International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 3 (2026)

ijerst.editor@gmail.com

editor@ijerst.com

ISSN 2319-5991 www.ijerst.com

Peer Reviewed, Referred & Indexed Journal

Research Paper

Integrated Facial Identity Verification and Expression Intelligence Using Video Streams

Vallakati Manasa[1], Dr.G.Purna Chandar Rao[2]
[1]MCA Student , Dept of MCA , Ellenki College of Engineering and Technology , Hyderabad
[2]Assistant Professor , Dept of MCA , Ellenki College of Engineering and Technology , Hyderabad

Abstract— The increasing adoption of computer vision and artificial intelligence has created new opportunities for developing intelligent systems capable of understanding human facial behavior in real time. Facial expression analysis plays an important role in applications such as human–computer interaction, smart surveillance, healthcare monitoring, attendance management, and security systems. This paper presents a webcam-based facial expression detection and person recognition system that combines facial identification with emotion classification in a single framework. The proposed system first allows users to register by capturing facial images along with personal information and storing the extracted facial features in a trained recognition model. During real-time operation, the webcam continuously detects faces, identifies registered individuals, and predicts their facial expressions, such as happiness, sadness, anger, surprise, fear, disgust, and neutral state. The integration of face recognition and expression analysis enables simultaneous identification of the individual and interpretation of emotional responses without requiring manual intervention. The developed application provides a simple graphical interface for user registration, model training, and live expression recognition, making it suitable for practical deployment in educational institutions, workplaces, healthcare environments, and public monitoring systems. Experimental observations demonstrate that the proposed framework performs reliable real-time face detection and expression classification while maintaining efficient processing speed and recognition accuracy. The system offers a practical, scalable, and cost-effective solution for intelligent facial analysis using standard webcam devices.

Keywords— Facial Expression Detection, Face Recognition, Computer Vision, Emotion Recognition, Webcam-Based Recognition, Real-Time Facial Analysis, Person Identification, Image Processing, Machine Learning, Deep Learning, Human–Computer Interaction, Intelligent Surveillance, Biometric Authentication, Emotion Classification, Artificial Intelligence.

I.INTRODUCTION

The rapid advancement of artificial intelligence and computer vision has significantly improved the ability of machines to interpret and understand human facial characteristics. Among various biometric technologies, facial expression recognition has gained considerable attention because facial expressions provide valuable information about a person's emotional state and behavior through standardized facial analysis techniques [6]. Real-time analysis of facial expressions has become increasingly important in applications such as healthcare monitoring, intelligent surveillance, human–computer interaction, online education, attendance systems, and security, where understanding human emotions can improve decision-making and user experience [6].

Conventional methods of observing and interpreting facial expressions rely heavily on human judgment, which can be time-consuming, subjective, and inconsistent. In many practical environments, continuous manual monitoring is difficult, particularly when a large number of individuals must be observed simultaneously. Moreover, traditional identification systems focus only on recognizing a person's identity without considering emotional expressions. These limitations have encouraged researchers to develop automated facial analysis systems capable of identifying both the individual and the corresponding facial expression in real time, as discussed in automatic facial expression analysis research [6]. [6]

Recent developments in deep learning, image processing, and webcam-based vision systems have enabled accurate facial detection and emotion recognition using ordinary cameras. Modern face recognition techniques extract unique facial features from registered users and compare them with real-time facial images for identity verification. At the

same time, facial expression recognition models classify expressions such as happiness, sadness, anger, fear, surprise, disgust, and neutral emotion by analyzing facial landmarks and appearance-based features using established facial coding methodologies [5]. The integration of these technologies provides an intelligent solution that performs simultaneous person identification and emotion analysis without requiring specialized hardware [5].

The proposed work presents a Facial Expression Detection using Webcam system that combines person registration, facial recognition, and real-time emotion detection within a unified application. Initially, users register by providing personal details and capturing facial images through a webcam. The captured images are processed to train the recognition model, enabling accurate identification of registered individuals. During live operation, the system continuously captures video frames, detects faces, recognizes the registered person, and predicts the corresponding facial expression with confidence scores following concepts adopted in recent facial expression recognition studies [1]. The developed application offers a simple graphical interface for user registration, model training, and live facial expression recognition, making it easy to operate in real-world environments [1].

