Kinect are: full body gesture recognition, face recognition and voice recognition. The Kinect was developed to renew the whole Xbox 360 experience by enabling touchless gestural input throughout the console (Wikipedia 2013a).

At launch, 17 games were made available. All of these took advantage of the new interaction possibilities enabled by the Kinect (Microsoft Corporation 2010). One of those games is “Kinectimals”, a game where the player adopts a pet animal that he or she can nurse and play with. It is possible to gesturally pat the animals and you can also teach them to do tricks by using your voice (Kinectimals 2010; Microsoft Corporation 2010).

3.4 Touchless Recognition Methods
Gesture based interaction between humans has evolved for centuries, thus it cannot be assumed that these gestures can be directly transferred into human-computer interaction. Touchless interaction with mobile devices needs to be considered and chosen carefully (Löcken et al. 2012, p. 15).

“However, gestural interfaces must fulfil the same requirements as any other interaction technique. In particular, it is important to define usable gestures for the functionalities that the particular application offers” (Löcken et al. 2012, p. 16).

There are two distinct technical approaches for recognizing touchless gestures: sensor-based and camera-based (Kela et al. 2006). An example of camera-based gesture recognition can be seen in illustration 4 where a girl is playing tennis using Microsoft Kinect which responds to her body movements.

Illustration 4: Camera-based touchless interaction
Camera-based gesture recognition makes use of ordinary camera technology. Gestures are recognized by tracking movements and objects that appear in a video stream. Entertainment products such as Microsoft Kinect make use of camera-based gesture recognition. Researchers have long been interested in camera based gesture tracking. Companies are exploring the possibilities to implement camera-based gesture interaction into personal mobile devices, one being Crunchfish with Touchless A3D™.

Sensor-based gesture recognition can be seen in illustration 5 where another girl is playing tennis. Only this time, with Nintendo Wii. This method relies on dedicated hardware for detecting movements from which gestures can be recognized. Nintendo Wii made a big commercial impact by making extensive use of sensor-based gestures. These sensors have then gradually made their way into mobile devices such as smartphones and tablets. Sensor-based gesture interaction has been widely adopted by researchers because it is relatively easy to implement in experiments (Löcken et al. 2012).

3.5 Multimodal User Interface

When looking at human to human interaction (HHI) it is clearly visible that while speech is the primary communication method, gestures are used extensively to amplify and illustrate the spoken words (Allwood 2012). Similarly, multimodal human-computer interaction (MMHCI) can incorporate different input methods to accommodate for varying use of scenarios and different uses. Mice and keyboards are often used together. The mouse provides the ability to select objects on the screen while the keyboard provides an efficient way to enter text.

Like the HCI discipline, MMHCI strives to “…determine how we can make computer technology more usable by people” (Sebe 2007, p. 116). In order to reach this goal, there are some things to consider. The first thing is to understand the importance of having enough knowledge of an intended user group to be able to make sound decisions on what functionality and features a product should include. The next thing is to design interfaces that support users in completing their tasks. To do this, it is important to understand which features users need at certain times (Sebe 2007; Allwood 2012).
Microsoft developed Windows 8 to take advantage of all the possibilities that are present with touch based interaction. Since Windows is intended to be used on a wide range of devices, including ones that does not feature a touch-enabled display, multimodality was a major concern when developing Windows 8 (Wikipedia 2013b). The user interface in Windows 8 was designed to offer a new experience that was optimized for touch while maintaining compatibility with traditional mouse and keyboard inputs (Microsoft Corporation 2013).

Nudelman (2013) points out that you need to forget all knowledge you have about human-computer interaction when it comes to mobile design and testing. “The uniform mode of interacting with a computer via only mouse and keyboard does not apply to mobile devices. Much of what the mobile age is all about is taking advantage of the body’s natural motions” (Nudelman 2013, p.57). Mobile devices typically support a wide range of sensors: microphones, cameras, touchscreens, accelerometers, gyroscopes, proximity and light sensors and more. Many of these were developed for specific uses. For instance, a front-facing camera is included to enable video conferencing. Beyond their originally intended uses, these sensors can also be used to measure the human body and can thereby enable natural and intuitive interaction methods.

To design an efficient user experience and intuitive interface, these different interaction methods need to be considered and evaluated. Due to the portability of these devices, it is important to realize that users attention may be easily distracted by their surroundings (Nudelman 2013).

4 Methods

“It’s our experience that in comparison, qualitative methods tend to be faster, less expensive, and more likely to provide useful answers to important questions that lead to superior design” (Cooper 2007, p. 51)

As Interaction designers from K3, Malmö University, our research makes use of qualitative methods such as user tests with observations and interviews. The design process makes use of brainstorming and prototyping to generate and evaluate design ideas. The fields of touchless gesture interaction and multimodal human-computer interaction are researched in a literature review.

4.1 Literature Review

To get a better understanding of how touchless can be used as an input modality, we have searched literature for articles and papers that investigate this field. We will research user interface design, specifically visual feedback to get a better understanding of the kind of feedback that is needed for various interactions.

To help us understand how users perceive touchless gestures as an input method, we will study other interaction designers’ previous work within touchless interaction.

The field of multimodality will be researched in terms of how touchless gestures as an input modality can be combined with other input modalities to navigate a digital artefact.

Further research is done to discover and potentially incorporate other interaction designers’ design methods in our design process.
4.2 Brainstorming

It was natural to us to make use of brainstorming during the project’s preface. We found brainstorming to be a quick and efficient method for letting the mind play with the topics and themes of the project. By doing this we also got a common understanding of the research area and form a mutual project vision.

Saffer (2009) points out that the brainstorming process continues after and in between session and that it therefore is a good idea to spread the brainstorming sessions across several days. During the conceptualization stage we were alternating between doing research and having brainstorming sessions. This to be able to gather insight into the topics and ideas that might have been under discussion.

We have used brainstorming as a tool to concretize our ideas and to get them analyzable. Brainstorming allowed us to discuss possible directions and to eventually determine the themes to investigate and the ideas to explore in this thesis. Multiple techniques were used to support our brainstorming. We used digital tools, Microsoft OneNote, as well as analog tools, whiteboard along with pen and paper.

4.3 Interviews

The touchless input on a tablet is not an established modality and users haven’t experienced this kind of interaction in this context before, and therefore it is important to interview potential users. The interviewed people could be seen as candidates that would use the application in the future and that their needs could be easier to meet with the data from interviews (Cooper 2007).

There are different methods to conduct an interview: structured, semi-structured and group interviews. The decision of what method to use depends on the purpose of the interview. The questions to ask alters in order to what kind of goals the interviewer has.

The unstructured interview method can give a deeper understanding of the topic, alternative paths and new ideas that haven’t been considered by the interviewer. A negative aspect of this kind of interview is that it can generate a lot of data. Interaction designers collect the data by taking notes or by doing audio/video recordings.

If the project has a clear goal the questions can be more precise. When using structured interviews it is common that the interviewed person gets to answer questions with alternatives that are predetermined. This method requires more preparation by the interviewer when deciding the right questions, than with an open structured interview.

