MIDTERM PROJECT REPORT FALL 2013

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I. Problem Space

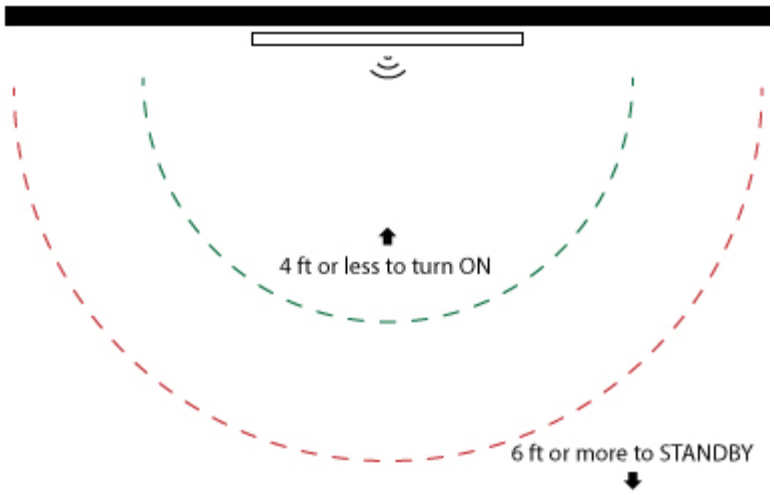
A. Context

"Natasha is almost late for her class. Coffee is ready for her tumbler and she decides to also grab the sandwich for the road. She quickly opens the wardrobe to change. She realizes it might get warmer during the day and it might also rain. She turns back to find her iPhone to quickly check the weather forecast to find that indeed it is likely to rain. Natasha scrambles to find a suitable dress to go with her hooded jacket. But she has to choose carefully, as there is also a formal lunch meeting she is scheduled to attend with her research advisor. She turns back again - this time to check the bus schedule to make sure she doesn't miss the right bus leaving for campus…"

Today's busy schedules require everyone to consciously keep track of tasks, efficiently manage time, stay updated on local surrounding while at the same time maintaining a healthy lifestyle and last, but not the least, looking one's best! Dressing appropriately involves considering the weather, nature of occasion, expected activities and an up-to-date knowledge of what is "in style". In addition, there is the process of finding what suits each individual in accordance with aesthetics. For some people the way they dress or look is a high priority, especially if they are attending important events such as business meetings, special high-profile dinners, a date etc. For others, dressing up is not even a priority and is usually something that they do very casually and without much thought. Not everyone can afford a personal fashion stylist who can cater to their everyday dressing needs or show them to dress right. So, what should you wear today? Rather than spending your valuable time searching every morning - or worse - leaving home dressed inappropriately, let DressWiser help you pick the right attire!

B. Use

DressWiser is activated by proximity sensor when a user stands facing the device within 4 feet distance. A built in camera uses face recognition to identify user and automatically loads personalized content stacked at the side of the large, fixed display, requiring no user intervention. It is left to the user's choice to initiate interaction through the touch interface by selecting one of the stacked "widgets" for details, be it today's events, weather, reminders, bus schedules or dressing tips. The delivered information will be relevant to the specific user, learned user preferences and habits, time of day and aggregated data fetched from online PIM services (e.g., calendar, maps and event services). Moving away beyond 6 feet from the mirror will switch off display, lock user information and make device function only as a regular mirror.



SALIENT FEATURES:

- Designed for personal use at home, in the form of a wall-mounted dressing mirror - a daily household utility generally of regular use by all family members.
- Device intelligence takes weather, location and past user actions to offer dressing recommendations by chosen event category.
- Help user rotate clothes by date-wise logging of user selections.
- Minimum user intervention is necessary to activate device features to initiate service; accomplished through proximity sensing, face recognition and user account linking to existing maps and calendar services.
- Large wall-mounted display with high display details for life-size virtual trial.
- Remember user choices to build up wardrobe inventory and learn information relevance through user interaction patterns.
- Important personalized information as display widgets including calendar, weather, notes, messages, travel directions and to-do lists.

USER INTERACTION MODE:

- No action is required for activation, user authentication, loading functional widgets and switching device / screen off.
- Touch gestures are required for detail operation. Users will be able to drag widget stack to a convenient location on the mirror (e.g., if sitting down for longer tasks such as browsing dressing options).
- Motion gestures are enabled to browse through wardrobe collection and during virtual trial.

C. People

- ***Primary users:*** Working women, especially young female professionals and students are assessed as target users to receive maximum benefit of the interactive dresser.

- ***Other users:*** Any adult or teenager who can benefit from either dressing suggestions or helpful information to plan and maintain schedule for the day.

- ***Required user knowledge / experience:*** Users should ideally be familiar with interacting with smart devices through touch and/or gesture commands. Optimum usage of widget services requires having online presence especially for Personal Information Management, maps and direction services.

- ***Challenges:*** UX of configuration and personalization of device services, user privacy concerns, accessibility features.

D. Usability and Experience Goals for Users

Category	Description
Effectiveness	Seamless, simple interface - intuitive, smooth and simple learning curve, fast
Efficiency	▪ Minimum user interaction for basic operation ▪ Accuracy and relevance of recommendations ▪ Browse records and make updates easily and frequently ▪ Highlight appropriately important notifications, reminders and changes
Safety	▪ Maintain separate user profiles ▪ Identify users correctly and provide access to the corresponding profile only ▪ Keep sensitive and personal records private. Keep Shared data and messages separate. ▪ Cannot delete user records/messages/notifications unless authorized/commanded to do so. Work only with one user data set at a time ▪ Lock device when not being used to prevent unauthorized access.
Utility	▪ Robust design ▪ Functions and widgets must available at appropriate time/position in the interface ▪ User preferences and configuration settings must be recorded and reproduced in subsequent sessions.
Learnability	▪ Take advantage of user's knowledge and experience with existing products (smart devices that make use of touch/audio feedback etc.) ▪ Functions and task procedures should be obvious, or require very minimal training. ▪ Use real-world nomenclature for labels and functions
Memorability	▪ Consistency of interface ▪ Graphical cues and continuous feedback (audio/visual) to help users remember functions and progress with a task

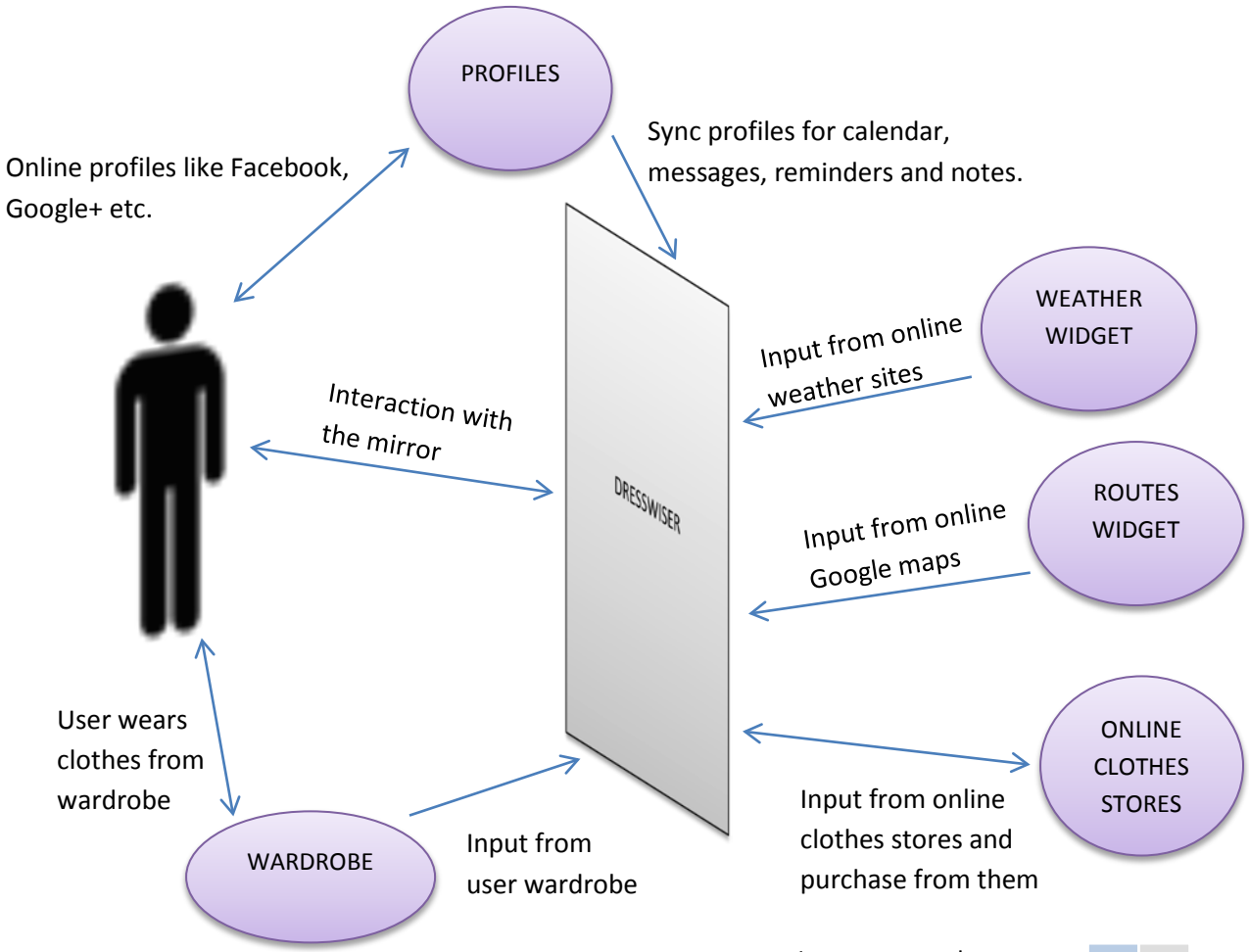
II. Conceptualizing

Our solution, DressWiser, will be an interactive high-definition display panel merged together with a regular dressing mirror, ideally fixed on the wall in a common household dressing area.

Interface Metaphor: “A Virtual Wardrobe”.

DressWiser mimics the process and user experience associated with browsing and trying clothes from an actual wardrobe within a virtual environment. Users are able to choose from event or occasion based categories to explore specific types of clothing collections and enter expanded view of each item. Smart options can be enabled to narrow down choices by weather conditions, color preferences and user activity from the past. Users also get an option to extend their search to linked online store collections that offer large life-size virtual trials.

A. Designing a Representation of the Target System



B. Building Objects and Actions

PHYSICAL SPECIFICATIONS

- **Dimensions:** Panel: 48 in X 24 in X <0.2 in (H X W X D), Core unit (housed at the back of panel): 2 in X 24 in X <0.5 in.
- **Weight:** ~3 lb.
- **Properties:** Display panel constructed of flexible film (made from OLEDs, organic light emitting diode, rather than using LCDs providing a sharper and better contrast and making it energy efficient) thus that can be rolled up for portability, water/humidity resistant housing for using as bathroom mirror.
- **Appearance:** Glossy mirror finish on front to produce accurate reflection.

DEVICE REQUIREMENTS

- **Power:** DC power from AC adapter and built-in Li-ion battery for portable operation.
- **Connectivity:** Internet through Wi-Fi, Bluetooth, NFC, micro USB port.
- **Imaging:** Embedded motion camera with LED light on panel for face detection and imaging.
- **Sensor:** Embedded proximity sensor for switching between active and standby modes.
- **Data processing:** Integrated CPU, storage, memory and firmware OS

FUNCTIONAL PROPERTIES

- **Activation:** The display panel activates on proximity when user is within 4 feet from the device, and will suspend when user either moves away beyond 6 feet distance, or manually suspend the display system through physical button.
- **User authentication:** Upon activation, the face detection system authenticates user identity and signs into corresponding user profile, or provides option to enroll a new profile

- **Service menu:** According to user customization and data availability, the panel displays an independently expandable “widget stack” at the edge of the panel. The collapsed widgets may display key information or action triggers next to corresponding service title and icon. For example, the dressing assistant will display action button to start browsing for dressing options, and weather widget will display the current weather conditions in graphical representation.

