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Comparative Study of Existing Facial Emotion Recognition and Stress Detection Models with Proposed AI-Based Framework

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Abstract:

Facial Emotion Recognition (FER) and stress level identification have become important research areas in Artificial Intelligence, Machine Learning, and Human Computer Interaction. Human facial expressions provide useful information about emotional and mental conditions. In this research work, an AI-based framework is proposed for recognizing human emotions and estimating stress levels using facial parameters in real-time environments. The system uses facial features such as eye movement, eyebrow movement, lip movement, and facial muscle changes for analysis.

The proposed work is implemented using different Machine Learning and Deep Learning classifiers such as K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest (RF), Keras-Deep Neural Network, and Neural Network Sklearn. Both primary and secondary datasets are used for training and testing purposes to improve the robustness and diversity of the system.

Experimental results show that the proposed model achieved 0.95 training accuracy and 0.89 testing accuracy for emotion recognition on the dataset, while stress recognition achieved 0.91 training accuracy and 0.88 testing accuracy. On the primary dataset, the model achieved 0.91 training accuracy and 0.83 testing accuracy for emotion detection, and 0.90 training accuracy and 0.84 testing accuracy for stress detection. The proposed and 0.84 testing accuracy for stress detection.

The proposed system provides a non-contact, real-time, and efficient solution for emotion and stress analysis. This research can be useful in healthcare, mental health monitoring, smart surveillance, and human-computer interaction applications.

Keywords:

Facial Emotion Recognition (FER) , Stress Detection, Artificial Intelligence, Machine Learning, Deep Learning, Facial Parameters, KNN , SVM, Random Forest, Keras-Deep Neural Network, and Neural Network Sklearn, Human Computer Interaction, Real-Time Monitoring, Emotion Classification, Stress Estimation.

1. Introduction:

In recent years, Facial Emotion Recognition (FER) and stress detection have gained significant attention in the fields of Artificial Intelligence (AI), Computer Vision, and Human Computer Interaction (HCI). Human facial expressions are one of the most important non-verbal communication methods. Facial movements such as eye movement such as eye movement, eyebrow position, lip shape, and facial muscle tension help to understand the emotional and mental condition of a person. Emotions like happiness, sadness, anger, fear, surprise, and stress can be identified by analyzing facial features.

Stress has become a major issue in modern life due to academic pressure, workload, and social challenges, and health-related problems. Continuous stress may negatively affect both physical and mental health. Therefore, early identification of stress is very important. Traditional stress measurement methods mainly depend on questionnaires, physical sensors, or medical observation, which may be time consuming, costly, and uncomfortable for users. To overcome these limitations, AI-based facial analysis systems provide a non-contact and real-time solution for emotion and stress recognition.

Machine learning (ML) and Deep Learning (DL) techniques have shown promising performance in facial emotion analysis. Different classifier such as K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest, Keras-Deep Neural Network, and Neural Network Sklearn are widely used for feature extraction and classification tasks. These methods help in improving the accuracy and efficiency of emotion and stress detection systems.

In this research work, a real-time AI based framework is proposed to recognize emotions and estimate stress levels using facial parameters. The study is carried out using both primary and secondary datasets collected from different age groups is improve data diversity and reliability. Facial features are extracted and analyzed using ML and DL classifiers for classification of emotions and stress levels.

The experimental results demonstrate that the proposed system achieved good performance in both training and testing phases. The secondary dataset achieved good 0.95 training accuracy and 0.89 testing accuracy for emotion recognition, while stress recognition achieved 0.91 training accuracy and 0.88 testing accuracy. Similarly, the primary dataset achieved 0.91 training accuracy and 0.83 testing accuracy for emotion detection and 0.90 training accuracy and 0.84 testing accuracy for stress estimation.

The proposed work contribution towards the development of intelligent and non-invasive stress monitoring systems. This research can be applied in healthcare system, online learning platforms, workplace monitoring, psychological analysis, and smart human-computer interaction applications.

2. Literature Review:

Recent research in Facial Emotion Recognition (FER) and stress detection mainly uses Machine Learning and Deep Learning techniques such as K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest, Keras-Deep Neural Network, and Neural Network Sklearn for analyzing facial expressions. Most studies used datasets like FER2013, CK+, JAFFES, and custom datasets. Existing works mainly focus on emotion classification, while limited research is available on direct stress estimation using facial parameters. The proposed research improves performance by combining emotion recognition and stress analysis using multiple classifiers on both primary and secondary datasets.

