Facial Emotion Recognition using VGG19 and Real-Time Detection

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1. Introduction

Facial emotion recognition is a significant application in the field of computer vision, enabling machines to interpret human emotional states from facial expressions. In this project, we develop a deep learning model using VGG19 and deploy it for real-time emotion detection using a webcam feed. The goal is to accurately classify emotions such as Happy, Sad, Angry, and more, from grayscale images.

2. Technologies Used

This project integrates various Python libraries for model development, data processing, and evaluation.

- Python: The core programming language used for implementation.
- TensorFlow and Keras: Used to build, train, and manage the deep learning model.
- OpenCV: Facilitates image processing and live video capture from the webcam.
- NumPy and Matplotlib: Used for numerical operations and data visualization.
- Scikit-learn: Provides tools for evaluating the model using metrics such as confusion matrices and classification reports.

3. Dataset & Preprocessing

The model is trained on a structured facial emotion dataset, that is downloaded from Kaggle, divided into training and testing sets. Preprocessing is crucial for improving model performance.

- **Dataset Structure:** Images are placed in train and test folders, each containing subfolders for emotion classes.
- **Resizing:** All images are resized to 48x48 pixels to match model input requirements.
- **Color Conversion:** Images are converted to grayscale for simplicity and computational efficiency.
- **Data Augmentation:** Applied to training data to artificially expand the dataset using transformations like rotation, zoom, shear, and horizontal flip. This helps the model generalize better to unseen data.

Link to the Datasets-

Name of the Dataset- archive.zip

4. Model Architecture

We use transfer learning with the pre-trained VGG19 model, which is effective for image classification tasks. The base model is modified to suit the emotion recognition problem.

VGG19 Base: Loaded without its top layer (include_top=False) and pre-trained on

ImageNet.
- **Input Handling:** Since the model expects 3-channel input, a 1x1 convolution layer is added to convert grayscale input (1 channel) to 3 channels.

Custom Top Layers:
- GlobalAveragePooling2D: Reduces the spatial dimensions while retaining important information.
- Dense Layers: Two fully connected layers with 512 and 256 neurons using ReLU activation.
- Batch Normalization and Dropout: Regularization techniques to prevent overfitting.
- Output Layer: A softmax layer with 7 neurons, representing the 7 emotion classes.

5. Training Configuration

The model is compiled and trained using optimal hyperparameters to ensure effective learning.

- **Batch Size:** Set to 64, meaning the model processes 64 images at a time.
- **Epochs:** The training runs for 50 full passes over the dataset.
- **Optimizer:** Adam optimizer is used with a learning rate of 0.0001, offering adaptive learning.
- **Loss Function:** Categorical Crossentropy, suitable for multi-class classification problems.
- **Transfer Learning:** To speed up training and improve performance, all layers of VGG19 are frozen except the last four, which are fine-tuned.

6. Evaluation Results

After training, the model is evaluated on the test dataset to measure its performance.

- **Test Accuracy:** Approximately 58.37%, indicating that the model correctly classifies emotions in more than half of the test images.
- **Test Loss:** The loss value is 1.21, which corresponds to the error in predictions.

Evaluation Tools:
- **Confusion Matrix:** Provides a summary of correct and incorrect predictions for each class.
- **Classification Report:** Shows precision, recall, and F1-score for each emotion category.

7. Real-Time Emotion Detection

The trained model is integrated with a live webcam feed to detect and display emotions in real time.

- Face Detection: Uses OpenCV's Haar cascade classifier to locate faces in each video frame.

- Image Preprocessing: Detected faces are converted to grayscale, resized to 48x48 pixels, and normalized.
- Emotion Prediction: The processed face is passed through the model to predict the emotion label.
- Display: The predicted emotion is shown on the screen with a bounding box around the face.
- Exit Condition: The real-time detection can be stopped by pressing the 'q' key.

8. Saving and Reloading the Model

To reuse the trained model without retraining, it is saved and reloaded when needed.

- Saved As: my_model_vgg19.h5, which includes model architecture and weights.
- Loading Method: The model is reloaded using load_model() from Keras.

