Smart Mirror with Emotion Monitoring

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ABSTRACT- In recent years, the integration of artificial intelligence has revolutionized human-computer interaction by enabling devices to provide personalized user experiences. This study focuses on the development of a Smart Mirror with Emotion Monitoring, which utilizes advanced facial recognition and deep learning algorithms to detect and classify user emotions in real time. By analyzing facial expressions, the system identifies emotional states such as happiness, sadness, surprise, angry, and neutrality. Based on these detected emotions, the mirror responds dynamically by displaying personalized content, including motivational messages, and aiming to enhance mental well-being. Beyond emotional responsiveness, the smart mirror also functions as a daily assistant, offering real-time information such as weather updates, calendar, and emotion monitoring insights. Its applications extend beyond residential use to sectors such as healthcare, retail, and corporate environments, where emotion-based interactions can improve user engagement and experience. In healthcare, for instance, the mirror can assist individuals dealing with stress or mental health conditions by providing therapeutic interactions. Similarly, in commercial settings, the mirror can be integrated into customer service environments to enhance user satisfaction. The proposed system is built using state-of-the-art computer vision techniques, deep learning models, and IoT integration to ensure accurate emotion detection and seamless functionality. A robust dataset is employed to train and optimize the facial recognition model, ensuring high accuracy in emotion classification. To validate the system's performance, extensive experiments are conducted, evaluating parameters such as detection accuracy, response time, and user satisfaction. The results demonstrate the system's effectiveness in providing real-time emotional insights and personalized interactions, contributing to the advancement of intelligent assistive technologies. By incorporating emotional intelligence into smart mirror technology, this study bridges the gap between functionality and user-centric design, paving the way for next-generation AI-driven smart devices.

I. INTRODUCTION- Today, technology is improving very quickly. Because of this, most modern devices are becoming smarter. These smart systems use Artificial Intelligence (AI), which helps make devices more connected and easy for people to use. Smart devices can now understand, process, and analyze information on their own. To help with this, this study suggests creating a smart mirror using Internet of Things (IoT) technology. This mirror can display all the essential information together in one view. The smart mirror also includes a face detection feature powered by AI to provide some level of security. The Smart Mirror with Emotion Detection takes this concept further by integrating deep learning-based facial recognition to analyze user emotions mirrors that only display news, weather updates, or calendar events, this system personalizes interactions by detecting and responding to users' emotional states. The emotion recognition model classifies expressions such as happiness, sadness, surprise, and neutrality, allowing the mirror to provide motivational messages, music recommendations, and adaptive ambient lighting. This real-time emotional awareness enhances user engagement and well-being, making technology more responsive to human emotions. Purohit et al. [1] developed a facial recognition-enabled virtual assistant-based smart mirror system aimed at home automation. The proposed device can function both as a standard mirror and as a smart mirror to deliver the user's daily updates. A Raspberry Pi is used to manage and power the components within this setup. Mohamed et al. [2] introduced an AI-driven smart mirror solution. To identify known users, they suggested a registration technique supported by facial recognition technology. More recently, Hollen et al. [3] built a smart mirror system using facial recognition to analyze the user's emotions in real time. They utilized facial expression detection and movement tracking to