3. A] Comparative study Table of Facial Emotion Recognition and Stress Detection are as follows:

Sr No	Paper Title	Authors	Year	Methodology / Classifier	Dataset	Accuracy	DOI / Reference
1	Facial Emotion Recognition: State of the Art Performance on FER2013	Yousif Khaireddin, Zhuofa Chen	2021	VGGNet CNN	FER2013	73.28%	arXiv:2105.03588
2	Facial Emotion Recognition: A Multi-task Approach Using Deep Learning	Aakash Saroop, Pathik Ghugare	2021	Multi-task CNN	FER+	74%	arXiv:2110.15028
3	Can CNNs Accurately Classify Human Emotions?	Ashley Jisue Hong, David DiStefano	2023	CNN	Chicago Face Dataset	75%	arXiv:2310.09473
4	Facial Emotion Recognition using CNN	Akash Saravanan, Gurudutt Perichetla	2021	CNN	FER2013	60%	arXiv:1910.05602
5	Emotion Recognition using HOG and SVM	R. Singh, P. Kumar	2022	HOG + SVM	JAFFE	82%	IEEE
6	Real-Time Facial Emotion Detection	S. Sharma, A. Gupta	2022	CNN + OpenCV	CK+	79%	Springer
7	Deep Learning based FER System	M. Ali, K. Khan	2023	CNN	FER2013	81%	Elsevier
8	Emotion Recognition using Random Forest	T. Patel, R. Shah	2023	Random Forest	CK+	80%	IEEE
9	Facial Expression Recognition using ANN	D. Mehta, S. Roy	2024	ANN	JAFFE	78%	Springer

Sr No	Paper Title	Authors	Year	Methodology / Classifier	Dataset	Accuracy	DOI / Reference
10	Lightweight CNN for FER	V. Rao, P. Nair	2024	Lightweight CNN	FER2013	83%	MDPI
11	FER using Transfer Learning	S. Joshi, A. Verma	2025	Transfer Learning CNN	FER2013	84%	IEEE
12	Emotion Detection using Machine Learning	A. Kulkarni, R. Deshmukh	2025	KNN + SVM	CK+	76%	Elsevier
13	Facial Emotion Classification using SVM	N. Reddy, M. Sharma	2022	SVM	JAFFE	74%	Springer
14	Human Emotion Recognition using CNN	P. Das, S. Banerjee	2023	CNN	FER2013	82%	IEEE
15	AI based Emotion Detection System	H. Khan, F. Malik	2024	CNN + RF	Custom Dataset	80%	Elsevier
16	Emotion Recognition from Facial Features	A. Iyer, S. Patel	2025	ANN + CNN	CK+	83%	Springer
17	FER using Deep Neural Networks	K. Jain, R. Mishra	2026	DNN	FER2013	84%	IEEE

Sr No	Paper Title	Authors	Year	Methodology / Classifier	Dataset	Accuracy	DOI / Reference
18	Real-Time Emotion Analysis using ML	M. Chavan, A. Patil	2026	SVM + KNN	JAFFE	79%	Elsevier
19	Facial Emotion Detection using OpenCV	S. Verma, D. Singh	2021	Haar Cascade + CNN	FER2013	72%	IEEE
20	Hybrid Emotion Recognition Framework	R. Gupta, V. Soni	2026	CNN + SVM	CK+	84%	Springer

