CulAmi

A Smart Kitchen Experience using Touchless Interaction

Final Project Report - Shivin Saxena | Spring 2015

Dr. Anthony Faiola [H681-Interaction Professional Practice-2]-IUPUI

Table of Contents

I. Ideation and Concept Design

A. Problem Space

Design for everyday life and the investigation of how technology can enter our lives in a smooth and enjoyable way have been some of the main goals of recent HCI research. One of the key areas of current research is the study of touchless interfaces and more natural and intuitive ways of interaction, beyond conventional input devices. While much gesture recognition and depth camera research explores the promise of the interaction space, the technology has advanced enough to be tested in practical environments. The kitchen has long been a focal point for futurists, who hope that digital technology could be tailored to enhance cooking and nutrition, and solve common problems.

In order to save time and paper to print a recipe, people often take their personal laptops/tablets/smartphones to read the recipes off the screen. Most people also like to listen to music and interact with a range of devices and tools within the kitchen such as timers, the oven and other appliances. However, most people are often concerned about using their personal interactive devices in the kitchen for the fear of damaging them or touching them with wet/messy hands. Moreover, it may not be possible to operate a laptop's touchpad (this even applies to other touch surfaces such as smartphones and tablets) with wet fingers.

Touchless, in-the-air interaction techniques could be a boon for messy hands in this case. Current devices, such as the leap motion controller can be less intrusive than depth sensing cameras in the kitchen. They are also more convenient to place in the kitchen and do not suffer from some of the intrinsic limitation of the (current version) Kinect, such as minimum interaction distances (56ft) for optimal recognition etc.

B. Proposed Solution

Based on some field observations and initial requirements gathering via informal interviews, surveys etc. I would like to propose 'CulAmi', a smart kitchen assistant designed for a better experience in the kitchen. Derived from 'culina amicum', Latin for 'kitchen friend', CulAmi is an app designed to reduce the overhead of cleaning your hands often just to be able to interact with multiple devices.

CulAmi runs on any tablet/phone and is hooked up to a Leap Motion sensor. The app binds a recipe tool, music player, timer and oven control and enables users to perform simple, recurring tasks with these tools using their hands. The advantage is that they needn't clean their hands again and simple tasks such as moving to the next step in the recipe, changing the current music track, setting a new timer or changing the temperature setting for the oven can be quickly and conveniently performed by

performing them in front of a leap sensor mounted on the wall. Users would use simple hand movements such as swiping left and right to browse through the steps of a recipe, swipe them up-down to adjust the temperature for the oven, could gesture to pause/resume playback, attend calls while they cook, switch between appliances and much more.
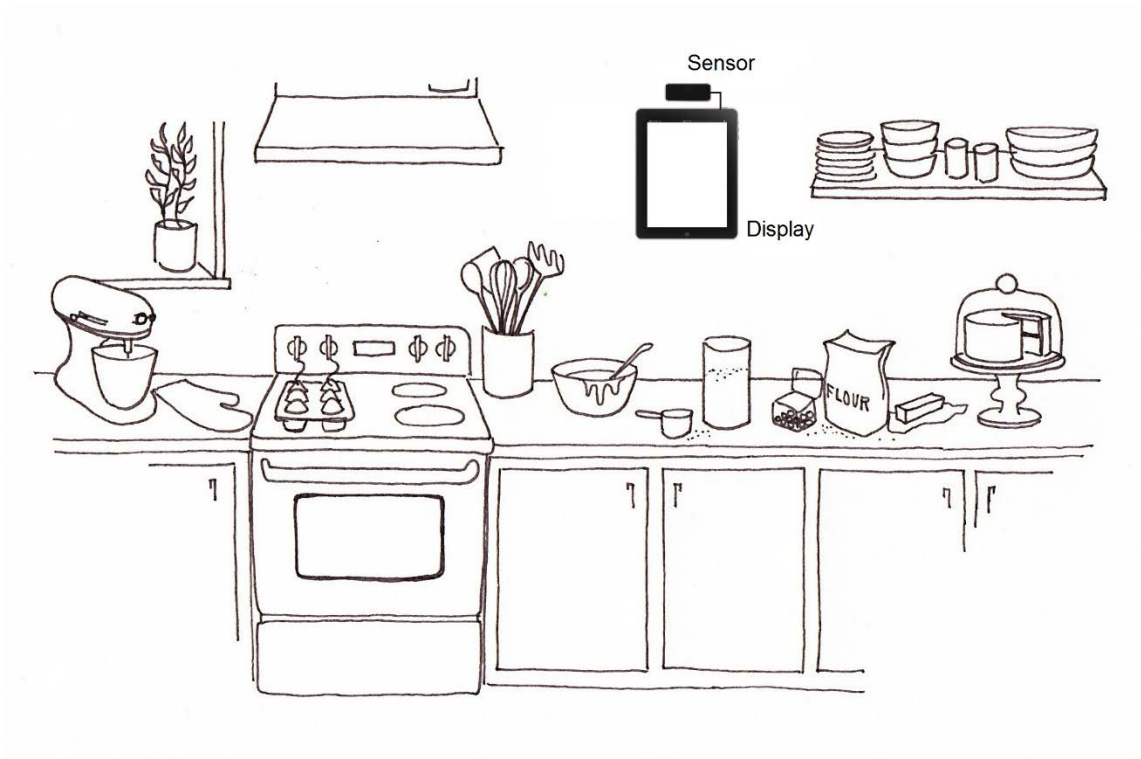

Figure 1 Illustrating how the 'CulAmi' system might be used within a typical kitchen.

