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EMO Mirror

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ABSTRACT

The "Emo Mirror" with Sentiment Analysis, Music Recommendation, and Alexa Integration is an innovative smart mirror that leverages advanced technologies to enhance user well-being and convenience. This project combines facial expression recognition, emotion analysis, personalized music recommendation, and seamless interaction with the Alexa voice assistant. Users stand in front of the mirror, which detects their presence and analyzes their facial expressions in real-time. The mirror categorizes emotional states and offers music suggestions tailored to the user's mood. Alexa integration enables voice commands for added functionality. This project prioritizes user-centered design, privacy, and security, ensuring a user-friendly and emotionally engaging experience.

Keywords*: Emo Mirror, Sentiment Analysis, Facial Expression Recognition, Emotion Analysis, Music Recommendation, Alexa Integration, User-Cantered Design, Privacy, User Experience, Voice Assistant, Human-Computer Interaction.*

I. INTRODUCTION

A. EMOTIONAL MIRROR

In a world increasingly dominated by technology, the Raspberry Pi has emerged as a versatile and accessible tool for a multitude of innovative applications. One such application that captivates both the imagination and the heart is the development of an "Emotional Mirror." This remarkable creation not only identifies and displays the moods of its user but also offers a harmonious solution by recommending songs that align with their emotional state. This fusion of technology and human emotion transcends traditional boundaries, showcasing the profound impact that Raspberry Pi can have on our daily lives.

Before delving into the intricacies of our Emotional Mirror, it's imperative to understand the Raspberry Pi's significance. Raspberry Pi, a credit-card-sized computer, initially designed for educational purposes, has evolved into a powerhouse of innovation. Its compact form factor, affordability, and open-source nature have encouraged enthusiasts and developers worldwide to explore its vast potential.

The Emotio20nal Mirror stands as a testament to the boundless creativity and utility that Raspberry Pi brings to the table. At its core, this interactive device utilizes a combination of hardware and software components to provide a comprehensive understanding of the user's mood and preferences, all while fostering a deeper connection between technology and emotion.

The Emotional Mirror operates by employing innovative facial recognition technology and sentiment analysis algorithms. A camera, integrated into the Raspberry Pi setup, captures the user's facial expressions and body language in real-time. These visual cues are then processed by the device's software, which interprets the emotional state of the user with remarkable accuracy.

To achieve precise mood identification, the Emotional Mirror relies on a vast database of facial expressions and their corresponding emotions. By analysing the user's facial features, such as eye movement, smile curvature, and brow furrowing, the Raspberry Pi can discern emotions ranging from happiness and sadness to anger and surprise. This intricate analysis ensures that the Emotional Mirror provides a nuanced and insightful perspective on the user's emotional well-being.

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Once the Emotional Mirror deciphers the user's mood, it transforms this emotional landscape into an engaging visual display. Using a high-resolution screen or projector, the device creates a dynamic and visually appealing representation of the user's emotions. This captivating display offers the user a unique opportunity to witness their emotional journey unfold in real-time, promoting self-awareness and introspection.

The Emotional Mirror seamlessly integrates with popular music streaming platforms, allowing users to access their preferred songs with ease. By understanding the user's emotional needs, the device ensures that the music recommendations are not only fitting but also therapeutic. Whether it's soothing melodies during moments of sadness or energizing beats when joy is abundant, the Emotional Mirror becomes a reliable companion in the user's emotional journey.

While the Emotional Mirror undoubtedly offers entertainment value, its applications extend far beyond mere amusement. The device can serve as a valuable tool for mental health management, helping users gain insights into their emotional patterns and offering music therapy as a means of emotional regulation. This fusion of technology and well-being highlights the profound impact that Raspberry Pi can have on improving

B. LEVELS OF COMPUTING SYSTEMS IN EMO MIRROR

The computing system in an Emotional Mirror (Emo Mirror) plays a crucial role in processing data, running algorithms, and enabling the mirror's intelligent features.

1) *CENTRAL PROCESSING UNIT (CPU)*

The CPU is the brain of the computing system and handles general-purpose processing tasks. It manages the execution of software, including facial expression recognition algorithms, emotion analysis, and user interface interactions.

2) GRAPHICS PROCESSING UNIT (GPU)

A GPU, often used in conjunction with the CPU, accelerates specific tasks related to image processing and deep learning. It's essential for real-time facial expression recognition and emotion analysis.

