ECE496
Final Report

Interactive Touch Table

Project Number:	2013146
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Executive Summary (author: C. Chang)

The goal of this project is to investigate the potential of the Interactive Touch Table as the platform in different practical circumstances. The expected outcome of the project are a set of multi-user-specific applications (app) built on a standard Android operating system (OS). The two completed modules, Meeting Table app and Browsing Module, are critical to many apps we aim to demonstrate.

The Group Highlights provide the overall design specifications of this project. The completed modules are separated into two types - stand-alone modules that implement the core functionalities (Text Fitting, Image Fitting and Browsing); features that would not be meaningful on their own but could significantly enhance the core modules' user experience (File Fitting, Inter-device Communication, and Independent Workspace). Furthermore, Text Fitting and Image Fitting had been merged as they are similar in nature.

The Individual Contributions section lays out each team member's accomplishment in this project. The work is explained in details with evidence provided in Appendices. There were several challenges that the team came across while implementing our design. The team has acknowledged the people that had been assisting us to reach this project's goal in the Acknowledgment section.

Our final design met the basic requirements in this project. The main function of the touch table applications is to support simultaneous touch points and different screen sizes. The selected Android OS provides a third-party application development environment. The applications also met a number of objectives: accessible to general public, flexible in number of users, promoting direct user-to-user interaction, and easy to present for demonstration purpose. Originally the team indicated that the design must at least support two touch points per person. This requirement has been taken out of our design consideration because non-game applications do not need more than one touch point most of the time.

As mentioned earlier, the team completed two different modules for demonstrations: Browsing Module for provider-to-client (P2C) situation and Meeting Table application. Due to the explorational nature of our project and time constraint, we implemented six features extracted from the design alternatives into independent usable Android application. These features have been integrated together to demonstrate two applications specifically for different use cases.

In order to examine the feasibility of the finished Android applications, we have verified the function correctness of the results through a number of tests. We compared the project requirement against objectives to see how close the team met the expected outcome. Testing and Verification section describes our test cases in details.

The overall Gantt Chart is included in Appendix A to indicate team progress and milestones throughout the year. Validation and Acceptance Tests in Appendix B give more details on our testing method. Screenshots of the actual application designs are included in Appendix C to provide visual module level test results.

Group Highlights (author: S. Wang)

The goal of this project is to explore and design software applications that are able to take advantage of the surface size of a large touch platform. More importantly, the applications should promote and enhance the interaction of people who are physically present around the device.

The team has implemented two stand-alone Android applications, namely Meeting Table and Browsing App. The Meeting Table application consists of the text fitting and image fitting modules, which enable free displacement of strings of text and images in a bounded area. The text and image resources can be dynamically added onto the surface for viewing and manipulation. Two features were completed in addition to the base functionality. First, the application allows creation of lists and tables, with sorting functionality available to the user. Second, it also supports annotations and drawings on existing image resources. On the other hand, the Browsing App provides the ability to browse through a set of predefined resources. The resources can be categorized to allow the user to browse only a subset of the resources. Browsing is done by “swiping” on items to scroll through each of them. The application also displays details for each item. Both Meeting Table and Browsing App utilize external storage to store and import their resources. By separating the applications themselves and the resources, the resources can be managed independently with more flexibility.

Since the goal of this project to is explore and demonstrate the capability of a new platform, we do not constrain ourselves to developing applications ourselves. The team has selected a few existing applications developed for mobile phones and tablets. These applications will be used to showcase the immediate potential that a large touch platform possesses.

Individual Contributions

Austin (Shee-An) Wang
I am mainly responsible of the development of the Meeting Table application. The details of my contribution is outlined as follows:

1. Framework to enable displacement of text and images on a canvas
This is the base of the Meeting Table application. It enables objects such as text and images to be placed onto the canvas and moved around freely by performing drag gestures on the touch screen. This framework supports any type of object, which means the displacement of lists and tables was already working with the completion of this framework.

2. Recognition of different gestures performed on objects
Recognition of multiple gestures was implemented to enable initiation of different operations on individual objects in addition to object displacement. The gestures include tap, double tap, press-and-hold as well as drag. Specifically, these gestures are used to initiate operations such as text editing, image annotation, list modification.

3. Lists and tables
The support for list and table is another core functionality of the Meeting Table application. This includes creation, addition of elements, modification of elements and basic sorting.

4. Parsing of external resource specification file in XML format
This utility is used in the Browsing App to interpret the resource specification file for information such as the location of the associated image file, category of the item and detailed description. Essentially this resource specification file acts as a database. XML file allows flexibility of data entries under each item, which can be adapted in different use cases.

Daniel (Dai-Jung) Lee

I am mainly responsible of the development of the Image Browsing application. The details of my contributions are outlined as follows:

1. Framework to enable application to run on individual workspace

This is the base of the browsing application. This framework divides the whole meeting table into multiple separate individual workspaces (which is also known as fragment). Each workspace allows the user to run individual application on it. Multiple workspaces can each run different applications separately and simultaneously without influencing other application.

2. Interface adjustment to the individual workspace

Adjust and scale the individual workspace to the ideal size on the table. Each individual workspace can be scaled and adjusted different according to the need of the developer. The interface adjustment grant developer the flexibility to place their application in anywhere of the screen in any size they desire.

3. Communication between different individual workspace

Allow different application to pass or share parameter between other applications from another individual workspace. This also allows application to call the shared functions from other application. The description display of an image and the enlarge functionality to an image all depends on the communication between different individual workspace.

4. Integration of application for individual workspace

Allow individual application developer to run the application developed on an individual workspace. The body and the implementation of an individual workspace are a little bit different from the standard workspace. Therefore, I assist the developers of other applications to migrate their code from standard workspace to the individual workspace

Jim (Ching) Chang

I am mainly responsible of the development of the Image Browsing application. The details of my contribution is outlined as follows:

1. Layout design and visual structure for the user interface

This gives the users the very first impression on the screen. The layout is divided into two sections: left, with a narrower view, and right, with a wider one. Left section is a menu of products. On the right section, the top half of the screen displays the smaller versions of all pictures (and product information) in a series, and the bottom half shows the enlarged version of the selected picture. The specifications are defined in the project's layout XML file.

2. Menu with selections of different image group

The connection between different tab and its image groups are handled. The menu section on the left contains different groups of images (products) in each tab. The user can make a selection by clicking it on the list and view all the images on the right section. Pop up messages are also implemented where they would show up and notify users additional information of the group when they make a selection.

3. Image swiping based on recognition of user gestures

Gesture recognition function was implemented to enable smoother and simpler browsing experience. Users can browse through images by making horizontal swiping motions with their finger. The input images in the resource folder are all pre-adjusted to have the same size and resolution to achieve better overall visual organization.

4. Comparison table and text display of image (product) information

A table will automatically be constructed if a user wants to see the comparison between two images (products) in the same group. Each specification of the product in the form of text strings will be listed in the table side by side to demonstrate similarities and difference.

Steven (Kuang-Ping) Niu

I am mainly responsible of the development of the Meeting Table application. The details of my contribution is outlined as follows:

1. Item Menu/List Feature of Meeting Table application

The meeting table application will have all the essential elements for the occurring meeting event collected in a side menu. Different methods can be triggered upon interacting with the menu item (application dependent and developer-specified methods). In our Meeting Table application, object will be placed at default location on the canvas upon clicking.

2. Dynamic Object Adding to Menu Feature

New elements (as canvas objects) may be created on the canvas during the meeting, and the dynamic object adding feature allows the newly created elements may be added to the menu collection. In our Meeting Table Application, new empty elements may also be dynamically added to the collection.

3. External Resource Importing Feature

Prior to the meeting, materials of various forms (images, charts, spreadsheets, etc.) may be prepared and stored into a shared storage (among meeting participants). The meeting table are supposed to automatically import these resources and add them to the Meeting Table menu upon starting the Meeting Table application (when the meeting starts). This calls for the external resource importing feature.