C. Preliminary Designs (Sketching and Prototyping)
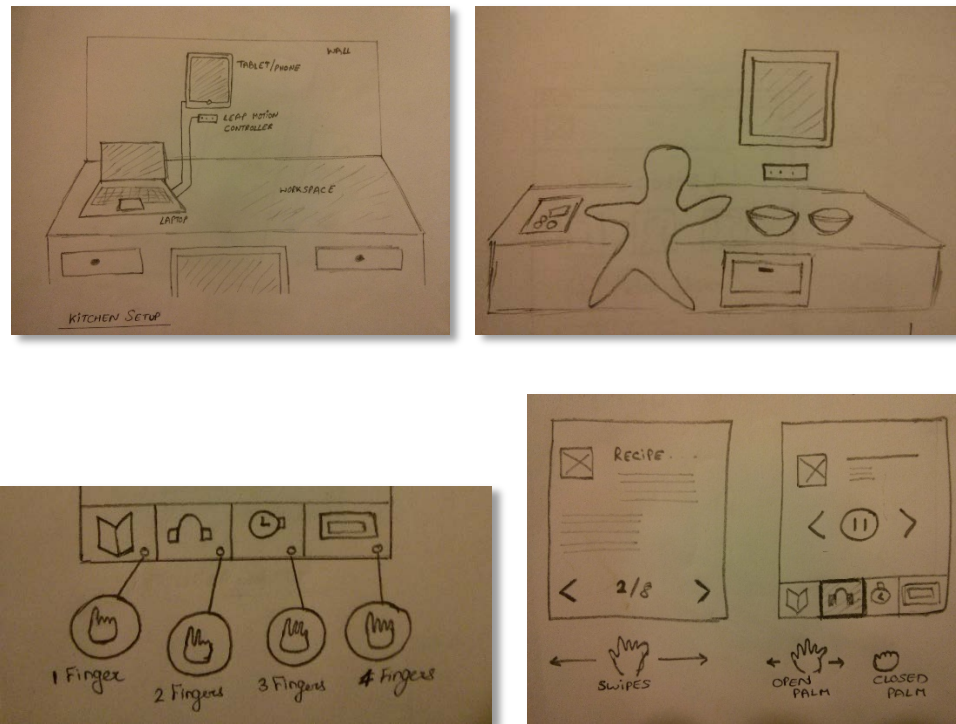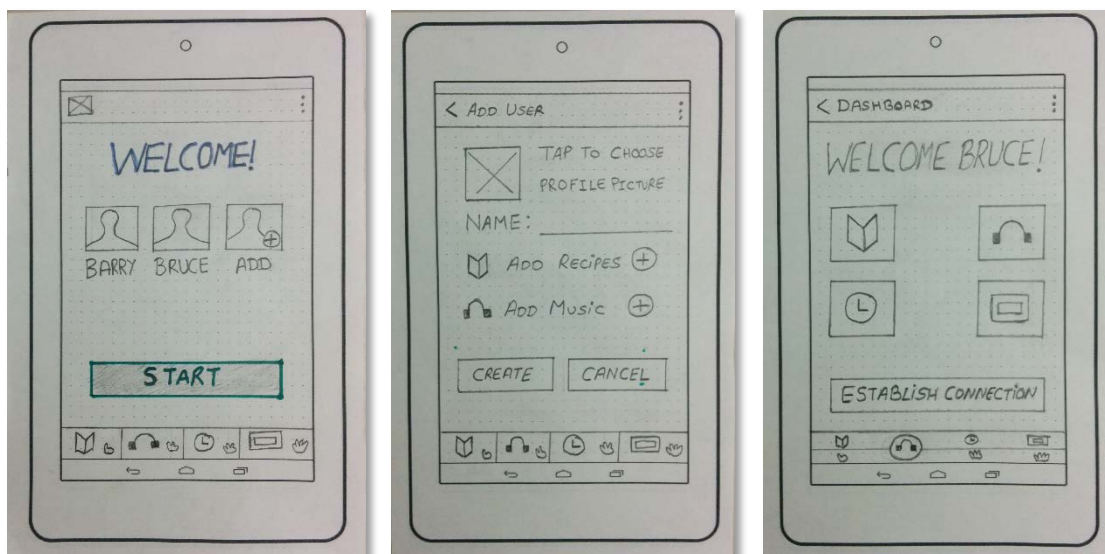
1. RAPID SKETCHES