These two methods can be combined to one, semi-structured interviews, which can have both open and closed questions. When conducting a semi-structured interview it is very important not to interrupt the interviewed persons, to let them take the time to consider their answers and talk until they have finished. This way the interviewer show interest in the person talking (Sharp et al. 2007).

When doing user tests with a prototype that have an experimental interaction it is important that the persons testing this new interaction doesn’t feel stupid. This can be avoided by testing the prototype with a focus group, this might create an atmosphere where testers can discuss their experience and thoughts about features with other testers. Even though the agenda is predetermined it is room for the participants to raise issues that they think are relevant for the session (Sharp et al. 2007).
In this thesis the interviews will be conducted as a discussion with open questions in a focus group, this because we feel the importance of rising this new touchless interaction, and to focus on the user’s perceived experience.

4.4 Observations

During product development it is a good thing to do observations of the intended user group to gather data of how the user perform activities, what goals they might have and in what context the user need these goals to be fulfilled. Early in the design process this method helps the designers to get an understanding of the users’ context, tasks and goals. This can be collected meanwhile the designer follow the user as they go about their day-to-day task, and make notes of what they observe. Later in the design process observations can help to measure whether the prototypes that are developed can met the intended user’s tasks and goals (Sharp et al. 2007).

Sharp et al. (2007) mention that it is important to prepare and structure an interview, they believe that this also should be implemented when planning of doing observations.

It is important

- To have a clearly stated goal, especially when an observation session takes place, to get relevant feedback from the user.
- To be prepared with a script on how the observation session should take place.
- That the participants will be greeted and informed of how many they are that participates in this workshop and what they can expect in the coming hour.

The strength of having observations in a controlled environment is that the participant can focus in completing the tasks without interruption. Also for the designers to get to learn about how a user understands the tasks, to raise questions they might have about the interaction. In this project it is valuable to make this kind of observation while conducting user tests because touchless as an input modality is rather new to use a mobile device (Sharp et al 2007).

4.5 Scenario

Scenarios are often used when developing for imagined situations to help expressing conceptual designs, and as a tool in the communication between team members but also for communication with the users. A scenario declares the direction of a project, to set the prototype in a context and to describe how one user can use the product. By using the scenario to sketch out screens and an early user guide, it’s hard not to start discuss features and information that needs to be on the screen, also what features to implement in the prototype. This sketching can be transferred to a storyboard that show how the prototype can be used in a defined context (Sharp et al. 2007).

When a scenario, the story about how a product may be used by one user to achieve a task is decided, it’s time to identify every moment and step the user takes to complete the task. By focusing on the interaction and create a storyboard, that can be scenes where each step is illustrated, or as a diagram, this can help to set the frames for the user while testing the prototype. Storyboards are also relevant for the design team, this helps in the discussions about what features and activities that are needed in the scenario (Sharp et al. 2007).

Saffer (2009) points out that a storyboard is the best way to document a complicated gesture that is difficult to understand outside the context. In this project the gesture that we investigates isn’t so
complex, but we believe that this can be a good way for us to illustrate how the interaction with the mobile device is experienced within the thought scenario.

The context we have chosen for this investigation is the kitchen. In this scenario, the persona, Nicklas, have a goal to prepare a dinner for his friends. To reach this goal he wants to use a tablet to see the instructions on, also to be able to navigate through the recipe steps. The key here is that in a kitchen, the hands are often wet or soggy, by hacking and washing vegetables, stirring in the pot and so on.

4.6 Prototyping

Prototyping is a good tool to express a concept idea, to highlight the interaction and to show stakeholders the project vision. Interaction designers make prototypes to experiment with different interactions, features and to test these with real people. “It’s often said that users can’t tell you what they want, but when they see something and get to use it, they soon know what they don’t want” (Sharp et al. 2007, p. 530). Especially when showing them a prototype. A prototype can be anything from a piece of paper with drawn storyboard to more advanced prototypes that have complex software. The main point of making prototypes is to show people involved in a project how the product, interaction or design can turn out. Even though the main goal of prototyping is to get the involved project people to evaluate the prototype, it is still important to get the prototype evaluated by real users. Testing the prototype in real environments, or by using fictive scenarios, can make it clearer what parts of a prototype that works well and what does not (Sharp et al. 2007).

Low-Fidelity prototyping is often analog and made by paper or cardboard to simulate the concept. Using these kind of prototypes require the Wizard of Oz manipulation, the designer has to make the product seem like it is interactive for the user that test the prototype. Paper prototypes are a way of testing and evaluating the flow and the concept in the context. The designer sketch the steps in the prototype and put it down on paper, each paper contains a step of the task in the design. The strength of making paper prototypes is that the material is cheap and quick to modify so they show the thought design and interaction even though the tester need to see through lack of flow (Sharp et al. 2007).

As interaction designer sketching wireframes is a sufficient tool to get information of user flow and interaction within a software.

Storyboarding is one example of how Lo-Fi prototyping can turn out, especially when GUI-based software is being designed. This method of prototyping is often used together with scenarios, which enables the designers to show their thought concept. The stakeholders in the project can interact with the prototype in a fictive scenario, following the steps in the storyboard gives the user an idea of how the system could work (Sharp et al. 2007).

While Lo-Fi prototyping was made by materials that isn’t expected in a final product, Hi-Fi prototyping use materials that can be seen in the final product. Especially when prototyping software systems, to be able to develop this kind of prototype requires knowledge and the right tools. Even though Hi-Fi prototyping have drawbacks (take long time to build, testers comment on the aesthetics rather than the content and from a developer’s perspective it gets harder to “kill your darlings”), it is a powerful tool to show for the stakeholders or other participants included in a project. The strengths of Hi-Fi prototyping is that the software can include complete functionality, that clearly shows how the navigation works, and that this kind of prototype has the look and feel of a final product (Sharp et al. 2007).
In this project where we will explore an experimental modality that depends on the integrated camera, therefore using Hi-Fi prototyping as a method is needed. This will make it easier for us to illustrate and show stakeholders how we think the interaction can be integrated in a mobile device. As our prototype will be a software application for the Android OS, the scenario within the application can be seen in an interface flow chart that have been made to illustrate the different steps that the user needs to take before their goal can be fulfilled.

4.7 User Testing

During user testing of a Lo-Fi prototype one can gather a lot of information on how certain features are perceived. Observations and interviews can be an effective way to get to an understanding of what features users want or not want in a prototype. The features that worked well or other features that needs to be changed can in the next iteration to be implemented and tested in a High-Fidelity prototype.

The basic approach of usability testing, according to Rubin (2008, p. 25) includes different elements, and here are chosen elements that have been conducted during user tests in this project:

- Usage of representative sample of end users which may or may not be randomly chosen.
- Representation of the actual work environment.
- Observation of end users who either use or review a representation of the product.
- Controlled and sometimes extensive interviewing and probing of the participants by the test moderator.

Testing is an artificial situation and it’s important to take this in consideration when the collected data is evaluated. Continuously testing a product in the real context is not a guarantee for the data to be useful in the long run. In an early stage of the development of a product it is not necessary to conduct usability testing, this because the team already know the obvious problems (Rubin 2008).

