Department of Electrical & Electronic Engineering

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EEE-5302: Digital Image Processing

Facial Emotion Recognition with OpenCV and Transfer Learning

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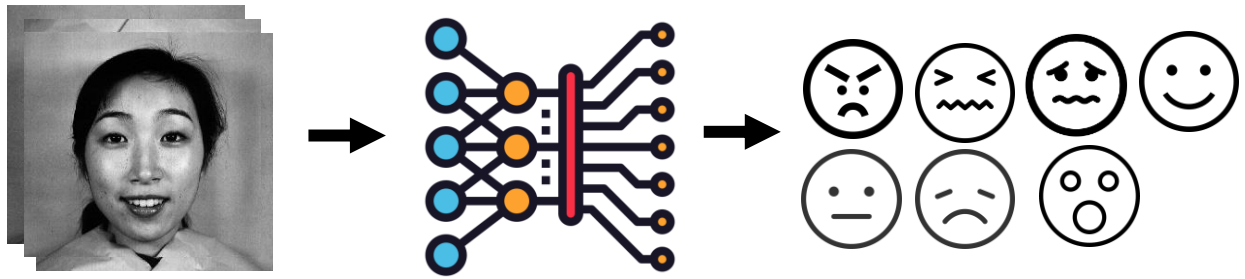
Facial Emotion Recognition (FER)

What's Emotion Recognition?

- **Emotion Recognition** is the ability to precisely infer human emotions
- Utilizing facial expressions, body language, speech patterns, and text.



Emotion Recognition through facial images

Why it's important?

Human-Computer Interaction (HCI) & Robotics

→ More intuitive and responsive to user emotions

Mental Health and Well-being

→ Detecting signs of stress, anxiety, or depression, enabling timely interventions

Security & Surveillance

→ Unusual or aggressive behaviors from emotional cues

Marketing and Customer Experience

→Gauge consumer reactions to products, services,

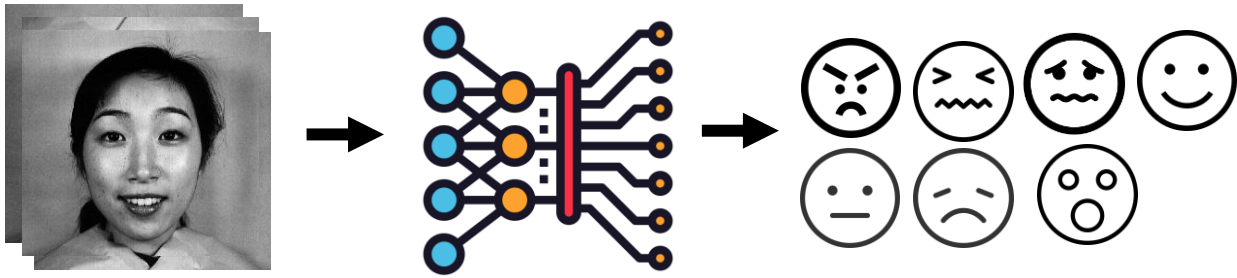
Facial Emotion Recognition (FER)

Advantages of Emotion Recognition from Facial Expressions:

→ Only visual input is required
→ SER is affected by background noise, making FER ideal for noisy environments

More Accurate for Subtle Emotional Expressions

→ Facial expressions often provide more nuanced cues such slight changes in micro-expressions
→ Can capture emotions even when speech tone or pitch remains neutral or ambiguous.



Emotion Recognition through facial images

Universal Across Languages and Cultures

→ Largely universal across different languages and cultures, making it more reliable for cross-cultural than SER
→ Works in environments where speech might not be available or appropriate, such as silent observation or in noisy settings

Less Sensitive to Health or Speech Impairments

→ Detect emotions in individuals with speech impairments, voice disorders, or conditions affecting vocalizations
→ Speech emotion recognition struggles with individuals who have compromised vocal expressions.

Facial Emotion Recognition Dataset

Dataset	Number of Images	Participants	Date & Place of Performance
JAFFE [1, 2]	213	10 Female	1996, Kyushu University
CK+ [3]	1237	123 (74 Feale, 49 Male)	2010, University of Pittsburgh
KDEF [4]	4900	70 (35 Male, 35 Female)	2000, Karolinska Institute
FER-2013 [5]	35,887	Diverse Participants	2013, ICML, University of Toronto

[1] M. J. Lyons, M. Kamachi, and J. Gyoba, "Coding Facial Expressions with Gabor Wavelets (IVC Special Issue)," *Zenodo*, Sep. 2020, doi: https://doi.org/10.5281/zenodo.4029680.

