1. PROBLEM STATEMENT

Each person's morning routine is a tone-setter for the day that follows, and no one should start their day feeling rushed or stressed before even making it to work. Mr-r Mr-r is an AI-integrated touchscreen mirror that aims to streamline the process of getting ready while also bringing entertainment, useful information, and enjoyment to the user.

1.1. Need Statement

According to YouGov, 30% of Americans spend over a week out of each year getting ready in the morning [1]. This could be time well spent, as a well-defined morning routine is associated with highly productive people [2]. However, 51% of people report feeling 'overwhelmed' after waking up to start their morning routines [3]. It has also been found that 17% of Americans aged 18-29 check the weather less than once a week before going outside [4]. This can result in people failing to dress properly, prepare for rain, or apply sunscreen when needed. There is a need for an innovative system that streamlines morning activities, reduces stress, and answers questions users may not have time to consult their smartphones about.

1.2. Objective Statement

Mr-r Mr-r combines an advanced mirror, sporting a personalized digital display, with AI features creating the epitome of a morning assistant that truly reflects the user. Utilizing customizable widgets and speakers, Mr-r Mr-r provides an all-in-one service for entertainment and convenience that allows users to display any information they want – such as weather and news. This innovation streamlines mornings and reduces stress.

1.1. Background and Related Work

The basic concept behind Mr-r Mr-r is to combine a display, two-way mirror, and touchscreen all framed together in that order. AI is then integrated to respond to voice input from the user via a microphone. The AI responds audibly through speakers and visually via on-screen widgets. Currently, the Capstone Smart Mirror is a design that has a similar concept to Mr-r Mr-r. Capstone is a smart mirror that casts the display of another device onto a display screen inside of the mirror [5]. This presents a major difference between Mr-r Mr-r and competing technology; Mr-r Mr-r functions as its own device and does not require an outside device to be cast for display. AI being integrated into the mirror also sets this design apart from other similar products. While many mirrors are customizable in the design process, the creative process usually ends with the final product, whereas Mr-r Mr-r has continuous customization via AI integration. Google Home statistics state that 76% of smart home device owners utilize the AI capabilities of their device weekly, and Mr-r Mr-r aims to leverage this trend to enhance users' morning routines [6]. Some limitations of current designs and technologies include the sizing of mirrors and the utilization of touchscreen. Monetary limitations are also common because of the expensive nature of some of its parts. Mirrors, touchscreen adapters, and single-board computers, like Raspberry PI or Jetson Nano, can all be pricey. No patents currently exist for a smart mirror of Mr-r Mr-r's caliber. The only patent that is relevant to the project was a patent owned by Capstone Smart Mirror that has since expired. Even still, that patent was different from what Mr-r Mr-r is trying to accomplish. In all, Mr-r Mr-r is unique and an advancement of the Smart Mirror market as a whole.

2. DESIGN REQUIREMENT SPECIFICATIONS

This section outlines the marketing requirements, engineering specifications, constraints, and standards essential for ensuring the success and safety of Mr-r Mr-r throughout prototyping, testing, and subsystem implementation.

2.1 Requirements

In order to cater to the preferences of our target audience, Mr-r Mr-r uses two main requirements. The marketing requirements show the basic functions of the Mirror, while the engineering requirements specify the measurable standards the device must meet to achieve optimal performance.

2.1.1 Marketing Requirements

The Mr-r Mr-r marketing requirements are outlined below:

1. The device is able to have a coherent conversation with the user.
2. The device delivers an intuitive interface anyone can master instantly.
3. The device has a clear touchscreen display with a mirror effect.
4. The device produces a clear, high-quality audio output.

Figure 2-1 shows an objective tree to show the marketing requirements in greater detail.