Once the hi-fi prototype has been developed, it is time to test this with real people. Saffer (2009) points out that when the prototype have an experimental way of interact with a device, it is important that participants in the user tests are as close as possible to the intended real environment for the prototype.

Soren Lauesen (2005) describes that three users can be enough when testing usability, at the first test, that serious problems can be found by one user and this is more time efficient. After an iteration and problem correction the next round of tests that may include three users can get out detailed information. The motivation for using three people is that during the design process the usability is measured several times inside the team. However since some of the components we are investigating are perceived partly subconsciously these will need to be tested by unintroduced people.

For this project it’s been decided that one of our user tests will be conducted in the thought context, preferably in the participant’s kitchen. We want to open a discussion with our testers where they get to describe their current experience and future expectations for the technology. It is interesting for us to understand the user’s experience and thoughts, while testing the prototype. In the test sessions there will be questions that the test person will be asked during the end of the test.

To get feedback from our research a decision was made to distribute the prototype application with brief instructions and a formula with questions for the tester to answer. In this way the collected data
can indicate in which way and how users interact with the software in their own homes, preferably when they make use of the application in the thought out context and scenario.

4.8 Personas

According to Cooper (2004) the most efficient tool that an interaction designer have in the design process is personas, a persona is a fictive user which is defined by his or hers goals to accomplish tasks with the product. Designing for a single user makes it easier for the interaction designer to hit the bull’s-eye in the goal of satisfying the user. When using personas it is important to be very specific in the description, the persona should come alive and become a person for the design team. This makes it easier to follow the same direction in deciding the specifications of the prototype, what features that the persona needs to accomplish the goal. The personas “...goal is an expectation of an end condition, whereas both activities and tasks are intermediate steps (at different levels of organization) that help someone to reach a goal or set of goals.” (Cooper 2007, p. 15)

The easiest way to create a genuine persona is to build it upon stereotypes, although it is important that the persona is like a real person. Cooper (2007) points out that it is important to identify the user that can represent the user group in mind, and a way to do this is to determine the user’s goals and what motivates the usage of this product. To make the persona more personal for the design team, give the persona a picture so the team can easier relate to their persona, and it can easier be integrated throughout the design process. Nudelman (2013) recommends that disagreement about the persona should also be written down, the persona doesn’t have to be detailed with a lot of information. And to remember that “The most important function of the persona is the sense of team cohesion and empathy toward the struggles and challenges faced by the target customer” (Nudelman 2013, p. 60). The persona is what keeps the design process on the right track, that the right features and that the right interactions are focused at by the whole team, cohesion as Nudelman says.

5 Design Process

In the planning for this project there were four things that needed to be sorted out. The knowledge of where the user might be during usage of the thought product, what equipment they might use and if they are doing anything else at the same time. The context can help to drive the team to choose a final design approach and a list of features that the product should contain. To know who the application is created for, the targeted person, a persona, can keep the focus within the group. When this is done, the fieldwork can start, by observe and interview people, followed by brainstorming sessions (Nudelman 2013).

“Interaction designers take the raw stuff produced by engineers and programmers and mold it into products that people enjoy using” (Saffer 2011).

The core of this project is to investigate how a new technology for tracking hand movements can be used when interacting with a digital device. From that starting point, and throughout the whole project we have followed a “technology centered view”. According to Saffer (2011) there are three major schools of interaction design, one of them being the aforesaid technology centered view. This view is all about working with the latest cutting-edge technology in an exploratory manner looking for design gaps.
5.1 Conceptualization

Conceptualization has been our primary design method and central in the search for a utilitarian use for touchless hand gestural interaction. Several conceptualization methods have been exploited to explore various aspects of our research area. Brainstorming has been used extensively for finding and defining our area of research. A Persona was created to provide a target user for the application. Storyboarding was used to select and organize ideas and concepts that were developed during brainstorming sessions. The storyboard roughly describes the intended scenario.

5.1.1 Brainstorming

The topic touchless is a new field for exploration where little research has been done within our selected context, mobile devices. We decided to use brainstorming as our primary tool for generating ideas and exploring potential concepts. Saffer (2010) inspired us to spread the brainstorming over several sessions to be able to research identified themes, and to discuss these in coming brainstorming sessions.

The discussions have gone from extracting qualities from mechanical buttons to creating a 3D browser and finally landed in prototyping a kitchen recipe reader.

After several brainstorming sessions recognizable patterns have emerged that reflected our interests in the touchless topic. Three themes were established that resonated well with our interests. One of the themes was multimodality; how can different input modalities work together. The next theme was visual feedback; how can the device assure the user that the device sees them and that the device is ready to respond to the user’s command. The third theme was about gestures; how can a touch swipe gesture input be transferred to a touchless swipe gesture input.

A rough sketch was created to get an overview of the features that could be implemented in the application. This list of features can be seen in Illustration 6 where backend features are to the left
Illustration 6: Features in Application

The illustration above provides an overview of design problems we have found: Would users want or need visual feedback for indicating a recognized touchless gesture? How can generic actions such as confirm, cancel, go forward, go backwards and scroll affordances be communicated to users? Will users ever need to tap a device or could anything be accessible through touchless input? When and how will touchless interaction be activated, by tilting the device or by tapping a button? Should the application force users to have their devices in a specific orientation to be able to use touchless input?

5.1.2 Persona
This investigation follows a technology centered approach where the purpose is to find a design gap that touchless could potentially fill. In essence, we are designing a new need rather than refining an existing one. To balance this thesis’s technical starting point, a persona was created. See Appendix: A. The persona was useful in determining what values certain features would add if they were to be implemented in the concept. This way we were able to maintain a user-oriented design process where we could make thoughtful design decisions based on actual user needs instead of adding the features that we wanted.

5.1.3 Scenario and Storyboarding
Storyboarding has been used and resulted in an interface flow chart (Illustration: 7). Creation of the flow chart helped identifying key activities that are associated with the considered scenario. Throughout brainstorming sessions it has been inevitable to avoid talking about the application’s structure. The user interface flow chart shows application features and how they would be implemented in the prototype application.
The user’s goal in this application is to find a recipe and to receive instructions to be able to cook dinner. When the user starts the application, the first screen is a recipe collection showing thumbnails of recent and favorite recipes. If the user can’t find a recipe in the local collection, there will be a feature to search for recipes online. When the user has found a recipe, a confirmation is required to proceed with that recipe. Then the required ingredients are shown and the user can compare this to their own inventory and add missing ingredients to a shopping list. This list can then be brought along while shopping for the missing groceries. With all ingredients collected, the user can return to the application and resume with the touchless instructions for the selected recipe.

Peripheral services that have been thought upon are: social and private sharing, recipe rating and ability to mark as favorite. Another service that was considered was to make the application suggest recipes that can be done from the remains of ingredients bought for a recipe.