[2] 'Excavating AI' Re-excavated: Debunking a Fallacious Account of the JAFFE Dataset," *zenodo.org*, doi: https://doi.org/10.5281/zenodo.5147170.

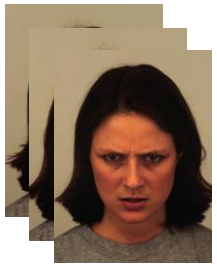
[3] P. Lucey, J. F. Cohn, T. Kanade, J. Saragih, Z. Ambadar, and I. Matthews, "The Extended Cohn-Kanade Dataset (CK+): A complete dataset for action unit and emotion-specified expression," *2010 IEEE Computer Society Conference on Computer Vision and Pattern Recognition - Workshops*, Jun. 2010, doi: https://doi.org/10.1109/cvprw.2010.5543262.

[4] Lundqvist, D., Flykt, A., & Öhman, A. (1998). The Karolinska Directed Emotional Faces - KDEF, CD ROM from Department of Clinical Neuroscience, Psychology section, Karolinska Institutet, ISBN 91-630-7164-9.

[5] I. J. Goodfellow *et al.*, "Challenges in representation learning: A report on three machine learning contests," *Neural Networks*, vol. 64, pp. 59–63, Apr. 2015, doi: https://doi.org/10.1016/j.neunet.2014.09.005.