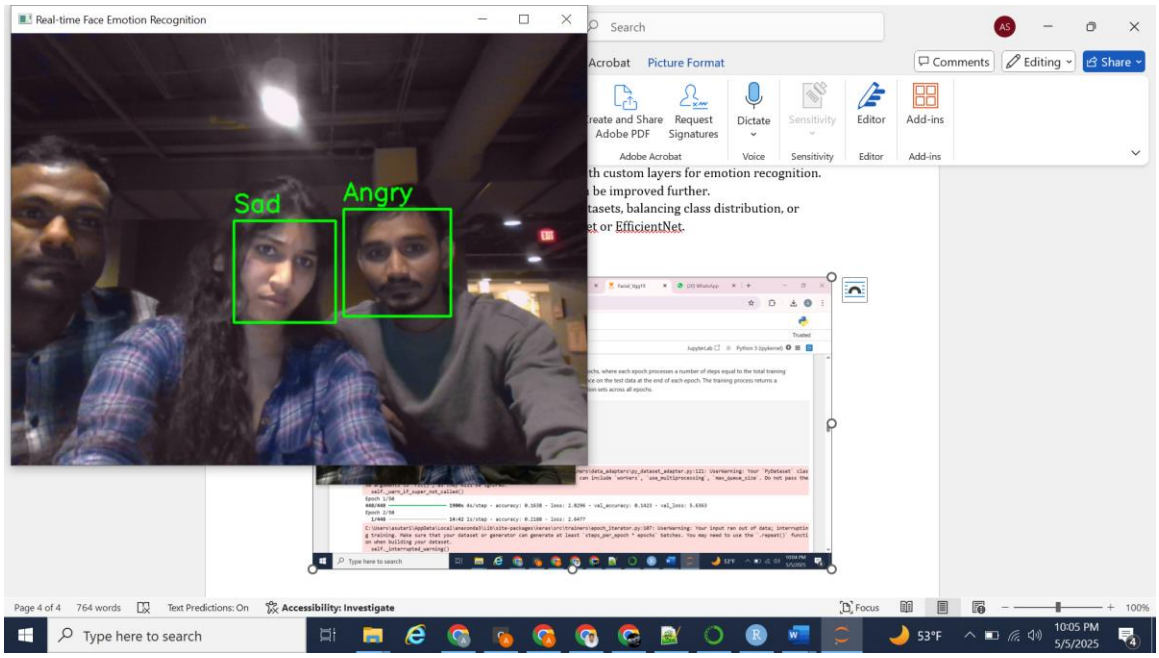
9. Conclusion

This project demonstrates how transfer learning and computer vision techniques can be used to recognize emotions from facial expressions in real time.

- It combines VGG19's pre-trained capabilities with custom layers for emotion recognition.
- The model achieved moderate accuracy and can be improved further.
- Potential enhancements include using larger datasets, balancing class distribution, or adopting more advanced architectures like ResNet or EfficientNet.