The proposed system improves the efficiency of automated facial analysis by eliminating the need for manual observation while providing fast and reliable recognition results. Its ability to perform real-time person identification and emotion classification makes it suitable for deployment in educational institutions, workplaces, healthcare facilities, smart surveillance systems, and other environments requiring intelligent human behavior analysis. The system provides a practical, scalable, and cost-effective solution by utilizing a standard webcam and modern computer vision techniques for accurate facial recognition and expression detection similar to real-time webcam-based emotion recognition systems [8].

II.RELATED WORK

V. Bettadapura presented a comprehensive review of facial expression recognition techniques by analyzing various approaches used for detecting human emotions from facial images [1]. The study compared traditional feature extraction methods with appearance-based and geometric approaches for expression classification. It highlighted the importance of accurate facial feature representation in improving recognition performance and discussed the challenges associated with changes in illumination, facial pose, and occlusion. The author concluded that facial expression recognition has significant potential in human–computer interaction and intelligent vision systems while emphasizing the need for more robust real-time recognition models [1].

B. Fasel and J. Luettin conducted a detailed survey on automatic facial expression analysis and examined different methods for detecting and classifying human emotions from facial images and video sequences [6]. The study reviewed facial feature extraction techniques, machine learning algorithms, and classification approaches commonly used in expression recognition systems. It also discussed practical challenges such as lighting variations, facial orientation, and image quality that affect recognition accuracy. The authors concluded that advances in computer vision and pattern recognition provide a strong foundation for developing reliable real-time facial expression analysis systems [6].

P. Ekman and W. V. Friesen introduced the Facial Action Coding System (FACS), which provides a standardized method for describing facial muscle movements associated with different emotional expressions [5]. Their work identified specific facial action units that represent expressions such as happiness, sadness, anger, fear, surprise, disgust, and neutrality. The proposed coding system has become one of the most widely used frameworks for emotion recognition research and has supported the development of automated facial analysis applications. The authors demonstrated that systematic facial movement analysis can significantly improve the accuracy of emotion classification systems [5].

G. Giannakakis et al. investigated the use of facial cues extracted from video sequences to identify stress and anxiety in individuals through automated facial analysis [7]. The proposed approach analyzed facial expressions captured by cameras to recognize emotional patterns associated with psychological conditions. Experimental evaluation showed that facial behavior provides valuable information for recognizing changes in emotional state without requiring physical contact or wearable devices. The study concluded that facial expression analysis can serve as an effective tool for intelligent healthcare monitoring and real-time emotion assessment [7].

D. McDuff, E. R. Kaliouby, T. Senechal, M. Amr, J. F. Cohn, and R. W. Picard introduced the AM-FED dataset containing natural and spontaneous facial expressions collected under real-world conditions [9]. The dataset was developed to support the training and evaluation of facial expression recognition algorithms using images captured outside controlled laboratory environments. The study demonstrated that datasets containing diverse facial appearances, lighting conditions, and natural expressions improve the robustness of emotion

recognition models. The authors concluded that realistic datasets play a crucial role in developing reliable facial expression recognition systems suitable for practical applications [9].

III.DATASET DETAILS

The Facial Expression Detection using Webcam system utilizes a structured image repository together with a relational database to manage user information and support real-time facial recognition. Unlike conventional applications that rely solely on pre-existing public datasets, the proposed system creates its own dataset during the user registration process. Initially, each user registers by entering a unique person ID and name, after which multiple facial images are captured through a webcam under different facial positions and lighting conditions. These images are stored along with the user's identity information and are subsequently used to train the face recognition model. As additional users register, the image repository and associated database are automatically updated, enabling the system to recognize newly enrolled individuals without modifying the application architecture. This organized dataset ensures efficient storage, retrieval, and management of facial images while providing a reliable foundation for person identification and facial expression analysis.