4. Image Annotation Feature

Making annotations on graphs, sketches or diagrams would be a handy feature during design review/revision meetings involving graphics or sketches. This is where the image annotation feature comes into place. This feature allows meeting participants to dynamically make markings on objects on canvas.

Acknowledgement

This project has provided the team with great engineering practice on mobile user experience enhancements, and we would like to give credits to many people/groups who made a difference in our learning experience.

Professor Nazir Kherani and Professor Belinda Wang have provided us very critical advice and constructive feedback throughout the year, and instructed us to come up with a software platform for general multiple-user-specific application instead of coming up with a system that solves a specific problem. The software design consideration was shifted to a higher level, in terms of both scope and difficulty

We also like to show our gratitude to the online communities such as the official Android Developers Guide, StackOverflow community, and various experienced Android developers' blog (such as Lars Vogel, Bill Lahti, etc.). A good portion of our design was inspired by their tutorials and introductions.

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Introduction (author: D. Lee)

In this report, we have summarized the background of touch screen device, our motivation to promote human interaction, the implementation and testing of our final design, and the final outcome of our design that is measured in terms of meeting the project goal and requirement. The report also includes the detail of the validation process in the appendix. Finally, It concludes with the reflection of final result and identification of areas of improvement.

Since Apple introduced iPod touch in 2007, touch screen technology had started to penetrate into the consumer market [1] and the amount of touch screen devices had grown tremendously. In 2013, a total of 1.8 billion units of touch screen panels were expected to be shipped in order to meet the demand of multi-touch user interface products [2]. With their benefits and increasing demand, these devices significantly improved interaction between humans and computers [3]. Among all, it is estimated that more than 70% of the population in most countries now own a smartphone and this number has increased by 30% since last year [4].

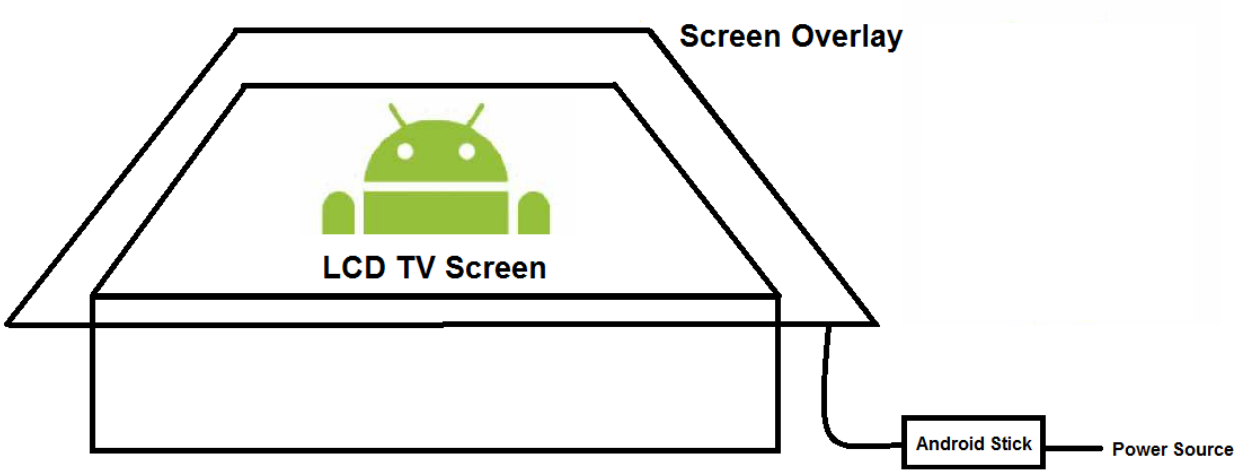
However, while they bring convenience to the world, personal touch screen device is causing the alienation of people interactions [5]. The root cause is that most digital products on the current market are mostly designed for personal usage. Thus, the fact that people send commands to the machine, and the machine acts as a medium and sends information back to us or to other participants is limiting the direct interaction between people. There is no direct interaction between participants themselves, because most designs do not allow multi-users to interact on the same machine simultaneously in a face-to-face fashion. Consequently, we believe that there are many possibilities to explore within area of touch screen device. We would like to take advantage of the rising multi-touch technology, and build applications that allow multi-user operation on one single display of a tabletop to promote human interaction. Our vision is to enhance human interaction using the applications we developed for real scenarios where a table is the most suitable medium.

As shown in *Figure 1*, the design team has decided implement our design with a set of multi-user-specific applications (app) built on a standard Android operating system (OS) and running on an overlay that is placed on a LCD TV screen ported with an Android Stick

(Hardware). The set of apps will demonstrate the enhanced simultaneous multi-user experience on a table top touch screen platform. The modules we have developed are the key ones which are critical to the apps we aim to demonstrate. The meeting table app and image browsing app most likely would be the first two demonstration-ready apps.

In our design, there were six modules to be implemented. These modules were separated into two types - stand-alone modules that implement the core functionalities (Object Fitting and Browsing); features that would not be meaningful on their own but could be integrated together to form meaningful applications with little deviation. Object fitting is a stand-alone application which allows displacement of strings of text and images in a bounded area. This base is also what defines the proposed Meeting Table application. On the other hand, the base of another stand-alone application, Browsing, was also implemented. This application provides the function of displaying data in picture forms, where the user is able to scroll through them to choose a particular picture of interest and it will be enlarged underneath. It specifies the basic idea of the proposed P2C application. Lastly, our design allows users to import text and images from software independent resources. This functionality can be integrated with both Fitting and Browsing applications.

Figure 1



Final Design

The design runs under the Android OS, and uses 2 applications to demonstrate the potential of multiple-user-specific applications, which are the Meeting Table, and the Browsing App.

Technical Design

Even though we have chosen three application alternatives, P2C and meeting table, we will not be building these individual applications as is. Rather, we will be building features extracted from these applications, or in other words, basic functional blocks which can be integrated to become applications of specific usage. The reasons behind this decision are the explorational nature of our project and time constraint. The goal of our project is to explore the potential of a touch table, which leads to various applications with different aspects. However, it is unrealistic to actually implement all of them with the time given. If we were to choose one specific application, time would be dedicated in tailoring the interface and underlying functionality to the use case, and there would be two negative consequences. Firstly, we would not be able to implement and showcase other features that do not fit with the specific application. Secondly, many real-world use cases are similar and can utilize the same type of applications with little deviation in features. It would be difficult for us to demonstrate how a type of certain application can also be use in other real-world examples if we only had an application specifically built for one use case. On the other hand, we will still be able to integrate these independent features in some form to demonstrate how they can work together as an application for specific use cases. In short, the implementation will be divided into features taken from different application alternatives. These features will be independent applications runnable and usable on the Android platform.

System-level Overview

The features extracted from the design alternatives are object fitting (image and text), browsing. Object fitting refers to the ability to maneuver and edit objects in a given space. Browsing refers to an interface to display a sizable amount of information in different forms. Two other design alternatives were not implemented due to time constraint, which

are inter-device communication and independent workspace. The inter-device communication capability is the interaction between the table and other popular devices. The independent workspace refers to small areas on the table's touch screen designated to work independently and to be operated by individual users. How these features can be integrated together to serve in specific usages is outlined in *Table 1*: Application features, and will also be described later in the module-level descriptions section. A system block diagram is also provided in Diagram 1: System block diagram.