Link to the Zoom Video Recording

Screenshots of the behavior of the Model in Real -time-


Real-time Face Emotion Recognition
Sad
Angry
Search
Acrobat
Picture Format
Comments
Editing
Share
Create and Share Adobe PDF
Request Signatures
Dictate
Sensitivity
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Add-ins
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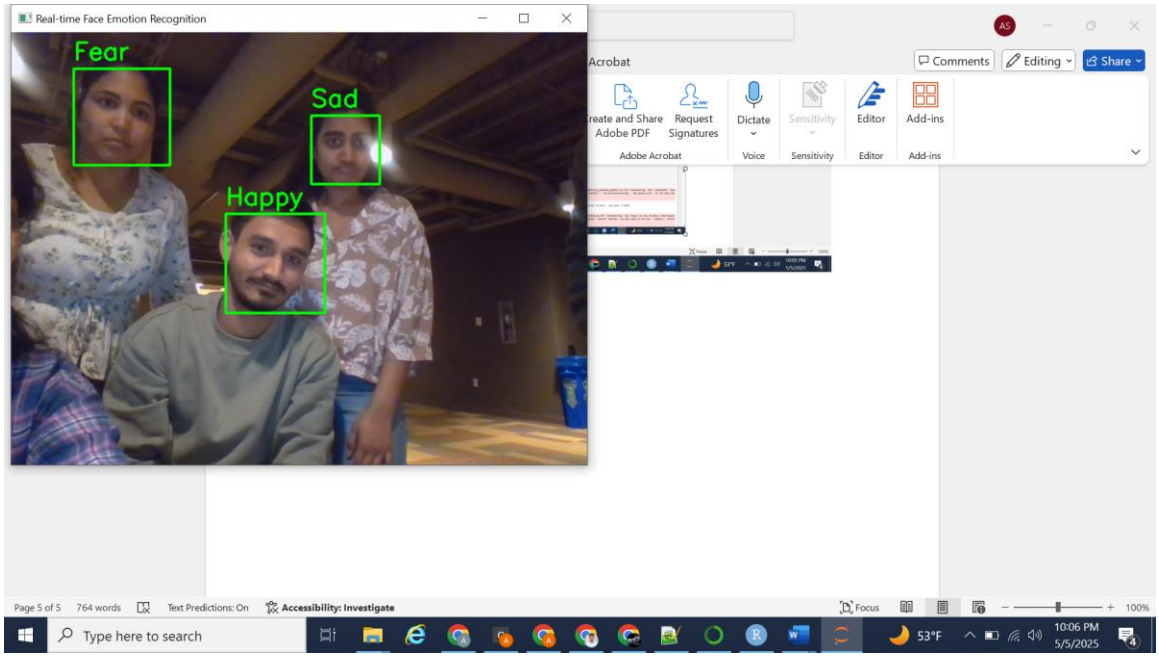