3) *MEMORY (RAM)*

Adequate RAM is necessary to store and quickly access data during processing. Emo Mirrors require sufficient RAM to handle large datasets and real-time calculations efficiently.

4) *STORAGE*

Storage devices, such as solid-state drives (SSDs) or microSD cards, store the mirror's operating system, software, and user data. Fast and reliable storage ensures responsive performance.

5) OPERATING SYSTEM (OS)

The Emo Mirror typically runs on a lightweight and optimized operating system, such as Raspberry Pi OS for Raspberry Pi-based mirrors. The OS manages hardware resources and supports software applications.

6) *FACIAL EXPRESSION RECOGNITION SOFTWARE*

Specialized software and libraries are used for facial expression recognition. OpenCV, Dlib, or deep learning frameworks like Tensor Flow and PyTorch may be employed to detect and analyse facial expressions.

7) ***EMOTION ANALYSIS ALGORITHMS*** Emotion analysis software processes data from facial expression recognition to categorize emotions. Machine learning models and algorithms are used to map facial features to specific emotions.

8) *MUSIC RECOMMENDATION ENGINE*

The music recommendation system uses algorithms to suggest songs or playlists based on the user's emotional state. It may rely on collaborative filtering, content-based filtering, or machine learning models to make recommendations.

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9) ***VOICE ASSISTANT INTEGRATION***

For Alexa integration or other voice assistants, the Emo Mirror requires software and APIs provided by the voice assistant platform. These enable voice commands, natural language processing, and interaction with the assistant.

10) USER INTERFACE SOFTWARE

The user interface software manages the display of emotional states, music recommendations, and user interactions. It may use web technologies like HTML, CSS, and JavaScript to create an intuitive interface.

11) SECURITY AND PRIVACY SOFTWARE

Privacy and security measures are implemented through software, including encryption protocols, access controls, and secure data handling practices. Compliance with data protection regulations is ensured through software implementations.

12) ***CONTINUOUS INTEGRATION AND DEPLOYMENT (CI/CD)***

CI/CD pipelines and tools are used to automate code testing, deployment, and updates, ensuring the mirror's software remain up to date and reliable.

The computing system in an Emo Mirror is designed to efficiently process data from facial recognition and emotion analysis, provide personalized music recommendations, and enable voice-based interactions through a voice assistant. It must strike a balance between performance, responsiveness, and data security to deliver a seamless and secure user experience.

B. ARCHITECTURE OVERVIEW

Emotional Mirror is an innovative and interactive system designed to identify and display the moods of a user while recommending songs that align with their emotional state. This unique architecture combines various components, with a Raspberry Pi serving as the core platform for seamless integration and real-time processing.

At its core, the Emotional Mirror utilizes innovative emotion recognition technology, often involving facial recognition and analysis of vocal tone to discern the user's emotional state. For facial recognition, a camera module connected to the Raspberry Pi captures the user's facial expressions and relays this data to a neural network model trained to recognize emotions. Simultaneously, a microphone captures the user's voice and tone, further enhancing emotion detection accuracy. These sensory inputs are then processed by the Raspberry Pi's computing power, which has been optimized for real-time data analysis.

To recommend songs based on the user's mood, the architecture interfaces with a music database or streaming service API. It utilizes machine learning algorithms to map detected emotions to a vast array of music genres, tracks, and playlists. These recommendations are carefully curated to match the user's emotional state, ensuring a personalized and immersive music experience.

The Emotional Mirror doesn't stop at music recommendations; it also features a user-friendly display interface, typically implemented using a touch screen or monitor connected to the Raspberry Pi. Here, the user can see their emotional analysis in real-time through visual cues, such as color-coded moods or expressive avatars. This provides an engaging and immersive experience, enhancing user interaction and self-awareness.

Furthermore, the system can log and analyse historical mood data, enabling users to track their emotional trends over time. This long-term data collection can provide valuable insights into emotional well-being and help users make positive lifestyle changes.

Overall, the Emotional Mirror represents a convergence of emotion recognition technology, machine learning, and multimedia integration, all seamlessly orchestrated by the Raspberry Pi. This architecture empowers users to connect with their emotions, discover music that resonates with their mood, and embark on a journey of self-discovery through the power of technology.