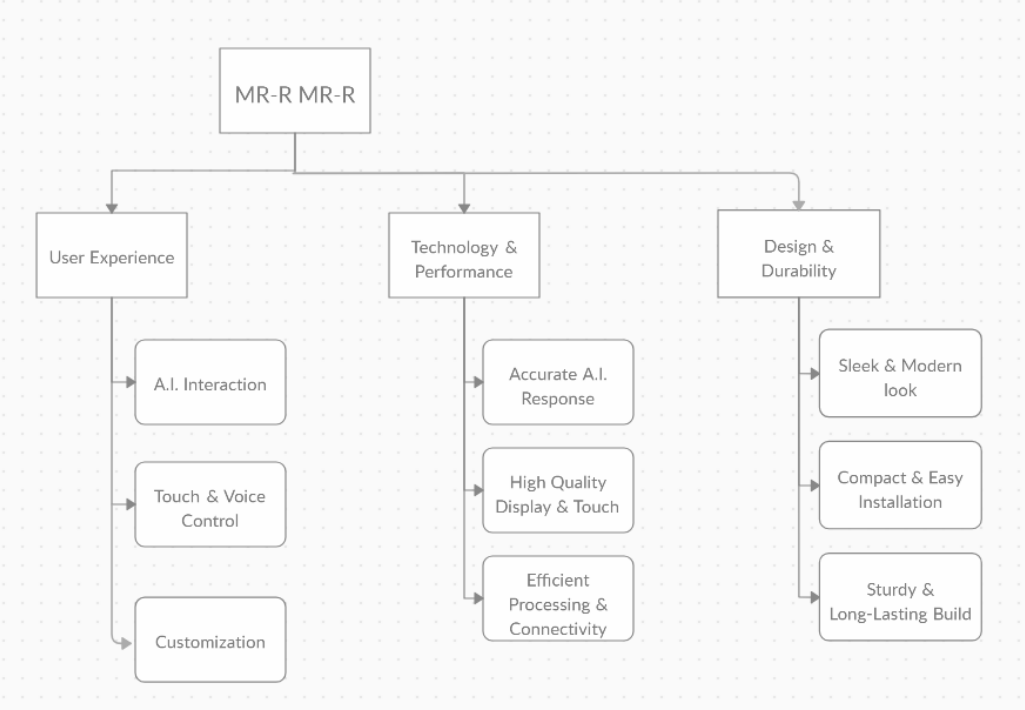

Figure 2-1: Mr-r Mr-r Objective Tree

The marketing requirements define the product's goals based on user needs. The following engineering requirements translate these goals into measurable design criteria.

2.1.2. Engineering Requirements

The engineering requirements of Mr-r Mr-r are outlined in Table 2-1. The engineering requirements are related back to each marketing requirement previously stated. A justification is listed for each requirement and how those measurements were determined.

Table 2-1: Engineering Design Requirements

Marketing Requirements	Engineering Requirements	Description
1, 4	Voice recognition accuracy ≥ 95% in standard indoor environments.	This accuracy rate ensures reliable conversation capabilities and clear response to user queries in typical home settings
1, 2	Response latency < 1.5 seconds	This response time provides a natural conversational flow and demonstrates reasonable processing speed for accurate answer
1, 2, 4	Advanced natural language processing memorizes context and language preferences for seamless conversational dialogue.	This capability enables coherent conversations by maintaining context and providing accurate answers to follow-up questions
3	Touchscreen display with resolution ≥ 1080p and reflectivity index of 85-95%	This specification ensures clear visual output while providing the required mirror effect when the display is inactive.
4	Audio output with frequency response of 100Hz - 20kHz and SNR > 70db.	These specifications ensure clear, high-quality audio reproduction across the full range of human hearing.
2	System must support customizable widgets for weather, calendar, news, and other user-selected information modules.	By offering widgets for common daily information like weather, calendar events, and news updates, we enhance the mirror's functionality beyond reflection, making it a central information hub that adapts to each user's lifestyle and preferences.
Marketing Requirements: 1. The device is able to have a coherent conversation with the user. 2. The device answers questions with reasonable accuracy. 3. The device has a clear touchscreen display with a mirror effect. 4. The device produces a clear, high-quality audio output.		

Mr-r Mr-r is an intelligent assistant that enhances daily routines by providing conversation-based task management and interactive features. It leverages advanced natural language processing (NLP) with high query accuracy (above 95%) and low memory requirements, allowing for efficient voice recognition and

contextual responses. With support for real-time information retrieval and widget control through both voice and touch, Mr-r Mr-r ensures a seamless and personalized user experience.

For clear readability, Mr-r Mr-r includes a high-quality mirror display that ensures both text and visuals are clear under various lighting conditions. Mr-r Mr-r features a high-resolution display, providing ample screen space for clear and dynamic visual output. This display is enhanced with a two-way mirror acrylic sheet, which allows digital content to be visible while maintaining the reflective properties of a traditional mirror. The acrylic material ensures durability, lightweight construction, and minimal distortion, making it ideal for both home and commercial applications. The display aligns with Illuminating Engineering Society (IES) standards for indoor display legibility [7].