Real-time Face Emotion Recognition
Fear
Sad
Happy
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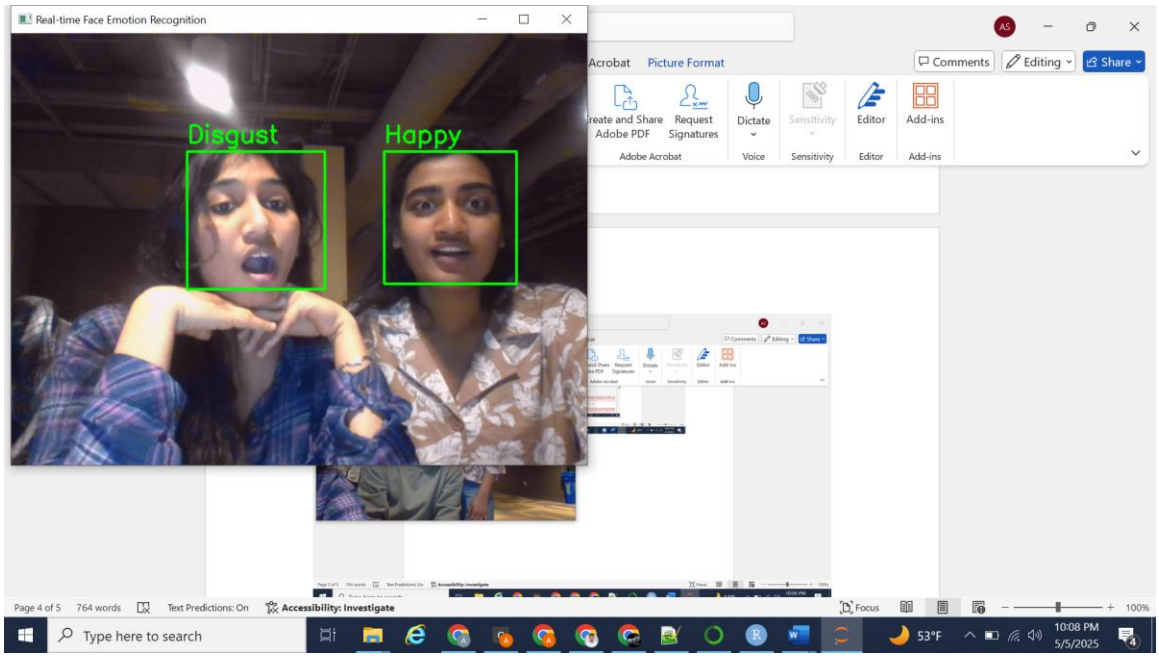
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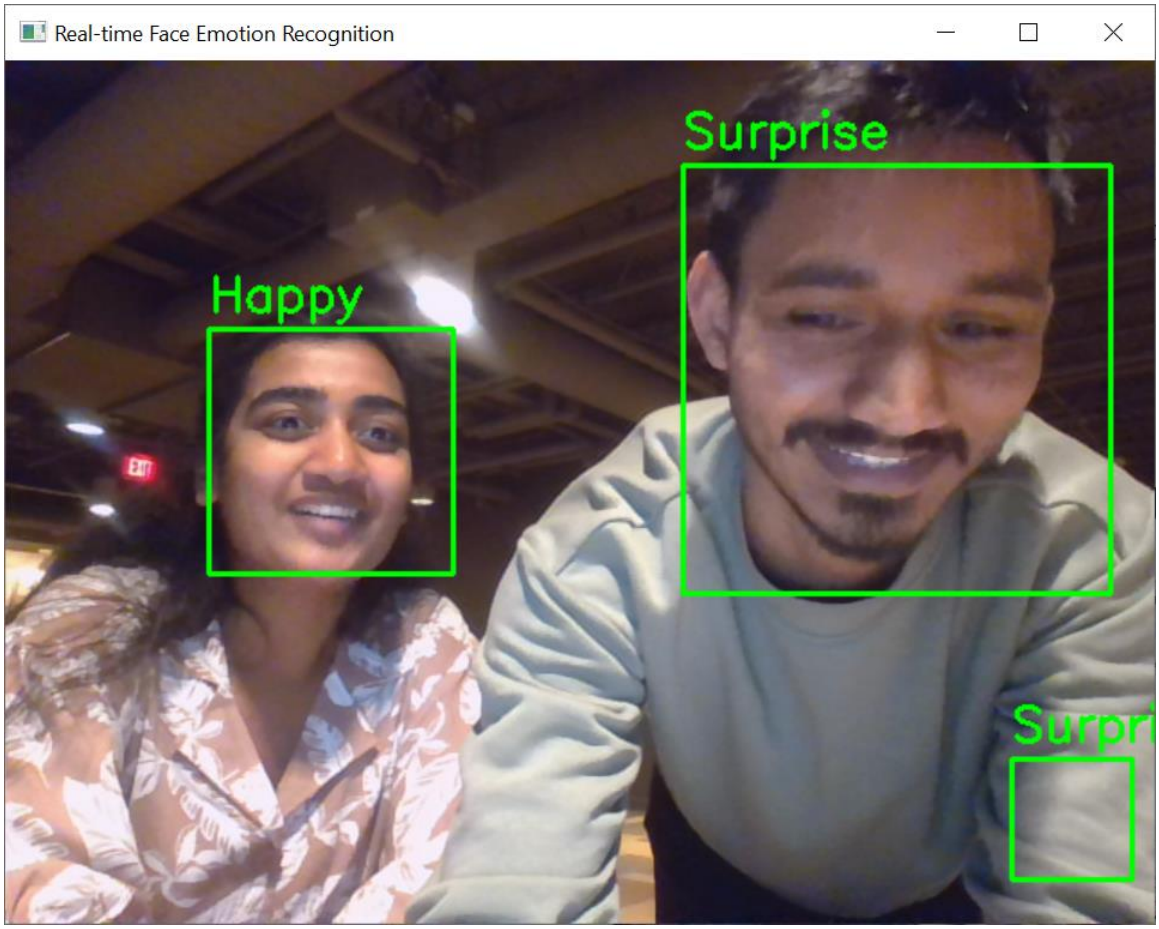
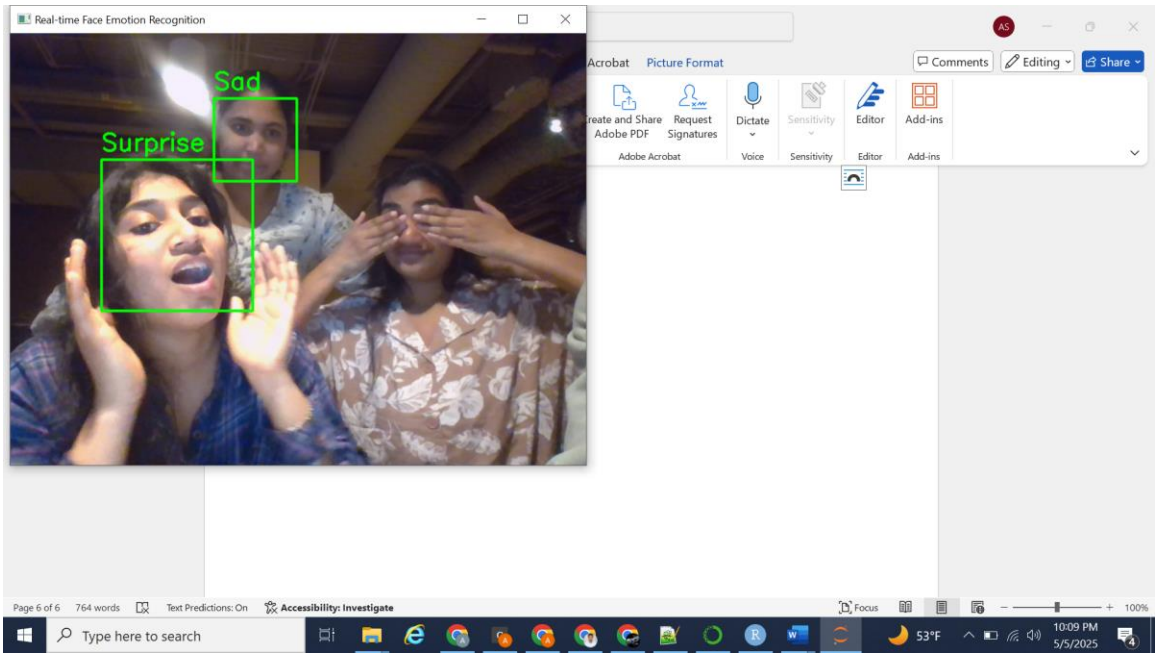

Real-time Face Emotion Recognition
Surprise
Happy
Surpri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