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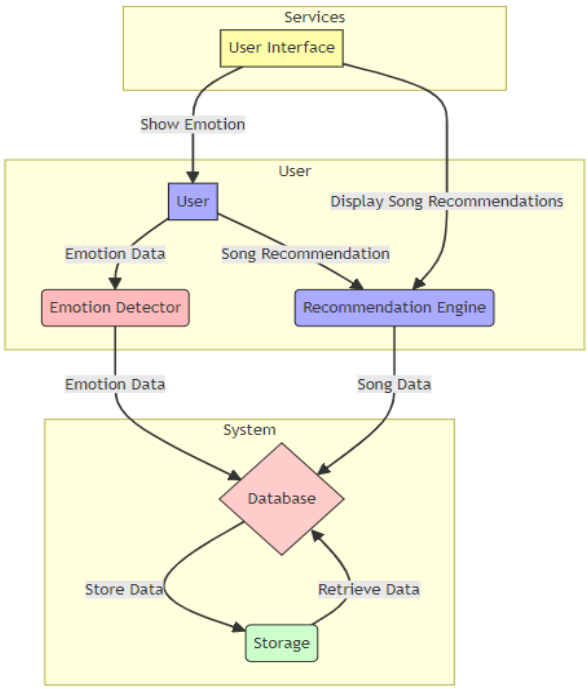

Fig 1.3 : Architecture diagram

II. LITERATURE REVIEW

A selection methodology of current research work was defined and performed in order to study the most relevant smart mirrors literature for this review.

A. *EMOTION RECOGNITION*

- Many studies have focused on emotion recognition using various methods such as facial expression analysis, speech analysis, and physiological signals.
- The use of machine learning algorithms, especially deep learning, has shown considerable progress in accurately detecting human emotions.

B. *HUMAN-COMPUTER INTERACTION (HCI)*

- Emotion-aware systems have gained attention in the field of HCI, aiming to create more personalized and emotionally responsive interfaces.
- These systems can adapt content or recommendations based on the user's emotional state.
- HCI principles are essential for creating an intuitive, user-friendly, and engaging experience for individuals interacting with the mirror.

C. MUSIC RECOMMENDATION SYSTEMS

- Recommender systems have been extensively studied in the context of music streaming services like Spotify and Pandora.
- Emotion-based music recommendation systems have emerged, where songs are recommended based on the user's current emotional state or preferences.

D. RASPBERRY PI AND IOT

- The use of Raspberry Pi in IoT projects has become popular for creating low-cost, compact, and customizable devices.
- IoT devices can be used to collect data related to a user's environment, which may include factors influencing their mood (e.g., lighting, temperature).

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E. INTEGRATION OF TECHNOLOGIES

- Combining emotion recognition technology with Raspberry Pi and IoT offers the potential to create an "Emotional Mirror" system.
- This system could use emotion detection algorithms to analyse user input (e.g., facial expressions, voice) or environmental data (e.g., light, temperature) to determine the user's mood.

F. USER EXPERIENCE

- User experience and user interface design play a crucial role in the success of such systems. A user-friendly interface for displaying moods and recommending music is essential.

IV. SYSTEM DESIGN

To design a system for an emotional mirror that identifies and displays the moods of a user and recommends songs based on their mood using a Raspberry Pi, you can follow this general system design:

A. Hardware Setup:

- Use a Raspberry Pi as the main computing device.
- Connect a camera module to the Raspberry Pi for capturing the user's facial expressions.
- Connect a display to the Raspberry Pi for displaying the user's mood and song recommendations.
- Connect a speaker to the Raspberry Pi for playing the recommended songs.

B. Facial Expression Recognition:

- Use OpenCV library and face detection algorithms to detect and track the user's face in real-time.
- Implement a facial expression recognition model (such as a deep learning model) to classify the user's expressions into different moods (e.g., happy, sad, angry, etc.).
- Train the model using a dataset of labelled facial expressions.

C. *Mood Display*:

- Based on the recognized mood, display an appropriate emoji or text representation of the user's mood on the connected display.

D. *Music Recommendation*:

- Create a database or use an existing music streaming API to store a collection of songs tagged with different moods.
- Based on the recognized mood, retrieve a list of songs from the database or API that match the user's mood.
- Use a music recommendation algorithm (such as collaborative filtering or content-based filtering) to recommend the most suitable songs to the user.

E. Song Playback:

- Play the recommended songs through the connected speaker using a music player library or API.
- Allow the user to control the playback, such as skipping songs or adjusting the volume.

1)*USE CASE DIAGRAM*

Use case diagrams are like maps that show how a system or multiple systems interact with external users (actors) through a series of actions (use cases). They help describe what a system can do and how it collaborates with its users.