- **Data aggregation:** DRESSWISER will have ability to connect to feeds and online PIM services such as notes, appointments and maps to collect data for the user and organize as aggregated display.

- **System learning ability:** DRESSWISER will learn from user interactions to apply customizations to profile data relevance. It will store timestamps and user choices to analyze user behavior, map relevance or to manage inventory (e.g., wardrobe collection for the dressing assistant).

- **Portability:** DRESSWISER can be disconnected from the fixed location and rolled up for easy portability.

C. General Proposal of the Product’s Objects and Interactions

PRIMARY INTERACTION METHODS

- *Device Sensing:*
  DressWiser uses proximity sensor and facial recognition through built-in camera to sense presence of user to switch on and load user content on screen. Sensors provide automatic activation and suspension to remove user initiated actions to access device features.

- *Touch Commands:*
  Basic navigation and user interaction is achieved through touch commands on the panel surface. Users are able to complete most interaction tasks through tap and swipe gestures on screen.

- *Motion Gesture:*
  The large scale preview mode - such as during virtual trial - enables motion gesture as an alternate interaction method to browse between items. Motion

gestures allow users to interact from a distance, making it possible for the user to remain at a comfortable viewing distance.

INTERACTION MODE

DressWiser will not require user action for activation, user authentication and display the personalized "widget stack". User interaction will be required for:

- Enrolment of new profiles
- Configuration of services
- Detail viewing and operation of specific widget, e.g. dressing assistant, viewing bus routes and commuting options.

- **Interaction mode:** The device will respond to either capacitive proximity gestures or touch commands from the user.

- **Context and setting for usage:** User may use the device while standing in front of the mirror, glancing over displayed information or for quick lookup of details. For a sitting position user may drag to adjust the position of the "widget stack" to appropriate height, especially when using advanced or time consuming features.

INTERACTION PARADIGM

Thinking about environmental requirements is particularly relevant when considering interaction paradigms. Considering DressWiser in the context of the following paradigms:

- *Ubiquitous computing:* We could imagine the DressWiser as being like a wardrobe/attire planner and assistant on the wall, but in an electronic form with which people could interact.

- *Pervasive computing:* Carrying around your own DressWiser builds directly upon current expectations and experience of personal assistants, who should be available almost every given time and everywhere.

III. Identifying Needs and Establishing Requirements

A. Target Audience and their Needs

DressWiser is intended to serve as a practical and effective solution to overcome everyday dressing-up and related decision-making hassle within the home environment. Given this context and goal, the target audience includes all members of a household (teenagers and grown-ups) with an active lifestyle, average to high social interaction and who commute to work, school or social events on a regular basis. The "Primary" user group is young professionals and students, especially women (owing to a relatively larger wardrobe inventory to choose from). Users should ideally be somewhat familiar with smart device interaction using touch and gesture commands. [We conducted a brief survey to better understand user needs, preferences and current trends. Questions included in this survey can be found in *Appendix Section A*].

Some of the basic user needs that have been identified include:

- Simple and intuitive interface with minimal learning curve.
- Minimum input on the part of the user for basic operations.
- High accuracy and relevance of recommendations.
- Maintain and secure user profiles and preferences.
- Seamless user experience.
- Ease of navigation within the interface and prompt feedback.

B. Requirement Analysis

1. User Requirements

- Can be placed and used in the bedroom setting where dressing facilities are located most often.
- Can be used while standing in front of the mirror while dressing and even while seated.
- Typically does not require longer than 15-20 minutes of standing to use basic features.
- Suggest dressing options based on nature of event, weather and mode of transport.
- Provide option to try wish list of clothes virtually on the mirror panel.

- Display important information such as weather forecast, reminders, appointments and traffic information relevant to user's profile and requiring minimum interaction for retrieval.
- Connectivity and constant synchronization with existing PIM services for to-do lists, notes and calendar.
- Maintain user preferences, personal details and updated wardrobe inventory securely.

2. FUNCTIONAL REQUIREMENTS

- Power supply and provision to switch to battery power.
- High definition image input and output on large display panel.
- Wireless internet connectivity.
- Service connectivity with personal information management tools for data sharing.
- Ability to process proximity and facial recognition.
- Ability to process touch and gestures as mode of user interaction.
- High processing capability and lag-free, prompt feedback.
- Background noise filtering capability.

3. USABILITY REQUIREMENTS

- Minimum user interaction for basic features used while standing to avoid fatigue and discomfort.
- Simple, intuitive interface with minimum and gradual learning curve.
- Device activation and suspend actions to trigger at comfortable distance by proximity sensing.
- Accurate profile matching based on face detection.
- Height adjustment and positioning for interactive controls on screen.
- Ability to interact comfortably with both basic and advanced features while in sitting position.
- Ergonomic data browsing capability.
- Appropriate visual cues and feedback in the form of prompt message display, helper functions, documentation within user manuals etc.

C. User Scenarios

- **SCENARIO 1: NATASHA, FEMALE, INTERNATIONAL GRADUATE STUDENT**

  It's been just a month that Natasha has come from India to the United States of America to pursue her Master' degree. Owing to her friendly and good hearted

nature, she has made quite a few friends from different backgrounds. This Saturday, some of her close American friends have invited her for a night out involving a nice dinner followed by a trip to one of the famous and exquisite night clubs in the city.

She has been to late night parties and events back home but this would be her first time in a new country and with a new set of people. She is not really familiar with the American fashion and dressing sense and doesn't want to feel out of place by wearing the wrong attire. She uses DRESSWISER to scan through her current wardrobe collection but on not finding anything appealing she then decides to look for new dresses online with the aid of the mirror. After trying virtually many dresses, she finally chooses a dress that suits her really well and orders it. Consequently, she looks stunning on Saturday night and is able to make a lasting impression.

- **SCENARIO 2: DAVID, MALE, SENIOR EXECUTIVE AT A REPUTED FIRM**

David is planning a work cum vacation trip to Munich. He intends to meet one of his major clients while at Munich for a brief business meeting and wants to spend the remaining time with his family. It's the month of January and it is snowing considerably in Munich but David is unaware of the exact environmental conditions in the city and so wants to be prepared with the right set of clothing. He uses his recently purchased DRESSWISER to first check the weather of his destination and based on the recommendations put forth by the smart mirror, David is able to pack the right set of clothes for his family and for himself to be able to meet his client for a formal meeting as well.

- **SCENARIO 3: BLAIR, FEMALE, TEENAGER**

Blair has just turned thirteen and like most teenagers is highly conscious of her looks and peer opinion. She wants to learn to dress right and is highly influenced by some of her girlfriends who always manage to dress and carry themselves well. She uses the DRESSWISER her parents gifted her to keep a track and sort out clothes that she should wear for regular classes and for special events, based on the mirror's recommendations. The mirror is able to keep her up to date with latest fashion trends, prevent repetition of dresses from the previous week, wear comfortable and appropriate dresses based on the weather and the nature of the event.

IV. Design and Prototypes

A. Concept Design

1. PRODUCT CONCEPT EXPLAINED IN DETAIL

In the context of a family home, today's technology can serve as an aid to each family member get ready to face the day with confidence. While getting ready in front of the dressing mirror for work, school or any social event, a large screen interactive mirror can offer dressing assistance, a virtual trial room (with items from participating stores), weather forecast, commuting options to routine destinations, medication reminders, notification of events or simply notes left by other family members. DressWiser is our idea for the "Personal Stylist" of the "Next Generation"!

FUNCTIONAL DESCRIPTION:

Physically, DressWiser is a 48 x 24 x 0.2 inches wall screen display with a glossy mirror finish to produce crisp mirror reflection and that can run on DC power from AC adapter and built-in Li-ion battery for portable operation and in absence of a power source. The display panel is constructed using a flexible film of Organic Light Emitting Diodes (OLEDs) for sharper and better contrast while being more energy efficient. The mirror display uses embedded proximity sensor and infrared camera; the former is used for switching between active and stand-by modes and the latter is used for face detection and imaging. The device makes use of an integrated quad-core processor CPU with built-in storage and firmware OS and connectivity through Wi-Fi, Bluetooth, NFC and a high speed micro USB port 3.0 on the side panel.

HOME SCREEN:

This is the screen which is first visible to the user when the device activates. Upon successful face-recognition, the device will log in to the correct profile. The primary elements that make up much of the home screen are the customizable widgets which are laid out close to the margins by default so as not to interfere with the mirror image of the user (although the individual positions of the widgets can be customized by the user). The following widgets can be seen:

- *Weather widget:* displays up-to-date weather forecast information for the current location or the destination location depending on the current scenario.

- *Message widget:* displays messages left by family members and/or other social contacts.

- *Map widget:* displays route and traffic information coupled with commuting options for most frequently visited destinations or specific target destination depending on the scenario.

- *Calendar widget:* displays reminders and event notifications.

- *Profile widget:* displays the user's profile picture and stores personal information such as contact details, payment details etc.

- *Settings widget:* allows users to customize DressWiser configuration settings and set preferences.

- *Wardrobe widget:* displays all (or specific) wardrobe collection and store inventory depending on the scenario. Allows users to apply filters for recommendation such as dressing category, color, recommendation influencing factors such as weather, destination etc. Also, allows user to purchase apparel from participating online stores.

WARDROBE SCREEN:

This screen mimics the user experience observed when browsing for clothes within a physical wardrobe. This widget stretches out in form of a drawer showcasing the user's wardrobe collection and allows users to browse through them using either touch or dynamic swiping hand gestures. A small ribbon at the top lists all event categories and the ribbon below it highlights all the dresses being recommended in the form of image thumbnails. One dress at a time is displayed in expanded view below the wardrobe drawer. Users can quickly flip through the clothes and even filter the clothes being recommended by doing one of the following:

- Choosing a particular event category
- Choosing a color from the color wheel.
- Turning on-off weather based intelligence.
- Turning on-off destination based intelligence.
- Turning on-off memory of previously worn attire on similar occasion.

Users can change the current destination and visit the online stores for more options.

VIRTUAL TRIAL-ROOM SCREEN:

Similar to the wardrobe screen, this scree showcases dress options from the inventory of a number of online stores based on search category and user preferences. A 3D avatar (efficiently mimicking the user's body image) is used to try on clothes and get a feel of how the dress would look on oneself. Users can rotate this avatar by 360 degrees within a 3D space to get complete feel of how the dress fits on all sides. A small text area at the side will be used to display apparel information and provides the option for on-click purchase (based on the user's payment profile details). Browsing and navigation within this screen can be done through both touch and gestures, similar to the wardrobe screen.

