**Emotion Detection from Uploaded Images**

**Introduction:**

Emotion detection plays a significant role in human-computer interaction, healthcare, education, and customer service. This project aims to develop a \*\*Streamlit-based application\*\* that detects facial emotions from uploaded images using \*\*Convolutional Neural Networks (CNNs)\*\*. It integrates image processing, deep learning, and user interface design to deliver a real-world, deployable solution.

**Objectives:**

- Build a system that detects and classifies human emotions from images.

- Implement face detection and facial feature extraction pipelines.

- Train and fine-tune a CNN model on the FER-2013 dataset.

- Deploy the system using Streamlit for end-user accessibility.

- Analyze model performance using key metrics like accuracy, precision, recall, and F1-score.

- Address ethical aspects like privacy and dataset bias.

**Methodology:**

**1.Data Collection**

- Dataset: \*\*FER-2013\*\* from Kaggle (`torchvision.datasets.FER2013`).

- Categories: Happy, Sad, Angry, Fear, Surprise, Neutral, Disgust.

- Image resolution standardized to \*\*48x48 grayscale\*\*.

**2. Data Preprocessing**

- Normalization and resizing of images.

- Data augmentation (rotation, zoom, flip) to improve generalization.

- Conversion to tensors for CNN input.

**3. Model Architecture**

- CNN model with multiple convolutional and pooling layers.

- Activation: ReLU, Softmax.

- Loss Function: CrossEntropyLoss.

- Optimizer: Adam.

- Batch Normalization and Dropout for regularization.

**4. Facial Detection and Landmark Extraction**

- Used \*\*OpenCV\*\* and \*\*Mediapipe/Dlib\*\* for face localization.

- Extracted key points like eyes, nose, and mouth for accurate feature alignment.

**5. Model Training and Evaluation**

- Split dataset into train, validation, and test sets.

- Evaluated with:

- Accuracy

- Precision

- Recall

- F1 Score

- Fine-tuned hyperparameters (learning rate, epochs, filters) for optimal results.

**6. Streamlit Application**

- Designed a clean, intuitive UI.

- Allows only image uploads (`.jpg`, `.jpeg`, `.png`).

- Displays detected face and predicted emotion.

**Results and Discussion:**

- Model achieved high accuracy in classifying basic human emotions.

- Real-time inference through Streamlit proved efficient and interactive.

- Detected emotion labels were displayed along with confidence scores.

**Ethical and Social Implications:**

- Privacy: No image storage; processing occurs locally.

- Bias: Mitigated through diverse dataset and balanced training.

- Transparency: Clear communication about model limitations and intended usage.

**Tools and Technologies:**

| Category | Tools |

|-----------|--------|

| Language | Python |

| Framework | PyTorch, Streamlit |

| Libraries | OpenCV, Mediapipe, NumPy, Pandas, Matplotlib |

| Dataset | FER-2013 |

| IDE | VS Code |

**Conclusion:**

This project demonstrates how machine learning and computer vision can work together to identify human emotions in real-time. The integration of CNN-based emotion detection with a Streamlit interface delivers both technical and user-centered value. Future improvements include deploying on cloud platforms and expanding emotion categories.

**Future Scope**

- Integration with real-time video emotion detection.

- Use of transformer-based architectures (e.g., Vision Transformers).

- Cloud deployment for scalability.

- Inclusion of multi-face detection and emotion tracking.

References

1. Goodfellow et al., \*Deep Learning\*, MIT Press, 2016.

2. FER-2013 Dataset, Kaggle.

3. PyTorch & Streamlit Official Documentation.