Table 1: Application Features

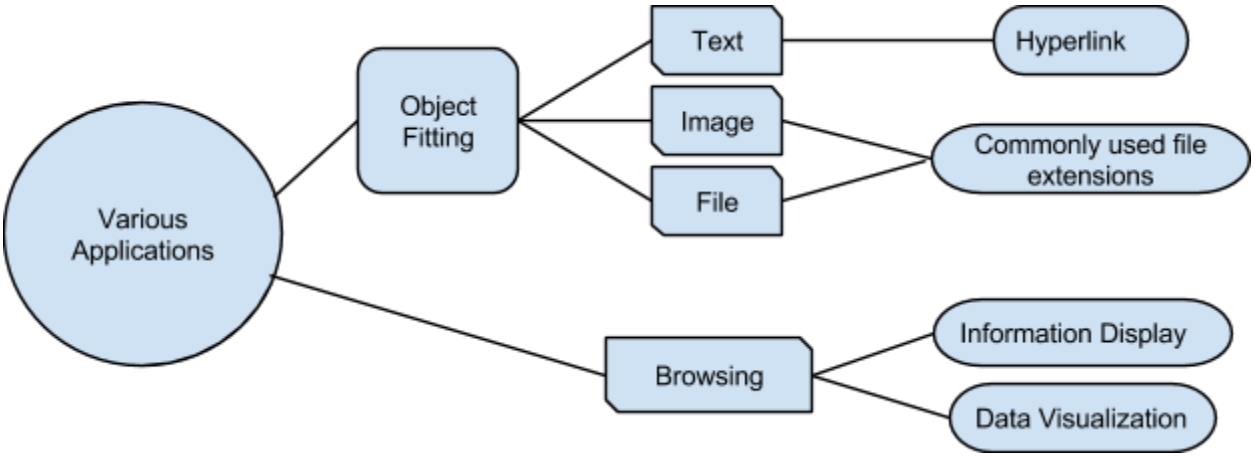
This table outlines how individual features can be integrated together to become a specific application.

	Object fitting	Browsing	Inter-device communication	Independent workspace
Banks/sales	Documents/forms	Service plans, documents	Non-disclosable and disclosable content separation	-
Furniture stores	Virtual floor plan	Catalog, documents	Item order retrieval	-
Children's Education	Drawing, collaborated creation	-	-	Independent creation
Meeting Table	Text, images, documents, links	-	-	Independent workspace
Social Media	-	Shared area	-	Personal space

System Block Diagram

The system block diagram outlines the overall system. The third column indicates the modules and the last column indicates elements contained by the modules.

Diagram 1: System Block Diagram



Module-level Descriptions

Text Fitting (author: S. Wang)

This module treats text as objects in order to move words, sentences or paragraphs freely in a given workspace. Sometimes people use text in a way that it is not a part of a larger body of text, but rather indepent notes or ideas. Such use of text is often difficult to maintain and organize in conventional text editor software, and even more difficult to do so on a physical medium. This module provides a way to both move and modify text freely on the touch table. Additional functionalities includes creating lists or tables, adding tags to text objects for the software to automatically sort into lists or organize into tables. Specific usage of this includes meeting table application for idea brainstorming sessions, where text comes from multiple users and requires reorganization and comparison utilities; a certain P2C application such as furniture placement for annotations; children's educational applications such as vocabulary games; and social media to display posts or messages in the central shared area on the table.

Image Fitting (author: K. Niu)

Image fitting would make images of any compression type shrink into various sizes, and will be treated as an object with various object attributes. This functional module would

be heavily used by the meeting table app, as well as the social media app, as well as some use cases of P2C applications. In the meeting table app, as idea and research results sharing will many times involve image sharing, image fitting would allow easy and flexible interface for zooming in or out the image. While loading news feeds in the social media app, news feeds are treated as individual objects, and there would be frequent occurrence on image based news feeds, the image fitting would allow users to select which image news feed to surface to top. P2C application such as house furnishing planner application for furniture fitting would require automated size fitting of floor plan image object to the right size as well as each furniture element to the same scale.

File Fitting (author: K. Niu)

File fitting would convert recognized formats of files into fixed size icon-like objects, and allow different operations on the selected file object. File fitting would come handy in use cases such as the P2C app, meeting table app, etc. In the meeting table app, information of various formats may be present; if a component datasheet of “pdf” format is on the table, and would be one of the topics to be discussed, it would be convenient if the person in control can make few taps on the object to activate or to minimize. P2C application under the bank or sales agent use case would allow service providers to swap between different electronic template forms for the client to sign.

Browsing (author: D. Lee)

This module is responsible for the display and visualization of data. It allows the user to display sizable amount of information and it could also transform these data into different forms such as statistical table and block diagram. If there are more data than the template of the touch table can display, the module should hide the visible data and show the data that is not yet visible in a first-in-first-out manner. In this way, the user will be able to overlook all the data available. The module will take the data as input and output the data in a human readable format on the touch table. P2C app for bank can utilize this module to analyze business data and generate relevant graph or report for business analysts to study business case better. Also, P2C app for point of sale could use this module to generate statistical table and usage diagram to show the customer the popularity of the

product and how it is use. The meeting table app can also use this module to categorize different ideas.

Independent Workspace (author: K. Niu)

Not adopted in our final design, but the practical concept is worth mentioning. The independent workspace functional module would distribute portion of the table touch surface to each user for their independent operations. General purposes such as single or dual touch operations, and independent touch keyboard on each designated workspace should be allowed. This feature would be used in applications in various categories. In a meeting where the meeting table application is used, each user are allowed to make text input to their own independent workspace for note taking purposes; while participant intend to present his/her findings, participant may simply drag objects of any form from his/her own workspace to the shared workspace region; users can also duplicate information from the shared workspace to their own workspace, which may support cloud feature, allowing post-meeting review at personal time. The social media application will require the independent workspace functional module as well; chances are there are going to be interesting news feeds that would not appear on the shared area on the table due to not all users on the same table have direct permission to the person of interest of the news feed, but if one of the participant seated does have the access, he/she may voluntarily share the news feed with the friends on the same table; each table participant should be able to make independent posts and comments, which is where individual touch keyboards comes into place. Various uses can be explored with this multi-user general interface functional module.

Inter-device Communication (author: K. Niu)

Not adopted in our final design, but the potentially desirable module is worth mentioning. This particular module is responsible for the interaction between the touch table and other devices such as smart phone, laptop, and tablet. The interaction between touch table and other devices should allow transferring data such as a word document or an image on to the touch table or the other way around. This module plays an important role for other modules such as text and image fitting because it import the text and image file for

manipulation from other devices. The input of the module is a file on the inter-devices and the output of the module is the same file on the touch table. This module can be used by a various applications. The P2C Application that involves negotiation such as house closing and banking could potentially use this module to pass around the business document between two parties. Moreover, P2C application for furniture providers could use this module to download the floor plan of the resident of clients from their smartphones and fit the furniture into the floor plan using the image fitting module; this can provide a better visualization of what the house will look like with the furniture. Interactive game such as air hockey can incorporate this module to play the game between touch table and other devices.

Assessment of Final Design

The proposed combination of OS and applications would be Android OS along with P2C, Meeting Table, and Social Media applications. Android is selected due to its wide user base and having a standard SDK; the implementation process would be simpler and faster, as there would be many resources available. The P2C application is selected for the instant solution to various scenario with paper based official agreements, as well as an improvement to various advertising process. The meeting table is selected due to the potential audiences will be designers of different kinds such as engineers, architects, fashion line industries, etc., who would heavily require a sharing-friendly media. The social media is selected for exposing a new possible form of social interaction, and lead audiences to think more about the possibilities of such multi-user experience on a single table.

Conclusion (author: C. Chang)

The main goal in this project is to discover the possibilities and potential of a big screen touch table with the help of our applications. An important objective is to enhance human-and-machine interaction and the interaction between users. After several changes in overall project orientation and final design specifications over the months, the team chose Android system as our OS platform and created two modules, Meeting Table Application and Browsing Module, to demonstrate this goal.

As shown through the validation and acceptance tests, the team met the basic requirements defined in the project proposal. Both our applications are able to support different screen sizes. Also, the selected Android operating system allows application development by a third party. In terms of the number of users, the Meeting Table application is intended to be operated in multi-user mode, while Browsing Module is more suitable for individual use. We disregarded the requirement on the number of supported simultaneous touch points per user because we changed our design direction from hardware to software and it does not directly reflect the purpose of this project.

The final design of our Meeting Table application provides a virtual environment for multiple users to brainstorm and organize ideas in a meeting scenario. Its functionalities are verified through different testing results and proven to reach the goal of enhancing human interactions. However, our Browsing Module is designed to allow better experience for individual use only. Even though it does not meet our main objective, the design idea of this module is proven to be useful in a P2C situation where the touch table can act as a digital platform to display image data and text information.