The core functionality of Mr-r Mr-r revolves around its ability to display information dynamically while providing interactive features. Utilizing the MagicMirror² platform, the system can show a wide range of customizable widgets, including weather updates, news, and calendar events. These features make it an ideal addition to both home and commercial spaces. The integrated AI model extends these capabilities, allowing users to issue voice commands, set reminders, and even search the web directly through the mirror interface [8].

Integrating a high-resolution touchscreen display with a resolution exceeding 1080p and a reflectivity index between 85% and 95% significantly enhances the visual clarity and user experience of Mr-r Mr-r. This reflectivity index strikes a balance between maintaining screen brightness and reducing glare, ensuring optimal readability both in well-lit environments and dimly lit settings [9]. The display is well above 400 nits, which is the value needed to see a display through a two-way mirror [10]. The touchscreen overlaid onto this high-resolution display ensures a high-quality user interface, combining sharp image clarity with effective visibility through the acrylic two-way mirror.

Mr-r Mr-r integrates a high-quality audio output, designed to deliver clear and immersive sound. It features a frequency response range from 20 Hz to 20 KHz, ensuring the full range of audio frequencies, from deep bass to high treble, is accurately reproduced [11]. This frequency range enhances the user experience, especially when Mr-r Mr-r is providing voice feedback or playing multimedia content. Additionally, the system boasts a Signal-to-Noise Ratio (SNR) greater than 70dB, which ensures that clarity is maintained even in noisy environments [12]. This high SNR reduces unwanted background noise and allows users to clearly hear notifications and responses from Mr-r Mr-r’s interface.

2.2. Constraints

Table 2-2 describes constraints pertaining to Mr-Mr’s design process that take into consideration overall durability, power allocation, processing limitations, production deadline, and budget. These constraints are outlined below.

Table 2-2: Constraints

Type	Name	Description
Economic	Cost	The total project budget is $1000.
Economic	Time	Mr-r Mr-r is required to have all subsystems completed by the end of April 2025 and be a fully functioning device by the end of November 2025.
Energy	Power	The device is powered by a standard 120V wall outlet.
Manufacturability	Durability	Mr-r Mr-r needs a rugged housing that is resistant to moderate amounts of water.
Operation	Processing	Mr-r Mr-r's AI functionality is limited by the capabilities of the AI system used.

The $1,000 budget allocated for Mr-r Mr-r under the "Cost" constraint can be distributed flexibly between the first and second deadlines specified under the "Time" constraint. Additionally, there is no requirement for the entire budget to be spent within the established timeline.

The "Durability" constraint ensures that Mr-r Mr-r is built with water-resistant materials to protect it from moderate amounts of water exposure, making it suitable for environments such as bathrooms or other areas where moisture may be present.

The "Processing" constraint acknowledges that the performance of Mr-r Mr-r is contingent upon the capabilities of the AI systems used. Limitations in computational power may affect the overall responsiveness and functionality of the device.

2.3. Standards

Table 2-3 details four standards which Mr-r Mr-r abides by, ensuring proper safety and ethical use.

Table 2-3: Engineering Standards

Specific Standard	Standard Document	Specification / Application
ISO/IEC 42001:2023	International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) Standard: *Artificial intelligence — Management system* [13]	The AI system implements a comprehensive management framework that ensures responsible development, deployment, and continuous monitoring of AI features within the digital mirror.
IEC 62368-1	International Electrotechnical Commission (IEC) Standard: *Audio/Video, Information and Communication Technology Equipment — Safety Requirements* [14]	The digital mirror incorporates protective circuits and insulation that prevent electrical hazards and maintain safe operating temperatures during extended usage periods.
ISO 9241-210	International Organization for Standardization (ISO) Standard: *Ergonomics of Human-System Interaction — Part 210: Human-*	The mirror's interface incorporates intuitive gesture controls, widgets and voice commands that accommodate

	Centered Design for Interactive Systems [15]	users of varying technical abilities and physical capabilities.
ISO/IEC 24368:2022	ISO/IEC Standard: *Information Technology — Artificial Intelligence — Overview of Ethical and Societal Concerns* [16]	The mirror's AI features are designed with transparency, providing clear indications when AI systems are active, and allowing users to easily disable these features.

These standards ensure Mr-r Mr-r will adhere to and uphold the safety, privacy, and provide accessibility to the user’s needs. The included standards adhere to electrical safety, the ethical use of onboard AI and its development as well as accessibility controls.

