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Personalizable Display Frame
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EXECUTIVE SUMMARY

Personalizable Display Frame is a product intended to allow users to make hotels, offices, or apartments more homelike by displaying their own pictures and schedules on an installed frame. The Display system is divided into two parts: a server for data storage and control, and a physical frame for displaying the user's information.

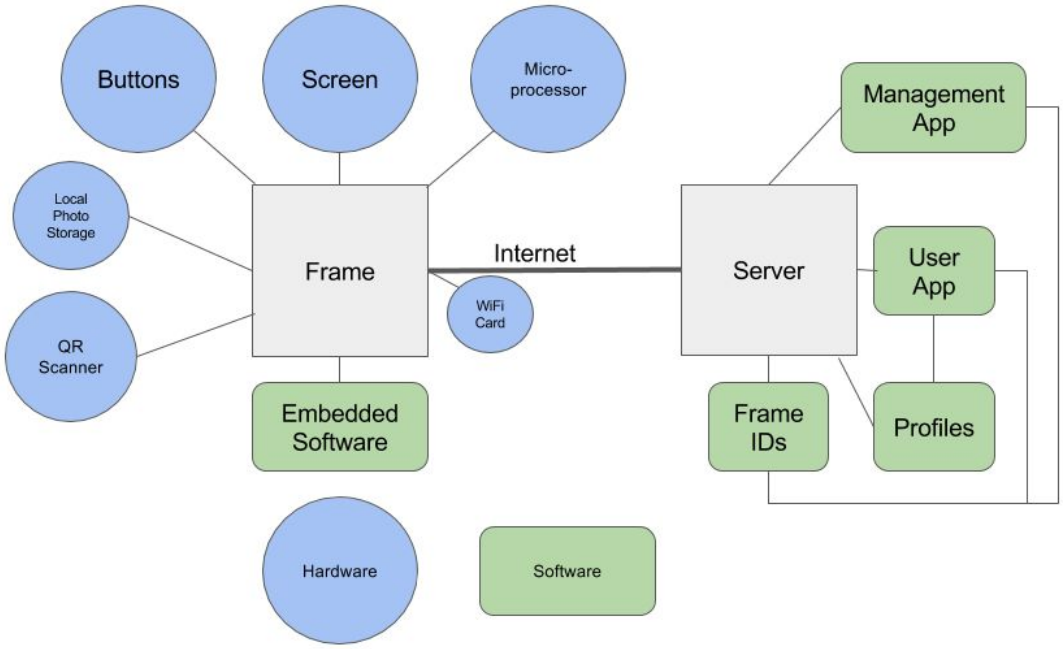

Figure 1 : Block diagram of Personalize Display Frame

The general responsibilities of each module are as follows:

- Server
    - Used to control overall system operation
        - Holds user and management applications for managing user information
        - Stores user profiles, containing their login info and photographs/calendars
        - Stores frame identifiers, used to keep track of which frames are linked to which users
- Frame
    - Displays user's pictures or calendar to help them feel more at home
        - QR scanner to scan a code from a user's phone to link to their profile
        - Screen to display the linked user's photographs or calendar
        - Push buttons to manipulate the display
        - Network communication interface to retrieve user data
        - Local storage to ensure sufficient space for user photographs

MISSION STATEMENT

This product, herein referred to as Personalizable Display Frame, is being developed as a design project at Northwestern University for client Mr. Dave Southern, with a desired finish time of end of Spring Quarter 2017.

Our mission is to create Personalizable Display Frame, a product that allows the user to customize their space and feel more “at home” by displaying their own personal pictures and calendar information via a web application interface.

Users will be able to use a phone or computer to access a web application that will allow them to upload pictures and calendar information. This information can then be retrieved by a physical display frame, allowing the user to personalize any location where a frame is available to them. This product was originally thought up as a means to allow hotel guests, office workers, and other individuals who utilize shared spaces to add their own personal touch to an otherwise non-personal environment.

CONSTRAINTS

In order to accommodate wireless internet access, Personalizable Display Frame must comply with FCC WiFi and RF communication standards as well as any other applicable regulations. Additionally, in order to allow a remote database server to control operation the server and frame must both follow appropriate networking and communication protocols such as TCP/IP.