Proposed Approach

Capturing Images



Human Subject

Pre-processing

Face-Cropping, Resize, Normalize, Augmentation

Train Pre-trained VGG19

Angry

Disgust

Fear

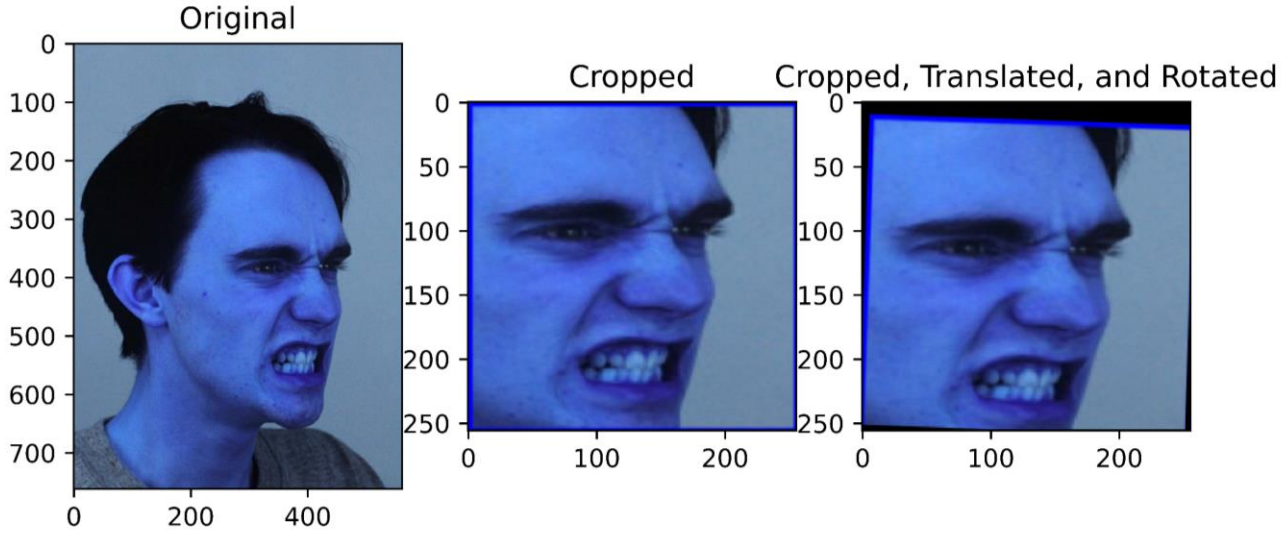
Happy

Neutral

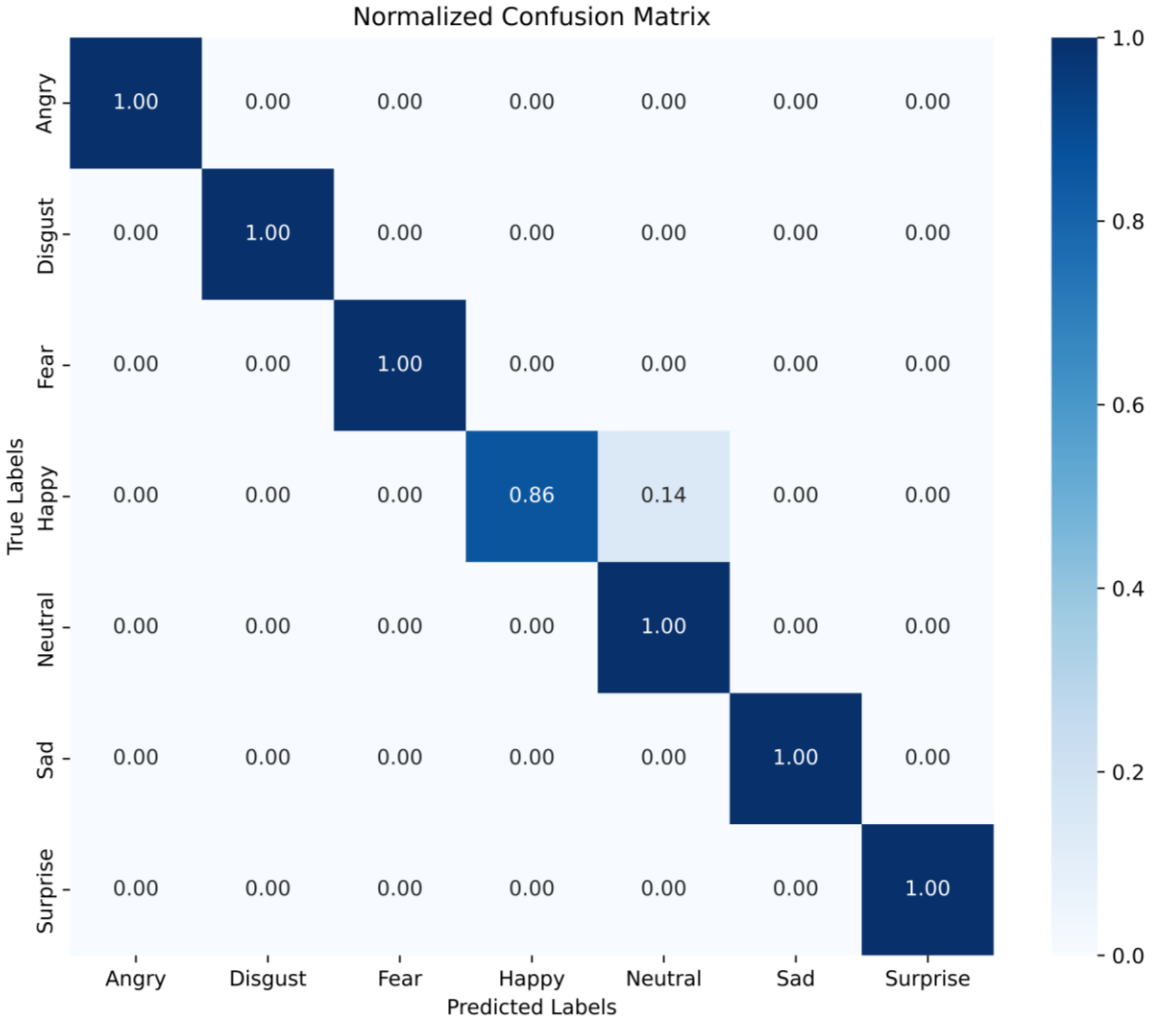
Sad

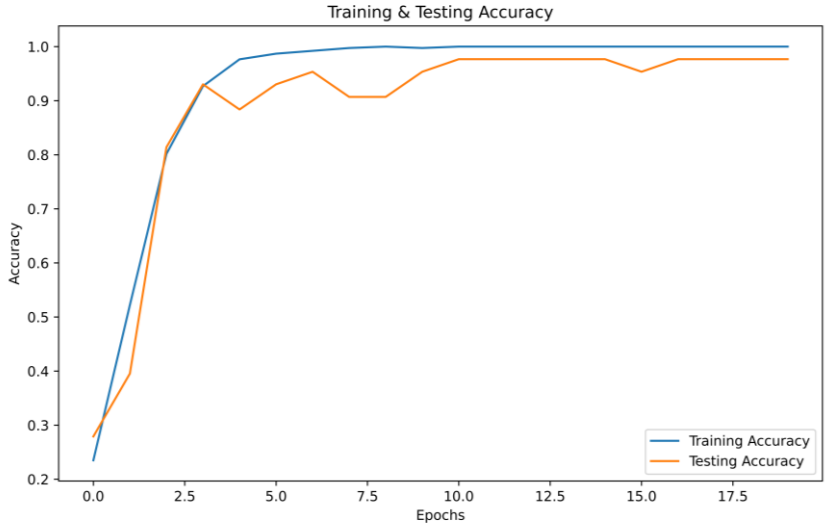