The user interface flow-chart (Illustration: 7) lays out a holistic view of the concept and proved to be an efficient tool for designing every detail in the concept. The persona was used extensively during the design of this flowchart. However since the goal for the prototype is to explore touchless interaction only the green “Cook dinner” step will be fully implemented.

5.2 Lo-Fi Prototype
In the prototype process we will present our Lo-Fi paper prototypes and then describe how the process have proceeded to the creation of a Hi-Fi prototype that we will test on actual users. This design process is a standard way in interaction design to show stakeholders a concept idea, but also
to be able to try this out with real users. For the Lo-Fi prototype, a choice not to test the Lo-Fi prototype with actual users is due to the lack of tangible interaction and therefore we test the Lo-Fi prototype within the project group to get an idea of the modalities we will design for.

Microsoft PowerPoint was used to create dynamic mockups of different touchless gestures. These mockups deliberately have a very low-fi appearance, partly to save time but mainly to focus completely on investigating gestures. Interactions were simulated by utilizing PowerPoint’s built-in animation and trigger functions. An animation is triggered by the test moderator once the test user attempts an interaction.

5.2.1 Semantic zoom gesture

Illustration 8: Touchless Semantic Zoom Gesture in Calendar

Semantic zoom was explored by portraying a calendar that switches between month- and week-view depending on whether the user’s hand is moved towards the screen or away from it (see Illustration: 8). When moving the hand towards the screen, month-view is replaced with week-view and vice-versa.

5.2.1.1 Results

Generally, users didn’t appear to understand what was happening when they performed the zoom gestures. We concluded that this could be due to this gesture not being as commonly used as others.

5.2.2 Feedback Frame

Illustration 9: Green Touchless Feedback Frame
Feedback was explored by having a green frame appear as the user enters the touchless interaction area (see Illustration: 9).

### 5.2.2.1 Results
Users induced the frame by waving their hand in front of the screen and it was seen as a direct feedback of this action.

### 5.2.3 Swipe Gesture

[Image of a sequence of screens with the words “Let’s go!”, “Keep going…”, “Keep going”, “Keep going…”, and “Done!”]

*Illustration 10: Touchless Swipe Gesture Test*

Swipe was investigated by creating screens that contained a simple text and an arrow icon that prompts the user to swipe in a specific direction. At first the screens directly emulated the touch swipe gesture, the content is swiped away in the same direction as the finger moves (see Illustration: 10). As it was discovered that users got confused when the content didn’t swipe in the direction they subconsciously were expecting it to, another mockup, where the swipe direction was reversed, was created.

### 5.2.3.1 Results
It was discovered that subtle feedback from the directly manipulated content is very important to achieve an enjoyable and predictable experience. The swipe gesture itself was well received, meaning that users quickly understood the gesture and performed it as intended. This may possibly be because they recognized the gesture from touch.

### 5.2.4 Wireframes

The initial steps in the creation of the prototype application involved taking the rough ideas developed during the conceptualization phase. Wireframes was the method that was chosen for generating tangible representations of the concept. This approach enabled us to quickly illustrate and
communicate our ideas of the application’s layout with each other. As well as let us test the application flow and to understand what features that does and doesn’t work.

The features and interactions that was decided in the user interface flow-chart diagram (see illustration: 7) was put into context in wireframes (see illustration 11). This way it was possible to get a visualization of what the application might look like and the intended interactions. The wireframes was evaluated and the generated content were iterated to eventually form a template to follow during the creation of the Hi-Fi prototype.

Illustration 11: Wireframes showing steps of the application

Illustration 11, are a graphical design extension of the user flow-chart, and how we visualized the layout. These papers illustrate the screens of an application, the thought content and interactions between the screens.

All ideas that emerged during brainstorming and meetings have been considered and included in the design process. Recipe overview, recipe thumbnails, categories and sorting, online search, local search, ingredient stock check, shopping list and recipe instructions are all features that have been considered during the creation and evaluation of the wireframes.

In accordance to our delimitations (see Chapter 2) many of these features were discarded in favor of creating as good of a touchless experience as possible for the user. We have chosen to exclude features such as instant messaging services, multimedia services, scan barcodes on ingredients to generate recipe suggestions, photo-sharing service and social networking as we found these features to distract the user from the actual investigation content. Those described and discarded features would risk to take over the application, and might provide us with irrelevant data from our user tests. To investigate how this way of interacting with a mobile device should be implemented, there is a need to put the touchless interaction into a natural context. Therefore it came natural to us as
interaction designers to make use of a persona (see Appendix: A), the process of generating these wireframes raised discussions of different use-cases and their possible features and interactions. Our persona, Nicklas, have been helpful in finding key events that are crucial in making concepts work in the previously decided context.

5.2.5 Wireframes Iteration

For the first prototype the wireframes was iterated to digital images to illustrate what the finished prototype would look like. Illustration 12 shows the starting screen and how the collection is thought to be designed. Illustrations 12 and 13 demonstrates the design of touch-only parts of the application, a recipe collection and a recipe overview.

![Illustration 12: Application Overview Screen, Lo-Fi prototype](image1)

The menu to the left provides navigation through food categories and users’ favorite and recent recipes. The grey squares serve as placeholders for recipe thumbnails which are meant to give users’ an overview of the different recipes they can choose among. Here the interaction mode is touch, where users can swipe and scroll through recipe thumbnails. Tap on a recipe thumbnail to display the corresponding recipe.

![Illustration 13: Application Detail Screen, Lo-Fi prototype](image2)

Illustration 13, depicts the recipe overview screen where a recipe is detailed. The overview screen presents a recipe similar to how books and websites do by offering a single-page layout with an ingredients list, recipe summary and a picture. A rating affordance as well as an “add to favorites” button is also present.
5.3 Hi-Fi Prototype
The Hi-Fi prototype’s purpose was to implement the previously created wireframes and provide a platform for testing and evaluating the touchless interaction mode. Therefore, the elements outside of the touchless instructions screens were implemented as static images. These non-interactive screens did however present a near-final visual design.

A lot of changes can be seen in the illustration above. While the earlier wireframes provided only placeholder texts and images this prototype iteration contains final texts and graphics. In detail, the menu to the left now include small icons to illustrate separate food categories.

The illustration above shows an iterated recipe overview screen where it is now possible to add ingredients to a shopping list. Some elements have been moved to better integrate with android design principles. The Android element action bar provides a common place for shortcuts and is located at the top of
application screens. An action bar was implemented in the recipe collection for holding shortcuts to search, share and shopping list functionalities.

When the user have chosen a recipe, the next step is to get guidance for how the preparation of the recipe is. In the action bar in the top right corner (see Illustration: 16) there is an icon in the shape of a hand. This icon indicates that the interaction mode has changed and now it recognize touchless as the main input modality.

Illustration 16: Application Guide Screen, Hi-Fi prototype

The guidance screens (see Illustration: 16; 17) has a very simple visual design, but none the less, the main focus for this test is the interaction made by the user. In the bottom of the screen the progress bar indicates how many steps that are left before the guidance is completed. This is a way of giving the user feedback on their progress that are easy to understand.