Figure 2: Snapshots of early sketches depicting the user interaction, product deployment in the kitchen and UI layouts
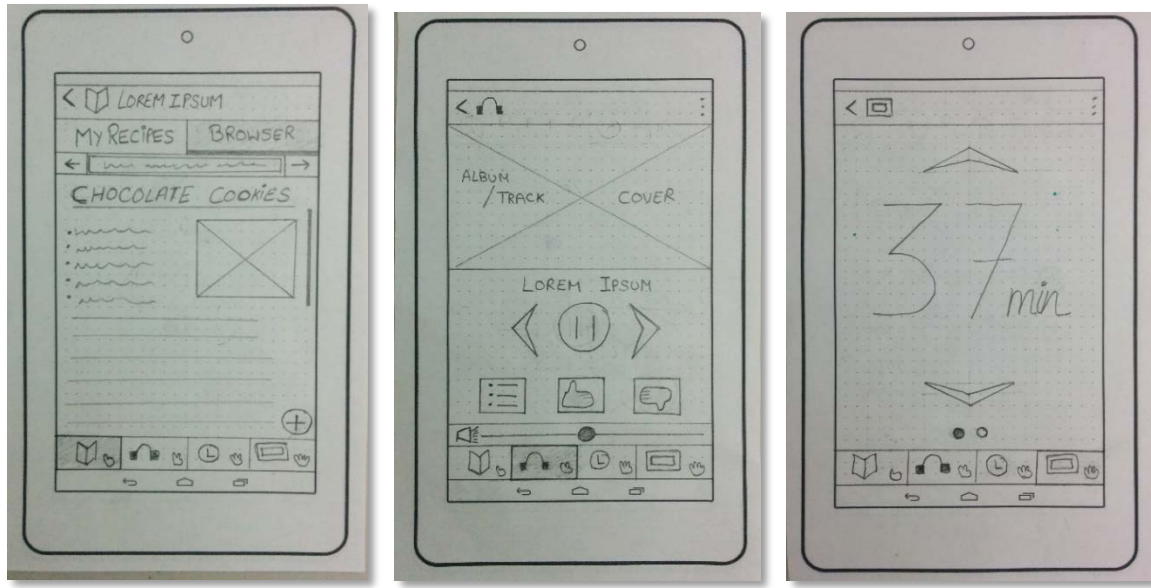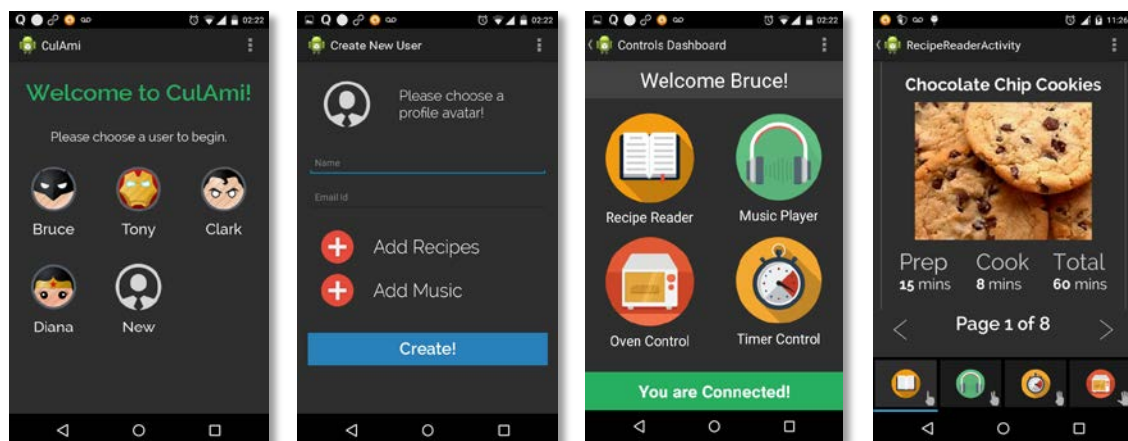
2. PAPER PROTOTYPING

Figure 3: Snapshots of a few paper mockups to give an idea of different screens (recipes, music, oven, timer, dashboard) etc. might look like and get feedback on these.
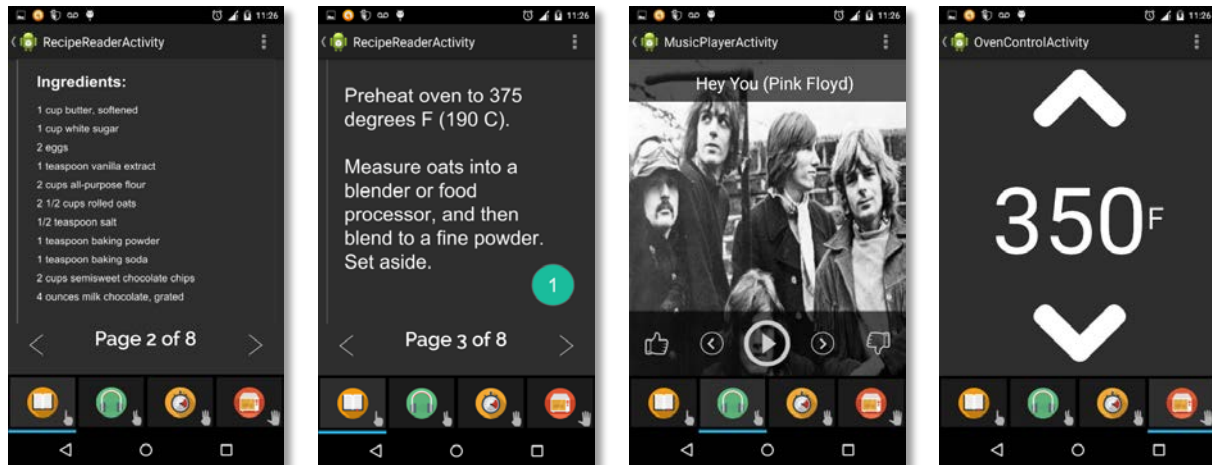
3. FIRST INTERACTIVE PROTOTYPE

Figure 4: Snapshots of the first version of the interactive prototype coded in Eclipse IDE and using the Android SDK. These were used to get first round of real user feedback.

D. Preliminary Feedback (Cognitive Walkthroughs + User Testing)

A cognitive walkthrough was conducted with a usability expert by giving him an ideal scenario and walking him through a list of ideal action steps that the user should take to achieve the desired task. At each step of the walkthrough, the expert was asked to evaluate a set of 4 questions that helped understand if users could make sense out of the user interface:

Q1. Will the user try to achieve the effect that the subtask has?
(Are the assumptions about what task the action is supporting correct given the user's experience and knowledge up to this point in the interaction?)

