Design

Problem Statement

With the advent of smart devices, customers are expecting a richer experience out of the appliances they interact with daily. Freescale, in conjunction with Iowa State University's Industrial Design Department, has noticed a market opportunity to use touchscreen interfaces for interaction with home appliances. During the course of this market research, the need for an interactive touchscreen prototype was discovered.

Our goal as an engineering senior design group is to provide a prototype platform for use in research to measure reactions to a home appliance touchscreen interface. The approach

that our group has taken was to interpret the compiled research and develop prototype appliance interfaces to be used on an Android tablet for continued testing and development. In order to fit the project's time constraints, the appliance interfaces that we chose to simulate are for a washing machine and Heating Ventilation Air Conditioning (HVAC/thermostat) Controller.

Concept Sketch

Because our aim was to create Android applications that acted as controls to an HVAC/thermostat and a washing machine, we based our prototype on the user interface designs created by Industrial Design teams. Their menu designs served as a model as we designed and tweaked our layouts. The wireframe diagrams and flowcharts guided us as we finalized the workflow our prototype would follow. We knew that the extensive consumer and market research that they did would be the foundation of our design.

Because the Industrial Design teams researched many different home appliances, we had to narrow the appliance scope to complete the project in two semesters. In order to make this decision, we considered the following traits for each appliance and its touch screen concept: a well defined design and workflow created by Industrial Design, room for advanced features within the appliance controls, and the most overlap between appliance features to promote module reusability. We chose the HVAC/thermostat controller and the washing machine interface based on these traits.

The choice to develop with Android was driven by a number of factors. First, due to the limited amount of time, we wanted to use a technology that we were comfortable with. Android was what we knew best. Secondly, Android is both portable and flexible which allowed us freedom. Finally, Android has built-in features that worked well with our plans for implementation.

In addition, the appliance, layout, and form factor decisions were influenced by Industrial Design team decisions and our budget. While the industrial design teams suggested numerous sizes and shapes of touchscreens, we were limited to touchscreens that were on the market. We were also influenced by the fact that development for the HVAC application and washing machine application would be displayed and tested on the same size touch screen. We chose to develop the applications in a landscape view to mimic the short, wide screen suggested by the both teams. Thus, we focused on matching the form factor presented by industrial design and choosing a product that was available on the market. In our process of creating prototypes that implement the basic features of the HVAC/thermostat and washing machine, we interpreted their research and designs, molding them into a design that could be programmed in an Android application. In respect to visual design, our intention was to utilize Android's built-in design, for example their color scheme and button style on a device that matched the form factor suggested by Industrial Design teams. As the Industrial design teams' designs recommended, the home screen of the HVAC/thermostat would feature basic thermostat features and settings. Similarly, the washing machine application would focus on their suggested dial-centric layout. Using their creativity and research and our technical skills, we were able to create an idea of how our project would unfold.

Specifications

Project Constraints

- Work in interdisciplinary teams.
- Propose alternative interface strategies and graphical user interface.
- Create a platform(s) for rapid prototyping and implementing different interfaces.

Intended Uses

- Conduct user testing to understand issues of human factors, user response, user reaction.
- Participate in data gathering to develop insights and define opportunities.

Functional Requirements

- System must be stable through application life.
- Application must simulate interaction with a home appliance.
- Application must allow user to customize appliance settings.
- Application must allow user to alter interface display settings.
- Application must interface with application data storage.

Non-Functional Requirements

- Application must be intuitive to the user.
- Code must be modular

User Interface Heuristics

Within our applications, we sought to follow user interface heuristics to make the interface intuitive, easy to use, and aesthetically appealing. The heuristics that we focused on most were: visibility of system status, match between system and the real world, minimalist design, and help and documentation.

Visibility of system status is meant to keep the user informed about what the application is doing. This was applied to the HVAC application by making the system temperature and states visible to the user on the main screen. This was also applied to the Washer application by allowing the user to view the current wash program's progress in the progress screen.

Match between system and the real world was achieved in the Washing Machine application by implementing a dial interface which should be familiar to users who are used to using a hardware dial to interface with their appliance. Also, in the HVAC, red is used on the button used to increase the temperature (head), and blue is used on the button used to lower the temperature (cool).

Minimalist design has been used throughout both applications to insure that the user can use the appliance with ease and so they are not hindered by irrelevant features.

Help and documentation were incorporated in all modules within both applications. A help menu can be accessed through a help button from each screen. These help menus describe how to use each of the different screens, so the user has reassurance on how to use their appliance.

System Description / Operating Environment

The applications were developed on the Android 4.1 platform to be tested on 7" touchscreen tablets. The Google Nexus 7 tablets were selected for their display size, touchscreen capabilities, and operating system version. By using the Android 4.1 platform for development, we were able to access newest features available. Our team primarily used the Eclipse IDE and used the Github repository for version control. We utilized other libraries including the AChartEngine Library, SQLiteAssetHelper Library and the WeatherUnderground API to add features and functionality to the applications.

User Interface Description

The following sections break down the User Interface elements that can be found in each screen and how the user interacts with these elements.

Menu Bar

Both applications have a menu bar with tabs for each module as well as a Help and Home button.

Weather

Both applications include a Weather screen. The days are laid out in a side scrollable view so all ten days can be viewed. Large weather icons and high and low temperatures for the day are shown at a glance.

Washing Machine Main Screen

The washing machine main screen contains a dial interface which can be used to select a program cycle as well as two seek bars and a switch which can be used to customize the program cycle. The dial interface was chosen to maintain the look-and-feel of washing machines with static interfaces which regularly make use of the component. The match between system and the real world makes the interface easier to understand by new users.

