**Human Facial Emotion Detection using CNN**

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# Abstract

This project aims to detect human facial emotions in real time using Convolutional Neural Networks (CNN). Using the FER-2013 dataset and OpenCV, the model is trained to classify emotions such as Happy, Sad, Angry, Surprise, and more. The system uses a webcam feed for live prediction and displays the emotion label over the detected face.

# 1. Introduction

Emotion recognition is an essential aspect of human-computer interaction (HCI). This project focuses on real-time emotion detection using deep learning (CNN) to enhance interaction through visual cues.

# 2. Dataset Description

The FER-2013 dataset is used for training the model. It consists of 48x48 pixel grayscale facial images. Each image is labeled with one of the 7 emotion categories:  
- Angry  
- Disgust  
- Fear  
- Happy  
- Neutral  
- Sad  
- Surprise

# 3. Methodology

1. Face detection using Haar Cascade Classifier (OpenCV)  
2. Image preprocessing: resize to 48x48, grayscale, and normalize  
3. Prediction using CNN trained on FER-2013  
4. Live webcam feed used for real-time emotion display

# 4. CNN Architecture

The CNN model includes:  
- Convolutional layers  
- ReLU activation  
- MaxPooling  
- Dropout  
- Dense layers  
The final layer uses Softmax to predict the emotion class.

# 5. Activation Functions

- ReLU: Used in hidden layers for speed and efficiency  
- Softmax: Used in the output layer to produce class probabilities

# 6. Loss Function & Optimizer

- Loss Function: Categorical Cross Entropy  
- Optimizer: Adam — adaptive and fast convergence

# 7. Evaluation Metrics

- Accuracy: Percentage of correct predictions  
- F1 Score: Balance between precision and recall  
- Confusion Matrix: Shows class-wise prediction results

# 8. Real-Time Output

The webcam captures the user’s face, and the CNN model processes it in real time. The predicted emotion is shown above the face in the video stream.

# 9. Challenges & Limitations

- Low accuracy in poor lighting  
- Difficulty in handling multiple faces  
- Confusion between similar expressions (Sad vs Neutral)  
- Dataset lacks real-world expression diversity

# 10. Conclusion

CNN-based emotion detection works well for real-time applications. With improvements in data and architecture, it can be used in security systems, education tools, and healthcare apps.

# 11. References

1. FER-2013 Dataset (Kaggle)  
2. Keras Documentation  
3. OpenCV Library  
4. Deep Learning Notes