When the user navigates through this application by using touchless swipe gesture, it is important that the user can understand that the software have seen the user’s hand. A frame is used to clearly indicate to the user when their hand is seen by the software, and when the user can make a touchless swipe gesture to navigate to the next instruction (Illustration 17).

Illustration 17: Application Guide Screen with Feedback Frame, Hi-Fi prototype
At this stage we have changed the background color from what was stated in the original wireframes. This due to a brighter background lights up the hand, and make it easier for the camera to track motions.

5.3.1 User Testing 1

During this test session of the Hi-Fi prototype we followed a template showing how to conduct thus test (see Appendix: C). The test session took place at Malmö University with two students (See Illustration: 18). The main purpose of this user test was to get feedback from the user of how they experienced the interaction of the device. At this early stage of development there were no real need to perform the user test in the real context.

Illustration 18: User Test session 1

For the next iteration, information was evaluated from the test of the prototype, what features that worked in the Hi-Fi prototype, decision on which of these features were to be implemented.

The gathered information that will be under considerations was:

- Should there be a tutorial?
- Bigger indication that the hand was recognized?
- When to start the gesture pattern?

We had to decide if to make the instruction screens look more finished, with a clearer progress bar, maybe with numbers instead, and illustrations on the step, what to do. This Hi-Fi prototype was made with static images and noticed during the tests that users wanted to interact with parts within the prototype. Therefore we chose to implement real layout elements for the next iteration of the Hi-Fi prototype, this could give us information on how the users would like to interact with the prototype, by simply observe where they tap on the screen.

5.4 Hi-Fi Prototype Iteration

Feedback that was collected from previous user tests and other people trying out the application without participating in a pronounced test session was incorporated into the design of this iterated
Hi-Fi prototype.

Illustration 19: Touch input modality with feedback

To get more relevant results from user tests the application’s user interface was rebuilt with interactive components to convey a more accurate user experience of the intended concept.

Illustration 20: Overview left: Tablet, right: Phone

A large change have been that the touch icon stands alone in the action bar. This makes the icon look larger and the intended message of the icon becomes clearer for the user. The other icons have been moved to Androids built in action menu.

Illustration 21: Icons: application icon, touch icon and touchless icon

The applications icons have been revised to better communicate their meaning. Outcome from earlier user tests indicated that users didn’t notice these icons which had a negative impact on the user’s experience with the application.

The previous icon for indicating whether or not touchless is available was modified to better resemble a hand making gestures in the air as well as to draw more attention. A complementary icon for indicating touch mode was added to address issues where users didn’t notice the input mode icons. An application’s icon, combining the familiarity of a cooking hat with the futuristic touchless icon, was also created.

Illustration 22: Categorical icons
These icons were added in the former iteration of this prototype to illustrate the different food categories. We found that the icons resembling farm animals were too cute, and inserted a strange tone in the application. Katrine (2012) presents in her article, that when a person see a visual representation of a figure, this can give a person the feeling of communicating with a real person. Therefore we decided not to continue have cute farm animals as the users might feel a connection with them. The choice not to refine these icons and to instead remove them from the design was ours.

Illustration 23: Recipe left: Tablet, right: Phone

In the previous version to activate touchless mode and to view instructions the device has an ordinary touch button as early user tests indicated a need for an explicit action. Another noticeable change for this screens have been the background color, due to the technology reasons we no longer needed the background to be white, and therefore adapt the default Android Holo Dark theme in our application (Android Developers 2013). Minor changes have been done between these device versions to enhance the reading capability on the smaller screen such as the text have been made larger and the “add to shopping list” checkmarks have been moved.

Illustration 24: Visual Feedback left: Tablet, right: Phone

The feedback frame got more prominent when the background color changed but to make it even more prominent the frame itself was enlarged. According to user test results the progress bar felt ancient and outdated. The progress bar was replaced with large numbers to give the user a clearer indication of where the user are in the row of instructions. As in previous changes on other screens the text were enlarged in the mobile version to simplify reading on the screen.
To instruct user’s on how to navigate through the instructions, the input mode icon in the action bar was complemented with an overlay tutorial showing a right-arrow. The decision of using a right-arrow was based upon tests conducted in the beginning of the design process, a power point that switches images depending on what way you were swiping (see Chapter 5.2). This was a good way to see how people thought when trying to swipe a side.

The swipe gesture was changed to allow faster interaction, by simply detecting a gesture instead of having the content stick to the hand. During observations it was revealed that users didn’t understand that their hand’s position over the screen corresponded to that of on-screen objects which made their interaction unpredictable and thereby hardly usable.

The swipe gesture is in the opposite direction from an ordinary touch gesture in a touch interface. This was discovered by PowerPoint animations with an arrow to the right and bottom, the interaction was then tested by us in the project and a couple of relatives. By doing this kind of quick interaction test to decide in what direction our tutorial arrow should point at. Even though it was few testers the
information we got was very competent, this was implemented in the Hi-Fi prototype for further testing (see Chapter 5.2).

For this iteration of the Hi-Fi prototype there were two versions created. One that had a feedback frame that showed when the user was interacting with the device, and one that didn’t give feedback when detecting interaction. This way we were able to test how this frame affects the user’s perceived experience by comparing results from the two prototypes.

5.4.1 User Tests after iteration

The second round of user tests was conducted in the homes of the participants where they performed the activity, baking. The participants got the device with our Hi-Fi prototype running and was instructed to use the application as they would use a recipe (see Appendix: D).

The research goals for these user tests were:

- How intuitive is the transition between touch and touchless modalities?
- How well is the introductory tutorial providing guidance on how to navigate using touchless?
- How much sense are the gestures perceived to make?
- How trustworthy is the touchless interaction perceived?

The transition between the modalities was a bit confusing for some of the users, they wanted to tap the icons in the action bar or perform a swipe gesture to activate touchless. 4 of 6 participants understood that they were to tap the “view instructions” button.

There was feedback from the participants that the tutorial instruction could show that it was touchless interaction, many wanted to swipe using touch either exclusively or interchangeably. When the participants had gotten used to the touchless modality, they performed swipe gestures happily and confidently. This was showed because some of the participants tried out the application and explored if they could do other gestures and got disappointed that some features wasn’t implemented. We previously referred to Sharp et al. (2007) stating that users don’t know what they want but if they get to try something, they soon know exactly what they don’t want. This has been seen during our tests, the participants came with suggestions to enhance the application and started thinking about how these could be implemented.
Other observations we have done and feedback we have collected during these tests are that several of the participants missed a back function in the application and was trying to swipe in the other direction or perform a swipe touch gesture. We observed that when touchless interaction wasn’t performing as the users were expecting, they would fall back to trying touch input instead.

The positioning of the device was different between the participants. Some of them wanted to have the device placed directly in the cooking or baking area, meanwhile others wanted to have it placed separately, away from kitchen mess. Some of the participants positioned the device flat while others tried having it angled upwards, as a traditional computer screen. The participant found the hand gesture to be awkward in this position so he quickly repositioned the device into a flat position.

User tests have generated feedback around features that are outside our focus but we believe it to be a good thing to consider these, as they have disrupted the user’s focus on the actual touchless interaction. The users wanted to be able to have a detailed overview over the recipe and the instructions on how the cooking should be conducted.