2. MULTIPLE SKETCHES

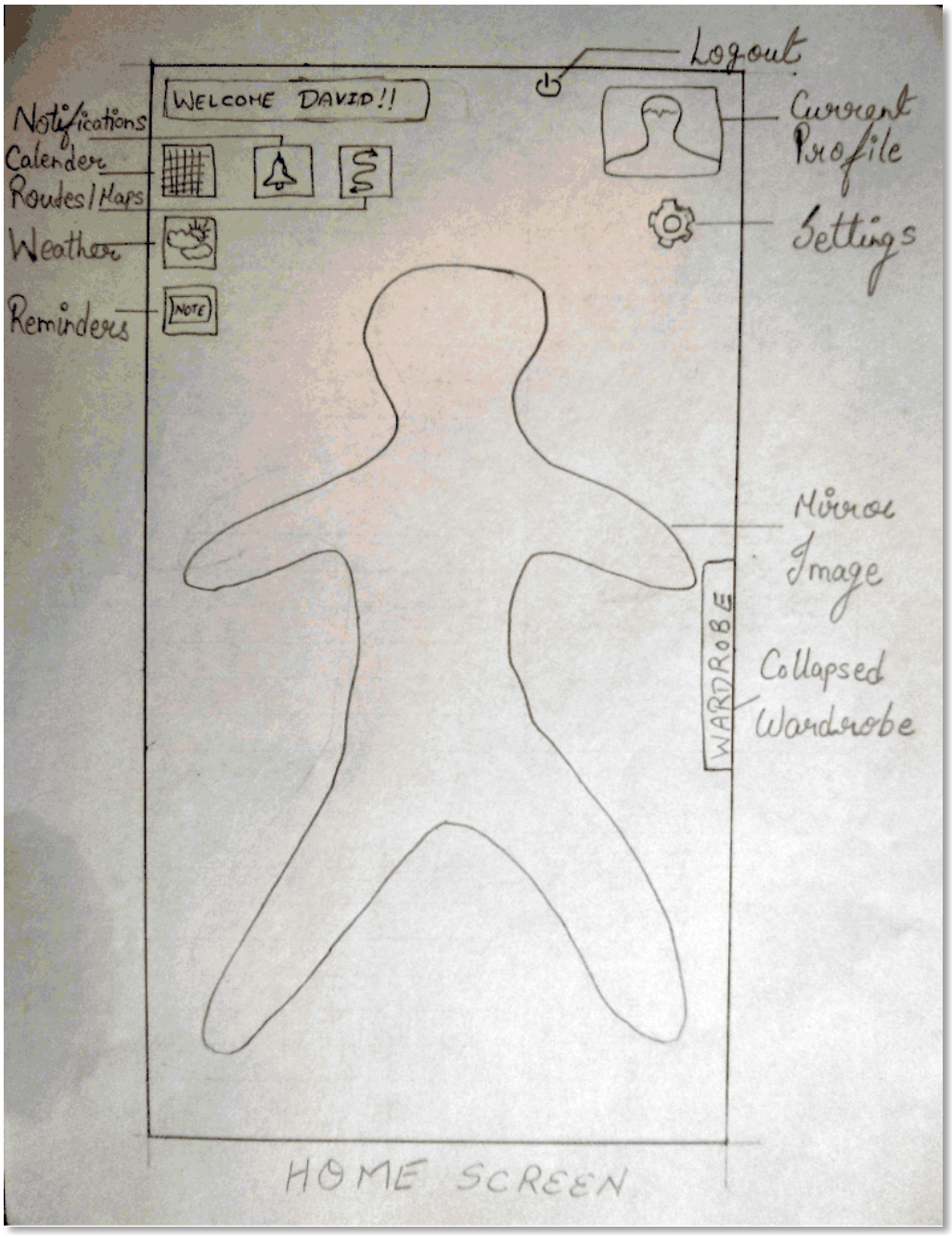


Figure 1: Sketch showing the Home Screen

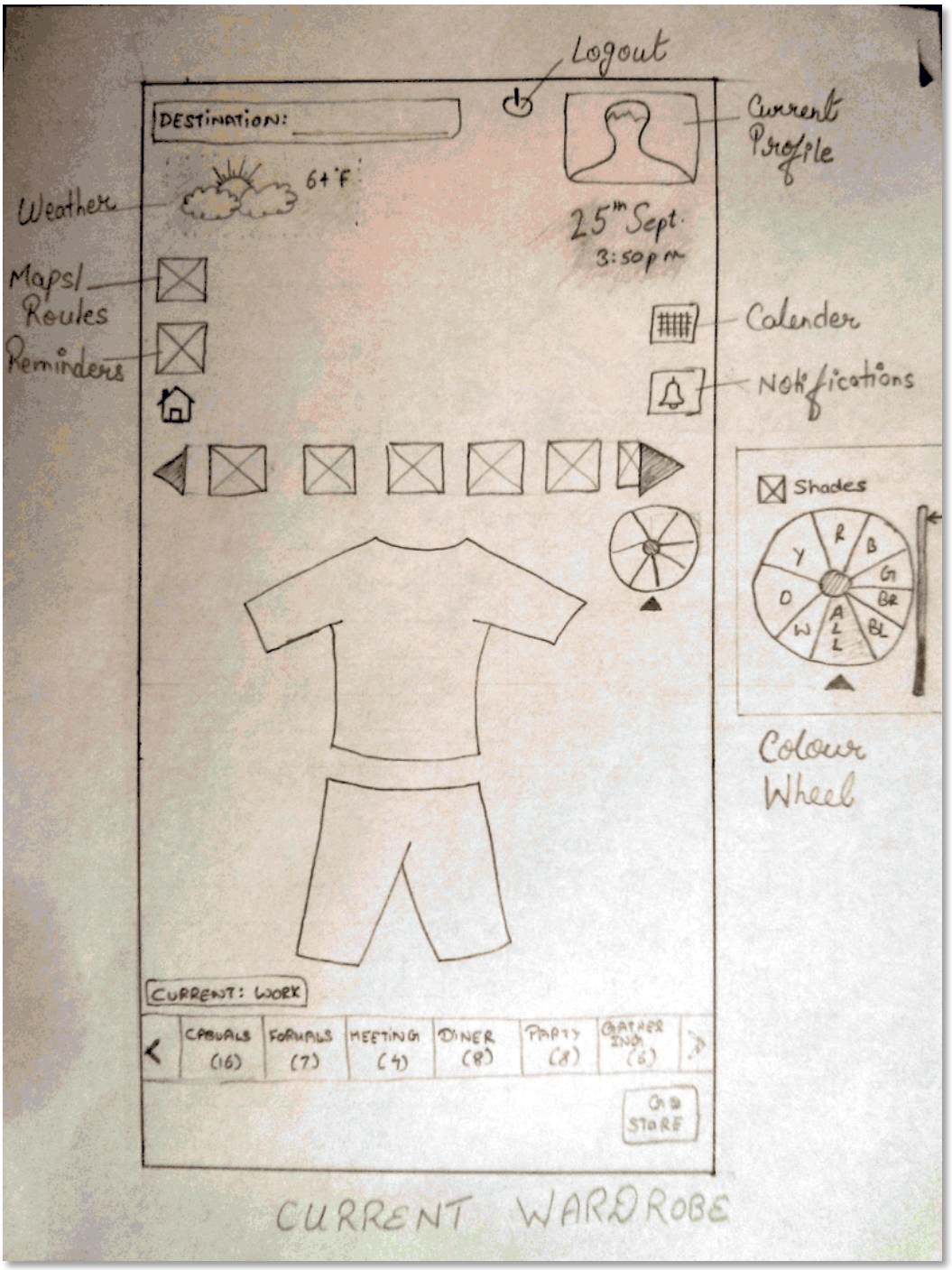


Figure 2: Sketch showing the wardrobe screen

(Additional sketches can be found in the Appendix Section B)

3. LOW-FIDELITY PROTOTYPE

In human–computer interaction, paper prototyping is a widely used method in the user-centered design process, a process that helps developers to create software that meets the user's expectations and needs - in this case, especially for designing and testing user interfaces. It is throwaway prototyping and involves creating rough, even hand-sketched, drawings of an interface to use as prototypes, or models, of a design. We chose this method because this method of prototyping and usability testing can provide a great deal of useful feedback which will result in the design of better products. We needed to get a feel of how users would interact with the product and this technique seemed the right way to do so.

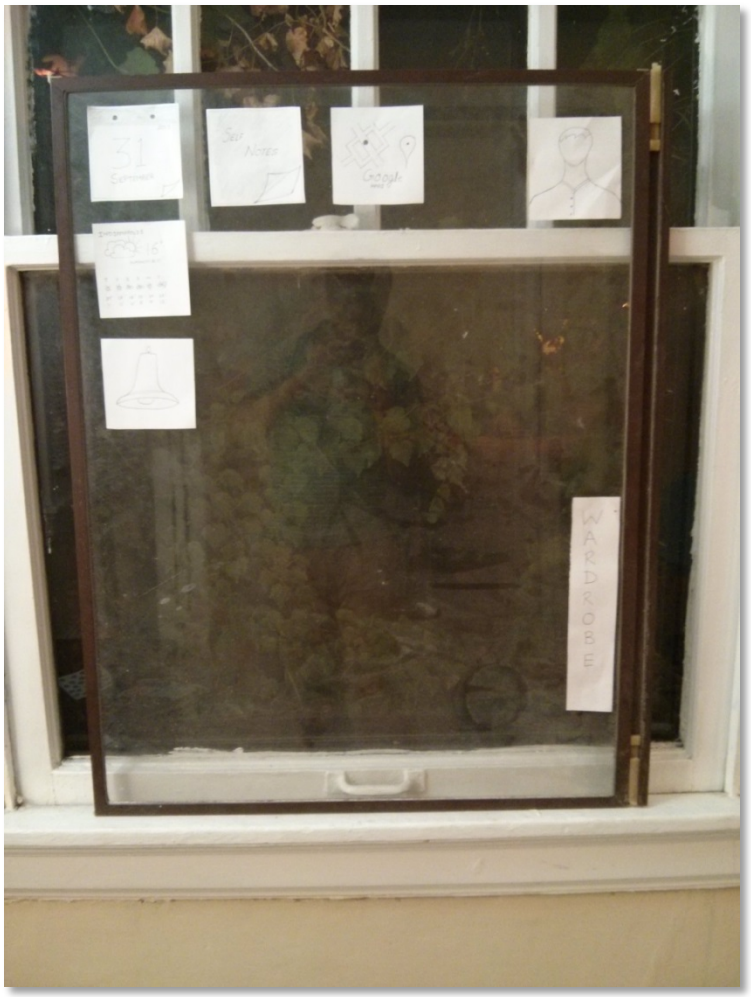


Figure 3: The mirror piece that served as our display panel. This was roughly the same dimensions as the original product and helped simulate true user experience.

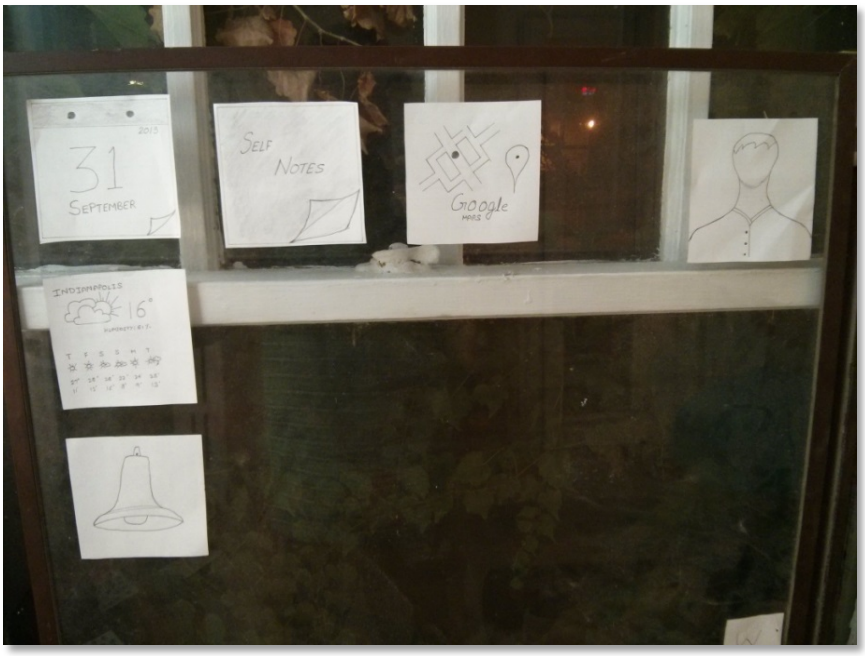


Figure 4: The paper cut-outs acted as widget controls.

Figure 5: One team member standing in front of and using the prototype by touching the mock widgets.