Q2. Will the user notice that the correct action is available?
(Will users see the button or menu item, for example, that is how the next action is actually achieved by the system?)

Q3. Once users find the correct action at the interface, will they know that it is the right one for the effect they are trying to produce?
(This complements the previous question. It is one thing for a button or menu item to be visible, but will the users know that it is the one they are looking for to complete their task?)

Q4. After the action is taken, will users understand the feedback they get?
(Assuming the users did the correct action, will they know that? This is the completion of the execution/evaluation interaction cycle.)

Following the cognitive walkthrough, a User Experience Study was conducted with potential users using a think aloud protocol in a task based scenario to evaluate the usability and user experience of using this product.

Summary of Findings:

- Users commented that for the most-part the app was well designed and visually appealing.
- Being able to interact with both touch and touchless hand gestures is helpful.
- The product concept has potential and could be very useful for users who regularly engage in cooking activities that are generally messy.
- The gestures are easy to understand and apply in general and even feel natural but it would help immensely to have a product walkthrough to better understand the product and interaction capabilities.
- The filtering options with the aid of color wheel and categories were helpful and made organization simpler.
- This could be relatively easy to deploy and use in the near future once there is enough support for mobile platforms (Android/iOS) and the need for a computer can be eliminated.
- Cloud collaboration/social integration could be helpful but not necessary.

Problem Areas:

- Most users complained about the lack of clarity on the recipe reader screen. Users misunderstood that the app lets them choose from 8 different recipes versus the idea that these are in fact 8 different steps/pages to the same recipe. Further, the wording used added to the confusion and lacked the intended affordance.
- Some users commented that the existing implementation of the prototype demands too many reverse swipes to get to the initial pages of the recipe.
- Lack of visual consistency between the recipe cover page and ingredients page.
- Some of the gestures to control music playback are not so obvious.
- It would be better to have a list of recipes and music tracks to choose from when a user accesses the tool the first time in each session.
- A music service would be preferred to having stored music on the device.

II. Participatory Design Iteration

After the initial conceptualization and preliminary feedback, another round of design iterations was conducted in the form of a Participatory Design activity involving real users (who might use the product) and UX experts to serve as collaborators for the design team. Some of the primary goals of this collaborative design activity were to revisit core and desired functions that the proposed system should support and generating preliminary ideas for layout and visual design elements that make sense to the users. The team was given a typical scenario where the product might be used and then were asked to collectively brainstorm. Comments, concerns and ideas were all recorded using a set of post-it notes that were then grouped in categories to identify core set of functions. After the concept building and requirements gathering, users were then asked to generate rapid sketches of what they think the layout should look. Users were then also shown snapshots of the initial wireframes for comments and feedback to analyze if the current version of the interface already supports some or all of the proposed activities and if it makes sense.

III. High-Fidelity Prototype Development

DIGITAL ILLUSTRATIONS OF REVISED PROTOTYPE

Figure 5: (From Left to Right) Welcome Screen, User Dashboard, Recipes Menu, Recipe Reader (recipe overview)

Figure 6: (From Left to Right) Recipe directions page, Music Player, Timer Control, Oven Control

EXPLANATION OF INTERACTION AND INTERFACE DESIGN COMPONENTS

The Hi-Fi prototype has been made in the form of a native Android mobile app using technologies Android SDK for implementing the visual layout and core functionality and written using Eclipse IDE. The gesture recognition script was written using LeapJS and the Leap Motion SDK and was designed to identify a limited set of gestures.

The following is a comprehensive list of functions and components than can be used and seen on the interface:

- The user profile 'Bruce' and the 'New' icon can be clicked to log into an existing user profile or create a new one respectively.
- The "avatar" icon can be clicked to choose a new profile avatar in the 'create new user' screen.
- Within the user dashboard, all device icons are clickable and would redirect the user to the corresponding tool.
- Users can switch between the four devices by clicking the corresponding icons on the control dock at the bottom. In the context of touchless gestures, this would be accomplished by stretching out the required number of fingers. For example, show 2 fingers to switch to the music player.
- Within the recipe reader, users can browse through the ingredients and various steps of the recipe. This can be done by touch swiping left-right or using the left and right arrows at the bottom.
- Within the music player, music tracks can be played/paused and users can swipe through music tracks using swiping gestures similar to the recipe reader. Music playback can be played/paused by opening/closing of the palm of the hand.
- The Oven control screen displays the current temperature of the oven and this can be further regulated by using the up/down arrows or swiping up/down using the hand.

Due to the limitations of the technical expertise in this domain and the given time frame, a semi-Wizard of Oz execution was adopted to test the prototype with actual users. That is, when users would perform gestures, the script would indicate the identified gesture and then the Wizard would perform the corresponding action on the user interface by triggering the same via a remote control application running on the computer.

IV. Product Evaluation

A. Participant Demographic

6 users were recruited for the user testing. This included 2 Americans, 1 American Indian, 1 Italian and 2 Indians. The ages of all participants ranged from 24-45 years.

- Participants that were recruited for this study were all required to be familiar with using mobile touch interfaces and should be capable of performing relevant hand gestures.
- All participants were accustomed to cooking in their kitchen at least multiple times a week, if not every day.
- 5 out of 6 participants used recipes, either sometimes or all the time.
- All participants listened to music and primarily used the oven-timer (or smartphone) to keep a track of cooking time.
- None of the participants were experienced in using a Leap Motion Controller.

