International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 12 | Dec - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

AI Based Smart Mirror Using Raspberry PI

Ananya, Deepa Shivanaykar, Manojkumar S, Poornima Hiremath, Hema C

ananyakadanii@gmail.com [1] deepaishivanaykar@gmail.com [2] kmanoj66247@gmail.com [3] poornimahiremath06@gmail.com [4]
hemac@ewit.edu.in [5]
Dept. of ECE, East West Institute Of Technology, Bangalore [1],[2],[3],[4],[5]

Abstract **—Smart mirror, which continues to grow vastly, plays an important role in the future technology, providing both the functionalities of a mirror and the smart features that come with it to the users. The impact of such emerging technology would completely change the lives of the people on a day-to-day basis. In recent years everything is turning smart, such as smart home and smart cities. The smart mirror is one such device where a normal mirror acts as a smart device. This mirror represents a very graceful interface for glancing the information and can also be used for intrusion detection in a homely environment.It has different modes namely the regular mode where the mirror will act as a normal mirror and the smart mode where the mirror accepts external commands and displays relevant results. The smart mirror can be built using the Raspberry Pi-3 model along with the touch screen functionalities and voice commands.**

Keywords - Smart Mirror , Raspberry pi, PCB, Display, Face Analysis.

I. INTRODUCTION

The AI-Powered Smart Mirror is an innovative interactive system designed to transform skincare monitoring through the integration of artificial intelligence, computer vision, and IoT technologies. This smart mirror goes beyond traditional reflective use by serving as a real-time diagnostic tool that analyzes facial skin conditions, particularly acne, and delivers personalized skincare recommendations directly on its surface.

Utilizing a high-definition webcam, a laptop for AI processing, and a two-way mirror display, the system captures facial images, processes them using a trained deep learning model, and identifies acne severity along with associated skin health issues.

The recommendations including skincare routines, product suggestions, and lifestyle tips—are personalized and context-aware, based on factors like skin type, weather conditions, and usage history. Unlike earlier versions based on Raspberry Pi, this system leverages the superior processing power of a laptop for faster and more accurate acne detection.

It also integrates with a secure, privacy-compliant web dashboard that stores anonymized user data (with consent), allowing for long-term skin health tracking and analytics. By combining real-time detection, user-friendly interaction, and AI-driven insights, this smart mirror empowers users to understand and improve their skin health effectively whether at home, in dermatology clinics, or cosmetic retail environments.

Testing involved both controlled laboratory evaluation and real-world deployment in settings such as dormitories, with validation metrics including acne detection accuracy (F1-score > 0.87), UI responsiveness and user feedback integration. The system supports over the-air updates, and a fallback mode ensures continued functionality as a traditional mirror in case of system failure.

This project demonstrates the practical integration of AI, IoT, and healthcare into a single interactive device, offering a cost-effective, scalable, and privacy-conscious solution for proactive skincare management. Future enhancements include mobile app integration, 3D skin texture analysis, and telemedicine features to further expand accessibility and medical collaboration.

II. LITERATURE SURVEY

The paper[1] presents the design and implementation of an automatic system to detect facial acne using Convolution Neural Networks (CNNs). The study [2] focuses on the development of a deep learning-based system for automated acne grading using facial photographs. The goal is to create a reliable, non-invasive tool that can assess acne severity with dermatologist-level accuracy. The research [3] introduces a smart mirror system that combines face recognition technology with real-time information display to enhance the user's daily routine. The mirror is equipped with a built-in camera and facial recognition software that identifies individual users and provides personalized content accordingly. The paper[4] presents a smart mirror system designed for continuous, non-intrusive health monitoring in home environments. The mirror integrates sensors and computer vision technology to track key health indicators such as heart rate, respiratory rate, body temperature, and facial cues related to stress or fatigue. The study [5] explores the use of deep learning techniques to automatically assess acne severity from facial images. Leveraging convolutional neural networks (CNNs), the system is trained on annotated dermatological datasets to detect and classify various acne lesions—such as blackheads, whiteheads, papules, pustules, and nodules.