To complement the second round of user tests we wanted to distribute the application to our friends to get feedback from other persons. The distribution channel was a Facebook event we linked the two exported versions of the application, one with feedback and one without. There was also a questionnaire for the users to fill out when they have tried and could compare the applications. Due to lack of interest there was only one that conducted the test and answered the questionnaire. But the test result indicates that the user wanted to perform a touch swipe gesture instead of a touchless swipe, this was discovered because we had included a way of measuring that the user tapped on the screen when the interaction mode was touchless.
6 Summary and Analysis

6.1 Summary

The main goal of this thesis was to explore how touchless hand gestures can be implemented alongside other input modalities, such as touch. As touchless is a novel input method without any prominent design paradigms to base an implementation on, we felt that we wanted to investigate how fundamental touchless interaction could be designed. We recognized early that feedback is a crucial component in a pleasant interface so we decided to make this our second research goal.

To answer our research questions we decided to create an application where we could test and evaluate touchless implementations. A recipe reader was chosen as we wanted a concept that was easy for a lot of people to relate to, and because we think that the kitchen is an area where people tend to have their hands occupied or messy, making touch less than optimal. The application consists of recipe management functions that are operated exclusively with touch and a recipe reading function that is operated exclusively with touchless. We decided to divide the input modalities like this to be able to freely explore different aspects of touchless and still have an application that was graspable for the people testing it. By having separate interaction modes, we investigated how to transition between the two modalities. As we didn’t want to define design principles for touchless GUI’s, the application followed default Android design guidelines which were created for touch interfaces.

6.2 The Feedback Frame

To inform the user that their action has been recognized a visual frame, providing feedback, was implemented along the edges of the application. This visual element was first evaluated with Lo-Fi prototypes and revealed that the user perceived the frame as a direct response to their action. Then it was incorporated into the first Hi-Fi prototype version. It was discovered during another test that the participants didn’t recognize the frame as we predicted. We found that it was not prominent enough to be noticed, which led users to not perceive any feedback. Enhancements were made to increase the frame’s visibility. In the next user test, it was clearly observed that users had an increased confidence and performed their tasks faster. During tests without the frame present, it was discovered that users had more trouble achieving their tasks and perceived the interaction as less accurate.

6.2.1 Analysis

Our findings corresponds to Saffer’s understanding that users want to have confirmation on actions taken. We discovered that feedback is paramount when users interact with technology. If a user doesn’t receive a confirmation of their action, they will try to perform it again, and again until something happens. This behavior was observed several times when the feedback frame was missing or too subtle to be noticed. We have found this to be particularly true when using a new interaction method. This might possibly be because when everything is new, users tend to do a lot of different interactions to discover what they can do. If nothing ever happens they can feel uncomfortable and might become frustrated and may eventually stop using the application.

We felt that a recognizable, and somewhat standard visual pattern for Android, would be good to follow to avoid making our prototypes unnecessarily confusing. The thought of having the frame was a parallel to the standard Android button that has a blue frame. We chose this way of giving users...
feedback on their actions because touchless interaction is not as detailed or task oriented as touch interfaces tend to be. By implementing this it has shown that the users can concentrate on the actions taken and not to focus on how the interaction is made with the device.

6.3 Interaction Mode Indicator
To indicate the kind of interaction the device will respond to at a certain time, an icon was placed in the Android system’s action bar. At first this icon was only present when the application was in touchless mode. User tests revealed that it was often unclear which input method that were available. We tried to address this issue by replacing the touchless input icon with a more descriptive one (see Illustration: 16). Furthermore, in line with Android design guidelines we hid all action bar icons except for the interaction mode indicator to increase its visibility. To achieve coherency between the interaction modes the touchless mode indicator icon was accompanied with a corresponding touch mode indicator icon.

6.3.1 Analysis
When the device only had an icon that indicated that the input modality to be used were touchless, the users didn’t recognize when the input modality was to be touch. To give the same kind of feedback regardless of the preferred input modality an icon for each mode where implemented and then the users could see in the interface what the device wanted to recognize.

6.4 Instruction Overlay
During the first Hi-Fi prototype test, it was suggested to us that some sort of guide on how to interact with the device would’ve helped understanding what direction to swipe in. An instruction overlay, consisting of a semi-transparent blue arrow, was implemented. In this test users swiped according to the instruction given in the overlay.

6.4.1 Analysis
The results from the user test showed that the users wanted to have an introduction, so the overlay where implemented. Nudelman’s theory that the user can think that this way of showing a tutorial is annoying, also that this can disrupt the user flow. Therefore we chose not to have a detailed overlay, this also because a presentation of the interaction mode during the user tests was made. Even though this only gave the user an idea of what direction the swipe gesture should be performed in, the users understood this due to our explanation of the feature. As the result from our user tests some of them came with ideas that they wanted to have an illustrated overlay that had a hand and that showed the interaction more describing.

6.5 Gestures
Interfaces that support touch gestures have become a common and well established way to interact with a mobile device. Saffer mention that if the content is outside the screen it is preferable to use a swipe gesture due to a navigation in the top of the screen can be difficult for the user to reach. By transferring the swipe gesture to a touchless interface the content of the screen can be changed on a way people can refer to. As in our prototype the instructions were changed with a swiping hand gesture, this resembles a gallery application were images are switch with this method on a touch interface. It was discovered in early mockup tests that people subconsciously presume that the “continue”-gesture is in the direction of the content.
6.5.1 Analysis
Transferring gestures as in this prototype can make a new way of interaction with the similar gestures easy to learn. It has been shown in user tests that the swipe gesture wasn’t a problem but the way the users wanted to perform it, people seemed to wave more than swipe with the software. The outcome of this has been to make the gesture recognition less precise which lead to a more intuitive interaction experience.

6.6 Multimodality
The multimodality aspect of this project have been that two modes were integrated. The start of the application were handled with touch interface and the second half of the prototype was handled with touchless as input modality. During user tests when the transition between these modes were observed, users assumed that the start interaction input should be touchless, this because we presented that the application had touchless interaction. Then we had to tell the participants to look at the interface and see if they got hints on the actual input modality. Tests also showed that users wanted to choose what input mode they wanted to use, this was especially in the touchless mode, the users tended to try swiping between the instructions even though they knew that the actual mode was touchless. This provides information that the users awareness should be considered in this new way of interact with mobile devices.

6.6.1 Analysis
The main idea that this results have led till is that the user doesn’t feel stupid, as Android Developers (2013a) mention that the users feel great when they can figure things out by themselves. In our prototype we wanted to discover this kind of users’ unawareness that our tests could provide. Even though it was clear in what way the input should be performed the users wanted to be able to choose this for themselves.

6.7 Technical Implementation Analysis
Initially, we set out to use Crunchfish’s Touchless A3D™ software which uses a camera to recognize hand gestures. Because Touchless A3D™ is camera based, it can be configured to recognize virtually any hand gesture.