B. Experimental Setup

- Venue: 5th floor, kitchen area (IT 560)
- Testing documents and project setup
- Briefing (Introduction, consent form)
- Leap Motion trial with Gesture sheet
- Task Based + Wizard of Oz experimentation
- SUS questionnaire + Open-ended interview

Each session lasted a maximum of 45 minutes.
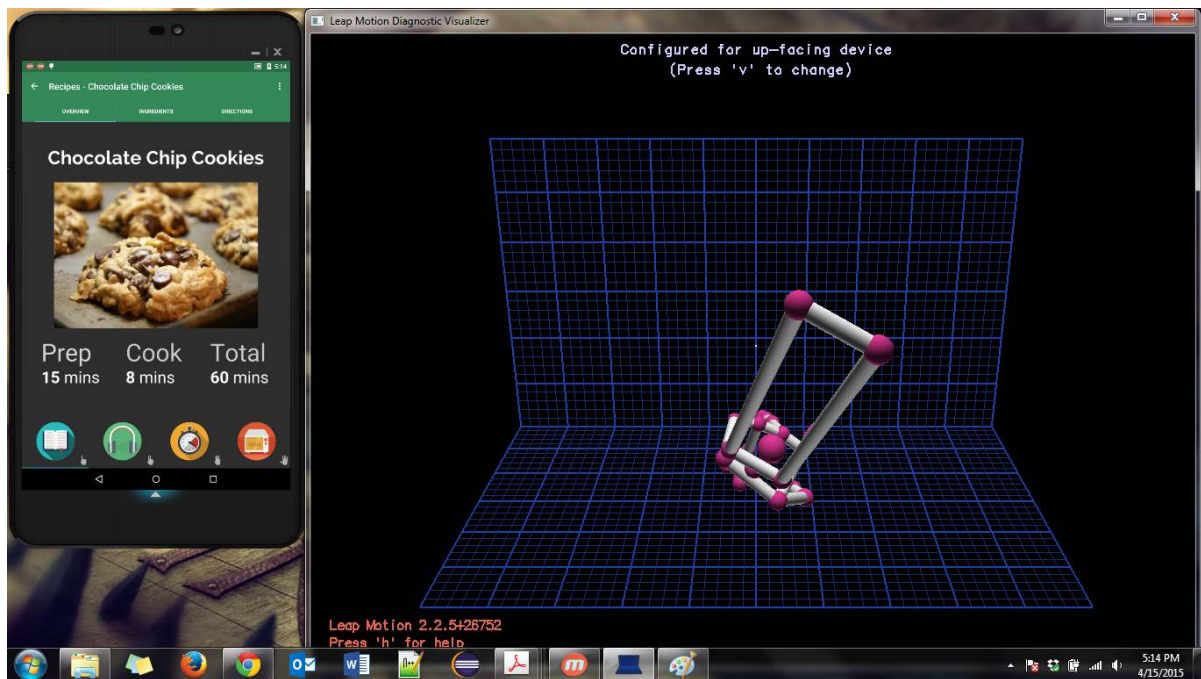
Figure 7: Experimental setup for product testing

Figure 8: Snapshot of the computer screen with the Leap Visualizer and the remote mobile control app running.
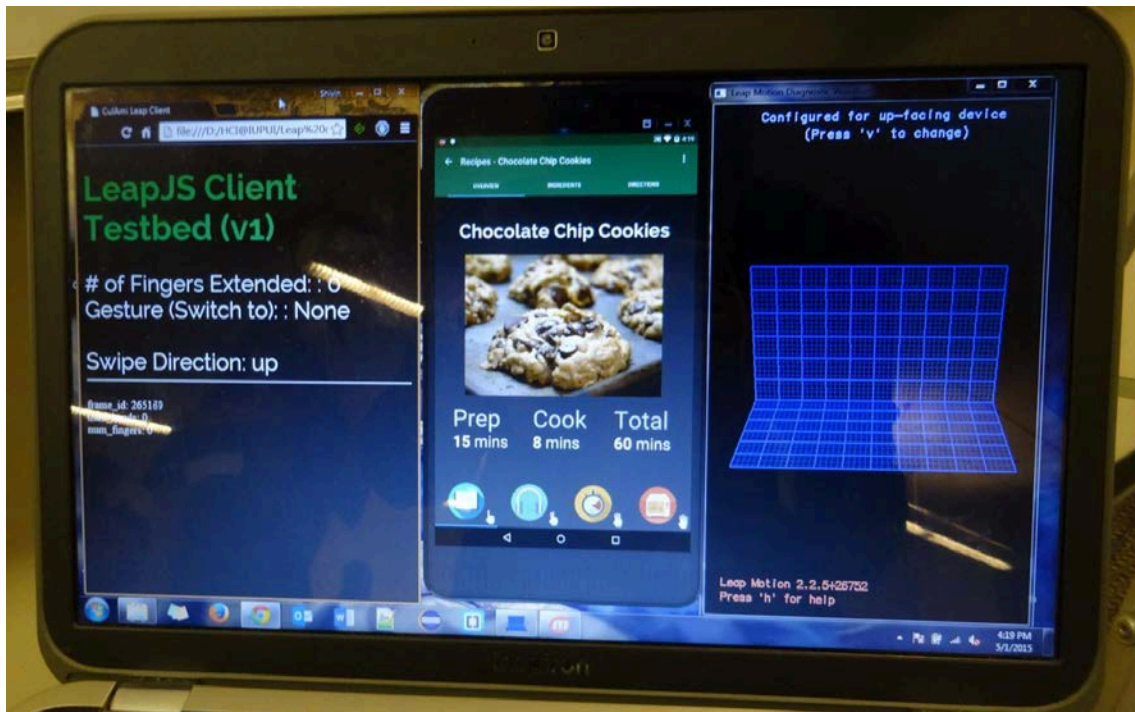
Figure 9: Snapshot of the computer screen with the custom gesture recognizer script, Leap Visualizer and the remote mobile control app running.