Upon the completion of these two applications, we can conclude from this project that the potential of an interactive touch table is huge. Here are some key points. Firstly, the significantly bigger screen size on a mobile device can be useful or helpful in many situations, as mentioned in Module Level Description for P2C applications and Meeting Table. Secondly, with the flexibility and portability of Android Stick, the touch table’s size is scalable and it is convenient to install the system onto any hardware. Thirdly, Android

system is open source, and there must be a lot more creative and innovative application ideas for a touch table that the team did not come up with in this project awaiting to be developed. As a result, our design is proven to be potentially useful in society with these benefits.

One process mistake that the team will avoid in the future is not strictly following the Gantt Chart. There were a few delays on the deliverables which caused a series of other delays. One execution mistake we should avoid is that all team members always worked independently on their responsible parts. It would be more efficient and productive if everyone could meet up to work together and help each other out when in difficulties. What worked well was that work was divided clearly and distributed evenly.

To go further in this project, the team should do more research on where else exactly a touch table might be needed. Also, work should be done on what specifically the potential clients want in an application to enhance their business performance (such as banks, retail stores, internet companies, etc).

Test Document (author: S. Wang)

Project Goal

In this project we will be creating software applications for multi-touch tables on a selected operating system. The goal of the applications is to explore the potential of a touch table in promoting direct interaction of people.

Project Requirements

The requirements of our project target primarily towards the support for multiple users. Finally, the objectives focus on what we can do to better showcase the potential of the touch table.

Functional Requirements

1. The applications must be able to support different screen sizes
2. The applications must not be personal applications for individual use only
3. The selected operating system must offer an application development environment for third party application development

Constraints

1. The applications developed must not be already available on the selected operating system

Objectives

1. The selected operating system should be familiar to people
2. The applications should be flexible in supporting various numbers of users
3. The applications should promote direct interaction of people
4. The applications should be accessible and useful to most people

Testing and Verification (author: S. Wang)

The project requirement and objectives are used to compare against the overall result of our project. As well, functional verification tests were created and performed to test the correctness of the Android applications. This section outlines the test cases. Testing details are included in Appendix C at the end of this document.

Requirement Verification

The project requirements are generalized requirements for any type of software application. Although they cannot be used to measure the successfulness of the developed software applications themselves, they do reflect how these applications are in respect to the overall goal of our project. The Meeting Table application passes all the requirements and achieves all of the objectives. However, our team strayed away from the requirements and objectives when we chose to develop the Browsing App. The operation of Browsing App is more suitable for one user, but can still enhance multi-user interaction in P2C situations.

Table 2. Overall Project Result Verification Against Requirements

Note: R# refers to requirements; C# refers to constraints; O# refers to objectives

Requirement	Final Result	Compliance?	Comments
R1. Different Screen Sizes	Applications are functional when run on device simulators of varying screen sizes.	pass	
R2. Non-personal Application	Meeting table is designed to be used in group setting. Browsing App does not fully comply to this requirement.	50% pass	Browsing App could arguably be used by multiple people depending on the situation
R3. Offer development environment	Android operating system offers Android SDK for application development.	pass	
C1. App not already available	No existing app offering the core functionalities of Meeting Table. Browsing app is a generalized version of some existing app with specific usage.	pass	Browsing App is unique excluding music and movie applications
O1. Familiar OS	Android operating system already widely used on phones and tablets.	100%	
O2. Flexible number of users	Meeting Table allow different number of users. Similar to R2, Browsing App does not fully comply.	50%	Browsing App's user interface is more suitable for one user
O3. Promote and enhance interaction	Meeting Table enhances discussions with the convenient interface. Browsing App enhances interaction in P2C setting	80%	Browsing App's effectiveness can vary depending on the situation
O4. Useful	Meeting Table is a practically more convenient than traditional paper and pen. Browsing App is also better than printed material with large amount of information	90%	

Functional Verification Tests

Meeting Table:

All test cases passed and function correctly.

Table 3. Test Cases for Meeting Table

#	Steps	Expected Result	Actual Result
1	Add new resource file into storage	Resource shows up in resource list	pass
2	Tap on an item in resource list	Item shows up on canvas	pass
3	Add text	Text shows up on canvas	pass
4	Drag and drop items to different location	Items move to new location	pass
5	Drag and drop an item onto another item	Item moves to new location, blocking the other item	pass
7	Drag and drop item onto invalid area	Item moves back to original location	pass
8	Create list and add items to list	List shows up on canvas with items as list entries	pass
9	Create table and add items to table	Table shows up on canvas with items as table elements	pass
10	Delete items	Items get removed	pass

The screenshots below illustrates the completed Meeting Table application. *Figure 2-1* represents one state of the application. *Figure 2-2* represents another state after rearranging items on the canvas.

Components include:

1. The menu on the right side of the screen, which contains the list of resources that can be added to the canvas on tap
2. The text box below the "+" button to input text to be added to the canvas
3. The "Add Text" button below the text box which adds the text onto the canvas when triggered
4. The "Add List" button and the "Add Table" button which create new list and table onto the canvas
5. A picture of a dog on the top left corner, which was added by tapping on the item in the right menu
6. A table containing weather information, which was created with the "Add Table" button
7. A list containing strings of text, which was created with the "Add List" button
8. A text string "New Text"

Figure 2-1. Meeting Table

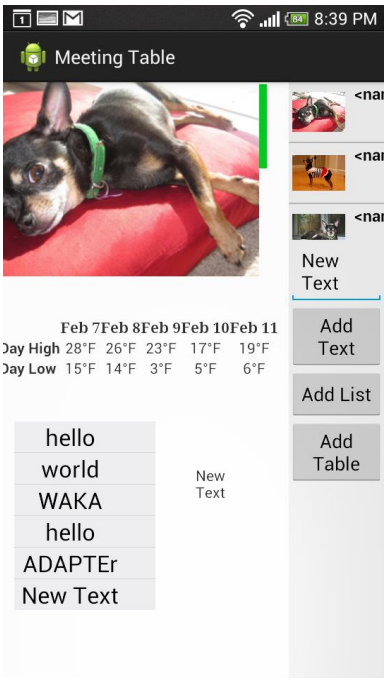
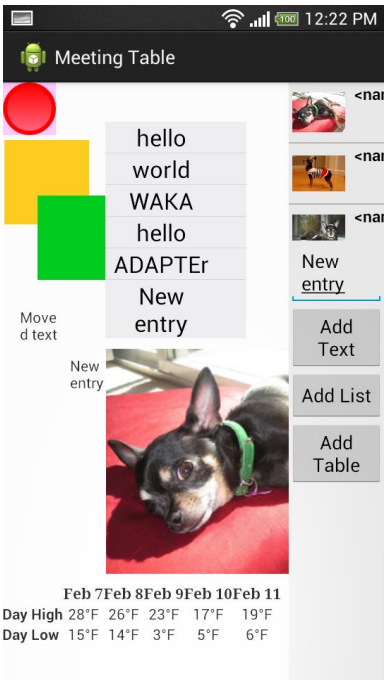


Figure 2-2. Meeting Table Rearranged



Browsing App:

All test cases passed and function correctly.

Table 4. Test Cases for Browsing App

#	Steps	Expected Result	Actual Result
1	Add 10 resources and swipe through them	Resources show up properly	pass
2	Put 5 resources into a different category and switch between categories	Resources show up in respective category	pass
3	Add descriptions for multiple items	Descriptions show up with corresponding item	pass
4.	individual workspace adjustment	Each individual workspace is able to be adjusted different according to the configuration of the XML file	pass
5.	Click on the browsed resource to enlarge and display a particular resource in separate workspace	When the a particular browsed resource is clicked, it will be enlarged and displayed in a separate workspace	pass
6.	Browsing category menu	When the menu is clicked, the resources correspond to the selected category will be displayed	pass

The screenshots below illustrates the completed Browsing application. Figure 2-3 represents the state when the app is first accessed. Figure 2-4 represents another state after the browsed resource is selected and the description is displayed.