recognize users and interpret their mood. In this paper, an IoT-based smart mirror model is presented, incorporating personalized data suggestions and facial recognition techniques for enhanced user interaction. Riva, G., Grossi, G., et al. [4,5] Our smart mirror provides an interactive interface that not only showcases real-time data but also presents insights derived from the evaluation of stored long-term information. This feature is particularly useful in understanding a user's emotional state. By comparing present and past emotions, the mirror can recommend ways to reduce negative feelings. In this sense, the emotional recognition and assistance offered by the mirror can be considered a form of "Positive Technology" — the use of digital innovation to enhance personal well-being. Everyone has the right to lead a content and peaceful life. Today's generation views creativity and innovation as a core driving force [6]. Now more than ever, connectivity and seamless access to information are essential. People should stay informed and involved in global initiatives, using platforms like television and the web. The term "Internet of Things" describes a system of interlinked embedded computing devices allowing everyday objects to communicate and exchange information. In [7], the design and advancement of a smart mirror are demonstrated, offering an elegant interface for data access and also capable of detecting cheating behavior within a home setting. A smart mirror works both as a regular mirror and a digital display for date, time, temperature, and weather updates. In [8], the presented method ensures fast and efficient facial feature extraction by continually applying filters to live images. It performs real-time emotion detection through three main stages: face detection, feature extraction, and emotion classification using a trained classifier Raspberry Pi serves as the platform for deploying the emotion detection system. In [9], although IoT has many applications, this research emphasizes its use in simplifying daily life. The mirror is capable of presenting date and time, news headlines, weather forecasts, to-do lists, alerts, and traffic updates. The processing unit is Raspberry Pi, which handles tasks without needing heavy computation.. In [10] T.R. Revanth Kumar et al. further expanded on the capabilities of smart systems by proposing an innovative strategy for real- time emotion recognition using facial analysis. The proposed technique achieves rapid and robust facial feature extraction through a continuous application of filters to the facial image. This involves a structured three step process: first, identifying the face in the captured image; second, extracting specific features such as eyes, mouth, and expressions from the face; and finally, using a classifier to categorize the detected emotions accurately. This methodology ensures a reliable and efficient way to recognize emotions in real-time, even in dynamic environments. In [11] Hollen et al. propose a facial recognition-based smart mirror that detects the user's mood in real-time. This system integrates face detection and outbound movement detection to accurately identify the user's face and emotions. Additionally, it incorporates personalized information recommendations, such as displaying motivational content or health tips based on the detected mood. By leveraging IoT, the mirror offers a fully interactive and intelligent experience, making it a promising innovation for both personal use and broader applications in Smart homes, healthcare and customer engagement. In [12] R. S. Deshmukh and V. Jagtap present a smart device featuring facial emotion recognition that continuously monitors emotions like happiness and sadness. Their system is built to display emotions in real-time and track them over a period, helping users recognize patterns associated with stress or depressive states. the user's emotional trends and helps track the effectiveness of interventions or lifestyle changes. In [13] Gu J. et al. underline the power of machine learning as a versatile method for solving a wide range of problems, including language understanding, speech recognition, and image identification. Their insights are particularly relevant to smart mirrors, as these systems heavily rely on machine learning algorithms for tasks such as emotion detection, face recognition, and personalized recommendations. A haiIn [14] A smart mirror system developed by Y.-C. Yu et al. integrates emotion recognition into its functionality, showcasing a practical implementation of advanced technologies in an IoT context. The system employs efficient face detection, leveraging its robust image processing capabilities to identify facial regions accurately. Additionally, Tensor Flow is utilized for emotion recognition, applying deep learning models to classify emotions into two categories: happy and sad. In [15] Bhuvaneswari T et al. explore the transformative impact of the Internet of Things on daily life through innovative ideas and initiatives. Their work showcases enables connectivity and automation in everyday objects, creating a seamless and efficient living environment. The smart mirror serves as a prime example of IoT integration, as it connects with other smart devices to provide real-time data, remote monitoring, and personalized user experiences. This

study emphasizes how IoT is redefining convenience and efficiency in both personal and professional settings.

II. OBJECTIVE: The primary objective of this project is to design and develop an intelligent smart mirror system that not only displays essential daily information but also monitors and responds to the emotional state of the user. This smart mirror will utilize facial recognition and emotion detection technologies to analyze the user's facial expressions in real-time. By identifying emotions such as happiness, sadness, anger, or fatigue, the system aims to provide personalized feedback and interactions that are both relevant and supportive to the user's current mood. In addition to emotion monitoring, the smart mirror will incorporate standard smart features such as displaying the current time, date, weather updates, calendar reminders, news headlines, and basic health-related metrics. The integration of emotion-aware responses, such as motivational quotes when the user appears sad or calming music suggestions when the user seems stressed, will help enhance the overall user experience. This project strives to create a seamless blend of technology and emotional intelligence to promote mental well-being, support daily productivity, and offer a more empathetic form of digital assistance. Ultimately, the goal is to make daily routines more engaging, informative, and emotionally supportive through a next-generation smart mirror interface.