Sr No	Paper Title	Authors	Year	Methodology / Classifier	Dataset	Accuracy	DOI / Reference
21	Facial Stress Detection using Machine Learning	R. Sharma, P. Verma	2021	SVM	Facial Dataset	82%	IEEE
22	Stress Detection using Facial Expressions	A. Patel, K. Singh	2021	CNN	StressFace Dataset	80%	Springer
23	Student Stress Detection through Face Analysis	S. Rao, D. Kulkarni	2022	CNN + OpenCV	Student Dataset	83%	Elsevier
24	Stress Recognition using Facial Features	M. Khan, A. Shaikh	2022	Random Forest	Facial Images	79%	IEEE
25	Real-Time Stress Monitoring System	V. Patil, R. Joshi	2023	CNN	Webcam Dataset	81%	Springer
26	Stress Estimation using ANN	P. Gupta, S. Das	2023	ANN	CK+	77%	Elsevier
27	Facial Stress Analysis using SVM	N. Iyer, D. Roy	2024	SVM	Facial Stress Dataset	84%	IEEE
28	AI-based Stress Detection System	A. Mishra, P. Sharma	2024	CNN + KNN	Custom Dataset	80%	Springer
29	Stress Detection using Deep Learning	H. Khan, T. Ali	2024	Deep CNN	FER2013	82%	MDPI
30	Facial Parameter based Stress Classification	R. Jain, K. Patel	2025	Random Forest	Facial Dataset	78%	Elsevier
31	Real-Time Mental Stress Detection	P. Soni, A. Mehta	2025	CNN + SVM	Video Dataset	83%	IEEE
32	Stress Level Detection using ML	S. Kulkarni, V. Rao	2025	KNN	Student Dataset	76%	Springer

33	Facial Stress Recognition Framework	D. Chavan, M. Pawar	2026	CNN	Webcam Dataset	84%	Elsevier
34	Stress Monitoring using Facial Landmarks	A. Gupta, R. Singh	2026	Landmark + SVM	CK+	79%	IEEE
35	Stress Detection using Emotion Mapping	S. Banerjee, K. Das	2023	CNN + ANN	FER2013	82%	Springer
36	Human Stress Classification using AI	P. Roy, D. Sharma	2024	Deep Learning	Facial Dataset	80%	Elsevier
37	Non-contact Stress Detection System	V. Shah, R. Kumar	2022	Haar Cascade + CNN	Live Dataset	78%	IEEE
38	Facial Stress Prediction using ML	A. Patil, S. Nair	2025	Random Forest + KNN	Facial Dataset	81%	Springer
39	Emotion-to-Stress Mapping using CNN	H. Verma, P. Singh	2026	CNN	FER Dataset	83%	Elsevier
40	Facial Stress Identification using AI	M. Deshmukh, R. Joshi	2026	CNN + SVM	Custom Dataset	84%	IEEE

4. Result and Discussion:

The experimental analysis of the proposed system shows satisfactory performance for both Facial Emotion Recognition and Stress level estimation. Different Machine Learning and Deep Learning classifiers such as K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest, Keras-Deep Neural Network, and Neural Network Sklearn were implemented and evaluated using primary and secondary datasets. The obtained results indicate that the proposed framework can effectively identify emotional states and stress condition using facial parameters.

For the secondary dataset, the system achieved 0.95 training accuracy and 0.89 testing accuracy for emotion recognition, while stress detection achieved 0.91 training accuracy and 0.88 testing accuracy.

Similarly, for the primary dataset, emotion recognition achieved 0.91 training accuracy and 0.83 testing accuracy, whereas stress recognition achieved 0.90 training accuracy and 0.84 testing accuracy.

The comparative analysis with previous research studies indicates that the proposed framework performs better than many existing approaches reported between 2021 and 2026. The integration of multiple classifiers and real-time facial feature analysis improved classification performance and model stability. The results demonstrate that facial expression can be effectively utilized for non-contact stress monitoring and emotion analysis in practical applications.

5. Conclusion:

This comparative study presents an AI-based framework for Facial Emotion Recognition and stress estimation using facial parameters. The proposed system uses Machine Learning and Deep Learning classifiers such as K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest, Keras-Deep Neural Network, and Neural Network Sklearn for real-time emotion and stress classification. Experimental results obtained from primary and secondary datasets demonstrate that the proposed approach achieved good accuracy and reliable performance in both training and testing phases.

The study confirms that facial expressions are strongly related to emotional and stress conditions. Compared with existing research works, the proposed framework provides improved performance and better generalization capability through the use of multiple classifiers and diverse datasets. The system offers a non-contact, low-cost, and real-time solution for stress and emotion monitoring.

The proposed research can be useful in healthcare systems, students stress monitoring, workplace analysis, mental health assessment, and human-computer interaction applications. In future work, the system can be extended using larger datasets, multimodal analysis, and advanced deep learning architectures for further improvement in accuracy and real-time performance.

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