USERS AND STAKEHOLDERS

The people herein referred to as **primary users** of Personalizable Display Frame are people who want to make their offices and hotel rooms more homelike by adding their personal photos and calendars. These are users who will interact with the physical frame itself in its desired location, as well as the application to manage their profile and data.

The class we consider **secondary users** would be people such as office owners, hotel companies, and Airbnb hosts to name a few. The secondary users would be those responsible for the purchasing and installing Personalizable Display Frame. These users represent people that are interested in making their nonpersonal areas (offices, hotel rooms) into a more customizable option for their guests.

Finally, **stakeholders** of Personalizable Display Frame include those that are invested in the development and operation of the product, or could be affected by the use of the product--this includes people like our client Mr. Southern, executives at hotel chains or office buildings, or even bystanders that might come within sight range of the display.

UNIVERSAL ACCESS

Users with Hearing Disabilities

Considerations may need to be made to account for users with hearing disabilities. While this initial version of Personalizable Display Frame does not include any audio features, if future upgrades lead down that path then this set of users will need to be carefully considered.

Specifically, if audio alarms or notifications were added to the system, perhaps to notify the user of calendar events, then these would need to also be coupled with some sort of visual feedback to accommodate users that may have trouble hearing the alarm. Additionally, if music is looked into as a potential upgrade, then this class of users will also need to be considered when making decisions, as many users with hearing disabilities can still enjoy music but in a different sense than those without hearing disabilities--this might needed to be accounted for in choosing the type of speakers. Further research should be done into this area to improve sensibility when making upgrades.

Users with Mobility Issues

Some of our users may struggle with mobility issues. This could be the result of things like arthritis, injury, or even simply age, among other reasons. The largest issue we foresee here is the accuracy of the controls in our application.

Care should be taken in the design of the web applications to ensure an appropriate layout on both cell phones and computers. In particular, if the application is to be displayed on a mobile device then special attention must be paid to ensure that the on-screen buttons are not too small or too close together for users to accurately manipulate. Similar considerations should be made for the placement of physical interfaces on the frame itself--buttons should be placed in an organized layout, but not so close together that it could potentially become difficult to manipulate one button without accidentally manipulating a second.

Users with Vision Disabilities

Future versions of this product could be expanded to be more inclusive for users with vision disabilities. While the current iteration will depend heavily on sight to operate the frame and application, future versions could include features to accommodate users who are limited by this.

For example, many modern cell phones already include a voice-recognition suite. Future application versions could take advantage of this functionality, allowing a visually disabled user to operate the application using their voice--this would require only development cost, and no additional hardware cost.

Upgrading the frame itself to accommodate users with visual disabilities would be a more difficult challenge. This would necessitate the inclusion of either audio or tactile feedback, to allow the user to know what buttons he/she is pressing or what operations they have requested. A voice command module could also be considered, with the tradeoff being additional hardware cost.

Finally, an increase in the feature set itself of our product would be a good step towards being more inclusive for users with visual disabilities. Our current features focus on displaying photographs and calendar information, but adding things like audio alarms and notifications would include more features that would be more easily usable by this particular class of users.

Users Outside "Normal" Height Range

Because the frame has the ability to be either hung on the wall similar to a regular picture frame or stood on a flat surface via the attached stand, it is possible to place the frame in a variety of locations that should be able to accommodate users of all heights. If the primary user has unrestricted access to the frame, they will many options for where to hang or stand the frame.

However, it is possible for situations to arise in which a user's height might be an issue for use of the product--for example, if a secondary user permanently fixed the frame to a surface, or hung it on the wall completely out of reach of a particular primary user. To prevent such situations, secondary users should always be mindful of potential primary user height issues when placing the frame and how they can take advantage of the different options for setting up the frame.

SPECIFICATIONS

Personalizable Display Frame will include two main components: a server and a frame. Specific details about the requirements and responsibilities for each module are included herein.

Server

The server will be responsible for storing applications, user and frame data, and controlling linkages between devices and users. This server is a crucial control component of the system, and will need to be live and online during the lifespan of the product to ensure proper functionality. Specifically, the server will need to include these features:

Applications

There will be two applications stored on the server-- a user application and a management application. Both of these applications will be accessible by either a computer or mobile device with a compatible browser.

The user application is intended for primary users, and will allow them to create, edit, and delete their personal profiles. Additionally, this application should be able to generate unique QR codes, to provide a quickly scannable unique identifier for specific users. This application is how users will upload their pictures and calendars to their profiles, and also how they will link their profiles to specific frames.