III. METHODOLOGY- In this section, the design methodology of the proposed framework is elaborated. In [16], as previously mentioned, this research utilizes facial recognition to verify the legitimate user before granting access to the smart mirror. The face recognition technique applied in this study is based on the architecture of Histogram of Oriented Gradients (HOG) features combined with a linear Support Vector Machine (SVM). The feature extraction method proposed by Dalal et al. [17], known as Histogram of Oriented Gradients (HOG), is utilized. In this technique, the image is first segmented into small cells, and then the gradient or edge orientation histogram is calculated within each cell. These individual histograms are then merged to generate a complete HOG descriptor. During the feature extraction process, HOG typically produces 3780 features for a single image. The suggested setup involves creating a smart mirror out of Raspberry Pi. In this article, we lay down the groundwork for a smart mirror that would provide its user access to cutting-edge features. Some of the components of a smart mirror include a two-way mirror, a Raspberry pi, a monitor, a camera, and some wooden frames. Crucial to the mirror's operation is the raspberry pi. The end goal of this project is to develop a user friendly smart system that can recognize faces. The user just needs to be present in front of a mirror for it to detect their face, send it to a Raspberry Pi for processing, and then show the results. The database will have the user's picture. One of the most well-known features of the suggested system, the Intelligent Raspberry PI based Smart Mirror (IRPISM), is the ease with which users may self-groom, engage in conversation with the mirror, and retrieve information. In addition to its reputation for data transmission, they may be part of a larger system that offers consumers improved experiences in areas like as many more uses. Raspberry Pi has many uses, and a smart mirror is only one of them. The glass chosen for usage is the first step in the fundamental design of an intelligent mirror. It seems incredibly futuristic to embed a computer screen in a mirror. The data seen on the mirror is controlled and managed by the raspberry Pi, which is located in the backend. Looking in the mirror may provide a variety of alerts, such as the current date, time, weather, and more. "**Table 1** summarizes the key hardware components used in the implementation of the Smart Mirror with Emotion Monitoring system, highlighting their core functions, connection interfaces, and essential features contributing to real-time interaction and intelligent emotion detection"

Component	Function	Connection/Integration	Key Features
Raspberry Pi	Central processing unit; runs software, manages display, emotion analysis, and audio output.	Connects to LED monitor via HDMI, camera via CSI/USB, speaker via Bluetooth or audio jack.	Compact, low power, versatile I/O (GPIO, USB, HDMI), supports emotion recognition via camera input.
LED Monitor	Displays information (time, weather, etc.) behind the mirror.	HDMI connection to Raspberry Pi.	High-quality digital display; content is visible through two-way mirror while maintaining reflectivity.
Speaker	Provides audio output for alerts or interactive features.	Connects to Raspberry Pi (wired or Bluetooth).	Adds immersive audio feedback; supports various speaker types.
Camera Module 2	Captures user's facial expressions for emotion monitoring.	Connects to Raspberry Pi via CSI port or USB.	High-quality image capture; positioned to face the user without affecting mirror usability.
Two-Way Mirror	Reflects user's image and displays digital content simultaneously.	Placed in front of the LED monitor; no electronic connection.	Reflective and transparent; enables seamless integration of real-world reflection and digital content.

Table 1. Smart Mirror Components Overview:-

The hardware setup forms the backbone of the Smart Mirror system. Each component was carefully selected to ensure compatibility, efficiency, and cost-effectiveness for real-time facial recognition and display functionalities as shown in Table 1, The chosen components collectively support smooth hardware-software integration, allowing the mirror to interact intuitively and respond to the user's emotional state.. The components were tested individually before final integration. This ensured compatibility and reduced the chance of failure during the final assembly. The finalized hardware configuration successfully supports all the features included in the project.

IV. SYSTEM ARCHITECTURE-

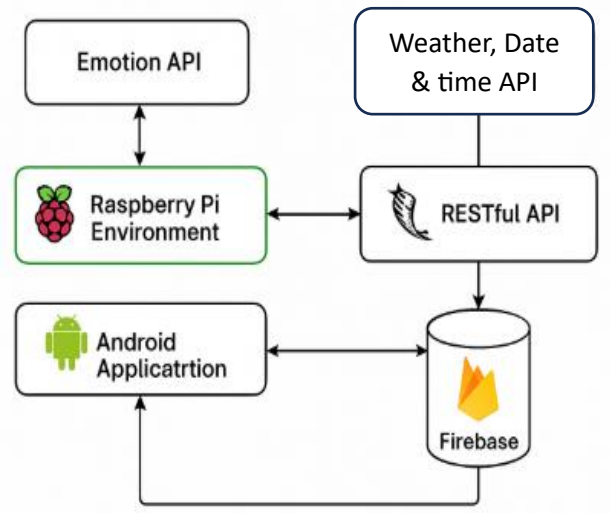

Fig.1 System Architecture

The smart mirror system architecture with emotion monitoring is designed to provide users with a personalized and interactive experience by combining hardware, software, cloud services, and APIs. At the core of the system is the Raspberry Pi environment, which serves as the central processing unit for controlling the mirror's functions and handling data from various sources. One key feature is the integration of an Emotion API, which analyzes the user's facial expressions captured through a camera embedded in the mirror. This emotional data is sent to the Raspberry Pi,

allowing the system to adapt content based on the user's mood—for example, displaying motivational quotes if the user appears sad.

The mirror also utilizes a Weather API to fetch real-time weather updates, Date & Time, which are processed via a RESTful API. This RESTful API acts as a middleware, facilitating seamless communication between external services and the Raspberry Pi, as well as connecting to Firebase, the cloud-based backend used for storing user profiles, emotional logs, and preferences.