Components include:

1. The menu on the top left corner of the screen contains the list of category of resources to be selected.
2. The workspace on the top right corner of the screen is the image gallery. The image can be switched by swiping.
3. The workspace on the bottom right corner of the screen is the description displayed for the selected item.
4. The workspace on the bottom left corner of the screen is displaying the selected image in a larger and more detail format.
5. The workspace size can be adjusted according to the configuration of the XML file.
6. Four individual workspaces that can communicate between each other.

Figure 2-3. Browsing App

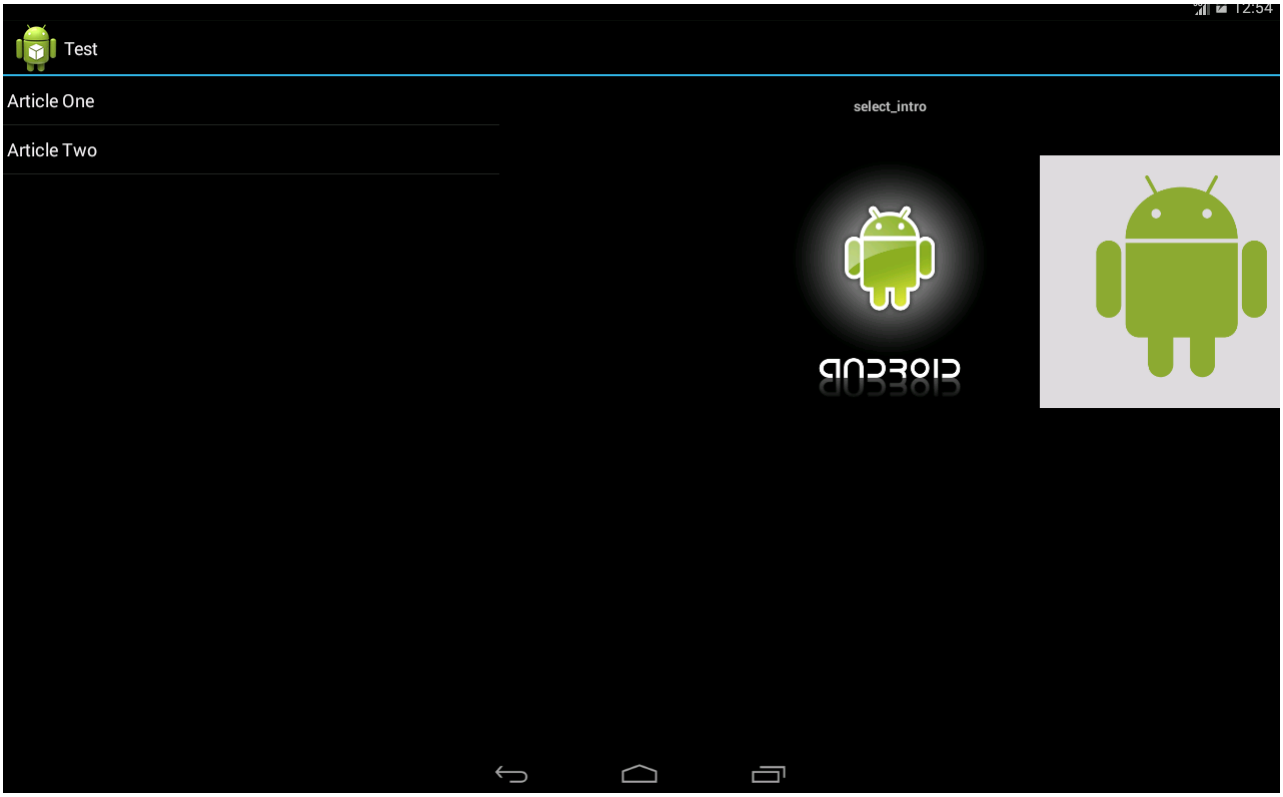
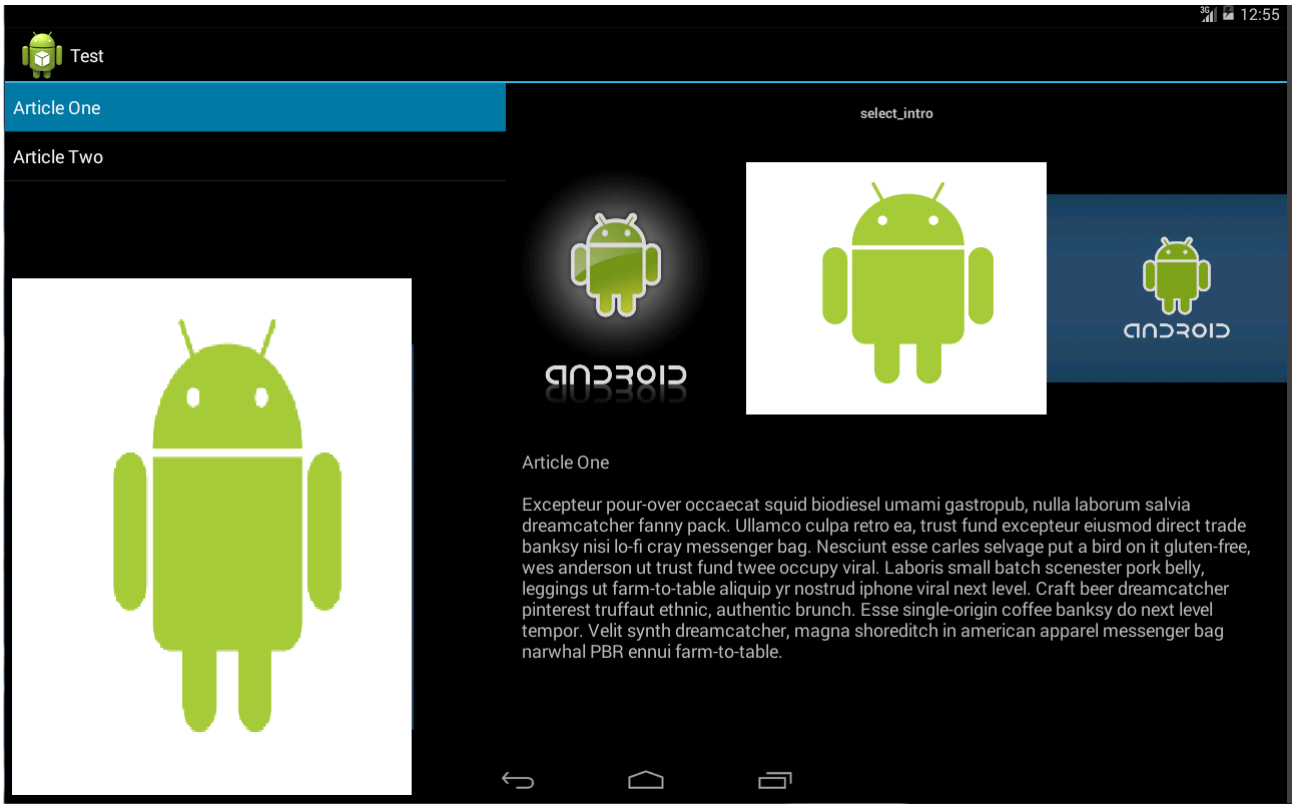