The management application is intended for secondary users in order to give them a greater freedom of control over the use of the product in their environment. This application will allow management to remotely send reset/delink requests to frames that they own, to give them final say on what will be

allowed to be displayed on Personalizable Display Frame (Note: this application will not give management access to view users' pictures, calendars, or other personal data--it is intended to provide control without sacrificing privacy). Additionally, this application will allow secondary users to create profiles and upload data on behalf of primary users who cannot do so themselves--once this information is successfully added to the user's profile it would immediately be hidden from view of secondary users, just as in other profiles.

Storing Data

In addition to hosting the applications, the server will also be responsible for storing the data itself that will be manipulated by the applications. This data includes the set of user profiles, the set of management profiles, and the set of connected frames and their unique identifiers.

User profiles will contain enough information to uniquely and securely authenticate and authorize users. This will include data like a username, password, and associated email account (required on first-time setup to help prevent DOS attacks). Additionally, a user's profile will also contain their photographs and calendar information. Primary users will be able to associate up to 30 photographs with their online profile, and select 5 of them to be "in rotation" at any given time on a physical frame (more information on this in the "Frame" section). Primary users will be able to have 1 associated calendar file at a time.

Management profiles will contain similar authentication and authorization procedures as the user profiles (albeit with secondary users as the target and not primary users). These profiles will contain information on what frames are owned by a particular secondary user, so the management application knows which frames the user will have the right to manipulate.

Finally, the server will need to store a set of frame identifiers--similar to serial numbers--that can be used to uniquely identify each frame currently available for use.

Controlling Linkages

The server will be responsible for keeping track of which users are connected to which frames. Frame identifiers can either be associated or not associated to an account, and will have a tag indicating if they are currently associated or not. For example, if a user's profile has a frame ID in it, then the user is currently connected to that frame (and the ID will also be marked as unavailable). Alternatively, if the frame ID field is empty then that user is currently unmatched. Management profiles will contain the set of all frame IDs owned by that particular secondary user.

Frame

The frame will be responsible for displaying user information, locally linking a profile, and retrieving and storing relevant data, as well as mechanisms for operation. Specifically, it will need to incorporate these features:

Displaying Information

The frame will include a display screen for viewing a user's photographs or calendar information. This screen will be capable of displaying either one photograph at a time at Full HD resolution (1920px * 1080px), or the user's calendar in either daily or weekly view.

Initiating Links

The frame will have an included QR scanner that will be utilized to initialize links between specific frames and primary users. This QR scanner will be able to view a code generated by the user application--once successfully scanned, the frame will notify the server that a new link has been created, and that the frame's ID should be added to the user's profile and marked as unavailable.

Retrieving/Storing Data

The frame will require a network communication interface to retrieve necessary data. This interface will need to check periodically if updates (like changes in which photographs a user wishes to use) are required, and download them if so.

A certain subset of user data will be kept in local storage on the frame itself. Specifically, this set includes 5 specific photographs indicated by the user in their profile, as well as their calendar file. Keeping this information in local storage will allow for quicker retrieval of data and make it easier to provide a responsive interface. Additionally, it will help to combat some potential network connectivity errors as the user will not need to be always online in order to view their 5 photos.

Operating Mechanisms

The first version of the frame will include two classes of physical push-buttons for operation--a "Select" class button and a "D-pad" class button. The "Select" button will be used for general toggling and selection, and the "D-pad" button will be used for navigation of on-screen information. This small set of controls will allow for navigation of any basic menu system we might include on the frame.

Additionally, the "Select" class button can also be used to manually put the frame into reset mode. This will allow frames to be delinked and power cycled at the physical frame if necessary.

For more detailed information on how these specifications were developed, see Appendix A: Use Cases and Scenarios.

FUTURE CONSIDERATIONS

Music

Future versions of Personalizable Display Frame could accommodate an included speaker for playing a user's music as part of the system. Preference would go to streaming music over local music files in order to conserve memory--this could potentially be achieved by having users associate their Spotify accounts or other music streaming services to their profiles.