V. CALCULATIONS-

1. Mirror Frame Size Calculation

- The mirror has a diagonal of **18 inches**.
- Assuming a square mirror:

Using the Pythagorean theorem:

$x2+x2=182$

$2x2=324$

$x2=162$

$x\approx12.73$ inches

So, the dimensions of the mirror are approximately **12.73 inches**

2. LCD Screen Placement

- The LCD display has a diagonal of **3.5 inches** with a 4:3 aspect ratio.

Width:

$45\times3.5=2.8$ inches

Height:

$35\times3.5=2.1$ inches

So, the LCD screen's dimensions are approximately **2.8 inches x 2.1 inches**.

The display occupies **5.88 square inches** of the mirror's surface area.

Mirror Area:

$12.73\times12.73=162$ square inches

Display-to-Mirror Ratio: $5.88162\approx3.6\%$

3. Power Supply Calculation

- The system draws power through a USB 2.0 port (5V, 500mA),delivering 2.5Wofpower.Power consumption of components:
  - LCD: **0.75W** (5V, 150mA)
  - Speaker: **1.0W** (5V, 200mA)
  - Camera: **1.25W** (5V, 250mA)

Total Power Consumption:

$0.75+1.0+1.25=3.0W$

Since USB 2.0 provides **2.5W**, the system needs a **USB 3.0 port** (4.5W) or an **external powered hub** for proper operation.

VI. SYSTEM WORKING- The Smart Mirror with Emotion Monitoring combines a Raspberry Pi, a camera module, a two-way mirror, and AI technologies to deliver real-time facial analysis and interactive features. The mirror doubles as a display, showing content like time, weather, and messages only when the screen is active. A camera captures the user's facial expressions, and machine learning algorithms analyze these to detect emotions such as happiness, sadness, or anger. Based on the emotion, the mirror responds with tailored messages, motivational quotes, or even music through a Bluetooth speaker, enhancing the user experience with emotional intelligence. This smart system also supports features like voice control, internet connectivity, and smart home integration. Users can check schedules, control IoT devices, or receive health tips through voice commands or future touchscreen options. The mirror can offer wellness suggestions based on stress levels and even act as a central hub for smart home automation. With its personalized responses and multifunctionality, the Smart Mirror not only improves daily routines but also supports mental and physical well-being, making it a modern and valuable addition to any home.

VII. FLOWCHART- The flowchart illustrates the working of a Smart Mirror system integrated with emotion detection. The process begins when a user stands in front of the mirror. A camera captures the user's facial expressions in real-time, and this input is sent to an AI-based emotion detection module. This module analyzes the facial features to determine the user's emotional state such as happy, sad, neutral, or stressed. Simultaneously, the system fetches external data such as weather updates and calendar events through APIs. All these inputs are processed by the main control unit, typically a Raspberry Pi 4B+, which coordinates the data and determines the appropriate response. Depending on the detected emotion and external information, the system sends outputs to both a display monitor and a speaker. The display shows personalized content like motivational quotes, reminders, or weather updates while the speaker provides audio feedback for a hands-free experience. This content is then visible through a two-way mirror, allowing the user to see both their reflection and digital information seamlessly. The system ensures a more

interactive and personalized daily experience by combining emotion recognition with smart features