Figure 2-4. Browsing App



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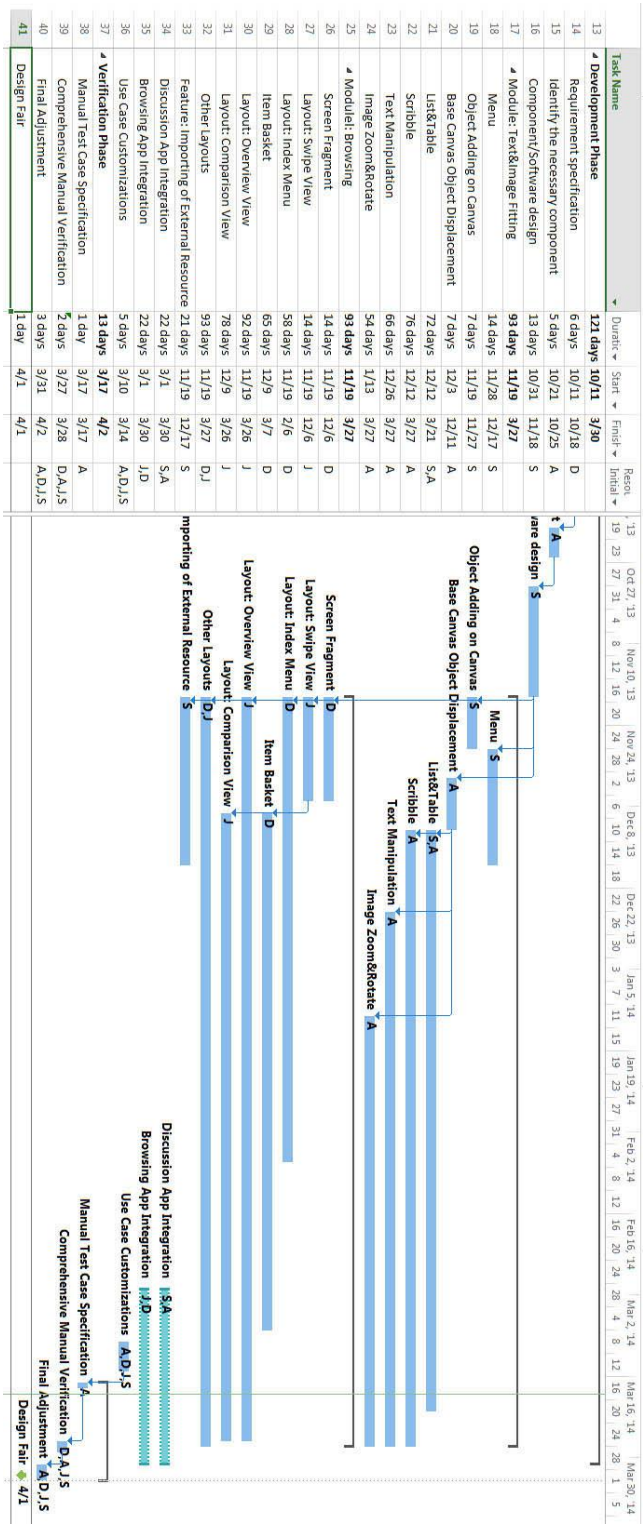
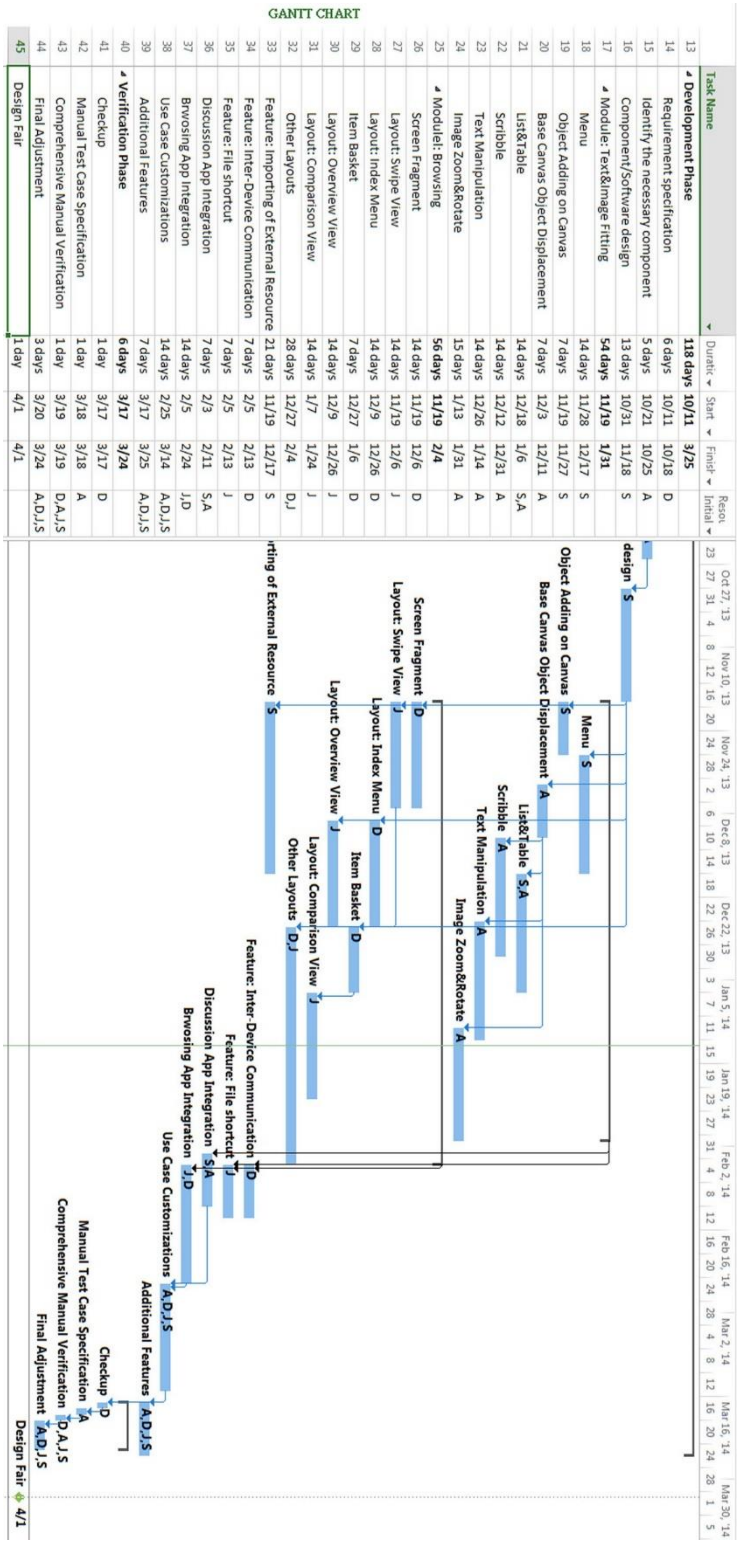
Appendix A: Gantt Charts