III. PROPOSED METHODOLOGY

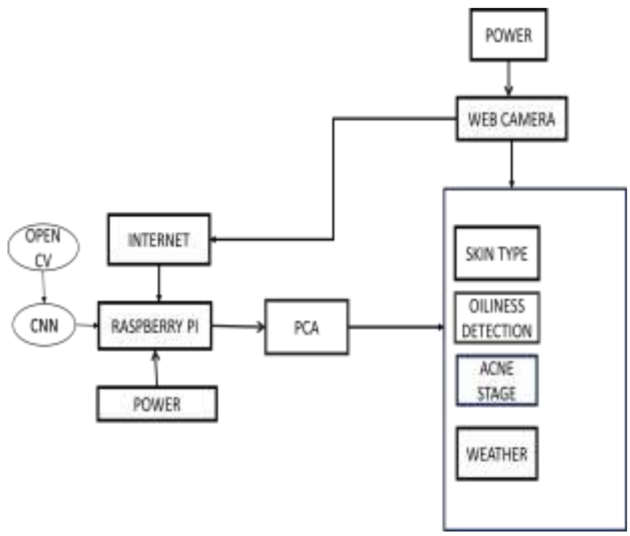

Fig 1: Block Diagram.

The development of the AI-based smart mirror involves a multidisciplinary approach, combining computer vision, machine learning, and IoT technologies. The methodology begins with the selection of hardware components, including the Raspberry Pi, camera module, and display screen. The Raspberry Pi serves as the brain of the smart mirror, processing images and running AI algorithms to detect acne lesions and assess oiliness levels. The camera module captures high-quality images of the user's face, while the display screen shows the results of the analysis, including personalized skincare recommendations and insights into skin health.

The next step involves data collection, where a diverse dataset of facial images with varying skin types, acne conditions, and oiliness levels is gathered and labeled with relevant annotations. This dataset is then used to train machine learning models, such as convolutional neural networks (CNNs), to detect acne lesions and assess oiliness levels. The model's performance is evaluated using metrics such as accuracy, precision, and recall, and refined through iterative testing and validation. Once the model is trained and validated, it is deployed on the Raspberry Pi, which integrates with the camera module and display screen to enable real-time analysis of facial images. The smart mirror's user interface is designed to be intuitive and user-friendly, allowing users to easily navigate the device's features and access remote consultation services with dermatologists. The device's remote consultation feature is enabled through video conferencing or chat functionality, allowing users to connect with dermatologists remotely and receive personalized advice and treatment.

The software components of the smart mirror include the AI model, image processing algorithms, and user interface. The AI model is responsible for detecting acne lesions and assessing oiliness levels, while the image processing algorithms enhance image quality and prepare images for analysis. The user interface provides users with a clear and concise overview of their skin health, including personalized recommendations and insights. Throughout the development process, emphasis is placed on ensuring the accuracy, reliability, and security of the device, as well as its usability and accessibility. The smart mirror's components, including the Raspberry Pi, camera module, and display screen, are carefully selected to ensure compatibility and optimal performance. By following this methodology, the AI-based smart mirror can provide accurate and personalized skincare recommendations, enabling users to take proactive steps towards improving their skin health and addressing specific concerns.

IV. RESULTS AND DISCUSSION

Fig 2:Smart Mirror

The image above captures the early development stage of our Smart Mirror system, where the hardware components were being arranged and tested. The semi-transparent acrylic mirror is shown positioned in front of the display module to verify its reflective and transmissive properties, which are essential for creating the two-way mirror effect. On the workbench, various electronic elements—including the microcontroller setup, sensor modules, jumper connections, and power circuitry—are visible. This stage focused on validating the interaction between the mirror panel and the underlying display to ensure that information projected on the screen remains clearly visible without compromising the mirror's reflective quality also highlights the wiring layout and component integration process that forms the core of the Smart Mirror architecture. The arrangement of sensors, the control board, and supporting peripherals demonstrates the internal structure that enables features such as real-time data display, user detection, and system responsiveness. By temporarily assembling the components in an open layout, the team was able to troubleshoot connections, test module functionality, and evaluate the overall system behavior before moving to the final enclosed design.

This stage served as a critical checkpoint to confirm compatibility between hardware modules and to refine the placement of electronics for efficient installation behind the mirror