(Additional images of the Low-Fi prototype can be found in the Appendix Section C)

B. High-fidelity Prototype

(Link to Hi-Fi prototype: DressWiser.html)

1. Digital Illustrations

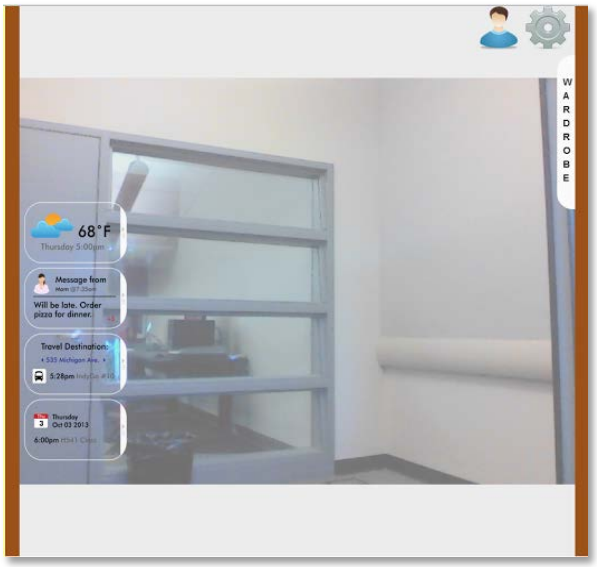


Figure 6: The Home page which is seen when the user logs into the system.

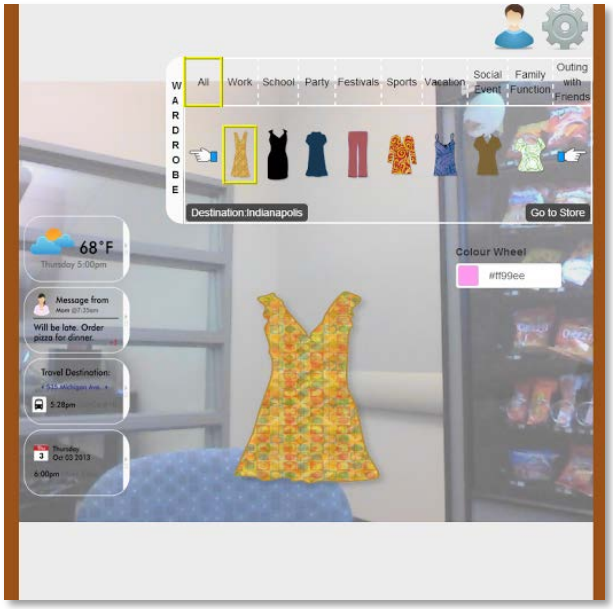


Figure 7: The current wardrobe screen where users can view and browse through their current inventory.

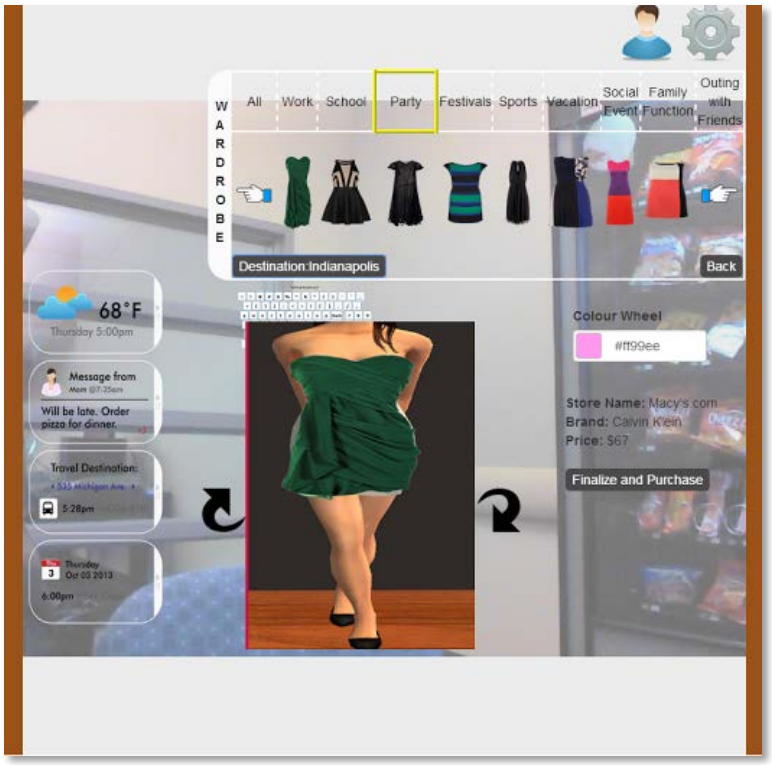


Figure 8: The virtual trial room screen where users can try apparels from online stores on a 3D avatar.

(Additional images of the Hi-Fi prototype can be found in Appendix Section D)

2. EXPLANATION OF INTERACTION AND INTERFACE DESIGN COMPONENTS

The Hi-Fi prototype has been made in the form of a website using technologies such as HTML5 for the layout and integrating the web camera (to simulate the feeling of viewing oneself within the prototype) and "jquery" for all transitions. The following is a comprehensive list of functions and components than can be used and seen on the interface:

- The "weather" and "messages" widget can be clicked to expand them. The expanded form of the widgets presents more detailed information for the user. Clicking the widgets again collapses them.
- The "wardrobe" widget can be clicked to slide it out in form of a drawer. Clicking the wardrobe label again collapses the drawer to its default state.
- Within the "wardrobe" widget, dress categories can be selected by clicking them. The default category selected is "All".

- Users can browse through the recommended clothes using the left-right hand icons on either sides of the thumbnails ribbon. On selecting a particular dress, it is shown in the expanded view underneath the drawer.
- The “color wheel” is clickable and allows users to pick a color of their choice. Upon choosing a color, only dresses matching that color will be displayed.
- The “Destination” button can be clicked to display a small keyboard on the screen. This keyboard will be used for user input.
- The “Go Store” button takes the user to the Virtual Trial Room screen where the user is shown all dresses available from online stores matching the current search criteria. Navigation within this screen is similar to the previous screen.
- The 3D avatar can be rotated by clicking the arrows on either side of the avatar.
- A small box to the right shows information related to the current dress being viewed.
- The “Finalize and Purchase” button allows users to make a one-click purchase instantaneously.
- The “Back” button takes the user back to the “wardrobe” screen.

V. Evaluating the Design

A. Usability Study

1. Interview with Users

Much of the usability study was conducted within a laboratory. Users were first asked to sign an Informed Consent Form (*Appendix Section E*) and then after the briefing were supposed to explore around the interface and answer some questions posed to them simultaneously.

Experimental setup for the usability test session was as under:

- The prototype was executed on a large wall display screen (13x5 feet).
- A web camera (mounted on a tripod and later attached to the screen) was used to capture the image of the user and project it back as a mirror image within the prototype.
- A video camera was used to record the entire session.
- Of three team members, one acted as the Interviewer, the second as the controller and recorded notes and the third recorded the entire session.
- Each user was made to stand in front of the wall display and interact with the screen by touching it. Touch and hand gestures were simulated by clicking using a mouse pointer (the controller operated the mouse while the user performed the touch and hand gestures).
- Interview questions were not 'task specific'. The users were asked to 'explore' at each step and 'think aloud' what they saw and felt. (Refer *Appendix Section F* for Interview Questions)
- Each session lasted approximately 30 minutes. No rewards of any kind were offered for participation within this study. Participation was voluntary and users were given the option of leaving the session at any time.

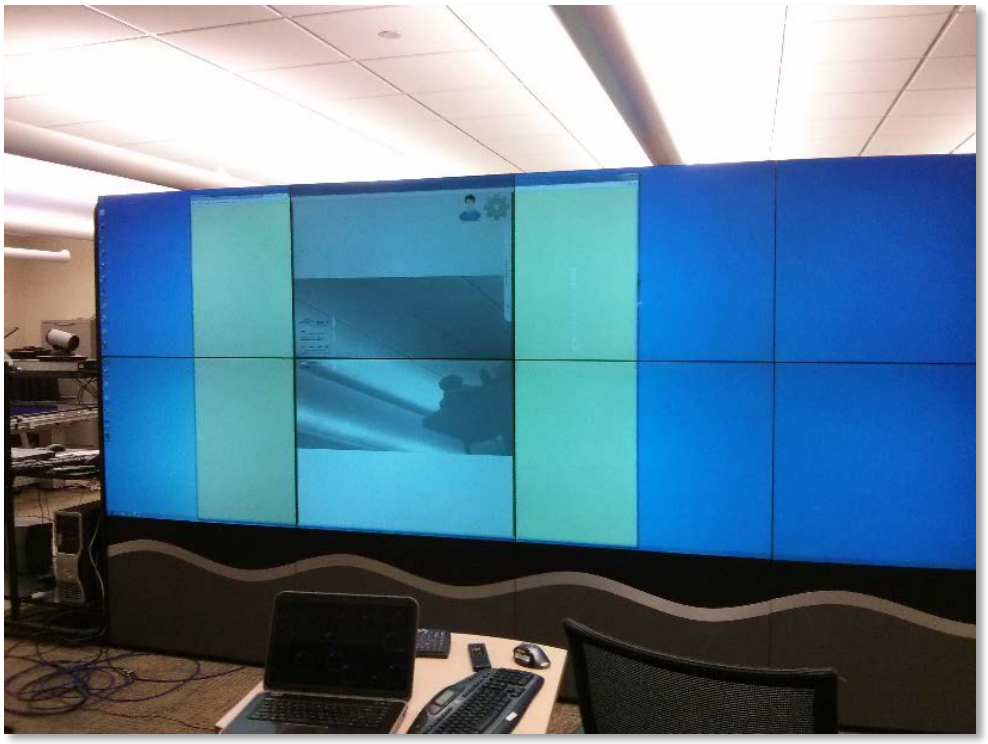


Figure 9: A snapshot from the laboratory where the session was conducted. The image shows the large wall display on which the prototype was executed.

2. INTERNAL WALKTHROUGH : TASK / STEP AND OBSERVATIONS

- ***Activation:***
  - It is not easily understood that the displayed information is based on user's profile. There can be brief welcome message stating user's name and that the user is logged in.
  - Being the main feature, "Wardrobe" maybe missing focus. It can be designed to have more prominence and recognition as a pull-out app. Or, at activation, the app can start as expanded with the welcome message and rolled in after a second.

- ***Open & browse wardrobe:***
  - Categorization is clearly visible and makes it easy to understand that the wardrobe can be browsed by category of events / occasions.
  - Filtering options seem scattered, causing difficulty to recognize which options are available to narrow down list. Perhaps Smart features

(weather, location), color selector could be made to look similar and placed together near category selection bar.
- Unless told, it may not be obvious that motion gesture is enabled for browsing through items. A cue or tip can be placed in the preview area as a hint to use motion gesture.

- ***Browse a specific category:***
  - There might be too many categories, making it difficult to choose an appropriate one. The main categories can be limited with a simpler understanding for high-level differentiation, eg., regular wear, casual event, formal event, active wear.
  - There is no info about how many items are there under the category, especially when they are not all in view. Maybe a count can be shown.
  - Moving between categories and browsing items is easy and comfortable.

- ***Go to online store:***
  - Switching to online store does not make it visibly clear that the system switched to a different section of the app. Perhaps the store interface can be designed to have unique visuals around the thumbnail list bar.

- ***Browse online catalog and use virtual trial:***
  - It is not possible to see what the best or most popular items are. The store environment can provide recommendations or sorting options as featured items, popular, new additions etc.

- ***Place an order from online store*:**
  - There is no confirmation at final purchase action. The user can be given option to review info to confirm purchase: Saved payment info, saved delivery address, estimated time of delivery etc.

- ***Check messages and to-do items from the messages widget:***
  - The widgets present a lot of information within a small space. When the wardrobe app is collapsed, widgets can be displayed as a larger horizontal carousel with the center one expanded to display full / expanded content - this way browsing between info widgets can also take motion gestures and provide easy navigation.