We decided not to include this feature in this version of our product for two main reasons: cost and redundancy. Adding a high-quality set of speakers (a must-have for music lovers) would add a good deal of hardware cost to the construction of the frame. Additionally, we felt that many people might prefer the use of their own headphones or Bluetooth speakers for playing music, and wouldn't see the need to have it as an integrated part of this particular system.

RFID

We discussed adding an RFID scanning module to the product in order to add more responsive user identification. The objective would be to recognize a user automatically when they enter the room by reading a unique RFID chip that they carry somewhere on their person. This would remove the hassle of having to incorporate QR scanning for device linkages.

We decided not to include this feature mainly due to added cost and complexity--adding an RFID scanner adds cost to the frame itself, and requiring individual RFID chips for every user adds overhead costs for secondary users (for example, a hotel manager who has to add RFID chips to every keycard).

With further research into the implementation of this feature, we believe it can become one of the most exciting assets for our product. The key initial requirement will be to first develop a fully comprehensive system to ensure that the frames will always recognize the correct user, and to combat cases where the frame might detect multiple possible users.

Videos

Another possible next step for Personalizable Display Frame is the addition of video-playing functionality. We decided against this as it would again increase the hardware cost and system complexity, and because we wanted to prioritize getting a system to work with photographs first and foremost. However, with a display module already in place for showing photographs it might be possible to add a video driver that would allow this feature to be added in a simple manner.

Flight/Local Information

At one point we discussed having the frame also be capable of displaying a user's flight information or information about the local surroundings, particularly targeting travellers in hotel rooms. The biggest reason we moved away from these features was an inability to conclusively decide a method for retrieving this information (i.e. does the user input a flight number, does the user link their Google account, etc.) Further research should be done into potential sources of this information and how it can be appropriately collected.

Caller ID

It should be possible to display the caller ID information from a person's phone on our display module. However, this would most likely require a Bluetooth connection, and would lack responsiveness using our current client-server model. We did not include this feature in this version to avoid adding a second required network for the frame to interact with, but further research into this area could yield promising results.

Adjustable Lighting

Finally, we discussed adding an adjustable lighting panel or stand to the back of the frame, to allow users to have personalizable accent lighting in their room. We decided against this feature after it received poor enthusiasm on our user feedback survey (see Appendix B). Our vision for the eventual inclusion in future products would be to have a controller in the user application that would allow the user to select brightness, color, etc. of the lighting, and that information would be retrieved and applied at the frame.

APPENDIX A: USE CASES AND SCENARIOS

This appendix is intended to summarize our examination of different use cases involved with the operation of Personalizable Display Frame, as well as to list a few extreme cases that should be researched further and a few failure cases to be accounted for.

Use Cases

Create a Profile

Summary:

The primary user creates a profile in our database for associating his choice of pictures and schedules with his particular user id. The user will be prompted to create a new account upon first access to our web application.

Preconditions:

- User has a phone or computer
- User has internet access
- Server is live and connected

Course of Events:

1. User visits webpage
2. User is prompted to log in or create a profile
    a. If they select log in, they give their current username/password and access their account
    b. If they select create a profile, they are taken to the profile creation screen
        i. Here, they are prompted to create a username/password
        ii. Email-account association to help prevent spam/DDOS
        iii. Once account creation is completed, users will be routed to the profile management screen, where they will be able to add/remove pictures and schedules, and change their account settings.

Upload Pictures

Summary:

The user will have the ability to add up to 30 photos to their account, and select 5 photos for local storage. These photos will be the set that is rotated through upon use of the buttons mounted on the physical frame.

Preconditions:

- User has a phone or computer
- User has an internet connection
- User has a viable account with our database
- User is logged into said account
- Server is live and connected

- User has viable photographs for upload

Course of Events:

1. Once user is at account management screen, they select the "Manage Photographs" button
2. User is directed to the Manage Photographs page, which contains an "Add Photographs" option:
    a. If less than 30 photographs, user will be able to continue to upload photos at will
    b. If at 30 photographs, or current upload would take user beyond 30 photographs, user will be prompted to delete a photograph in order to continue with upload

Upload Schedule

Summary:

The user will be able to add their schedule, either in an appropriate CSV format, or by direct association with their Google account.