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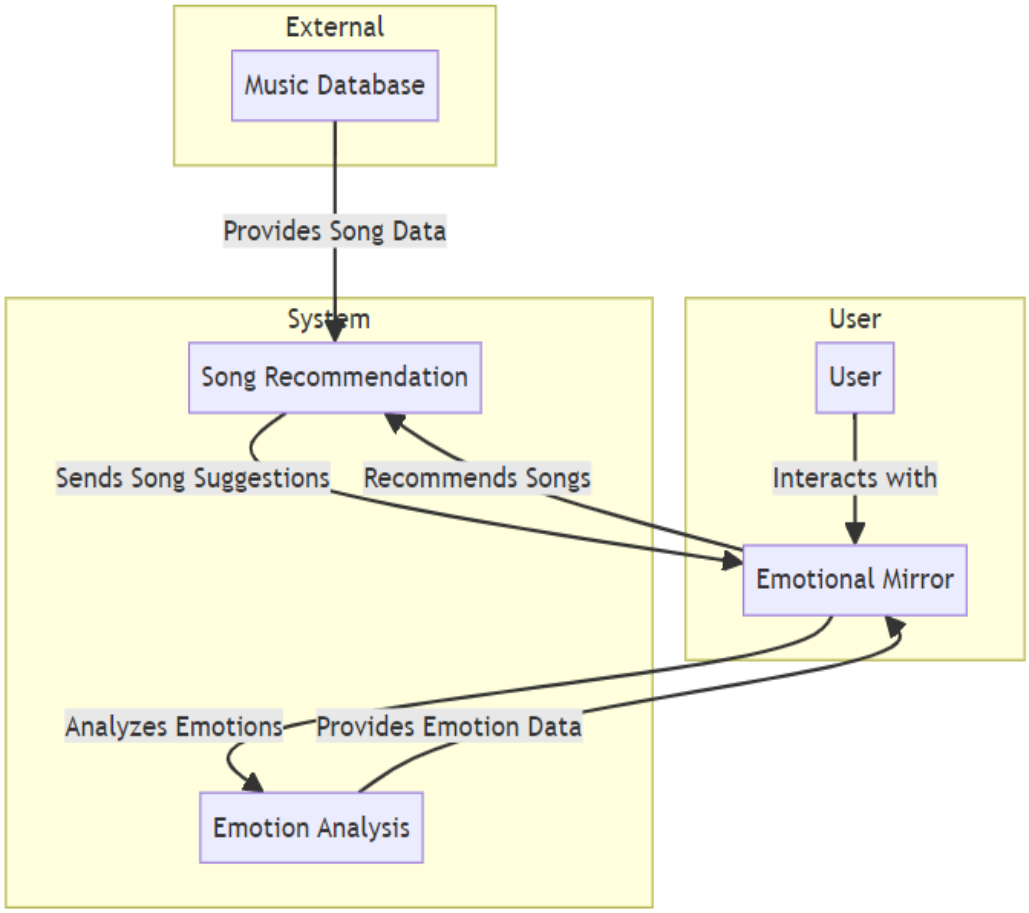

Fig 4.2.: Use case diagram

2) *DATA FLOW DIAGRAM*

Data Flow Diagrams (DFDs) are like visual roadmaps that illustrate how data moves within a system. Think of it as a way to show the journey of information. In simpler terms, it's a tool to help us understand how data is input, processed, and output in a system. It's like a snapshot that captures the flow of data, showing where it comes from, how it's processed, and where it goes.