B. Assessment of Findings

1. The Positives

- Users could comfortably make sense out of the home screen and could identify most widgets and the wardrobe button correctly.
- It was clear that the users must tap on the widgets to open/collapse them.
- The availability of gestures to quickly browse through dress collections was a welcome and convenient feature that saved the effort of tapping the screen repeatedly.
- Users appreciated the fact that the mirror displayed intelligence in recommending clothes taking into account weather, destination and previously worn clothes on similar occasions.
- The filtering options with the aid of color wheel and categories were helpful and made organization simpler.
- One-click purchase appealed to the users.
- The fact that DressWiser can maintain independent profiles and store them securely was a plus.
- Being able to actually try the clothes on without having to visit a store was highly appreciated.
- The fact that the mirror did most of the job and required minimum input was appealing for the users.

2. The Problem Areas

- The "Messages" widget was unclear in its collapsed state. Only upon touching and opening the widget users understand the information being displayed. Also, total number of messages must be displayed.

- Users thought that they could stretch the image of the clothes being displayed from their current wardrobe and then superimpose this image on their mirror reflection and thus, get an idea of how they would look in that dress.

- The mirror's intelligence was not immediately clear. Most users failed to guess that current recommendations take weather and destination into account.

- The "Destination" button was ambiguous and did not convey enough information by itself.

- Some users needed an additional filter by type of garment. For example, receiving recommendations only for the lower garment.

- Users swiped over the widgets to receive more information. Such as, sliding over the weather widget to see the forecast for the subsequent time-hours or days.

- After a successful purchase on the online store, the purchased apparel must automatically be added to the current wardrobe without user intervention or the need to scan the cloth again.

- Within the online store mode, users wanted to be able to select the stores from which clothes were being displayed and to be able to specify a price range.

C. Revised Interactive Prototype: Indication of key design changes

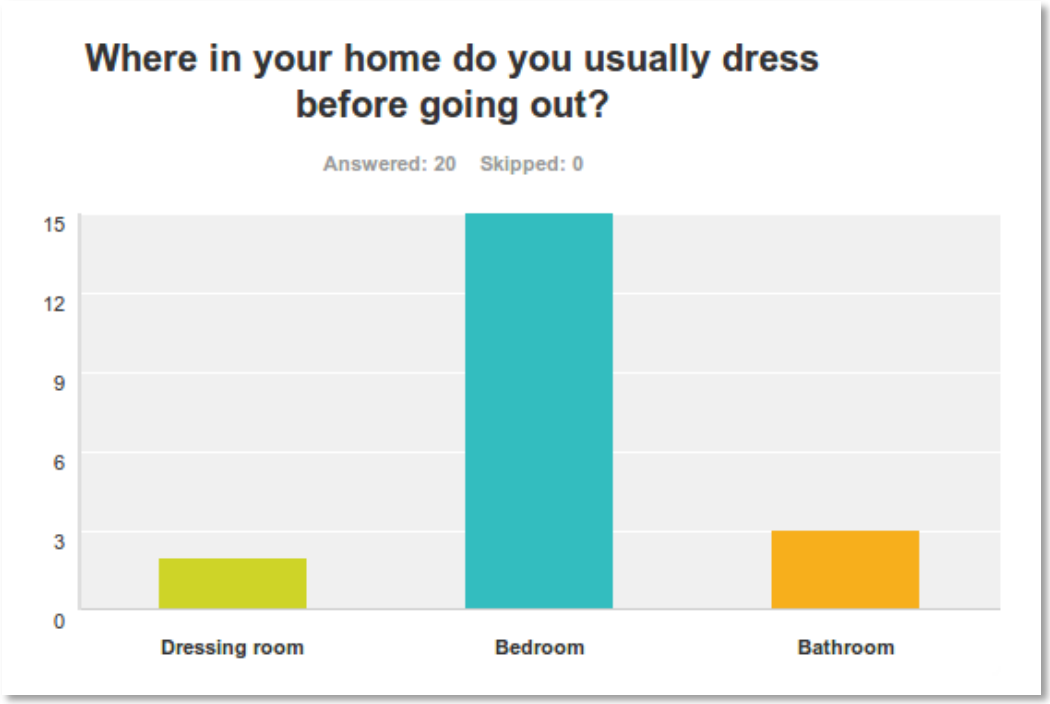
Some of the changes we incorporated within the revised prototype, based on the findings from user testing, include:

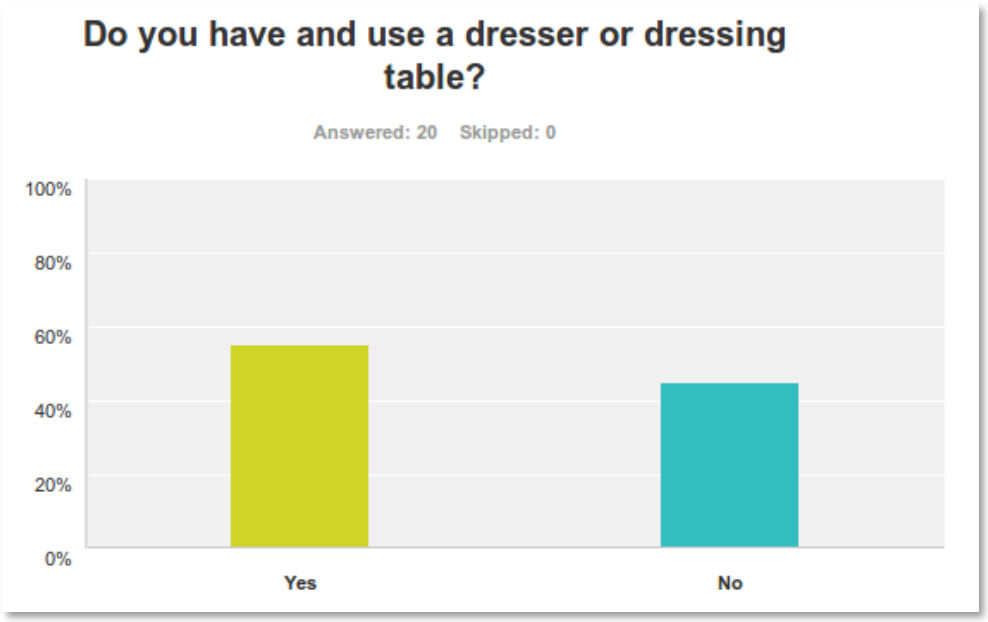
- Readability of all widgets was enhanced by improving upon the font style and size.
- The Message widget has been modified to make it clearer. It also displays the total number of unread messages.
- The Routes widget has been modified to make it more understandable. A label was added to enhance readability.
- Added the option to turn on/off the destination, weather and color filters within the wardrobe drawer.
- A timer was added to simulate the scenario of the user walking to the mirror and the mirror displays that the user has been logged in by showing the widgets and wardrobe.
- Information like brand name, store name and price of the online store clothes was displayed in the right hand side.
- A ‘purchase online’ button was added with a confirmation dialog box.
- Additional clothes were added to the inventory so that user can differentiate between wardrobe clothes and online store clothes.
- Avatar image was made more accurate by super imposing the store clothes on the avatar body.

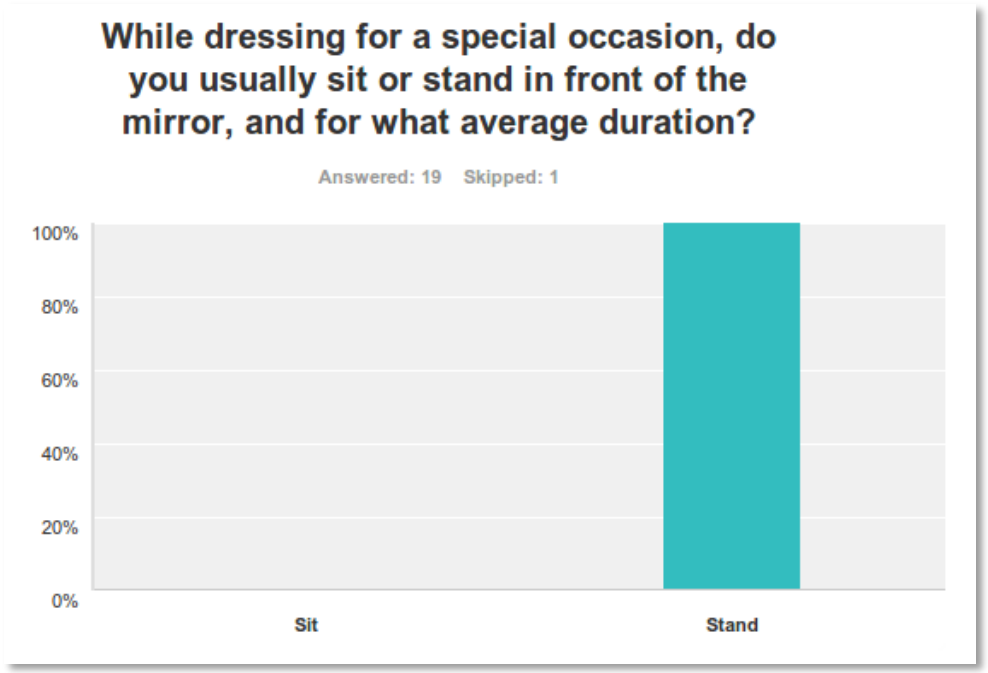
VI. Appendix

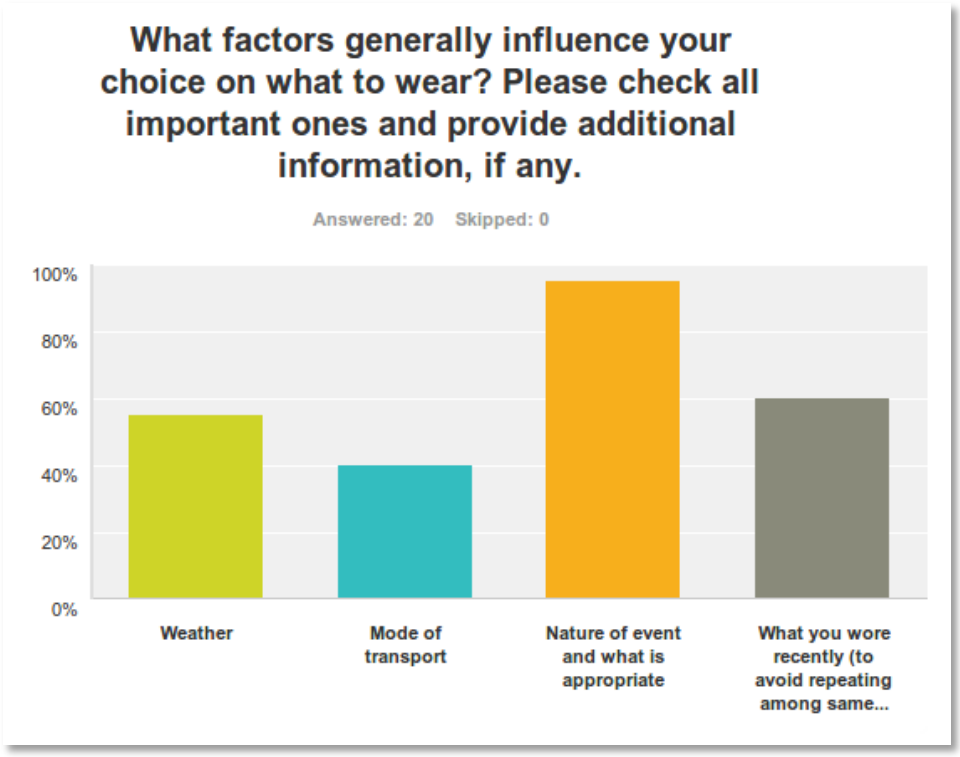
A. Survey Questionnaire and Statistical Results