We also considered simulating touchless hand gesture recognition using a proximity sensor. A proximity sensor’s single function is to provide a value that represents the distance between the sensor itself and the nearest object in front of it. To simulate a touchless swipe, one basically connects an action to the event of a proximity sensor’s value change. This method severely limits the amount and complexity of recognizable gestures.

To investigate how touchless might be combined with touch in a multimodal interface, we chose to transfer an established touch gesture, swipe, into a touchless gesture.
With swipe being the only touchless gesture we investigated, it made sense to us to simulate hand gesture tracking with a proximity sensor because we found this to be a quick and convenient way to implement touchless.

By not implementing Crunchfish’s “real” camera based touchless interaction it was only possible to implement a single touchless gesture. We think that by narrowing our focus to a single touchless gesture we were able to more thoroughly investigate how this gesture can be successfully designed and implemented alongside touch input. Looking at it from another perspective, we lost an opportunity to explore multiple and potentially more advanced touchless gestures. If we had
implemented multiple touchless gestures we might have been able to solve some of the annoyances that users experienced during user tests. With more advanced gestures, we could possibly have been able to create new and innovative touchless gestures from scratch rather than taking the fairly incremental approach we took by re-designing an existing touch gesture.

As mentioned previously, the main advantage of simulating touchless gesture recognition with a proximity sensor was that it was quick for us to technically implement in our application prototype. This way we were able to efficiently develop an executable and evaluable prototype. We were allowed to focus our efforts on investigating people’s response to having an additional interaction method as well as allocating more time for designing the actual implementation of the touchless interaction (see 2.4.1 Hypothesis).

A positive side-effect from using the proximity sensor instead of camera based gesture tracking to detect movement was that a user’s hand could travel much quicker. This because camera based tracking requires a hand to be recognized prior to making a gesture whereas the proximity sensor reacts immediately to anything above its sensor.

6.8 Context and Persona Analysis

The kitchen context might be considered to be the obvious choice for demonstrating the possibilities of touchless. Before reaching the decision to go with the kitchen context we held several brainstorming sessions where we discussed the purpose of our thesis. We reached the conclusion that we wanted a context in which we were able to create a scenario that could open people’s eyes and show them how touchless interaction can be useful in everyday activities and not only for gaming and entertainment purposes. By selecting the kitchen context, we believe that we are able to design an experience that a lot of people can easily relate to. We hope that by having an almost obvious use-context, people can easily imagine other places where touchless interaction would seem useful.

We chose to make use of a persona because albeit having a technology centered design approach, one unspoken objective for this thesis was to create an application prototype that clearly demonstrates how touchless may be truly useful in everyday situations. To accomplish this, we acknowledged that to focus solely on developing a technologically sophisticated gesture wasn’t going to be enough, we also needed a way to make user centered design decisions.

The reasoning for not taking advantage of real people during context creation was that since touchless is a fairly new and unexplored interaction method, people are generally unfamiliar with touchless interaction. The only commercially available implementations of touchless have until only recently mostly been within entertainment contexts. We argue that it is difficult for users to know what they would actually want and need if they have not experienced anything similar in the past. Therefore we decided to use our abilities as designers to create a demonstrative experience that cautiously introduce people to the new interaction model.

Utilizing a persona instead of real people during initial design stages comes with certain risks. The most prominent one might be to abuse the persona by having it change to fit the design instead of making a design that fits the persona. We’d like to believe that this didn’t affect our design process as we stopped working on and didn’t allow changes to our persona once it was created. Realizing that personas don’t replace real people.
7 Conclusions and Discussion

7.1 Conclusions
Based upon the results presented in the section above we have come to the following conclusions and answers to our research questions:

*What visual feedback will users require when interacting with software in a touchless setting and how can this be implemented?*

Users require feedback as an instant response to a performed action. This feedback can be implemented as a visual frame around a touchless-enabled application.

*How can touchless hand gestures be combined with touch gestures in one user interface on everyday devices?*

An interface on an everyday device can support different input modalities by having separate interaction modes. It was observed that users expect to have both input modalities available in one interaction mode where users can use both inputs according to their personal preferences.

7.2 Discussions
The results we found by extending a touch interface with a touchless hand gesture is that it can be very handy in situation where the user doesn’t want to touch their mobile device and when they are somewhat stationary.

The multimodality in our Hi-Fi prototype has shown that users require instant visual feedback, by giving users a frame to show when they have “pressed” the button, the users can easier understand when the interaction is recognized. Also by placing an icon that indicates the actual input mode have made it clearer for users to know what interaction they should use. Even though we made it clear that it was two different modes in the Hi-Fi prototype, users subconsciously tried to interact with the device using another input modality. Our conclusions lies upon the research we have gathered that the preferred way of interacting with the software in an everyday scenario is by making an explicit decision. Therefore the result on our questions is that users want to be able to make their own choice in an interchangeably interface and choosing for the situation required input modality.

A major discovery in this project has been that when the touch gesture was transferred into a touchless gesture, users subconsciously inverted the direction of the swipe. This has affected the navigational structure in the touchless interaction mode and can be clearly seen in the visual design of the instructional overlay, where a right-arrow instructs users how to go forward. It is important to note that this is something that is experienced sub-consciously and is thereby difficult to investigate. This would need further explorations to define a paradigm for designing touchless swipe gestures.

The feedback frame in combination with the interaction mode icon provides some fundamental guidelines for implementing touchless in everyday devices, such as:

- An icon that indicates the currently available interaction mode can be helpful in making users understand how to interact when several interaction modes are present.
- A visual feedback in the shape of a frame that activates when a touchless interaction is detected can make users’ touchless experience more satisfying.
A semi-transparent overlay that appears on first-use only to instruct users how to use touchless interaction is a fast and efficient way to introduce new users to touchless interaction.

A touchless gesture may advantageously derive from an existing touch swipe gesture.

Four hypotheses were formed to provide us with a starting point for this thesis. Three of these proved to be valuable in creating a satisfying and predictable touchless experience while the hypothesis regarding an instructional overlay didn’t add as much guidance as we had originally thought. In a future iteration this feature may well be removed to investigate how it affects user experience.

7.3 Further Research Areas

Touchless is on the verge of becoming more commonly available. With this thesis we aspired to perform fundamental research on how touchless could be integrated into existing everyday devices. We hope that our research can inspire and help the design of future touchless experiences.

In the course of this thesis we have discovered several related research topics which we had to delimit ourselves from, but still believe to be interesting to investigate. To encourage further research within the field, we present these topics here.

- Investigate the direction of a touchless swipe gesture.
- Investigate how to seamlessly switch input modes. Within one mode or to separate input modes.
- Investigate how an interface can communicate a touchless input affordance.
- Investigate additional touchless gestures.
- Investigate security and comfort issues that may arise when a personal device is used openly and possibly shared among others.
8 References


Cooper, Alan. (2004). The inmates are running the asylum: [why high-tech products drive us crazy and how to restore the sanity]. [new ed.]. Indianapolis, Ind.: Sams.