Preconditions:

- User has a phone or computer
- User has an internet connection
- User has a viable account with our database
- User is logged into said account
- Server is live and connected
- User has a viable way of acquiring calendar in correct format

Course of Events:

1. Once user is at account management screen, they select "Manage Calendar"
2. User is directed to calendar management screen
    a. If no Google account is associated with the profile, the user is prompted to link their Google account
        i. If user has been asked before, database remembers and doesn't prompt again unless user changes this in account settings
    b. If user has successfully linked Google account, Google API is used for retrieval of calendar files automatically
    c. If user opts not to use Google account, they will have the option of uploading a calendar in a CSV format by selecting the "Upload Calendar" button
        i. Upon upload, calendar file is examined to ensure compatibility with our platform
            1. If file is compatible, the calendar information will be associated with the user's profile
            2. If the file is incompatible, an error notification will be displayed to the user with information on how to create a compatible file

Change Displayed Information

Summary:

The user will be able to change the displayed information on our screen by manually operating buttons mounted on the frame. Control will be by a set of two buttons: one "Select" button, used for toggling particular features, and one 4-directional "D-pad" button, used for navigation.

Preconditions:

- User has a valid account
- User's account is associated with a particular product
- User is present in the same room as product
- Product has been successfully loaded with user information

Course of Events:

1. Scenario 1: Frame is currently on default (unlinked to profile) display
    a. Pressing the "Select" button will begin QR code scanning (there will be directions for this on the default screen)
    b. Pressing any direction on the "D-pad" will have no effect
    c. Holding the "Select" button will prompt the user to reset the system
        i. If "Select" is pressed again, system will reset
        ii. If any direction on the "D-pad" is pressed, prompt will close with no change
        iii. If nothing is pressed within 5 seconds, prompt will close with no change
2. Scenario 2: Frame is currently displaying photographs
    a. Pressing the "Select" button for less than 3 seconds will prompt the user to switch to calendar display
        i. If "Select" is pressed again, display will switch to calendar
        ii. If any direction on the "D-pad" is pressed, prompt will close with no change
        iii. If nothing is pressed within 5 seconds, prompt will close with no change
    b. Pressing any direction on the "D-pad" will change the currently displayed picture
        i. "Up" and "Right" directions will navigate to the next picture in the queue
        ii. "Down" and "Left" directions will navigate to the previous picture in the queue
    c. Holding the "Select" button for 3 seconds will prompt the user to reset the system
        i. If "Select" is pressed again, system will delink from profile and reset
        ii. If any direction on the "D-pad" is pressed, prompt will close with no change
        iii. If nothing is pressed within 5 seconds, prompt will close with no change
3. Scenario 3: Frame is currently displaying calendar
    a. Pressing the "Select" button for less than 3 seconds will prompt the user to switch to photograph display
        i. If "Select" is pressed again, display will switch to photograph
        ii. If any direction on the "D-pad" is pressed, prompt will close with no change
        iii. If nothing is pressed within 5 seconds, prompt will close with no change
    b. Pressing any direction on the "D-pad" will navigate through the calendar display
        i. "Up" and "Down" directions will switch the calendar display from daily view to weekly view

ii. “Left” and “Right” directions will navigate to the previous or next day/week, depending on current view

c. Holding the “Select” button for 3 seconds will prompt the user to reset the system
   i. If “Select” is pressed again, system will delink from profile and reset
   ii. If any direction on the “D-pad” is pressed, prompt will close with no change
   iii. If nothing is pressed within 5 seconds, prompt will close with no change

Update Information

Summary:

User will be able to update their profile information from the online webpage by logging in with their user account information.

Preconditions:

- Server is live and connected
- User has an account in our profile database
- User has information associated with said account
- User has logged into account management system via webpage

Course of Events:

1. Upon visiting the account management page, there will be three main buttons for managing user information presented to the user
   a. “Manage Photographs” - this button will take the user to a screen where they will be able to add/remove their photographs
   b. “Manage Calendar” - this button will take the user to a screen where they will be able to update their calendar information
   c. “Manage Account” - this button will take the user to the account settings screen, where they will be able to update their account information, including things like:
      i. Updating username
      ii. Updating password
      iii. Deleting account
      iv. Changing specific privacy settings

Discerning Between Users

Summary:

The product will be able to link to specific users via a QR code scanning interface.