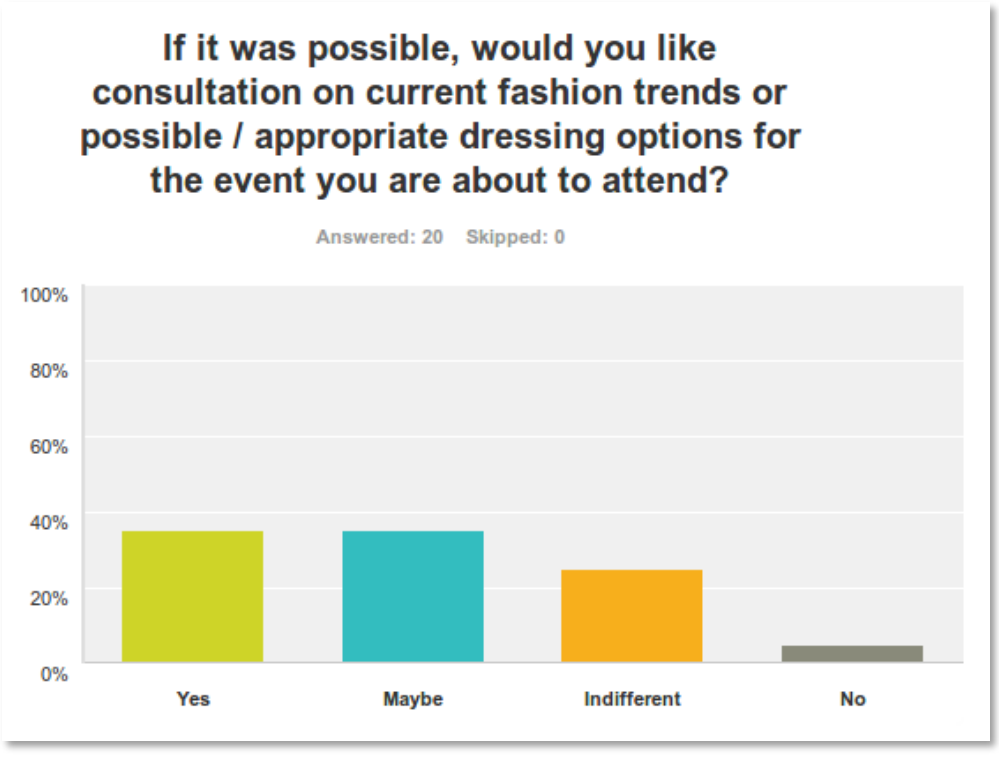
A Survey comprising of 8 generic questions was conducted to understand user requirements, preferences and expectations. The responses from all respondents were collected, analyzed and findings were used to frame a stronger conceptual model for the product and lay down the key user and functional requirements. We tried to target a diverse group of potential users comprising of both male and female students and working professionals and belonging to different nationalities. This ensured that the responses collected belonged to a diverse user group. The questions and their responses (shown with the help of bar graphs) are as under:

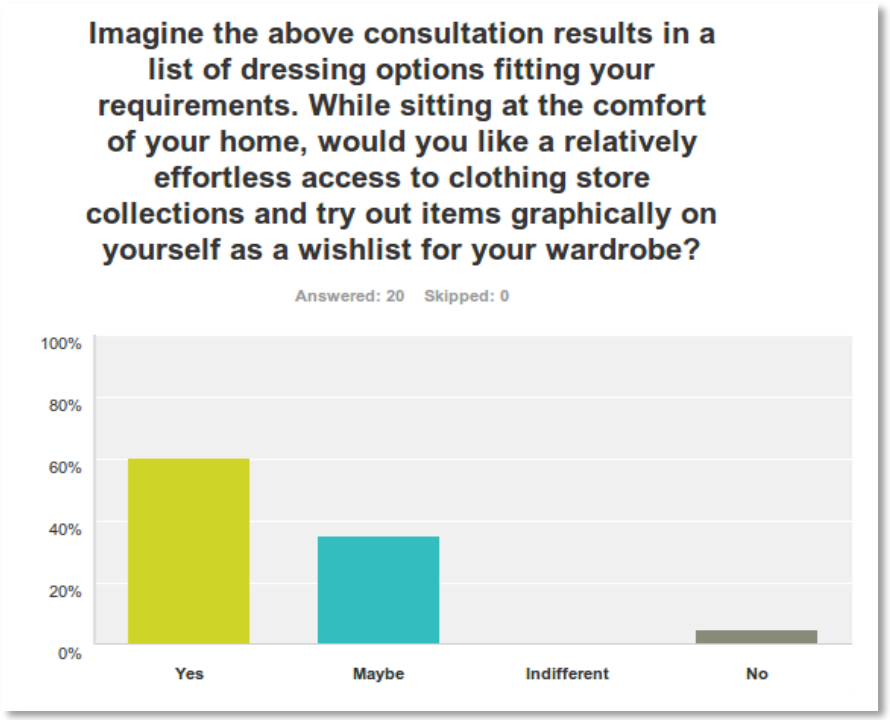


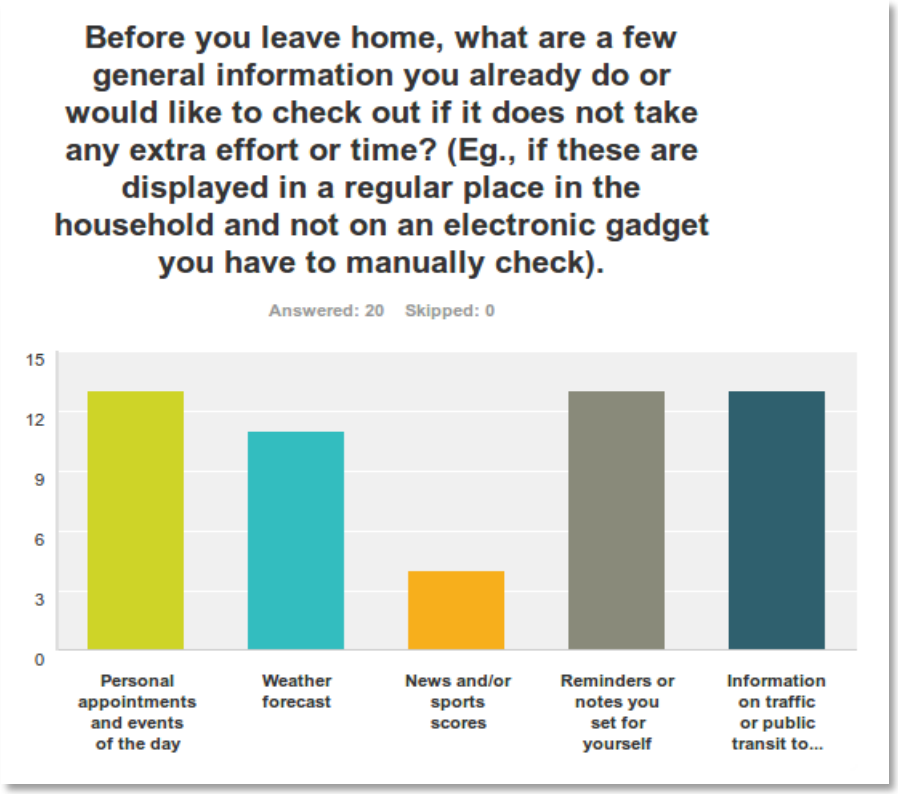

Do you have and use a dresser or dressing table?
Answered: 20 Skipped: 0
100%
80%
60%
40%
20%
0%
Yes
No

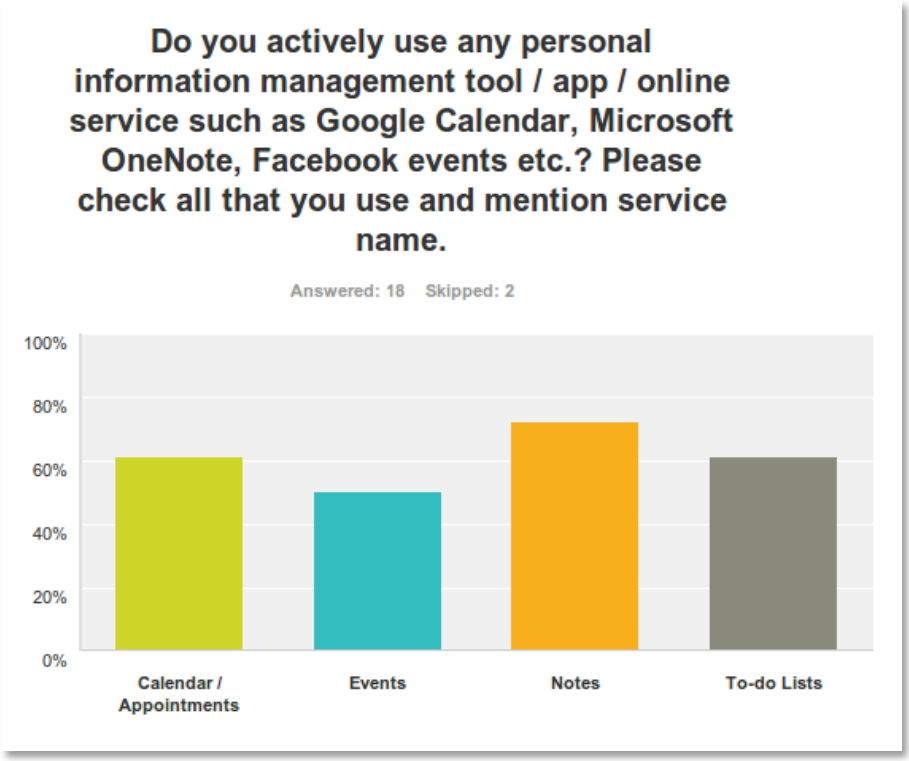

While dressing for a special occasion, do you usually sit or stand in front of the mirror, and for what average duration?
Answered: 19 Skipped: 1
100%
80%
60%
40%
20%
0%
Sit
Stand


What factors generally influence your choice on what to wear? Please check all important ones and provide additional information, if any.
Answered: 20 Skipped: 0
100%
80%
60%
40%
20%
0%
Weather
Mode of transport
Nature of event and what is appropriate
What you wore recently (to avoid repeating among same...


If it was possible, would you like consultation on current fashion trends or possible / appropriate dressing options for the event you are about to attend?
Answered: 20 Skipped: 0
100%
80%
60%
40%
20%
0%
Yes
Maybe
Indifferent
No


Imagine the above consultation results in a list of dressing options fitting your requirements. While sitting at the comfort of your home, would you like a relatively effortless access to clothing store collections and try out items graphically on yourself as a wishlist for your wardrobe?
Answered: 20 Skipped: 0
100%
80%
60%
40%
20%
0%
Yes
Maybe
Indifferent
No


Before you leave home, what are a few general information you already do or would like to check out if it does not take any extra effort or time? (Eg., if these are displayed in a regular place in the household and not on an electronic gadget you have to manually check).
Answered: 20 Skipped: 0
15
12
9
6
3
0
Personal appointments and events of the day
Weather forecast
News and/or sports scores
Reminders or notes you set for yourself
Information on traffic or public transit to...



Conclusions that could be drawn from the Survey at this stage were:

- Most people get dressed in their **bedrooms**. There was a majority of votes for dressing up in the bedroom as against the bathroom or a separate dressing room (if available). This indicated that our choice of the target environment for the mirror was right.
- Most people prefer to **stand** in front of the mirror while getting dressed. This indicated that “dressing right” takes a **greater priority** over body fatigue that may be induced due to long durations of standing.
- All participants answered **positively** for a **visual reality feature** where they could try dresses.
- Most people were **unsure** about whether they would like to receive information on **fashion trends**. Some participants however, looked forward to this feature.