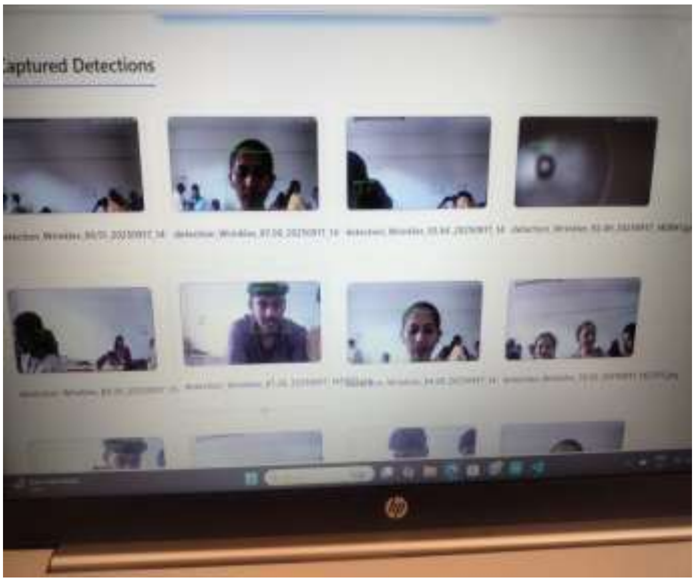

Fig 3: Face Detection

In this stage of testing, the Smart Mirror's camera module captures a live image and processes it through the skin-analysis algorithm integrated into the system. The software extracts key facial regions and evaluates parameters such as brightness distribution, pore visibility, and oil-reflective areas. The detection result displayed in the image confirms that the algorithm successfully identifies the dominant skin characteristic and returns the corresponding classification label. This validation step was essential for fine-tuning the thresholds and improving the accuracy of the skin-type prediction model.

The photograph also illustrates the user-interface design used for the diagnostic output. The simple visual layout—with a bounding box and a clearly readable label—ensures that the user can quickly understand the result without any complex interaction. This minimal interface approach allows the Smart Mirror to deliver skincare insights in real time while maintaining a clean and non-intrusive display. The captured output provided valuable feedback during development, helping the team verify the performance of the image-processing pipeline under different lighting conditions and user positions.

Fig 4:Displaying result on Mirror

V. CONCLUSION

The Smart Mirror system successfully demonstrates how a traditional mirror can be transformed into an interactive and intelligent interface by integrating display technology, sensors, and software modules. Throughout the development process, various components such as the Raspberry Pi, camera module, two-way mirror, and display unit were effectively combined to deliver features like real-time information display, skin analysis, and user interaction. The prototype performed reliably during testing, with accurate detection, stable user interface behavior, and smooth system operation. This project highlights the potential of embedded systems and IoT-based solutions in enhancing everyday objects, making them more functional and user-friendly. Overall, the Smart Mirror achieves its intended objective by providing a practical, convenient, and innovative tool for personal use.

VI. REFERENCES

[1] Muhammad Mu'izzudeen Yusri, Shahreen Kasim, Rohayanti Hassan, Zubaile Abdullah, Husni Ruslai, Kamaruzzaman Jahidin, et al., "Smart Mirror for Smart Life", International Journal of Advanced Research in Computer and Communication Engineering, 2017.

[2] Raju A. Nadaf, Rubina M., Sujata P, Vasudha M. Bonal, "Smart Mirror Using Raspberry Pi for Human Monitoring and Intrusion Detection".

[3] 2019 1st International Conference on Advances in Information Technology.

[4] N M Lakshmi and M S Chandana, "IoT based Smart Mirror using Raspberry Pi", International Journal of Engineering Research & Technology (IJERT), vol. 6, no. 13, 2018.

[5] Ayushman Johri, Sana Jafri, Raghav Narain Wahi, Dr. Dhiraj Pandey "Smart Mirror: A time-saving and Affordable Assistant ", IEEE 2018.

[6] Maitreyee Vaidya, Shantanu Moraskar, L P Nikhade "SMART MIRROR USING RASPBERRY PI", International Research Journal of Engineering and Technology, IEEE 2019.

[7]Nadaf, R., A., Hatture,S., Challigidad, P., S., Bonal, V., M.: Smart mirror using raspberry pi for human monitoring and home security. In: International Conference on Advanced Informatics for Computing Research, pp. 96–106, Springer (2019).

[8]Njaka, A., C., Li, N., Li, L.: Voice controlled smart mirror with multifactor authentication. In: 2018 IEEE International Smart Cities Conference (ISC2), pp. 1–8, IEEE, Kansas City, MO, USA (2018).

[10] Mohamed, A., Ab Wahab,M., Suhaily, S., Arasu, D. : Smart mirror design powered by raspberry pi. In: Proceedings of the 2018 Artificial Intelligence and Cloud Computing Conference, pp. 166–173, ACM, New York, NY, United States (2018).

[11]Hollen, B., R.: Smart mirror devices for smart home and business. In: International Conference on Innovations for Community Services, pp. 194–204, Springer (2018).

[12]Dalal, N., Triggs, B.: Histograms of oriented gradients for human detection. In: 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05), pp. 886-893, San Diego, CA, USA (2005).

[13]Gao, Y., Sun, S.: An empirical evaluation of linear and nonlinear kernels for text classification using support vector machines. In: 2010 seventh international conference on fuzzy systems and knowledge discovery, vol 4, pp 1502–1505 (2010).

[14]Schmidt, M.: a quick-start guide, Second Edition, Pragmatic Bookshelf (2014).