Preconditions:

- The user has a valid account with our profile database
- The user is able to access their profile on our webpage via a smartphone
  - If not available, then a printed version of the code would suffice

Course of Events:

1. User will go to “Account Management” on webpage
2. User will select the “Link to Device” button

3. User will be given a unique QR code image that is associated with their account
    a. This image can be scanned directly from a phone screen, or from a sheet of paper
4. When no profile is associated, product will be in default mode, which will have some message prompting the user to scan their code
5. Upon successful scan of code at indicated scanning area, product will query database for profile associated to code, and download relevant data for that profile
6. Once data is downloaded, the product will display the user's personal information

Deleting Profile via Application

Summary:

The user will have the ability to disassociate their profile with a frame from the account management section of the webpage. In addition, management (of the office or hotel) will have a separate application, giving them the ability to reset and/or disable frames without the ability to see private information.

Preconditions:

- User has a valid account and has associated their profile with a frame

Course of Events:

1. Scenario 1: User visits webpage, logs in, and goes to account management
    a. If currently associated with a frame, the "Link to Device" button will be replaced by a "De-Link from Device" button
    b. Selection of this button will result in disassociation from the physical frame
        i. All user information will be deleted from local memory
        ii. Database decouples frame from profile
2. Scenario 2: Management visits management webpage, logs in, and goes to account management
    a. Here, they will be able to see the frames they have control of, as well as tags they have associated with said frames (e.g. room numbers)
    b. From this screen, they will be able to reset frames and wipe their local storage
        i. This will allow them to ensure they have final say on use of displays
        ii. This will allow them to ensure rooms are reset at the proper times (i.e. when the hotel reservation ends)

Deleting Profile via Frame

Summary:

The user will have the ability to disassociate their profile with a frame via physical interaction with the frame itself. From any display screen, holding down the "Select" button for more than 3 seconds will prompt a device reset.

Preconditions:

- User has a valid account and has associated their profile with a frame
- User is in same room as frame

Course of Events:

1. User presses the “Select” key for at least 3 seconds, causing a prompt to appear asking the user if they would like to continue with the reset
    a. If “Select” is pressed again, system will delink from profile and reset
    b. If any direction on the “D-pad” is pressed, prompt will close with no change
    c. If nothing is pressed within 5 seconds, prompt will close with no change

Extreme Cases for Further Consideration

Users with No Phone/Computer

Our initial specification requires primary users to access the profile interface via a web application, which will require access to a computer or mobile computing device (cell phone, tablet, etc.) with a compatible web browser. However, it would be potentially possible to accommodate the system even for users without access to such means.

There are a couple of different ways this could be achieved. For example, a USB or SD card interface could be added to frame itself, allowing the user to locally upload their profile data. Alternatively, the management application could in future versions include the ability to create and manage profiles, so users without proper means could have their profiles created for them. However, there are tradeoffs to these additions- adding a physical interface adds to cost per unit but protects user privacy, whereas upgrading the management application requires only development cost at the potential expense of user privacy. More research should be done on the pros and cons of different features targeting this issue before inclusion in future versions.

Users with No Internet Connection

A scenario could potentially arise in which a primary user has a compatible computer or mobile device for accessing the web application, but is unable to reach it due to lack of internet connection. In this case, it would be difficult to provide any server-side help or protection for the user, as that would necessitate a connection to begin with. The most straightforward solution would be for the user to wait until they can find a viable connection, but this may not always be possible.

As for now, solving issues for this set of users should be approached in the same fashion as for those considered in the section “Users with No Phone/Computer.” That is, future solutions to this issue should target profile operation either via interfacing with the physical frame or by having a secondary user (management) operate on behalf of the primary user.

Users with No Viable Pictures

It is possible that some primary users may successfully access our webpage and create a profile, but will be unable to successfully add pictures to their profile. This could be caused by a number of reasons--for example, a user might have no photos in storage on their computer or mobile device, or a user might have photos but in an incompatible format.

It should be possible to diagnose some issues via the web application itself. For example, if a user uploads a photo that is in a format that will not display on the frame the application can recognize this and refuse the upload, while notifying the user of the error and a potential solution.

Additionally, it might be pertinent to discuss the creation of an "FAQs" page located somewhere within the web application. This page would act as a one-stop location for many answers to common questions, including things like which photo formats are compatible or how to add photos to a location that can be accessed by the application.