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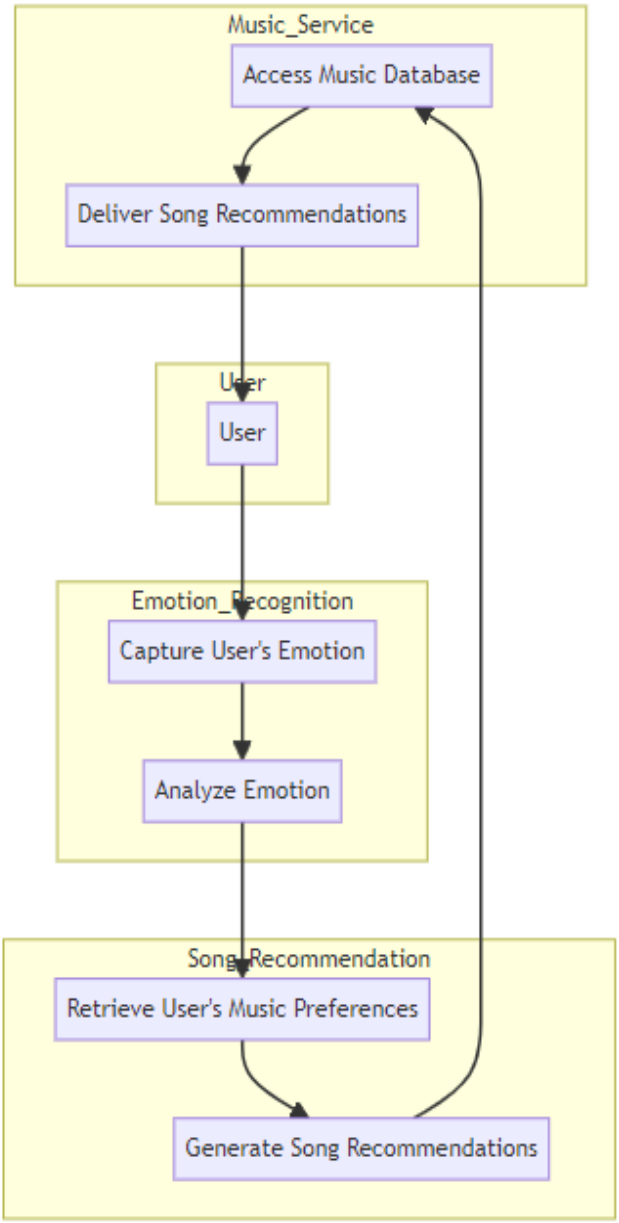

Fig 4.3.: Data flow diagram

V. PROJECT MODULES

3 MODULES

The project consists of three modules. They are as follows:

1. Facial expression recognition module
2. Emotion-based music recommendation module

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3. User Interface and display

A. Facial expression recognition module

This Module is divided into two parts:

- Face Detection — Ability to detect the location of face in any input image or frame. But integrating it with an android app was a complex task so the Face Detector class available in Java was considered. This library identifies the faces of people in a Bitmap graphic object and returns the number of faces present in a given image.

- Mood Detection — To classify emotions on faces like happy, angry, sad, neutral, surprise, fear, or disgust, we employed Mobile Net—a Convolutional Neural Network (CNN) architecture specifically designed for image classification tasks on mobile devices using Mobile Vision. What sets Mobile Net apart is its efficiency in terms of computational power, making it suitable for running or applying transfer learning to the FER 2013 dataset. The FER 2013 dataset comprises grayscale images sized at 48x48 pixels. Mobile Net's uniqueness lies in its ability to handle image classification tasks with a lower computational burden, making it well-suited for mobile applications or scenarios where resources are limited. This makes it an optimal choice for efficiently recognizing and categorizing emotions based on facial expressions in real-time scenarios.

B. Emotion based music recommendation module

Emotion-based music recommendation is a sophisticated approach to tailoring music playlists and recommendations to match an individual's emotional state and preferences. It leverages advancements in artificial intelligence, data analytics, and emotional analysis to create a deeply personalized musical experience. At its core, this system relies on the understanding that music has a profound impact on our emotions and can be used to enhance mood, alleviate stress, or amplify joy.

To implement emotion-based music recommendation, a vast amount of data is gathered and analysed. This data includes the user's listening history, explicitly stated preferences, and, most importantly, real-time emotional cues. Facial recognition, voice analysis, and other physiological indicators are used to assess the user's emotional state at any given moment. This could involve detecting facial expressions, voice tone, heart rate, or even wearable device data.

Once the emotional state is determined, the recommendation engine springs into action. It employs machine learning algorithms that have been trained on extensive music libraries tagged with emotional attributes. These algorithms factor in the user's current mood and musical preferences to curate a playlist or suggest specific songs that are likely to resonate with the user on an emotional level.

The goal of emotion-based music recommendation is to create a musical journey that not only matches the user's current emotions but also helps guide and influence their mood. For example, if a user is feeling down, the system might suggest uplifting and energetic songs to boost their spirits. Alternatively, if someone is relaxed and looking to wind down, it may suggest calming and soothing tunes. Ultimately, the system strives to provide a more profound and emotionally resonant musical experience, fostering a stronger connection between the user and their chosen music. This approach not only enhances user satisfaction but also opens up new avenues for using technology to improve mental well-being and overall quality of life.