B. Additional Sketches

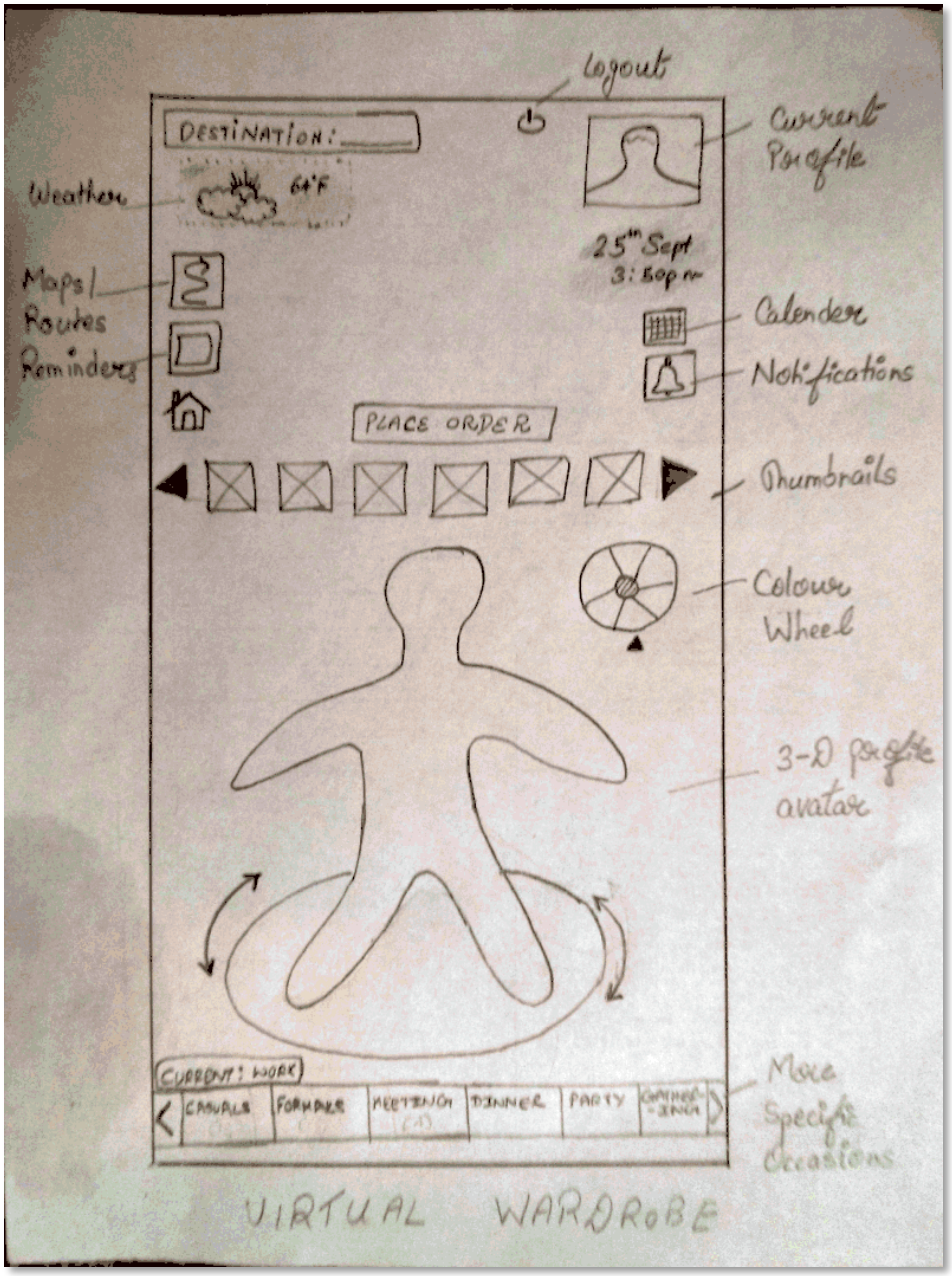


Figure 10: Sketch showing the virtual wardrobe screen

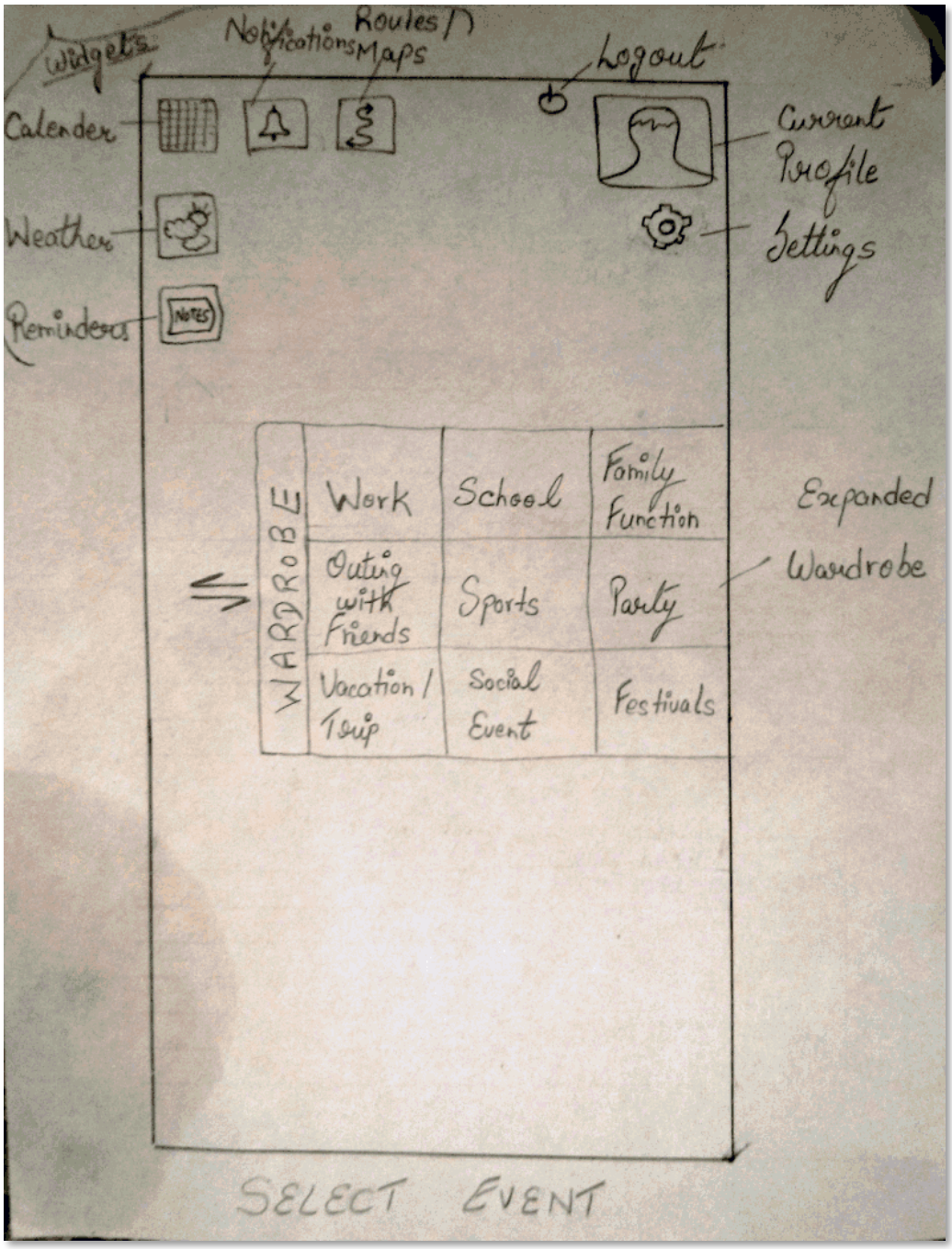


Figure 11: Sketch showing the expanded Wardrobe widget and event categories.

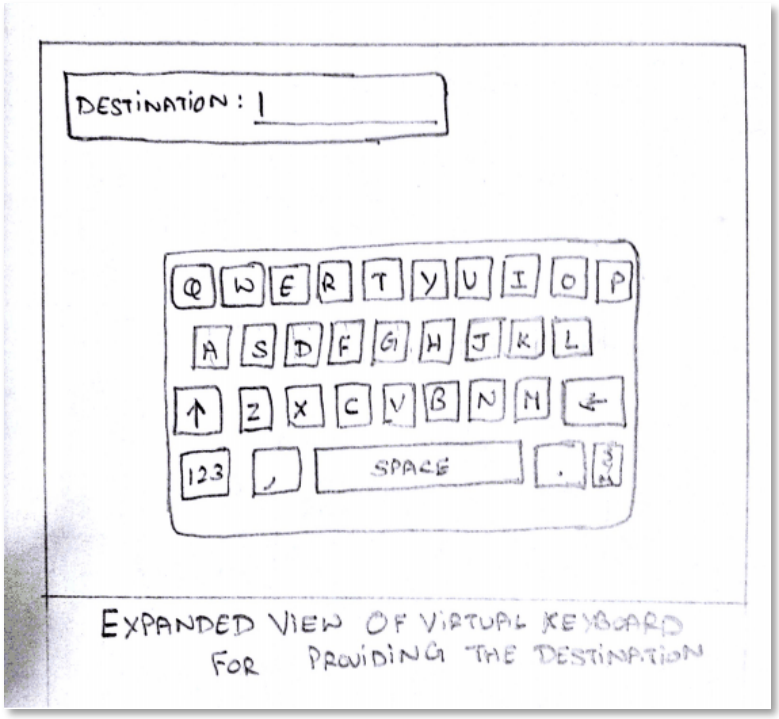


Figure 12: Expanded view of the virtual keyboard.

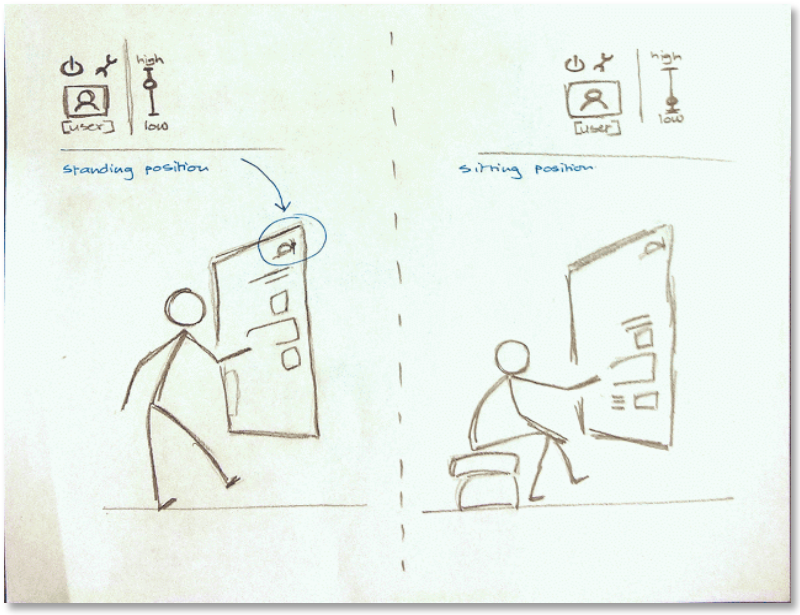


Figure 13: A user interacting with DressWiser in the standing and seated positions.