C. Tasks

A task based scenario was used to test users on the product prototype. Users were asked to perform four simple tasks that were designed to test different aspects of the interaction design, visual design and the overall user experience.

Task 1: Accessing the Recipe Reader tool.

- Log into user profile 'Bruce'
- Open the Recipe Reader
- Find the 'Chocolate Chip Cookies' recipe
- Check the total cooking time and ingredients needed
- Read the first two steps of the recipe.

Task 2: Interacting with the Recipes (touchless ONLY)

- Assume your hand are dirty and you can't directly touch the tablet. You are at step 2 of the recipe. Switch to the next two steps, one after the other, pausing at every step to consume the displayed information.
- Switch back to the Ingredients tab.
- Switch back to where you were in the recipe directions.

Task 3: Switching between tools

- Switch to the Music Player by actually touching the display.
- Switch to the Oven Control using touchless hand gestures ONLY.

Task 4: Interacting with the Oven Control

- Increase the temperature to 400 degrees using touchless hand gestures ONLY.
- Switch back to the Recipe Reader.

D. Quantitative Analysis

Shown below is the task comfort rating for all participants. It is easy to see that that almost all participants were at least comfortable with most of the tasks.

Task Comfort Rating
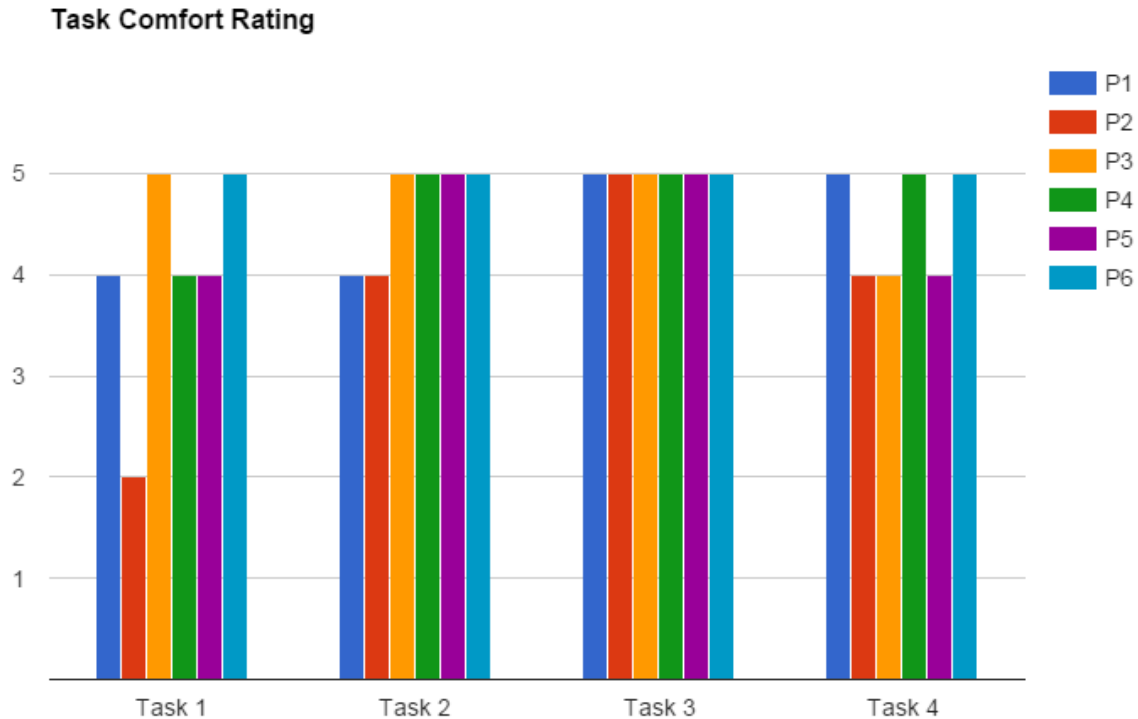
Avg. time on task (four tasks) = 2 min 44 sec
All tasks were completed successfully without assistance.
Error count (missed clicks, incorrect gestures):
- Task 1: 3
- Task 2: 0
- Task 3: 1
- Task 4: 1

Participants' responses to the SUS questionnaires were collected and then computed to get the final SUS score across all participants.
SUS score: 88.33
(Graphical summary of responses to the SUS questionnaire can be found in the appendix X)

- All participants agreed they would like to use this product frequently.
- 5/6 participants agreed the product was easy to use.
- All participants agreed that the product was well integrated and most people would learn to use it quickly.
- 5/6 participants felt confident using the product.

E. Qualitative Analysis

User Feedback:

- All users agreed that CulAmi will integrate well with their current workflow.
- All users agreed that the system was really easy to use and gestures were a quicker, convenient alternative to first cleaning their hands and then interacting with devices.
- Users appreciated the responsiveness of the system and admitted that the learning curve was minimal.
- The visual cues at the bottom (hand icons) were very useful.
- The visual design was well appreciated for the most part.
- The swipe-and-hold gesture's functionality was not immediately visible to some participants.
- Not tiring at all and the use-case is compelling.

