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Smart Mirror Application for Social Event Based Outfit Recommendation and Skin Health Analysis

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I. Introduction

The rapid evolution of Artificial Intelligence(AI) has paved the way for innovative applications in everyday objects. Among these, a smart mirror is a representation of a traditional mirror with integrated technologies to provide real-time personalized recommendations and health insights. Busy schedules make it challenging for individuals to manage their to-do lists, health, and even dress code choices.

According to the past work done, both Khandaker et al. [1] and Simone et al. [2] developed smart mirrors with various features, such as face verification, weather updates, calendar events, news, traffic, and emotion recognition. Considering social event-based fashion recommendation, Federico et al [3] proposed an event classifier combined with a recommender by implementing a fashion object detector for social events. Nikita et al [4] proposed outfit recommendation by detecting user outfits, identifying the social event, and suggesting similar outfits for the detected event. However the system lacks the ability of considering outfits suitable for multiple social events. In the context of acne detection, Quan et al. [5] proposed an automatic system that employs Faster Region-based Convolutional Neural Network (R-CNN) for acne lesion detection and LightGBM for severity grading. Similarly, Hang et al. [6] introduced an ensemble neural network-based approach featuring a classification module for severity estimation and an acne localization module. However, prior research has focused on general acne detection, there is limited work addressing localizing acne within the ”Danger Triangle of the Face” which is a crucial clinical aspect. This research proposes a comprehensive Internet of Things(IoT) smart mirror framework to address past limitations. Mainly, it has features for face verification, acne detection with ”Triangle of Death” localization, and social event-based fashion recommendation. By leveraging these components, the proposed smart mirror represents a significant advancement towards smart computing, seamlessly integrated with digital intelligence.

II. Methodology

A. Hardware Implementation

Figure 1 shows the structure of the smart mirror, which consists of a 24-inch display, acrylic two-way mirror, webcam, Raspberry Pi, power supply, and required cables integrated into a customized frame to achieve operational functionality. Display and mirror dimensions need accurate measurement while the system includes spaces for keeping cables. Display remains in the center to match the orientation of the two-way mirror by arranging its reflective surface to face outwards and transparent surface to look at the display. Webcam installed at the upper section of the frame uses Universal Serial Bus(USB) to connect with Raspberry Pi for capturing images. Facial verification, acne, and outfit detection are run on the Raspberry Pi to analyze data for display results.

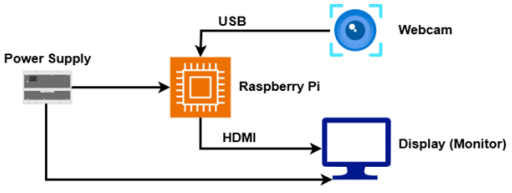

Fig. 1: Hardware Implementation

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B. Face Verification Module

To perform real-time face verification, both speed and accuracy are essential factors. Algorithms such as Haar Cascade, ResNet+SSD, YuNet, and MediaPipe for face detection, along with Python Face Recognition, DeepFace-FaceNet, and SFace for recognition, were evaluated to balance speed and accuracy. Selection of these algorithms was based on findings from past research [7]. This research primarily focused on Central Processing Unit(CPU) performance to ensure practical accessibility of the system in low-resource environments.

C. Acne Detection Module

To perform acne detection capable of differentiating acne within "danger triangle" of the face we incorporated a YOLOv8 for acne detection with an around 930-image acne dataset and MediaPipe to detect key facial landmarks to identify the critical region. Mediapipe [8] has proven to be more precise in detecting facial landmarks than other methods.

D. Social Event Based Fashion Recommendation Module

The workflow of fashion recommendation consists of detecting the user's outfit, decide its suitability for a given calendar event, and recommending outfits that match. A mapping mechanism is used to map the outfits to social events like formal wear for a meeting, party wears for a wedding, and parties to handle the issue of similar outfits for multiple events. The dataset includes 400 images per outfit, and YOLOV8 is used to train the outfit detection model.

III. Results and Discussion

Table I shows obtained accuracy, speed for face detection & recognition. Among them Mediapipe, FaceNet have the highest accuracy and the processing speed for face verification resulting in it working in real time. YOLOV8 for acne detection has around 66% precision, 60.9% recall, and mAP50 of 64.8%. Figure 2 shows the results of accurate acne classification inside and outside the triangle area. Figure 3 shows results for trained fashion objects for social event-based fashion recommendation. It validate that the model is well-calibrated to accurately identify the fashion objects however certain classes show misclassifications due to visual similarity between them.

TABLE I: Comparison of Face Detection and Recognition

Face Detection	Face Recognition	Accuracy (%)	Speed - CPU (fps)
Haar Cascade	Python Face Recognition	85.25	6.03
ResNet + SSD	Python Face Recognition	96.16	8.34
Haar Cascade	DeepFace - FaceNet	74.63	3.61
ResNet + SSD	DeepFace - FaceNet	84.48	4.40
YuNet	SFace	94.03	14.62
MediaPipe	FaceNet	98.93	24.40

IV. Conclusion

The presented smart mirror system enhances user convenience by integrating face verification, acne detection, and outfit recommendations for social events. The integration of these features enhances user convenience and personalization and makes the smart mirror to a versatile assistant for daily routines. Future work will focus on acne severity classification and refining fashion recommendations based on weather, seasons, and user preferences.

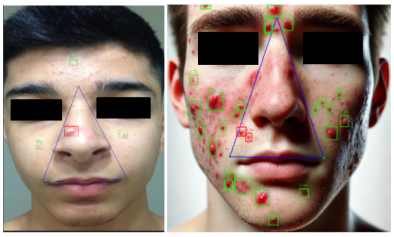
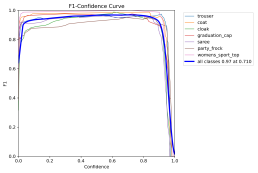
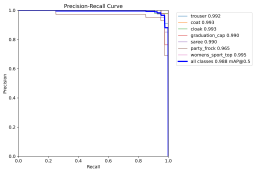


Fig. 2: Acne Detection Results



(a) F1 Curve



(b) PR Curve

Fig. 3: F1 and PR curves for fashion object detection

V. Acknowledgment

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