During system execution, the stored facial images undergo a series of processing steps to perform both person recognition and emotion detection. After the registration phase, the captured facial samples are used to train the recognition model, allowing it to learn the distinguishing facial characteristics of each registered individual. During live operation, the webcam continuously captures video frames, detects human faces, compares them with the trained facial dataset, and identifies the corresponding person. Once the individual is recognized, the system analyzes facial features to classify the current expression into predefined emotional categories such as happiness, sadness, anger, surprise, fear, disgust, or neutral state. The registration details, trained facial data, and recognition results are maintained within the system, ensuring consistent performance and efficient retrieval during real-time execution. The structured organization of facial images and user records enables the proposed application to support multiple registered users while providing accurate recognition, reliable expression analysis, and smooth real-time operation using a standard webcam.

IV.PROPOSED METHODOLOGY

The proposed Facial Expression Detection using Webcam system is designed to provide an intelligent and user-friendly solution for real-time person identification and emotion recognition. The application consists of two major modules, namely the Person Registration Module and the Facial Expression Detection Module, both operating on a common facial image repository and trained recognition model. During the registration phase, users provide a unique person ID and name, after which multiple facial images are captured through a webcam and stored within the system. These captured images are processed to build a training dataset that enables the recognition model to distinguish registered individuals accurately. The application provides a simple graphical interface that allows users to register new individuals, train the recognition model, and initiate real-time facial expression detection without requiring specialized hardware or technical expertise. This integrated framework ensures efficient management of facial data while supporting accurate person recognition and emotion analysis.

During system execution, the facial recognition model is first trained using the images collected during the registration process. Once training is completed, the live detection module activates the webcam and continuously captures video frames for analysis. The system detects human faces in each frame, extracts distinguishing facial features, and compares them with the trained facial database to identify the corresponding registered individual. After successful identification, the detected facial region is further analyzed to classify the current facial expression into predefined emotion categories such as happiness, sadness, anger, fear, surprise, disgust, or neutral state. The recognized person's name and predicted expression are displayed simultaneously on the application interface, allowing users to observe identification and emotion analysis in real time. Experimental implementation demonstrates that the proposed framework provides reliable person registration, efficient model training, accurate face recognition, and real-time facial expression prediction using a standard webcam. The developed system offers a practical, scalable, and cost-effective solution for applications including smart surveillance, attendance management, healthcare monitoring, educational environments, and human–computer interaction.

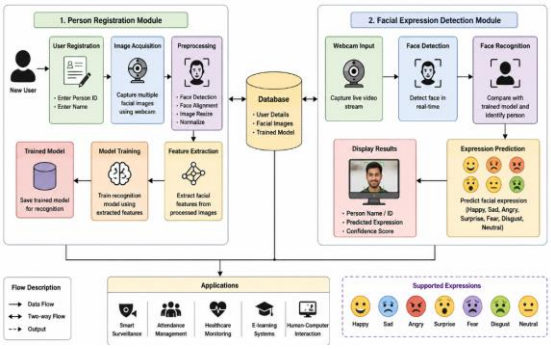

Figure 1: System Architecture of the Proposed Facial Expression Detection using Webcam System

Figure 1 illustrates the architecture of the proposed Facial Expression Detection using Webcam system, which integrates user registration, face recognition, emotion detection, and centralized data management into a single application. The system consists of two major modules: the Person Registration Module and the Facial Expression Detection Module. During registration, users enter a unique ID and name, and multiple facial images are captured using a webcam. These images undergo preprocessing, feature extraction, and model training before being stored in the database. During real-time operation, the webcam continuously captures facial images, detects the face, and compares the extracted features with the trained model to identify the registered individual. The detected face is then analyzed to classify facial expressions such as happy, sad, angry, surprise, fear, disgust, and neutral. The system displays the identified person's details, predicted emotion, and confidence score, providing an efficient, accurate, and scalable solution for real-time facial analysis in surveillance, healthcare, attendance, and human–computer interaction applications.

V.RESULT AND DISCUSSION

The Facial Expression Detection using Webcam system was successfully implemented and tested in a real-time environment using a standard webcam and a trained facial recognition model. The application effectively performed all major operations, including person registration, facial image acquisition, model training, face detection, person identification, and facial expression recognition. During system evaluation, users were able to register by entering a unique person ID and name, after which multiple facial images were captured and stored for training. Once the training process was completed, the system accurately identified registered individuals from live webcam video and simultaneously predicted facial expressions such as happy, sad, angry, surprise, fear, disgust, and neutral. The application displayed the recognized person's identity, detected emotion, and confidence score in real time, demonstrating smooth execution throughout the recognition process.