Recommendations:

- Increasing the font size of the labels in the recipe tabs.
- Vertical continuous scrolling for the recipe directions vs page-by-page scrolling.
- An introductory tour for recognizable gestures and general interaction guidelines will definitely help a new user.
- The Leap Motion's field of vision is not physically visible, making it difficult to understand if the user's hands are still within the right interaction distance. A visual indicator is needed.
- One user pointed out that this won't work with mittens.
- Making the recipe pages look more visually appealing and 'fun' by adding more images of the food in the background and/or videos etc.
- Length of gestures: how short/long must the motion be for it to be recognizable?

V. Appendix

A. Informed Consent Form

INFORMED CONSENT FORM

CulAmi - A Smart Kitchen Experience using Touchless Interaction

Thank you for participating in this study!

--	PURPOSE: This study is part of the HCI Capstone requirements for the graduate-level Human-Computer Interaction course, H681 - Professional PRactice-2, at IUPUI taught by Dr. Anthony Faiola.
--	RISKS: There are no risks anticipated with participation in the study. The study will involve observation of and questioning about tasks that are familiar to you.
--	CONFIDENTIALITY: This session will be recorded (video and audio). No personal information will be distributed or shared with anyone outside this study, unless required by law.
--	VOLUNTARY: Your participation is voluntary and you may choose not to take part or you may leave the study at any time.
--	CONTACTS: For questions about the study, contact the investigator: Shivin Saxena (saxenash@iupui.edu) or the project advisor and course instructor, Dr. Anthony Faiola (faiola@iupui.edu).
--	PARTICIPANT'S CONSENT: Participation in this study is an acknowledgment that you understand the nature of the study and have given your permission to participate.

Date: _____

Signature of the participant: _____

Signature of the Investigator: _____

B. Briefing

CulAmi - Briefing (Usability Test Session)

Thank you for coming in today to help me improve a product with your valuable feedback. My name is Shivin and I'm a final year MS HCI student in SoIC. To give you a brief background, my HCI Capstone Project, **'CulAmi'**, is a smart kitchen assistant designed for a better experience in the traditional kitchen. CulAmi is an app designed to reduce the overhead of cleaning your hands often just to be able to interact with multiple devices. CulAmi runs on any tablet/smartphone and is hooked up to a Leap Motion sensor. The app binds a recipe tool, music player, timer and oven control and enables users to perform simple, recurring tasks with these tools using their hands.

In this session, you will be performing some simple tasks with the system that closely resemble regular tasks you would perform in a traditional cooking setup. Remember, we are here today to test the system and NOT YOU, so there's nothing wrong you can do here. If at any point you feel tired or uncomfortable proceeding with the session, you are free to leave. After the tasks, I'm going to ask you to fill in some ratings and feedback questionnaires, followed by a short interview about your overall experience using CulAmi. If at any point during the session you have any questions, feel free to ask them. However, I would encourage you to hold your questions to the end of the session, when I can best answer them. Once again, I thank you for taking some time out of your busy schedule to help me evaluate this prototype. If you do not have any other questions, we can proceed with the first round of introductory questions.

Background Questions
Let us start with some preliminary background questions before working with the system.
- How often do you personally cook in the kitchen?
- Do you prefer to cook alone or with others?
- Do you refer to recipe books? If so, how often?
- (If uses recipes) What sort of tools/devices do you use to access recipes? Laptops/smartphones/tablets/cooking-books?
- Do you listen to music while cooking? If so, where do you play it and how often?
- What's your strategy for keep a check on the cooking time? Regular clock/timer?
- Off the top of your head, what's the most recurring challenge you face when dealing with multiple appliances/devices in the kitchen?
- Are you familiar with the Leap Motion controller? Have you ever tried using it?
- The Leap motion controller is a computer hardware sensor device that supports hand and finger motions as input, analogous to a mouse, but requires no hand contact or touching. Let's take a few minutes to give you some hand-on experience with the leap.
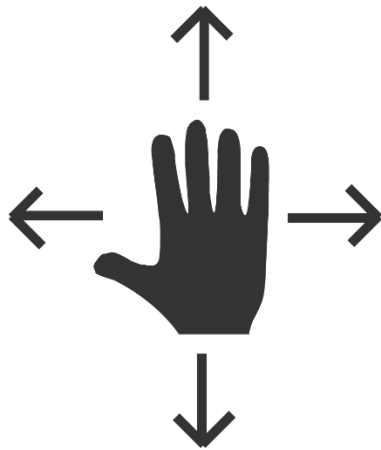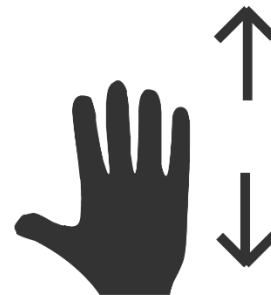
C. Gesture Vocabulary

Supported Gestures
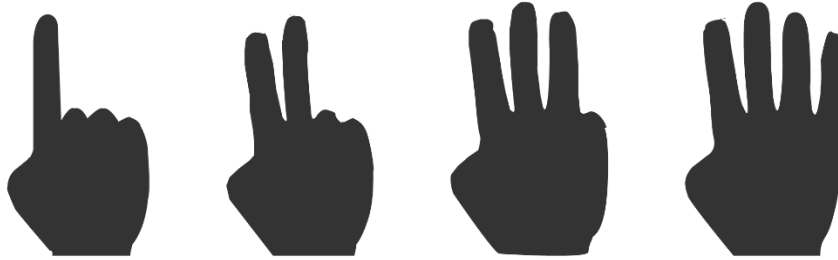
Simple finger-count based gestures to switch between different tools (recipes, music, timer, oven).