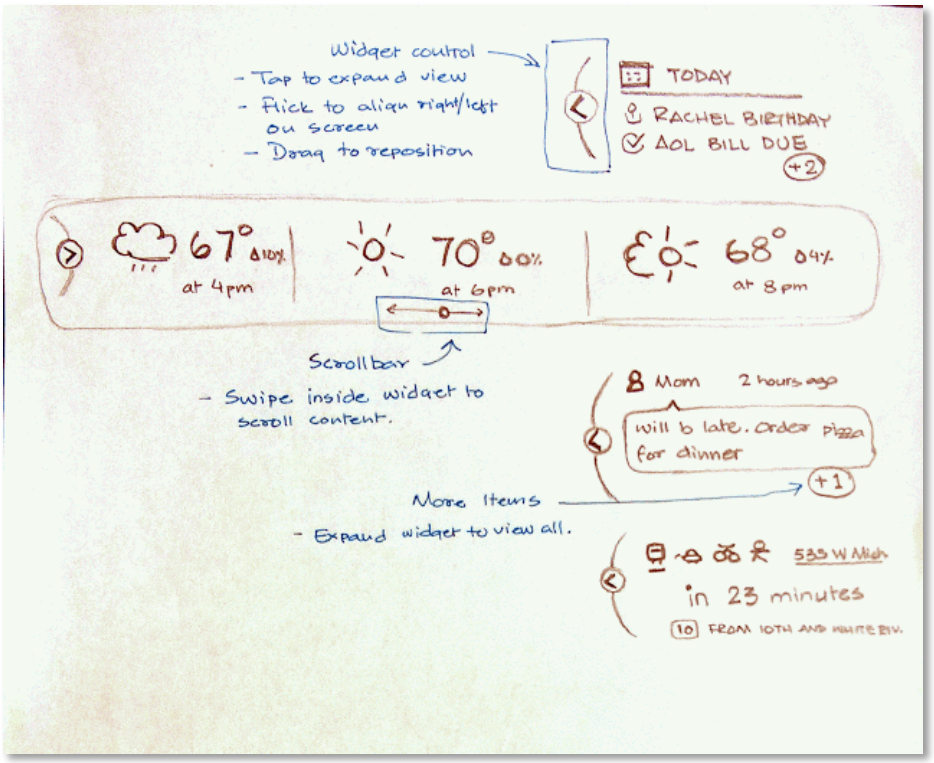


Figure 14: Expanded Weather widget.

C. Low-fidelity Prototype (Additional snapshots)

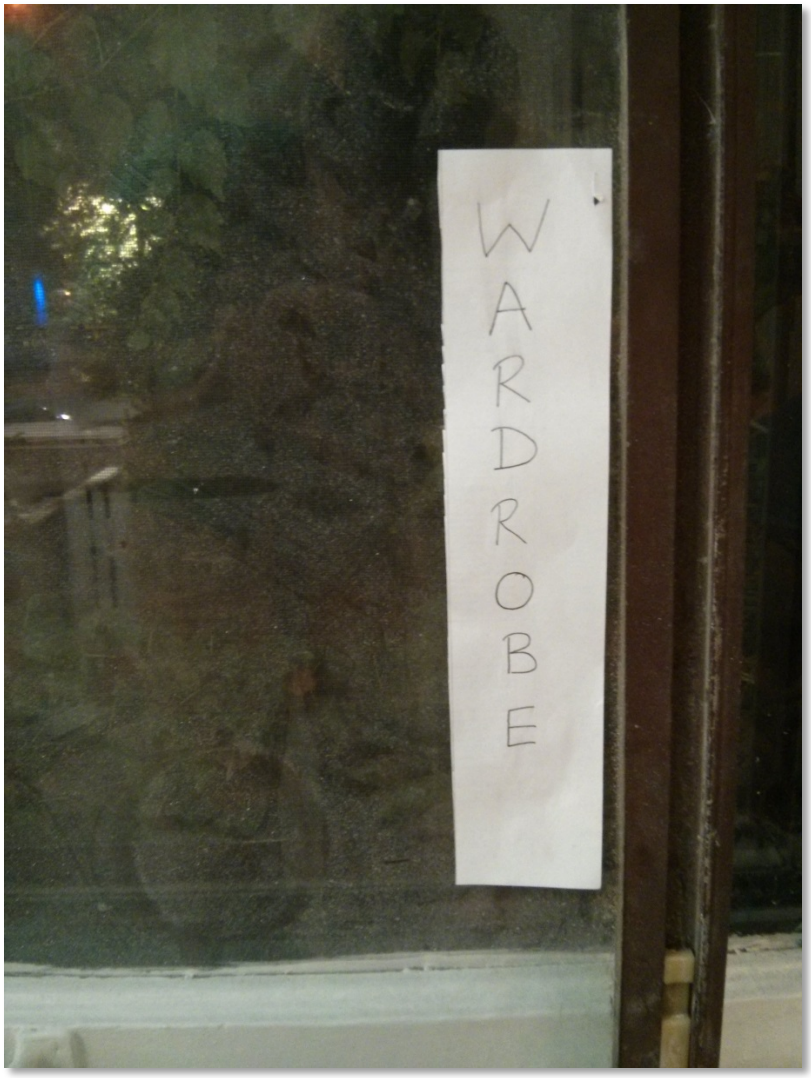


Figure 15: The wardrobe widget.

D.High-fidelity Prototype (Additional Snapshots)

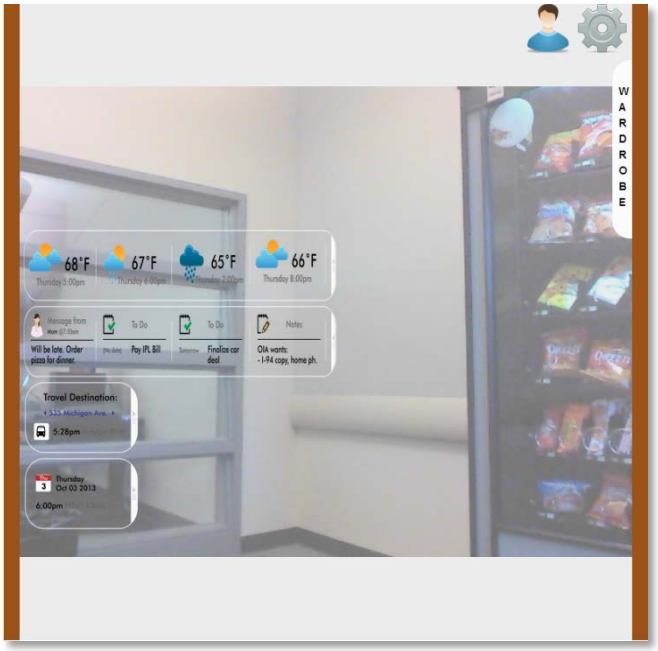


Figure 16: Expanded widgets

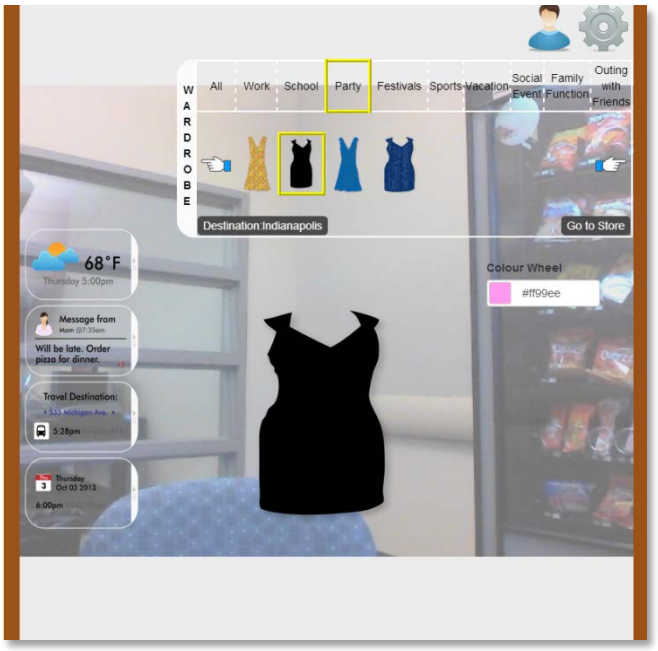


Figure 17: Browsing through a selected category of dresses within the wardrobe.

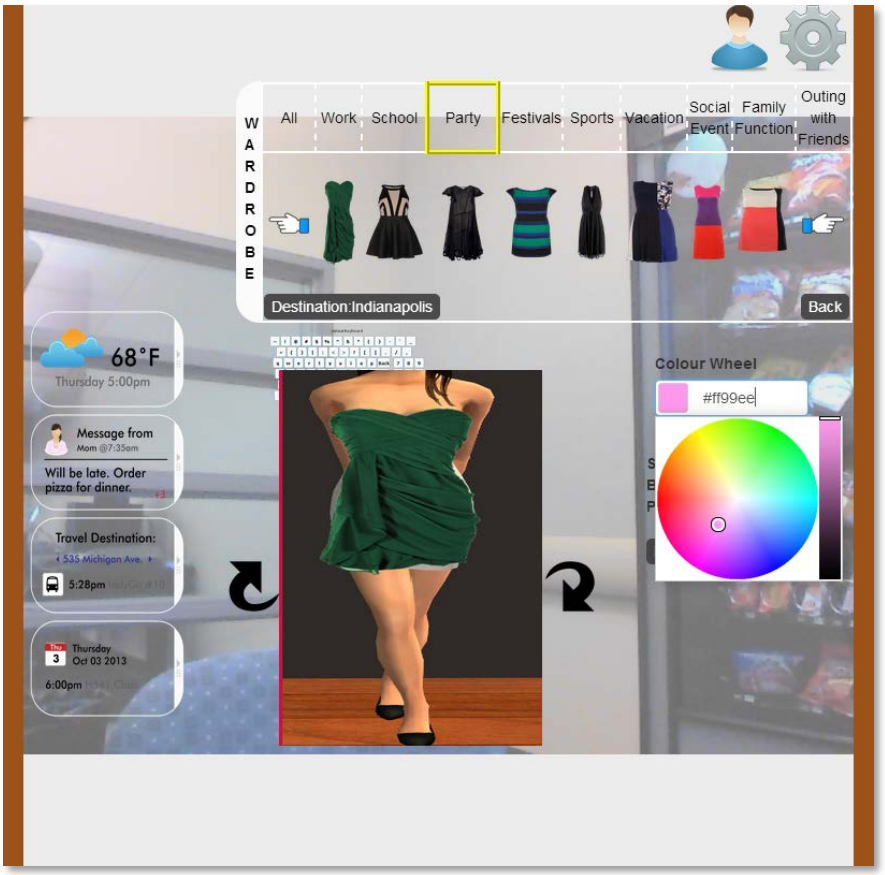


Figure 18: Expanded view of the color wheel that allows filtering by color

E. Informed Consent Form

DressWiser Prototype Usability Test

Informed Consent Form

Please read and sign this form before you proceed to the usability testing session.

In this usability test:

- You will be asked to perform certain tasks on a website prototype of a smart interactive mirror.
- We will also conduct a simultaneous interview with you as you interact with the mirror.
- The testing session will be recorded on video and your responses will also be recorded on paper by one of the investigators.
- There are no substantial benefits and rewards for your participation in this test. Additionally, there are probably no risks to you.

Participation in this usability study is voluntary. All information will remain strictly confidential. The descriptions, recordings and findings will only be shared amongst persons directly involved within this study and may be used to help improve the product. However, at no time will your name or any other identification be used. You can withdraw your consent to the experiment and stop participation at any time.
If you have any questions after today, please contact Shivin Saxena (saxenash@iupui.edu).

I have read and understood the information on this form and had all of my questions answered.

_____ _____

Subject's Signature **Date**

_____ _____

Usability Investigator **Date**

F. Interview Questions

The following set of questions was asked to the human participants whilst they explored the interface. Responses were recorded.

- What is your name? Where do you live?
- Do you find it challenging to dress up for important occasions? If so, please describe your strategy and the factors that influence your decisions and favor particular clothing over another.
- Describe what you see on the screen. What do you think this screen does or helps accomplish?
- How easy or difficult is it to read the text and images being shown on the screen over your mirror image?
- Please describe the four icons to the left of the interface? What do you think is their purpose?
- What does the weather icon show?
- What do you suppose will happen if you tap on the weather widget? What are your expectations, if any?
- This mirror can help you choose from appropriate dressing options for your trip. How would you proceed to use that feature? Please think aloud while you are exploring.
- What do you think the “Wardrobe” label does?
- Please proceed to tap on the wardrobe widget? What do you think the expanded widget is illustrating?
- What kind of clothes is being shown to you? Can you perhaps change the type of clothes? If so, how would you do this?
- Do you use online shopping for clothes? If so, how frequently?
- Say you are not satisfied with your current wardrobe collection! Where would you proceed next to look at online catalogs for new clothes?
- Please select the “color wheel” widget. What do you think this widget does?
- Do you feel any strain from using the interactive features on the mirror? Would you rather be standing or sitting while you are using this?