2.4. REFERENCES

[1] K. Palmer, “The Morning Routine: 30% Spend Over a Week in Getting Ready Each Year,” YouGov, https://today.yougov.com/society/articles/3890-morning-routine-30-spend-over-week-getting-ready-e (accessed Feb. 4, 2025).

[2] DreamMaker, "Morning Routine Statistics: Surprising Facts About How People Start Their Day," https://dreammaker.co.uk/blog/morning-routine-statistics/ (Accessed Feb. 10, 2025).

[3] StudyFinds, "Poll: The most stressful time of day is 8:15 in the morning!," https://studyfinds.org/most-stressful-time-of-day/ (Accessed: Feb. 10, 2025).

[4] T. Orth, “How Often and Where Americans Get Information on the Weather,” YouGov, https://today.yougov.com/health/articles/45672-how-and-where-americans-get-information-weather/ (accessed Feb. 4, 2025).

[5] Capstone Companies Inc., "Products," https://capstonecompaniesinc.com/products (Accessed Feb. 10, 2025).

[6] Coolest Gadgets, "Google Home Statistics: Facts and Trends," https://www.coolest-gadgets.com/google-home-statistics/ (Accessed Feb. 10, 2025).

[7] Illuminating Engineering Society (IES), "Illuminating Engineering Society (IES) Standards for Indoor Display Legibility," https://www.ies.org/standards/ (accessed Mar. 5, 2025).

[8] GitHub, "MMM-Voice-Commands: Voice commands for MagicMirror²," https://github.com/Veldrovive/MMM-Voice-Commands/blob/master/README.md (accessed Mar. 7, 2025).

[9] DisplayMate Technologies, "DisplayMate's Display Technology Shoot-Out: Glare and Reflections," https://displaymate.com/glare.html (accessed Mar. 7, 2025).

[10] TT Plastic Land, "Two-Way Mirrors: Everything You Need to Know," https://www.ttplasticland.com/blogs/news/two-way-mirrors-everything-you-need-to-know#:~:text=Applications%20of%20Two%2DWay%20Mirrors&text=Observation%20Rooms:%20Commonly%20found%20in,discreetly%2C%20deterring%20theft%20and%20shoplifting (accessed Mar. 7, 2025).

[11] VCELINK, "Audio Frequency Range: Understanding the Spectrum of Sound," https://www.vcelink.com/blogs/focus/audio-frequency-range?srsltid=AfmBOoqrIwMyluUER97TuUbKLG4ksEoD0sjbAun96JEB0fTkBiUxisrf (accessed Mar. 26, 2025).

[12] Audioengine, "What is Signal to Noise Ratio & Why Does It Matter?," Audioengine, [Online]. Available: https://audioengine.com/explore/what-is-signal-to-noise-ratio-why-does-it-matter/?srsltid=AfmBOopI_L3aSFO9X2vwsvkvCl7AGjKenYv0SqUC8GpuC5npuQTZrQAG. (Accessed: Mar. 7, 2025).

[13] *Artificial intelligence — Management system*, ISO/IEC 42001:2023, International Organization for Standardization and International Electrotechnical Commission, Geneva, Switzerland, Feb. 2023. https://www.gsc-co.com/wp-content/uploads/2024/08/SCAN-ISO-420012023_-Web.pdf (accessed Mar. 15, 2025)

[14] *Audio/video, information and communication technology equipment — Part 1: Safety requirements*, IEC 62368-1:2018, International Electrotechnical Commission, Geneva, Switzerland, Oct. 2018. https://cdn.standards.iteh.ai/samples/23618/92449acef5b2481da95e6e59387999ad/IEC-62368-1-2018.pdf (accessed Mar. 15, 2025)

[15] *Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems*, ISO 9241-210:2019, International Organization for Standardization, Geneva, Switzerland, Jul. 2019. https://cdn.standards.iteh.ai/samples/77520/8cac787a9e1549e1a7ffa0171dfa33e0/ISO-9241-210-2019.pdf (accessed Mar. 15, 2025)

[16] *Information technology — Artificial intelligence — Overview of ethical and societal concerns*, ISO/IEC TR 24368:2022, International Organization for Standardization and International Electrotechnical Commission, Geneva, Switzerland, Nov. 2022. https://cdn.standards.iteh.ai/samples/78507/c543f2b8885c4a45bf1558d6d0201553/ISO-IEC-TR-24368-2022.pdf (accessed Mar. 15, 2025)

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