Nicklas Anderson, 28 years and grown up outside Malmö in a village called Staffanstorp. Nowadays he lives in Västra Hamnen and works on an IT Company. Nicklas is an intermediate user of technical artefacts.

Nicklas likes to spend money on home decorations, especially kitchen aids. This due to his interest in gourmet cooking.

When not working, Nicklas spend his time with his brother, Stefan. Every week they meet up on Wednesdays to play squash at Kockum fritid. The brothers have been doing things together since they were children, while growing up in Staffanstorp they had a lot of friends and they tried to have different friends but in the long run they ended up with being at the same place. Nicklas are two years older than Stefan and they have followed each other from kindergarten. They even shared apartment when Nicklas started at the Computer Science program at Lund University, while Stefan started to work at a service station as a car mechanic also in Lund. They are very competitive to each other, back in the days they competed about everything, who’s going to buy milk? The punishment: Go and buy milk, and the competition could be resolved by Rock-Paper-Scissor, best of three. Otherwise the “game” to compete in could be anything from who can run fastest to whatever come up in their minds. Their bible is Richard Horne’s book 101 Things to Do Before You Die. In this book there are different task that you should do before you die, cities to visit, things to eat, tasks to do and other more or less embarrassed things to do.

The brothers share interest in technology, they want to have better and or bigger things than the brother. Larger TV’s, better and newer mobile devices such as phones and laptops. The recent thing Nicklas have bought is a Nexus 7 tablet and this new device take up a lot of his time when he is home.

Nicklas often invite Stefan and their friends to dinner and watch sports together at his large projector. This is a perfect event where Nicklas can show his cooking skills to his friends, try out new cooking methods and enjoy an evening with friends.
Appendix B: Scenario: An evening with the boys

Nicklas has decided to invite some of his friends to an evening filled with dinner and football at his place, there is a possibility that the party continues the late evening to one of the cities night club.

Nicklas wants to find a recipe that he can use to prepare the dinner for his friends. He hasn’t decided what kind of food he wants to serve. To get inspiration on what other people have had for dinner he opens up his browser and search for recipe sites. When the search is done, there are a lot of different sites that comes up and he doesn’t know which one to choose, which is good and how do they present the dinner suggestions. Nicklas goals with this search is to get dinner solutions, perhaps of what others have prepared in the past, the most important is that the image of a recipe is accurate. When a recipe is found, Nicklas would like to save the ingredients to a shopping list, otherwise he need to write with paper and pen. A great thing is if the shopping list could be shared to the mobile phone. At the store, while shopping the ingredients he would like to check each article when it is in the cart.

Back home, Nicklas wants to continue to read the instructions on how the recipe should be prepared. He place the tablet on a plain surface in the kitchen in the middle of the cooking mess and starts to follow the screen instructions of the recipe.
Appendix C: Test Plan for First User Test

Purpose and goals

This test aims to find out how the application and its interactions are perceived.

We let the participants know that we would like to know how they perceive the application and the interaction with it. We let them know that it is an application that use both touch and touchless as input modalities. We let the participants explore the application and try out the interaction.

We will point out that the actual recipe instructions are for demonstrational purposes only. The content as well as its layout is not what we’re evaluating; graphics and information design is outside of this thesis’s scope.

Interview Questions

1. What do you think about the graphical user interface?
2. How do you know that you can use touchless?
3. How do you know when to swipe?
4. How do you feel about the swipe gesture you just performed?

Test Layout

Presentation

The user test will begin with a quick presentation of the project. Next, the participants will be informed about the duration of the test. They will also be informed that we will be taking notes of what they do and ask for their permission to take pictures of them during the test.

User Tasks

The participants get the task to imagine that they are going to prepare a dinner. They are going to use the application to search for a recipe, chose one, and then cook the food according to the instructions they get.

Interview and discussions

Afterwards the participants will get questions that they can answer and hopefully it will become a discussion about the different features and interaction modes.

Test Environment

These participants are asked to try the application outside the thought context, since it is the interactions that are tested and not the whole application.

Test Moderator Role

The moderator sits beside and listen to what the participants thinks and observes what they do.
Appendix D: Test Plan for Second User Test

Purpose and goals

The primary purpose of this test is to evaluate how our design and implementation of touchless hand gestures is supporting the user in reaching their goals in the intended scenario. The test will specifically focus on a number of details surrounding perceived ease of use when interacting touchless, along with examining the transition from touch to touchless mode. Although not being central in the project, feedback on recipe presentation will be gathered to aim to answer the following questions:

- How intuitive is the transition between touch and touchless modalities?
- How well is the introductory tutorial providing guidance on how to navigate using touchless?
- How much sense are the gestures perceived to make?
- How trustworthy is the touchless interaction perceived?

Interview Questions

1) Do you cook or bake often?
2) Do you commonly use recipes?
3) Have you used digital recipes before? Was the recipe available in the kitchen?
4) What’s your general impression of the app, how was the test?
5) Your best experiences with the app?
6) Your worst experiences with the app?
7) What was missing in the app?
8) How did it feel to wave your hand above your device?
9) How did it feel to navigate between the instruction screens?
10) Would the app have been equally useful if it had only featured touch?
11) Will you miss using the app?

Test Layout

Our test aim to investigate interaction in a relatively new technology which means that the participants might not at all understand how to interact with the prototype. Therefore, the participant will be left to explore the possible ways of interaction on their own. We will rely heavily on observation and the participant will be asked to “think out loud” to make it easier for us to understand what they think. The participant will always be encouraged to share any suggestion or idea that they might think of during the test.

Presentation

The user test will begin with a quick presentation of the project. Next, the participants will be informed about the duration of the test. They will also be informed that we will be taking notes of what they do and ask for their permission to take pictures of them during the test.
User Tasks

The participant will be given the app, running on a tablet, and instructed to follow a recipe of their choosing. This will be the only information we give to the tester; use the app and its recipes to cook or bake.

Interview and discussion

Once the participant has finished cooking or baking they will be asked questions about who they are and their cooking and baking habits. After establishing the characteristics of the participant, the question will become more open and eventually open enough to start a discussion. If the participant tested the prototype without the touchless feedback implemented they will get to try the prototype that has the touchless feedback implemented. Again, they will be observed and asked to think aloud while using the app. They will also be asked to tell what and if they notice any differences between the two versions.

Test Environment

The test will be taking place inside a, during initial design defined, kitchen scenario. Testers will either be invited to a kitchen we provide or let us join them in their own kitchens as they test the application. The test user will be informed in advance of which recipes are available to ensure that all ingredients are available and that the test won’t be interrupted by a lack of ingredients. As previously stated, this test will not focus on the application’s peripheral services such as the shopping list component.

Test Moderator Role

The user tests will launch with us giving a quick project presentation. After that our primary function during user tests will be as observers. We will quietly take notes, photographs and in other ways document what the user is doing and experiencing. During the second part of the user test, we are going to perform an interview and lead an open discussion with the test participants.

Distributed Test

The test will also be distributed electronically to allow people to try out the application on their own. A questionnaire consisting of the aforementioned “Interview Questions” will accompany the application. The questionnaire will be web-based and is to be answered anonymously.