Washing Machine Customize Program Screen

If the user selects the “More Wash Settings” button from the main screen, they will be taken to the Customize Program Screen where they can use seek bars, radio buttons and switches to customize every detail of the wash program.

Washing Machine Progress Screen

After selecting and starting a program cycle, the washing machine application displays a progress screen that contains a countdown timer, progress bar, cancel button, and program details. The countdown timer and progress bar offer two options to visualize the progress of the current wash program.

Washing Machine Stain Guide

The stain guide in the washing machine application contains 4 main components. First, there is a list of stains on the left which can be scrolled up and down by flinging the field with one’s finger. Second, there is a stain viewing area on the right which becomes populated with stain removal instructions when a stain has been selected from the list on the left. Third, there is a search field within the menu bar so that the user can quickly search for the appropriate stain. Each change within the search field updates the stain list on the left. Fourth, there is a panel of buttons that allow the user to narrow their search to find only stain removal instructions for the appropriate fabric type.

Washing Machine Maintenance Guide

The maintenance guide in the washing machine application contains 3 main components. First, there is a list of maintenance instruction items on the left which can be scrolled up and down by flinging the field with one’s finger. Second, there is a maintenance

instruction viewing area on the right which becomes populated with maintenance instructions when an item has been selected from the list on the left. Third, there is a search field within the menu bar so that the user can quickly search for the appropriate maintenance instructions. Each change within the search field updates the list on the left.

HVAC/Thermostat Main Screen

The main screen is the first screen presented to the user. This screen presents three interactions with the user. Firstly, the user is presented with the current thermostat operating temperature, and quick temperature adjustment controls. Secondly the user may select the fan speed and system mode. Finally, quick weather for the current day is also displayed.

HVAC/Thermostat Energy Efficiency Screen

The energy efficiency is displayed upon touching the Energy Efficiency tab Menu bar. This feature allows the user to view the amount of energy used by their HVAC system throughout the day, week, month or year. While the default view is week view, the user can select which graph to view using the column of buttons on the left side of the screen.

HVAC/Thermostat Energy Efficiency Screen

The settings screen, accessible from the tab on the Menu bar, allows users to customize different aspects of their user interface. Currently, the settings menu offers the user the choices to change the screen brightness, the zip code, and the time zone. Selecting one of these options will expand another small screen to change this setting.

HVAC/Thermostat Scheduler

The scheduling functionality provided by HVAC is presented as a main screen with auxiliary functions inside the “Time Selection Toolbox.” The Time Selection Toolbox is a floating panel that allows users to bring up a dialog for times and system modes. The times and system modes calibrate a preview panel appearing next to the day’s events. An insert button allows users to take the preview and change it into an event, which populates the schedule.

Functional Decomposition

The following sections describe the components within each module and how they behave within the system.

Weather

This module connects via Internet with Weather Underground to acquire and display a ten day weather forecast. By clicking the weather icon, the user is shown a detailed text forecast for the day.

Washing Machine Main Screen

From the main screen of the Washing Machine application, users can select a program cycle, customize the program details, and start a wash program.

Washing Machine Customization Screen

Users can customize a program cycle to fit their own needs including: water temperature adjustment, agitation level selection, and steam setting.

Washing Machine Progress Screen

The progress screen displays the progress and details of the current wash program. The program can be cancelled by selecting the Cancel Wash button.

Washing Machine Stain Guide

The Stain Guide can be used to search and find stain removal instructions for a variety of stains and fabric types.

Washing Machine Maintenance Guide

Users can solve their washing machine issues by searching and reading information within the built-in Maintenance Guide.

HVAC/Thermostat Main Screen

From the main screen of the HVAC/thermostat application, users can view and change the current temperature, as well as set the system to heat/fan/cool the state to on/auto/off, and check the daily weather.

HVAC/Thermostat Setting Screen

The Settings Screen allows the user to change the color scheme, screen brightness, zip code or time zone.

HVAC/Thermostat Energy Efficiency Screen

The user can view the energy usage of their HVAC system for the day, week, month and year from this screen.

HVAC/Thermostat Scheduler

The scheduling feature allows users to program their thermostats with different modes, which are states corresponding to heating, cooling, fan speed, and energy saving settings. Each mode has a time frame associated with it, and the two together is called an Event. Events are used to completely define the programming features in the thermostat scheduler, and allow the user to customize their settings for different time periods, such as when on vacation or at home.

Testing

Goals

First we aimed to quantitatively measure time needed to accomplish each task as well as the number of times the user needed to restart the task, if any, before they could complete it. Also, we wanted to analyze qualitative aspects of the user experience. This included evaluating the users' frustration level with the new interface and control paradigm and determining the

users' prefered look and feel of the application. Finally, we hoped to verify the applications have the expected functionality of the appliance they control. For example, the washing machine application would need to give users a way to choose water temperature and load type, and the HVAC control would need to allow the users to change the system temperature and fan settings. More about the approach used for testing and results can be found in the Usability Testing Results document.

Results

After finishing the testing and analyzing the results, we found that the prototypes were a good first step for intuitive touchscreen controls for appliances. Overall, users were able to complete tasks without much difficulty or confusion. We heard several test subjects say "[I] didn't need detailed directions to figure it out." when referring to the tasks they were instructed to carry out. The applications had features that the users believed the HVAC/thermostat and washing machine should. They also appreciated other non-essential features, such as the weather. While the testing did expose some areas for improvement, they were manageable. Indeed, some of the changes were implemented right away, based on user feedback. These included changes to the overall font size and button and screen labels, as well as modifications to make the modules to be fail-safe. In short, this period of testing gave us insight to users' responses to our prototype.