Surprise

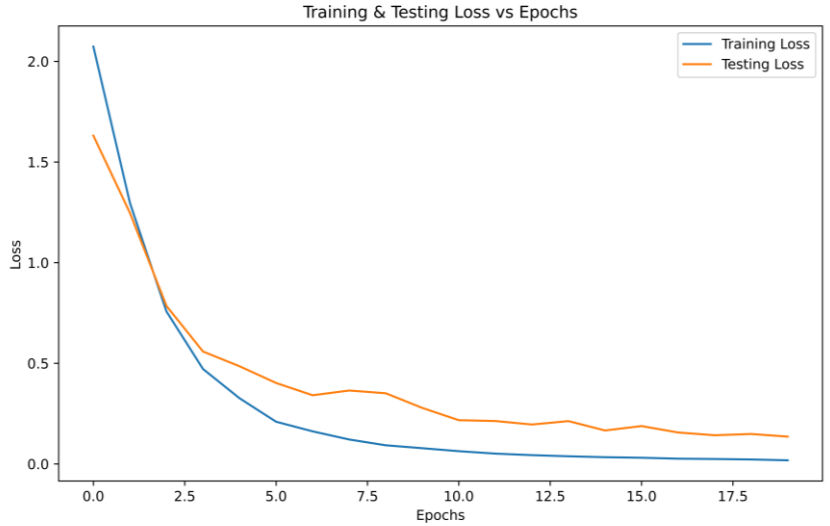
Image Preprocessing Outcomes



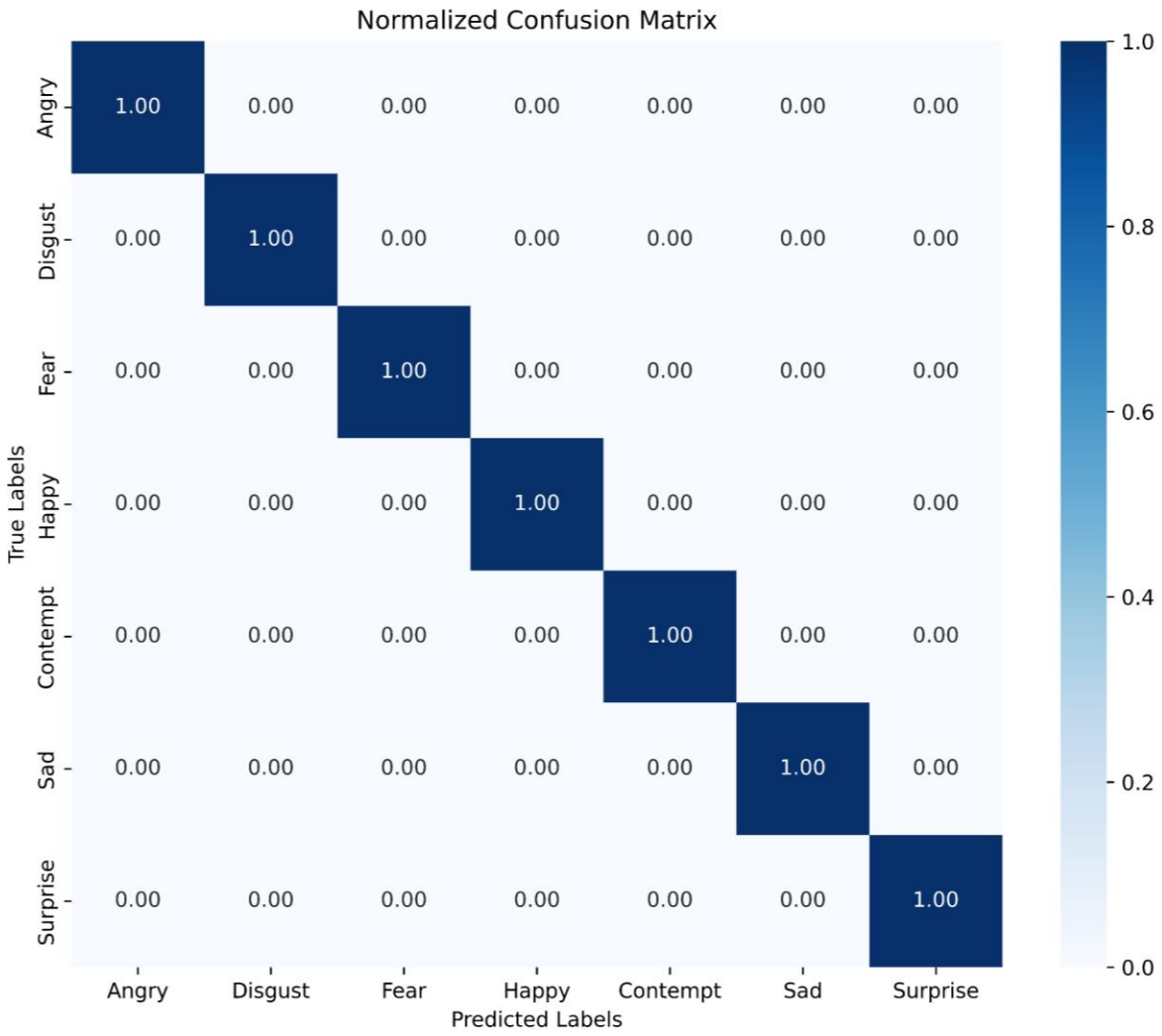
Performance Analysis (JAFFE)