C. User interface and display

The user interface and display module for the Emotional Mirror, designed to identify and display the user's moods and recommend songs based on their emotional state using a Raspberry Pi, features an intuitive graphical interface. The interface is divided into two main sections:

- mood detection display
- song recommendation panel

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In the mood detection display, a live video feed from the Raspberry Pi's camera captures the user's facial expressions, which are analysed in real-time using machine learning algorithms to determine their emotional state. This emotional state is then represented using color-coded emoticons and text labels, creating a visual representation of the user's mood.

In the song recommendation panel, a list of recommended songs is dynamically generated based on the detected mood. Each song is accompanied by its title, artist, and album cover art, providing a rich and engaging experience. Users can interact with the interface by selecting songs, which are played through integrated speakers or headphones, creating a seamless audio-visual experience. Additionally, a menu allows users to customize their preferences, such as adjusting the sensitivity of mood detection or exploring different music genres for recommendations. Overall, this user interface and display module offers an interactive and emotionally responsive platform for users to explore and enjoy music tailored to their current emotional state.

IV. SYSTEM REQUIREMENTS

A. INTRODUCTION

This chapter involves the technology used, the hardware requirements and the software requirements for the project .

B. REQUIREMENTS

Designing an emotional mirror system that identifies and displays a user's mood while recommending songs based on that mood using a Raspberry Pi involves several components and steps. Here's a high-level system design for such a project:

1) Hardware Requirements

2) Raspberry Pi

Use a Raspberry Pi as the central processing unit for the system.

3) Camera

Connect a camera module to the Raspberry Pi to capture the user's facial expressions.

4) *Display*

Attach a display (e.g., touch screen monitor) for showing the user's mood and song recommendations.

5) *Speakers*

Connect speakers to the Raspberry Pi for audio output.

C. Software Requirements

1) *Facial Expression Recognition*

Implement a facial expression recognition algorithm using machine learning libraries like OpenCV and dlib. Train the model to detect various facial expressions (e.g., happy, sad, angry, surprised, etc.).

2) *Emotion Analysis*

Analyze the user's facial expression to determine their mood. Translate this into a mood category (e.g., happy, sad, relaxed).

3) *Song Recommendation Engine*

Develop a recommendation engine that suggests songs based on the user's mood. You can use APIs or datasets of songs categorized by mood, or train a machine learning model to recommend songs.

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4) ***User Interface***

Create a user interface to display the detected mood and song recommendations on the connected display. You can use Python GUI libraries like Tkinter or PyQt for this purpose.

5) ***Audio Playback***

Use the Raspberry Pi's audio output capabilities to play the recommended songs. You can control music playback using libraries like Pygame or VLC.

SYSTEM WORKFLOW

- The camera captures the user's facial expressions at regular intervals.
- The facial expression recognition algorithm processes the captured images to identify the user's mood.
- The system categorizes the detected mood (e.g., happy, sad, etc.).
- Based on the user's mood category, the song recommendation engine selects and displays a list of recommended songs on the user interface.
- The user can interact with the system through the touch screen interface to select and play a recommended song.

CONCLUSION

Emotional Mirror, powered by Raspberry Pi, represents an impressive fusion of technology and emotional intelligence. Its precision in identifying and visually presenting the user's mood elevates its functionality to a personalized and engaging level. Beyond mere utility, the mirror enhances the user experience by recommending songs tailored to the individual's emotional state, adding an extra layer of delight and connection. This innovative device not only demonstrates the potential of technology to augment emotional well-being but also offers a glimpse into the future of interactive and empathetic devices.

Our smart mirror prototype stands out from existing models in the literature, both academic and commercial, due to its extensive functionalities. Unlike many state-of-the-art smart mirrors that are limited in features or constrained by on-board processing capabilities, our design incorporates an external server, distributing the workload efficiently. This approach enables the inclusion of computationally intensive features, improving overall performance. The integration with Amazon Alexa further enhances user interaction, particularly for those less accustomed to technology, such as the elderly, and contributes to reducing on-board computational demands.

Based on user feedback and usability tests, we are actively exploring hardware enhancements. For instance, to address low-light conditions, we are considering the addition of a night vision camera to improve image quality. Additionally, we plan to replace the microphone with a higher performing one. The data generated by the emotion recognition features play a crucial role in monitoring and understanding the user's long-term emotional well-being. Ongoing efforts are focused on hardware improvements and refining the processing workflow to incorporate features like night vision seamlessly.

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