Gantt Chart Final Version: Final Report

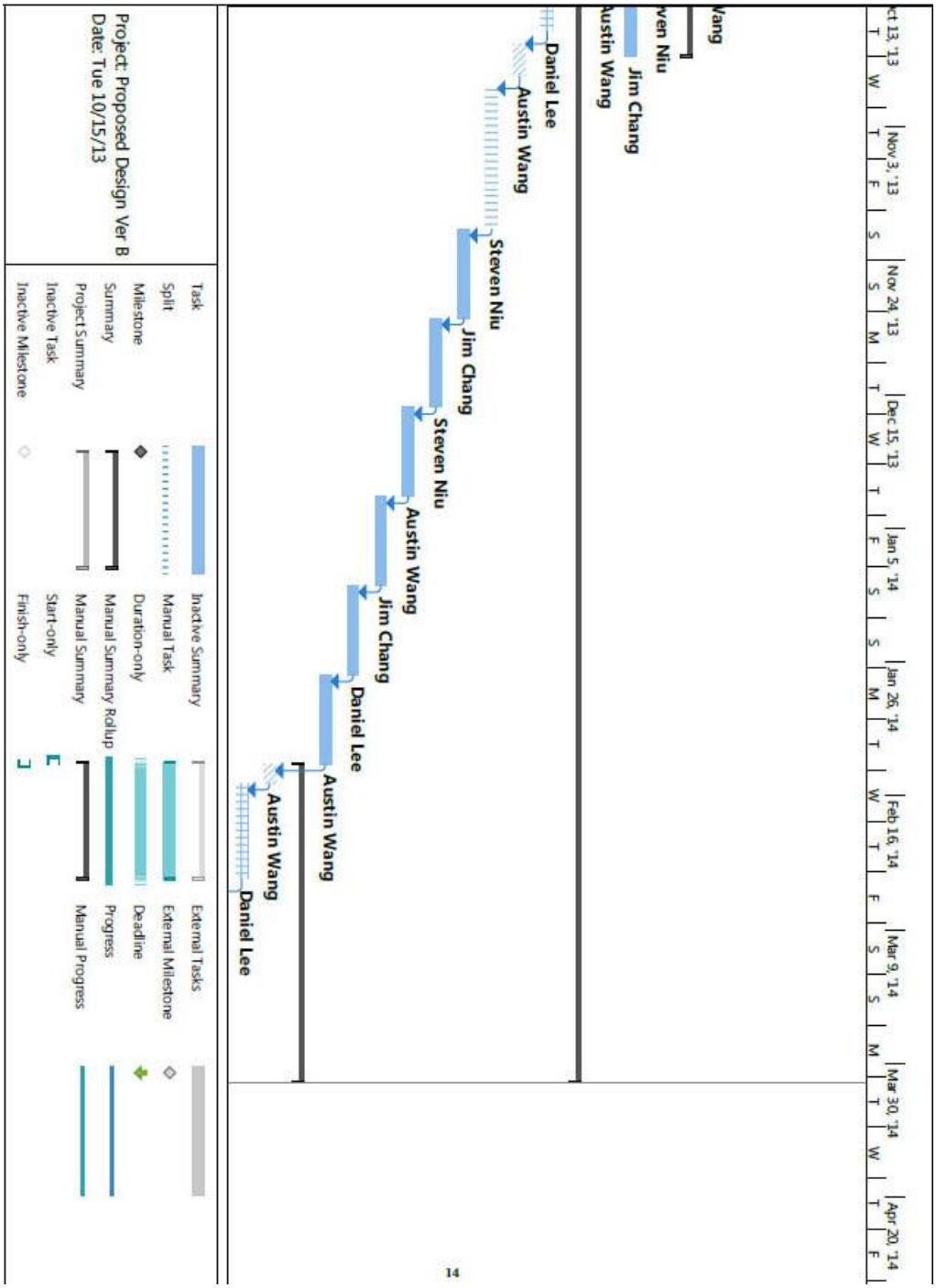


Gantt Chart 2nd Version: Progress Report:



Gantt Chart 1st Version: Project Proposal

Note: This version of Gantt Chart was crude and did not provide useful information, hence only a snippet is shown as a record.



Appendix B

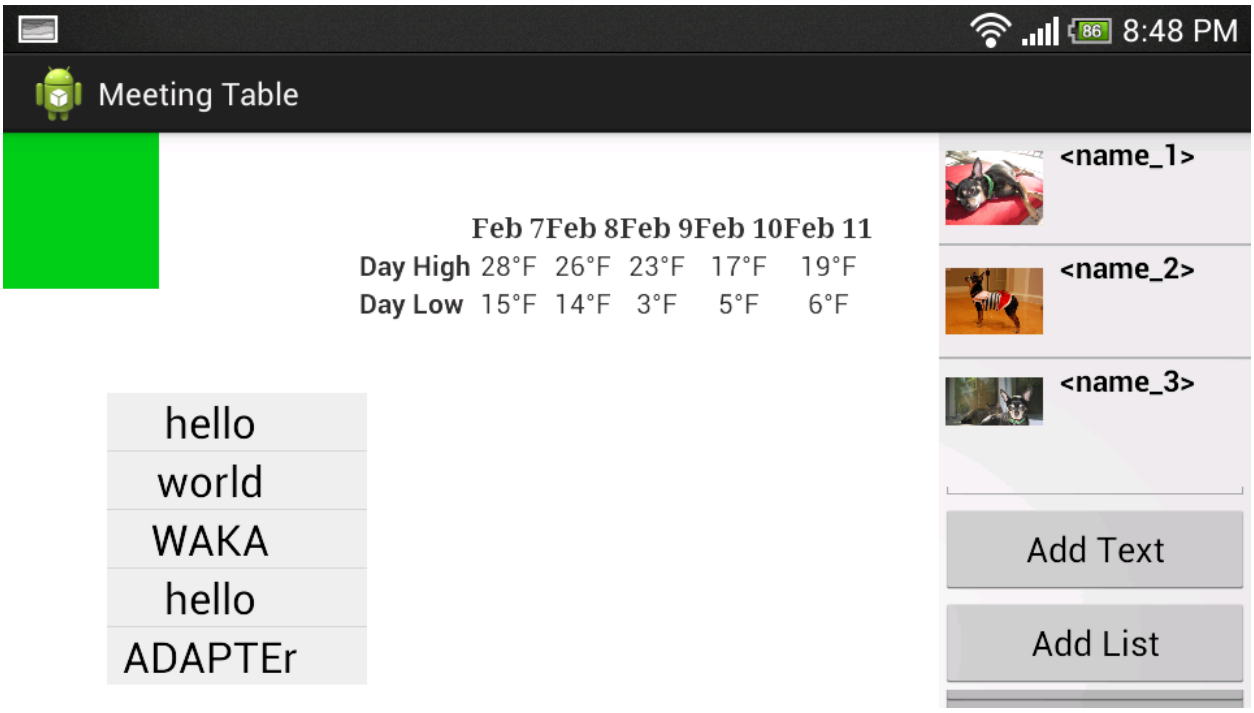
Validation and Acceptance Tests

To verify and validate the project requirements and objectives, we will employ individual testing methods, listed in Table X: Testing Method.

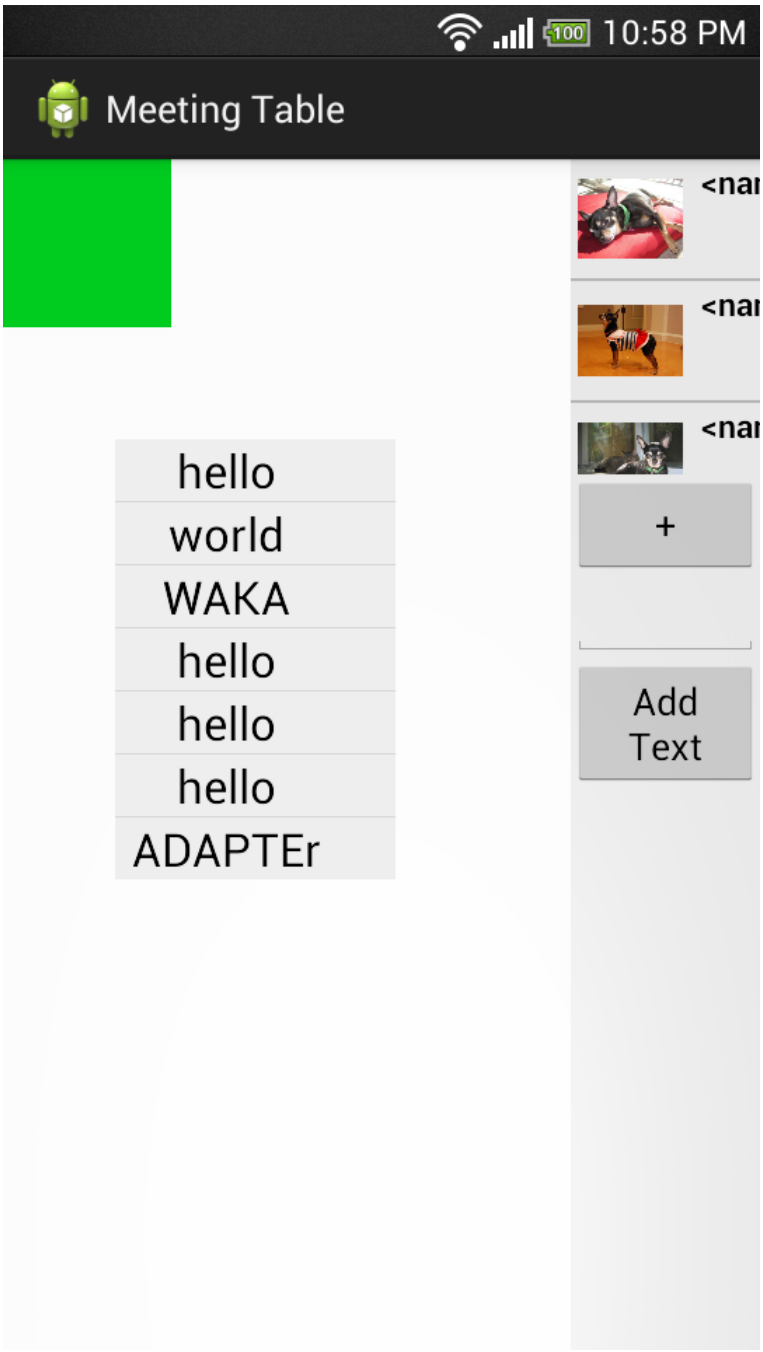
Table 5: Requirement and Testing Methods