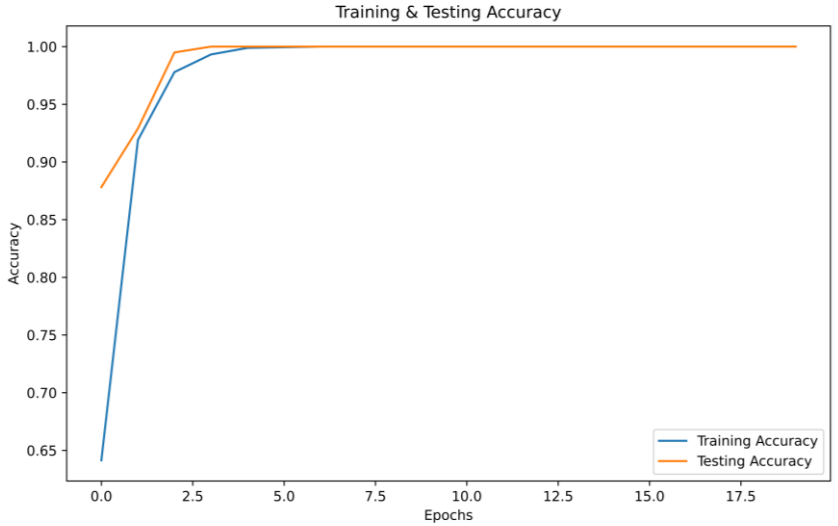


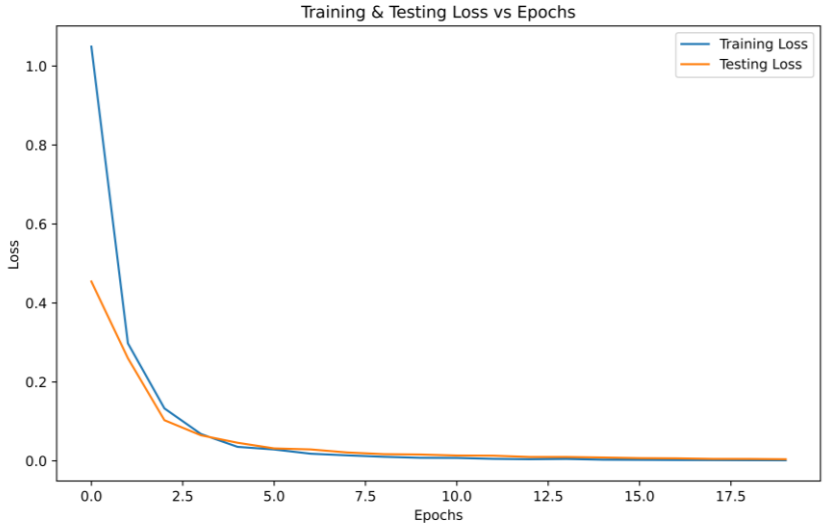




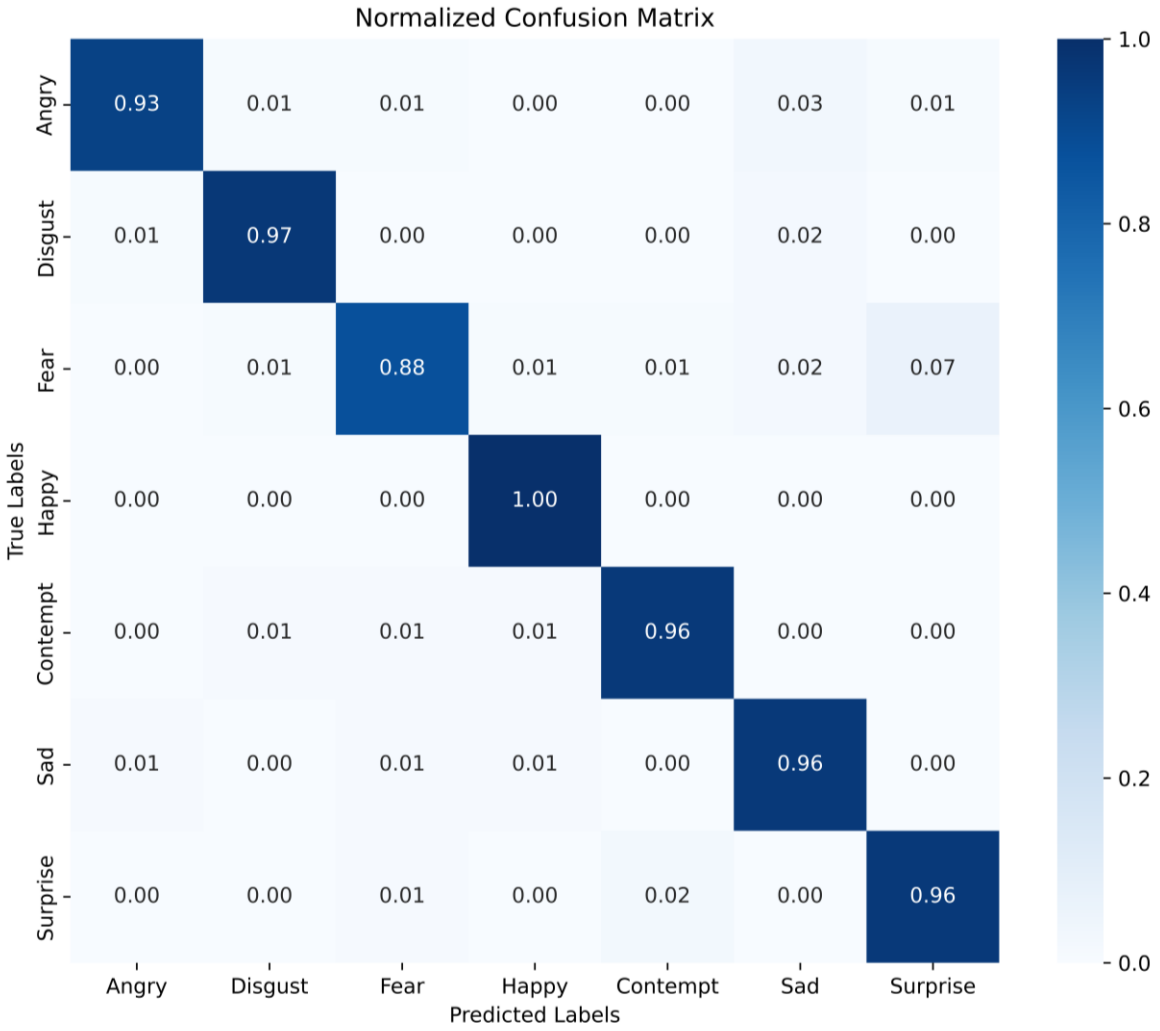
Performance Analysis (CK+)

