Design Evolution

Feedback received on our Alpha prototype helped guide modifications and evolutions to the design. The feedback highlighted several critical usability and functionality issues, which prompted us to implement targeted modifications to improve the overall experience.

The following design modifications were implemented for our final prototype:

1. Redesign of Remote Control Button Mappings

Change: Updated the button mapping scheme to utilize more intuitive single-press buttons instead of hold-based gestures.

- **FUNC/STOP button** now serves as the Back button (previously was “hold left for 2 seconds”)
- **EQ button** now switches between widgets (previously was “hold up/down for 2 seconds”)
- **VOL+ and VOL- buttons** now control brightness (previously were numeric keys 1 and 0)

Source: Insight from observing user interaction patterns during alpha prototype testing and applying standard usability heuristics.

Rationale:

- Usability - Eliminating Hold Gestures: The previous design required users to hold directional buttons for 2 seconds to access secondary functions. Testing observations revealed that hold-based interactions created several usability problems: (1) users were uncertain whether they had held the button long enough, leading to repeated attempts and frustration, (2) the lack of immediate visual feedback during the hold period created anxiety about whether the system was responding. Single-press buttons eliminate these issues entirely by providing immediate, predictable responses.
- Usability- FUNC/STOP as Back: The FUNC/STOP button is semantically associated with “stopping” the current action, a natural mental model for “going back” or “exiting”. This mapping leverages existing user expectations from consumer electronics. The single-press interaction provides instant feedback and eliminates the timing uncertainty that plagued the hold-left gesture.
- Usability- EQ button for Widget Switching: The EQ (Equalizer) button's traditional function involves cycling through preset options, making it a semantically appropriate choice for switching between different information widgets on the mirror display. Users familiar with audio equipment will recognize this cycling behavior, while new users can easily understand the on-screen "press to switch" instructions without additional training.
- Usability- VOL+/VOL- for Brightness: This mapping creates a powerful mental model alignment between volume (sound intensity) and brightness (light intensity). Both concepts involve adjusting intensity levels, making the metaphor highly intuitive. Volume

buttons are among the most frequently used controls on any remote, ensuring high discoverability.

Impact: During testing with the updated mappings, first-time users achieved a 100% success rate in discovering and using the Back function (compared to 45% with the hold-left gesture). Brightness adjustment task completion time decreased from an average of 12 seconds to 3 seconds. Users consistently reported that the new mappings "just made sense" and required minimal to no instruction.

2. Implementation of Auto-Start Service on Boot

Change: Configured the Raspberry Pi to automatically launch the server and web application when powered on, eliminating the need for manual software initialization.

Source: Designer insight from observing setup friction during installation testing and applying consumer product expectations.

Rationale:

- Usability: Consumer electronics establish a clear expectation: when you power on a device, it should be immediately ready to use. Requiring users to manually launch software violates this fundamental usability principle and introduces unnecessary complexity. The previous design required users to either (1) connect a keyboard/mouse to the Raspberry Pi and manually execute startup commands, or (2) SSH into the device remotely—both approaches are completely impractical for typical household users who purchased a smart mirror, not a computer project. By implementing auto-start, the smart mirror behaves like any other consumer appliance: flip the power switch, and within 30-45 seconds, the interface is active and ready.
- Feasibility: The Raspberry Pi operating system supports systemd services that can automatically execute scripts on boot. Implementing this required creating a service file that manages the server startup sequence, handles dependencies (ensuring network connectivity is established first), and includes error recovery mechanisms (automatic restart if the service crashes).

Impact: Setup complexity was eliminated entirely for end users. Installation testing showed that users could successfully set up and begin using the mirror without any technical knowledge or command-line interaction. The boot-to-ready time averages 42 seconds, which users found acceptable and comparable to smart TV startup times.

3. Removal of “Display Off” Text When Screen is Deactivated

Change: Removed the "Display Off" text message that previously appeared when users pressed the power button to deactivate the screen.

Rationale:
- Usability - Mental Model Alignment: When users press a power button to turn off a display, they expect the screen to go completely black. Showing "Display Off" text contradicts the user's action: they explicitly requested the display to turn off, yet the screen remains illuminated with visible text.
- Usability- Privacy and Context: sers turn off the mirror display for specific reasons: to save energy, to reduce light in a dark bedroom, to prevent screen burn-in, or to maintain privacy when guests are present. Displaying "Display Off" text defeats these purposes.

Impact: The behavior now matches user expectations perfectly, with several testers specifically commenting that "it works just like my TV."

4. Addition of Brightness Adjustment Step in Setup Guide

Change: Added an explicit step in the initial setup sequence that prompts users to adjust display brightness using the VOL+ and VOL- buttons, including on-screen instructions demonstrating the brightness control.

Source: Observing that users were unaware of brightness controls and subsequently experienced suboptimal viewing conditions.

Rationale:
- Usability- Discoverability: Brightness adjustment is a critical feature for smart mirrors because optimal brightness varies dramatically based on room lighting conditions, time of day, and individual user preferences. However, alpha testing revealed that users rarely discovered the brightness controls organically. By proactively introducing brightness adjustment during setup, we ensure 100% of users know this capability exists and understand how to access it.
- Usability- Immediate Contextualization: The setup phase is the ideal moment to teach brightness control because users are actively engaged with learning the system and are standing directly in front of the mirror in their actual usage environment. They can immediately adjust brightness to match their specific lighting conditions and personal preferences, use rather than tolerating suboptimal settings for days or weeks.

Impact: Post-implementation testing showed that 100% of users successfully adjusted brightness during setup (compared to only 12% who discovered the feature organically in the previous version).