

Real-Time Facial Emotion Detection with Confidence and Temporal Trend Analysis Using Deep Learning

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Introduction

- Facial Emotion Recognition (FER) is a key area in AI, computer vision, and affective computing
- Deep learning models (especially CNNs) improve emotion classification accuracy
- Widely used in:
 1. Mental health monitoring
 2. Human-computer interaction
 3. Smart learning environments
- Limitations of current FER systems:
 1. Work on a frame-by-frame basis
 2. Fail to capture temporal/dynamic emotions
- Other major issues:
 1. Produce overconfident predictions
 2. Lack interpretability
- These limitations reduce reliability in real-world applications

Research Question

1. How can real-time facial emotion detection systems be improved using confidence estimation?
2. Can temporal trend analysis enhance the reliability and interpretability of emotion recognition systems?

Dataset

The system uses standard benchmark datasets:

- FER2013 Dataset
 - 48x48 grayscale facial images
 - 7 emotion classes
- CK+ Dataset
 - High-quality labeled expressions
 - Used for validation

These datasets ensure robustness and comparability with existing research.

Methodology

1. Capture real-time video using webcam
2. Detect faces using OpenCV
3. Preprocess images (resize, normalize)
4. Apply CNN model for emotion classification
5. Extract softmax-based confidence scores
6. Perform confidence calibration (ECE, temperature scaling)
7. Store predictions with timestamps
8. Apply temporal analysis (smoothing, trend tracking)
9. Visualize results using Streamlit dashboard



Literature Review

1. Deep learning-based FER systems outperform traditional methods (Zhao et al., 2021).
2. CNN architectures such as ResNet improve feature extraction (He et al., 2016).
3. Guo et al. (2017) showed neural networks are poorly calibrated.
4. Temporal modeling using LSTM improves sequence understanding (Hochreiter & Schmidhuber, 1997)



Next Steps

1. Train CNN model using FER2013 dataset
2. Implement real-time webcam-based system
3. Integrate confidence calibration techniques
4. Develop temporal analysis module
5. Build interactive dashboard using Streamlit
6. Evaluate system performance and optimize

References

1. Guo et al., 2017 – Calibration of Neural Networks
2. He et al., 2016 – ResNet
3. Zhao et al., 2021 – FER Survey
4. Li & Deng, 2022 – FER Advances

Technologies