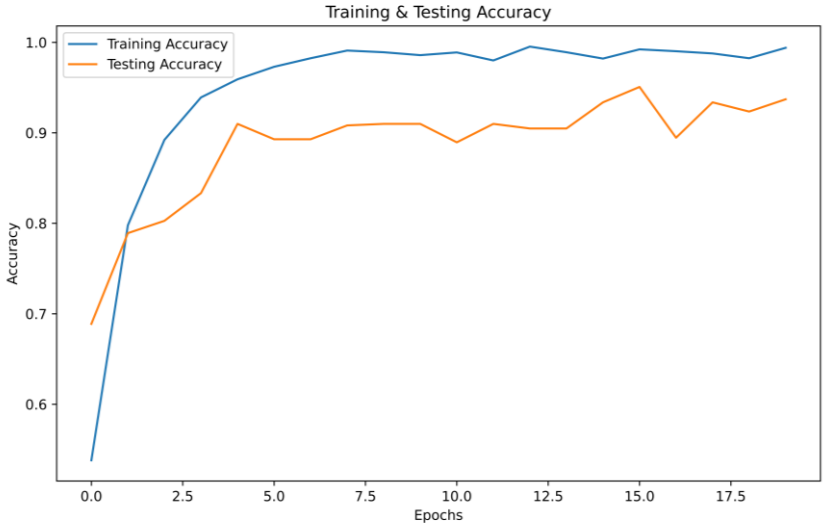




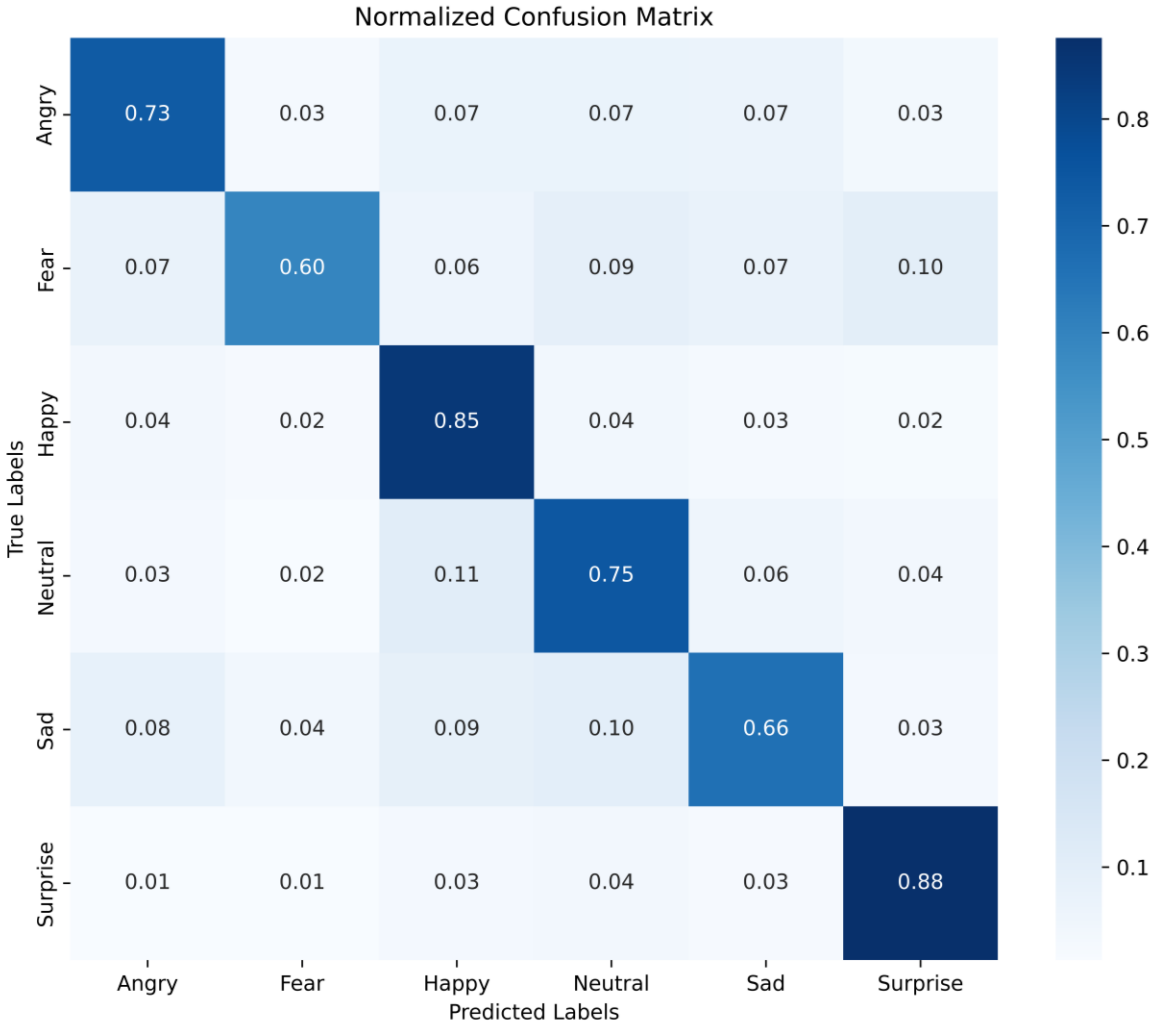


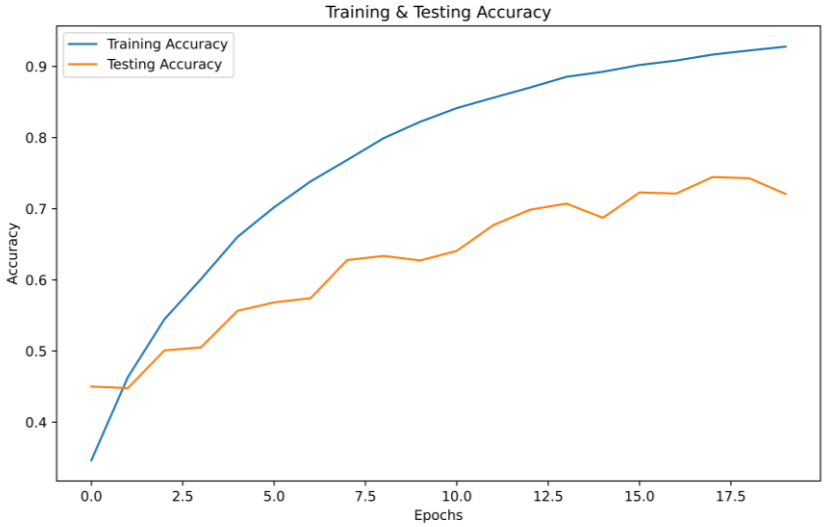
Performance Analysis (KDEF)

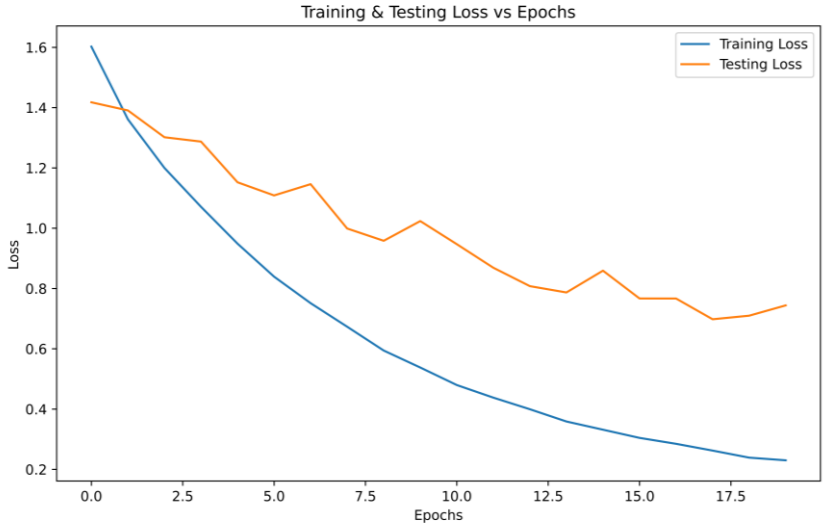




Performance Analysis (FER-2013)







Comparison Table

References & Year	Architecture Used	Dataset Used	Performance (%)
[6], 2021	CNN	CK+, JAFFE	99.36, 95.65
[7], 2023	Saliency Map + CLAHE + GAN + CNN	JAFFE, CK+, FER-2013	99.7, 99.9, 84.2
[8], 2022	CNN + ELM Classifier	JAFFE, CK+	96.67, 98.40
[9], 2024	Inception v3	JAFFE, KDEF	94, 93
This Work	OpenCV image processing + VGG19	JAFFE, CK+, KDEF, FER-2013	97.67, 100, 95.07, 74.45

[6] A. Khattak, M. Z. Asghar, M. Ali, and U. Batool, "An efficient deep learning technique for facial emotion recognition," *Multimedia Tools and Applications*, Oct. 2021, doi: https://doi.org/10.1007/s11042-021-11298-w.

[7] N. Kumari and R. Bhatia, "Saliency map and deep learning based efficient facial emotion recognition technique for facial images," Jul. 2023, doi: https://doi.org/10.1007/s11042-023-16220-0.

[8] N. Banskota, A. Alsadoon, P. W. C. Prasad, A. Dawoud, T. A. Rashid, and O. H. Alsadoon, "A novel enhanced convolution neural network with extreme learning machine: facial emotional recognition in psychology practices," *Multimedia Tools and Applications*, Aug. 2022, doi: https://doi.org/10.1007/s11042-022-13567-8.

[9] E. S. Agung, A. P. Rifai, and T. Wijayanto, "Image-based facial emotion recognition using convolutional neural network on emognition dataset," *Scientific Reports*, vol. 14, no. 1, p. 14429, Jun. 2024, doi: https://doi.org/10.1038/s41598-024-65276-x