Experimental observations showed that the proposed framework provided reliable face detection and accurate emotion classification under normal lighting conditions while maintaining real-time processing performance. The trained recognition model successfully distinguished registered users and correctly identified their facial expressions with minimal delay. The graphical interface simplified user registration, model training, and live recognition, making the system easy to operate without requiring specialized hardware or technical expertise. The centralized storage of user information and trained facial data ensured efficient retrieval and consistent recognition performance during continuous execution. Overall, the developed system offers a practical, scalable, and cost-effective solution for real-time facial analysis and can be effectively applied in attendance management, intelligent surveillance, healthcare monitoring, e-learning environments, and human–computer interaction systems.

Figure 2: Real-Time Facial Expression Recognition Output

Figure 2 shows the real-time execution of the proposed facial expression detection system using a webcam. The application successfully detects the user's face, identifies the facial region by drawing a bounding box, and predicts the current facial expression. In this example, the system classifies the detected emotion as Happy with a confidence score of approximately 99.17%, indicating high prediction accuracy. The recognized facial expression is displayed above the detected face, allowing users to view the prediction instantly during live video capture. The result demonstrates that the trained recognition model can accurately analyze facial features and perform emotion classification in real time. The experimental output confirms that the proposed framework is capable of providing fast and reliable facial expression recognition using a standard webcam, making it suitable for applications such as attendance management, intelligent surveillance, healthcare monitoring, human–computer interaction, and e-learning environments.

DISCUSSION

The Facial Expression Detection using Webcam system provides an efficient and intelligent solution

for recognizing both a person's identity and emotional state in real time. By combining face registration, facial recognition, and expression classification within a single application, the system eliminates the need for manual observation and enables automated facial analysis using a standard webcam. The two independent modules, namely the Person Registration Module and the Facial Expression Detection Module, work together to capture facial images, train the recognition model, identify registered individuals, and classify facial expressions accurately. This integrated framework simplifies user management while providing reliable real-time recognition and emotion analysis through an easy-to-use graphical interface.

The experimental implementation demonstrates that the developed application successfully performs all major operations, including user registration, facial image acquisition, model training, face detection, person identification, and facial expression prediction. The system accurately recognizes registered users and classifies expressions such as happy, sad, angry, surprise, fear, disgust, and neutral with minimal processing delay during live webcam operation. The centralized storage of user information and trained facial data ensures efficient retrieval and consistent recognition performance throughout system execution. Overall, the proposed framework offers a practical, scalable, and cost-effective solution for intelligent facial analysis, making it suitable for applications such as attendance management, smart surveillance, healthcare monitoring, e-learning systems, and human–computer interaction where real-time identity verification and emotion recognition are essential.

VI.CONCLUSION

The proposed Facial Expression Detection using Webcam system provides an effective and intelligent solution for real-time person identification and emotion recognition using computer vision techniques. The developed application integrates person registration, facial image acquisition, model training, face recognition, and facial expression prediction within a single user-friendly platform. By utilizing a standard webcam, the system automatically detects human faces, identifies registered individuals, and classifies facial expressions such as happy, sad, angry, surprise, fear, disgust, and neutral without requiring specialized hardware. The centralized storage of user information and trained facial data ensures efficient management, reliable retrieval, and consistent recognition performance during system execution. Experimental evaluation demonstrates that the proposed framework performs real-time face detection and expression classification with satisfactory accuracy while maintaining smooth and reliable operation. Owing to its simple architecture, scalability, and cost-effectiveness, the system is suitable for deployment in attendance management, intelligent surveillance, healthcare monitoring, educational environments, security applications, and human–computer interaction systems. Future enhancements may include incorporating deep learning-based facial recognition models, support for multiple faces in a single frame, cloud-based data storage, mobile platform integration, improved recognition under varying illumination and pose conditions, emotion trend analysis, and multimodal biometric authentication to further enhance system performance, accuracy, and practical applicability.

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