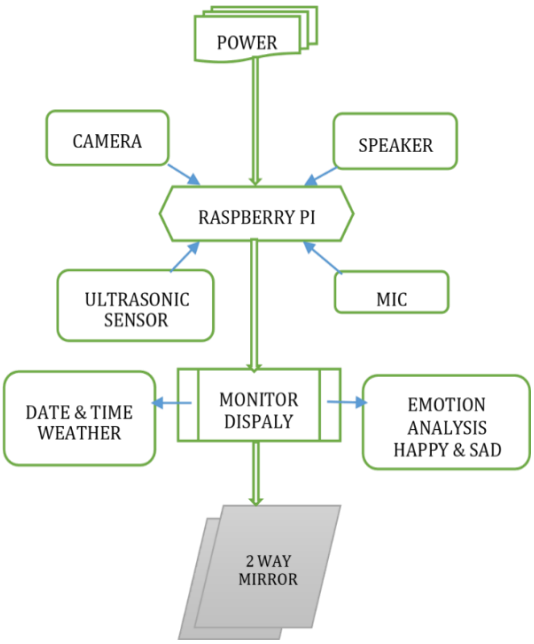

Fig 2. Flowchart

VIII. RESULTS AND OUTPUT- The Smart Mirror project transforms a traditional mirror into an interactive, AI-powered device that enhances daily routines. Using a Raspberry Pi 4B+, a two-way mirror, display, camera, speaker, and cooling fan, the system displays real-time information like weather, time, and reminders, while also analyzing facial expressions to detect user emotions. Through AI-based emotion detection, the mirror offers personalized responses such as motivational quotes or productivity tips. A cooling fan ensures stable performance, and the speaker provides voice feedback, making the mirror more interactive and accessible even when the user isn't directly looking at it. The, runs on lightweight AI models, and maintains user privacy by processing data locally. It also opens up potential uses in mental health tracking and wellness support. Built on the modular CNN platform, the smart mirror supports future upgrades like voice control and smart home integration. Overall, the project successfully combines AI, IoT, and smart display technologies into a user-friendly and innovative personal assistant.

OUTPUT:

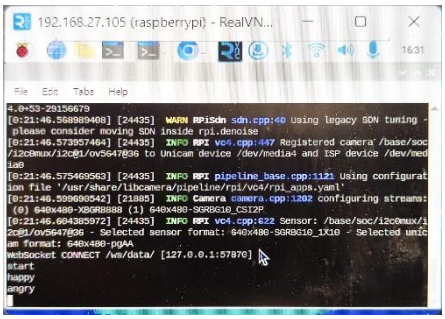

fig 3. VNC Terminal

This VNC terminal screenshot shows a Raspberry Pi booting up and initializing a camera module, which is likely used for facial recognition or emotion detection in your smart mirror project. Here's a short breakdown of what's happening:

1. Camera Initialization:
   - The system registers a camera sensor (ov5647) to the Uni cam interface.
   - The camera stream formats are set, e.g., 640x480-XBGR8888 and 640x480-SGRBG10.
2. Warnings and Info Logs:
   - A warning indicates the use of legacy SDN tuning (rpi.denoise is recommended).
   - Multiple INFO messages show successful initialization and configuration of the camera pipeline.
3. WebSocket Connection:
   - A WebSocket is opened at 127.0.0.1:57870 for data communication. This could be for sending live camera feed or emotion recognition results.
4. Emotion Detection Output:
   - Terminal logs show printed outputs: start, happy, angry – likely detected emotions.

This confirms that your smart mirror is up and running, actively detecting and classifying facial expressions through the camera!

Fig 4. LED Monitor display screen

This display is the user interface of the smart mirror system. It shows the current time and date, helping users stay updated at a glance. The message "Wait for face" indicates that the system is actively checking for a user's face to begin emotion detection. Additionally, it displays the weather status as "Clear Sky" along with the current temperature of 41.19°C, providing useful real-time environmental information.

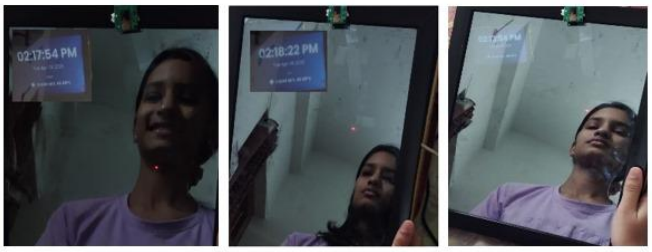

fig 5. Emotion Detection

This output shows the smart mirror detecting and displaying different facial expressions: **Happy**, **Sad**, and **Neutral** as well as display Angry and Surprise also. The mirror uses the camera module to recognize the user's emotions in real time and responds accordingly. The screen also shows the current time and weather, while the face detection and emotion recognition system adjusts based on the user's expression.

IX. CONCLUSION: In conclusion, the Smart Mirror with Emotion Monitoring is an innovative system that integrates facial recognition, emotion detection, and personalized recommendations to enhance user experience and well-being. By leveraging AI-powered emotion analysis, the smart mirror provides real-time insights into a user's emotional state, helping them manage stress, improve their daily routines, and receive personalized recommendations. The successful development and implementation of this system require expertise in computer vision, AI, IoT, and user interface design. The accuracy of emotion detection depends on the quality of the dataset, the robustness of the facial recognition model, and the effectiveness of real-time processing. This technology has a wide range of applications, from mental health monitoring to personalized skincare, virtual fitness coaching, and smart home integration. However, challenges such as data privacy, security, and algorithmic biases must be addressed to ensure ethical and reliable use. Moving forward, advancements in AI, deep learning, and IoT connectivity will further enhance the capabilities and accuracy of smart mirrors. As this technology evolves, it has the potential to redefine personal care, healthcare monitoring, and smart home automation, making daily interactions more intelligent and user-friendly.

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