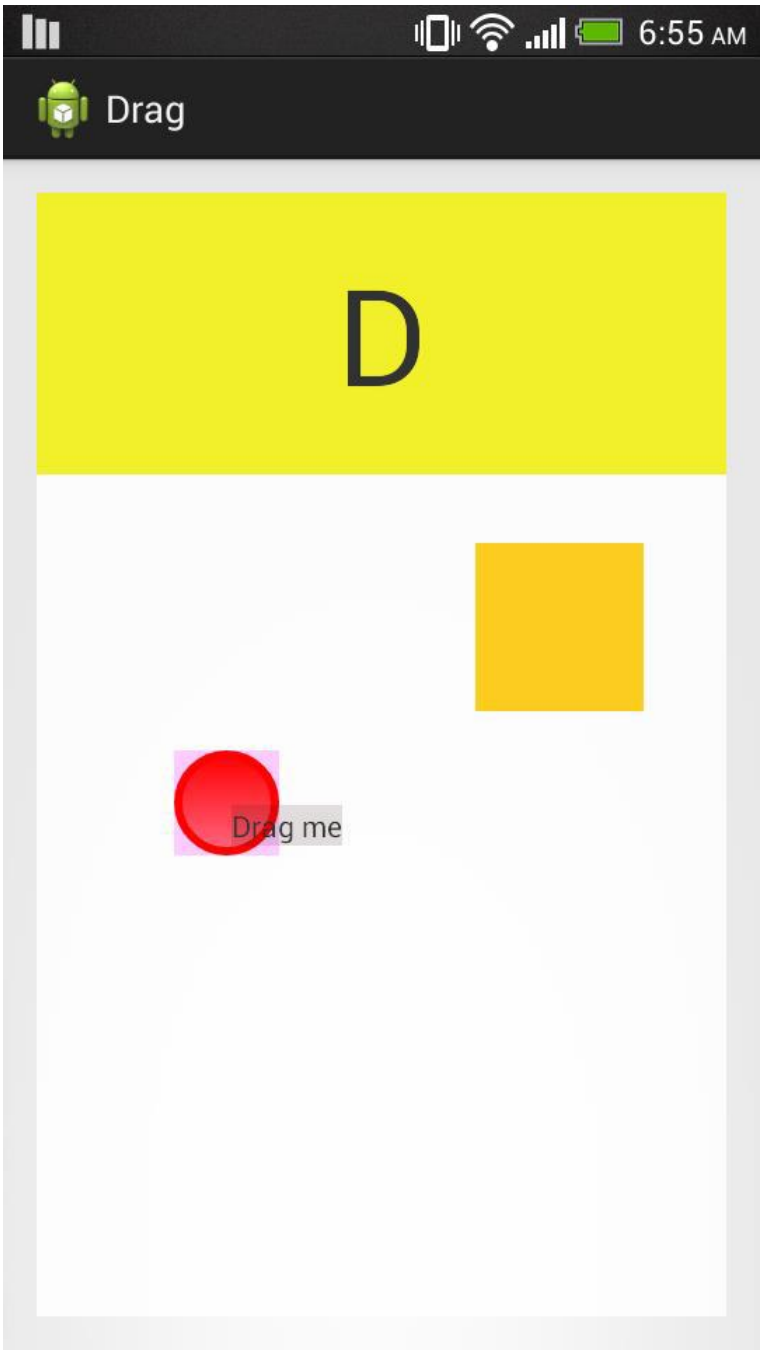
Requirement	Testing Method	Test result
Correctness of the applications	Manually test the functionalities of the applications during development and at the end of the development cycle with a comprehensive test plan	Test cases are outlined in the test document. All test cases passed. Details are documented below in module level test section.
Support for different screen size	Run the applications on a personal hand-held device with much smaller screen size	Test passed. Both applications are able to function correctly with different screen sizes. (See Figure 3)
Support for multiple touch points	Manually test if the applications remain functionally correct with different numbers of touches until the designed limit	Meeting table does not support simultaneous drag and drop of multiple items. This requirement is not applicable to Browsing App.

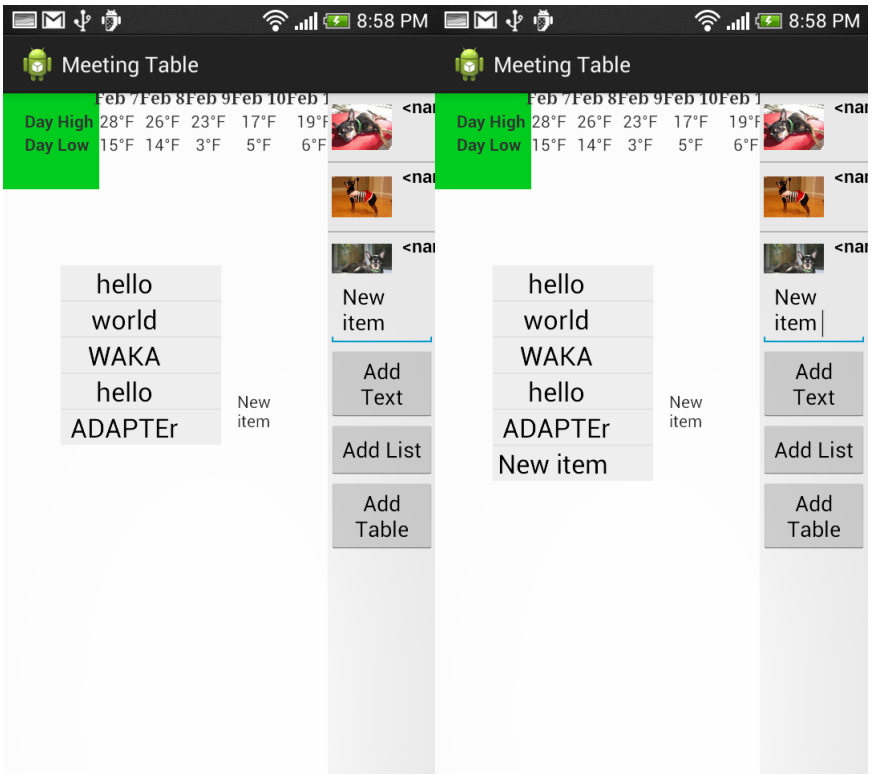
Figure 3. Screenshot of Meeting table operating with a horizontal screen



Appendix C: Module Level Tests

Test summary/steps	Meeting Table: Add resource
Expected Result	Resource should show up in the menu
Actual Result	Resource shows up in the menu on the right side 

Test summary/steps	Meeting Table: Put one item on top of another
Expected Result	Item should be blocking another item
Actual Result	Text “Drag me” blocks the red circle 

Test summary/steps	Meeting Table: Drag text item into list
Expected Result	The list should have the text item as its new entry
Actual Result	Item shows up in list 

Test summary/steps	Meeting Table: Image Annotation
Expected Result	The graphical elements may contain user markings
Actual Result	Graphical elements contain user markings