Swipe up/down, left/right to change pages, music, temperature etc.

Swipe up/down -> hold -> exit, for faster scrolling.

D. Post Task Questionnaire

Task 1 Comfort Rating						
Strongly Disagree	1	2	3	4	5	Strongly Agree

Task 1 Comfort Rating						
Strongly Disagree	1	2	3	4	5	Strongly Agree

Task 1 Comfort Rating						
Strongly Disagree	1	2	3	4	5	Strongly Agree

Task 1 Comfort Rating						
Strongly Disagree	1	2	3	4	5	Strongly Agree

E. Post Test Questionnaire (SUS)

- I think that I would like to use this product frequently.

- I found the product unnecessarily complex.

- I thought the product was easy to use.

- I think that I would need the support of a technical person to be able to use this product.

- I found the various functions in this product were well integrated.

- I thought there was too much inconsistency in this product.

- I would imagine that most people would learn to use this product very quickly.

- I found the product very cumbersome to use.

- I felt very confident using the product.

- I needed to learn a lot of things before I could get going with this product.

Every question was scored as under:

Strongly Disagree	1	2	3	4	5	Strongly Agree

F. SUS Results Summary

I think that I would like to use this product frequently.

1	0	0%
2	0	0%
3	0	0%
4	2	33.3%
5	4	66.7%
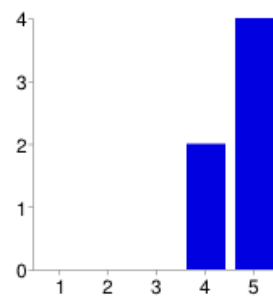
I found the product unnecessarily complex.
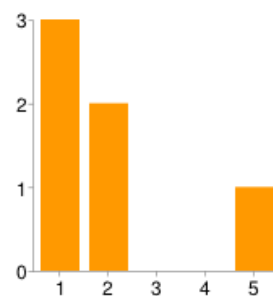
1	3	50%
2	2	33.3%
3	0	0%
4	0	0%
5	1	16.7%

I thought the product was easy to use.
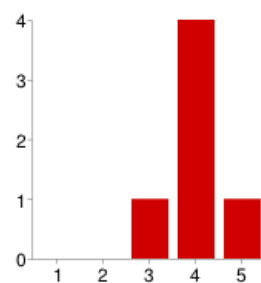
1	0	0%
2	0	0%
3	1	16.7%
4	4	66.7%
5	1	16.7%

I think that I would need the support of a technical person to be able to use this product.
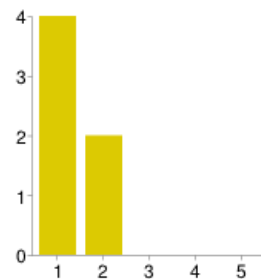
1	4	66.7%
2	2	33.3%
3	0	0%
4	0	0%
5	0	0%

I found the various functions in this product were well integrated.
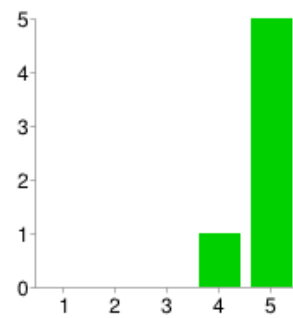
1	0	0%
2	0	0%
3	0	0%
4	1	16.7%
5	5	83.3%

I thought there was too much inconsistency in this product.
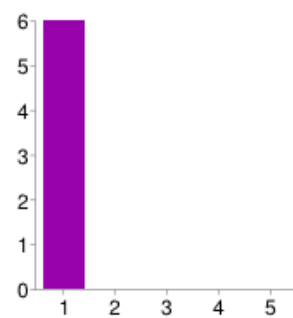
1	6	100%
2	0	0%
3	0	0%
4	0	0%
5	0	0%

I would imagine that most people would learn to use this product very quickly.

1	0	0%
2	0	0%
3	0	0%
4	2	33.3%
5	4	66.7%
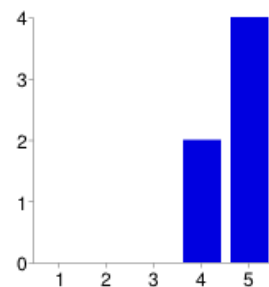
I found the product very cumbersome to use.
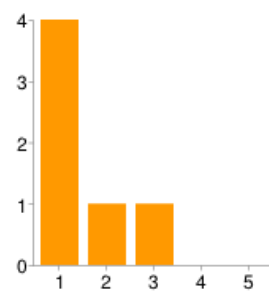
1	4	66.7%
2	1	16.7%
3	1	16.7%
4	0	0%
5	0	0%

I felt very confident using the product.
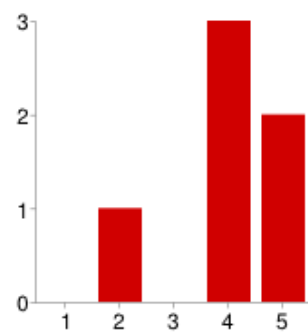
1	0	0%
2	1	16.7%
3	0	0%
4	3	50%
5	2	33.3%

I needed to learn a lot of things before I could get going with this product.

1	5	83.3%
2	1	16.7%
3	0	0%
4	0	0%
5	0	0%