Users with No Viable Calendar

See "Users with No Viable Pictures." These users are essentially the same set, replacing viable photographs with viable calendar files. In much the same way, as many problems as possible should be diagnosed and displayed to the user on the web application side, not the frame side, when upload or linking occurs. Again, an "FAQs" page could be a good place to put relevant information on troubleshooting for this area.

Frame Operation is Too Complex

The design of the system should be careful to ensure that at no step is operation too complex for a primary user with average or even limited technical literacy. However, it is always possible that unforeseen circumstances could arise in which users are unable to discern how to operate the interface without assistance.

Careful attention should be paid to the success of the product's first iteration, and particularly user feedback on its operation. If data shows that there are some confusing operations, or that the frame is being operated in an unintended manner, then this should be taken into consideration when revising the design for future versions.

Failure Cases

This section describes a few cases in which we would describe our project as having failed--note that this does not include all potential failures for our system, but instead represents a few issues that we believe should take priority in this design.

User Information is Compromised

We believe that user privacy should be of the utmost importance. This represents the protection of all profile information, including names, usernames, email addresses, passwords, pictures, and calendars. It also represents the protection of data locally stored on a particular frame, such as pictures and calendars.

This is an area that will require special attention during the development stage of this product, to ensure that our server and frame have sufficient protections in place to prevent compromise of user data. Future research in areas like end-to-end encryption could potentially provide even more security.

If a scenario does arise in which one or more users' information does become compromised, it will be necessary to provide responsive support to diagnose and fix any potential flaws or vulnerabilities. This

requires more labor cost over the life of the product, but we believe this tradeoff would need to be considered in order to maintain a high product standard.

Application Failure

This represents cases involving a failure of the user or management applications, or a failure by the server. This could be caused by the server losing internet connection, a software update that renders our applications out of date, a power outage, an unforeseen bug in the application code, or many other potential reasons.

Again, the best way to combat this issue is through responsive support that can investigate and diagnose issues as they occur--this would also include things like ensuring the server's software and firmware is up to date, ensuring the application is up to date, and other minor bug fixes. We again stress that we believe that this increased labor cost should be considered in order to maintain a high product standard over the life of the product.

Frame Broken

This represents the set of all cases in which the frame itself ceases to operate correctly. This could be because the frame is physically broken, because a connection inside the frame was lost, because a chip no longer works correctly, because of an unforeseen bug in the code, or a variety of other reasons.

A large part of dealing with this use case is prevention. Care should be taken in the design to ensure that all parts have an estimated longevity of at least the minimum intended life span of an individual frame, and that the structure of the frame itself is sufficiently sturdy enough to pass a selected set of drop and stress tests--this should be done during the prototyping and testing phase. Additionally, there should be consideration into how other elements of the design can lend itself to longevity. For example, changing the location of the buttons on the frame could potentially change the likelihood of the frame being knocked over or off the wall.

Once again, responsive support is the best way to diagnose and fix any of these potential issues when they arise. However, there is increased cost for these issues because of the difficulty in remotely diagnosing and solving physical issues with the frame, as well as the potential cost of replacement parts. This should be taken into account when considering any potential warranties or guarantees to be sold alongside the product.

APPENDIX B: USER SURVEY RESULTS

Control

Based on the responses we received, people seemed generally favorable to a few different methods for controlling our product. In particular, users under the age of 25 showed a strong indication that a phone app would be preferred (although other forms of control would be acceptable), whereas older users tended to favor a more widely ranging selection.

Social Media

There were mixed responses on linking our product to social media accounts. Some of this was most likely due to people's natural inclination to protect their own privacy, and perhaps more evaluation (with a more advanced line of questioning) in this area could lead to more helpful results. We believe that with the pros and cons of linking social media in this scenario laid out more carefully before them that people might respond differently.

Usefulness

Based on the responses, the majority of the people preferred music, local information, schedule and pictures to be included in the frame. People in the age range 25-50 preferred having their schedule and local information being displayed on the screen. Some people also felt lightning to be useful but there were some misinterpretation regarding the control of the same (i.e lightning of the room or the screen).

Notes

There may have been some misinterpretation with some of the questions that we asked in the survey. The one misinterpretation being that our phrasing caused people to take the question of how useful certain features are as how much they would improve productivity or something similar rather than how homelike it would make hotels/offices. Another misinterpretation being that the question on the best methods to control the display should have been made into two questions about how to change what information is being displayed as well as how to update their profile information