# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

## BELAGAVI-590018

*A Digital Image Processing Mini Project Report on*

## "FACIAL EMOTION RECOGNITION"

***Submitted in partial fulfillment of the requirements for the VI semester***

***and award of the degree of Bachelor of Engineering in AI & ML***

***of Visvesvaraya Technological University, Belagavi***

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**2022-2023**

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## CERTIFICATE

Certified that the mini project work entitled **"Facial Emotion Recognition"** has been successfully carried out by **Prajwal S** bearing USN **"**1RN20AI038**"**, **Sourav NG** bearing USN "1RN20AI052" and **Vishnu Kashyap** bearing USN "1RN20AI062", bonafide students of **"RNS Institute of Technology"** in partial fulfillment of the requirements for the 6th semester of **"Bachelor of Engineering in Artificial Intelligence and Machine Learning Engineering of Visvesvaraya Technological University"**, Belagavi, during academic year 2022-2023. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the Digital Image Processing laboratory requirements of 6th semester BE in AI and ML.

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# Acknowledgement

Any achievement, be it scholastic or otherwise does not depend solely on the individual efforts but on the guidance, encouragement and cooperation of intellectuals, elders and friends. A number of personalities, in their own capacities have helped us in carrying out this project work. We would like to take this opportunity to thank them all.

We are grateful to **Management** and **Dr. M K Venkatesha**, Director and **Dr. H S Ramesh Babu** Principal, RNSIT, Bangalore, for their support towards completing this mini project.

We would like to thank **Dr. Harsha S**, Head, Department of Artificial Intelligence and Machine Learning Engineering, RNSIT, Bangalore, for his valuable suggestions and expert advice.

We deeply express our sincere gratitude to our guide **Ms. Ashwini K**, Assistant Professor, Department of AI ML, RNSIT, Bangalore, for her able guidance, regular source of encouragement and assistance throughout this project.

We would like to thank all the teaching and non-teaching staff of the Department of Artificial Intelligence and Machine Learning Engineering, RNSIT, Bengaluru-98 for their constant support and encouragement.

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# Abstract


This project focuses on the development of a Convolutional Neural Network (CNN) architecture for Facial Emotion Recognition (FER) using the FER2013 dataset. The objective is to accurately classify facial expressions into different emotional categories.

The proposed CNN model consists of six layers with varying kernel sizes. The model leverages the power of deep learning techniques to learn complex features from facial images and make accurate predictions. The FER2013 dataset, which contains a large number of labeled facial images, is used for training and evaluation.

The project follows a four-stage process: pre-processing, face detection, feature extraction, and expression classification. In the pre-processing stage, the images are prepared by resizing, normalizing, and augmenting the data to improve training performance. Face detection techniques are employed to localize and extract the facial region of interest from each image. Next, the CNN model is trained using the extracted facial features. The model learns to automatically extract discriminative features that represent different facial expressions. The training process involves optimizing the model's parameters using a suitable optimization algorithm and loss function. Finally, the trained CNN model is evaluated on a separate test set to measure its performance in classifying facial expressions. The accuracy, precision, recall, and F1-score metrics are used to assess the model's effectiveness in recognizing various emotions.

The results demonstrate the efficacy of the proposed CNN architecture in accurately recognizing facial expressions. The project contributes to the field of facial emotion recognition by providing a practical and effective approach to automatically classify emotions from facial images. The findings of this research have potential applications in areas such as human-computer interaction, robotics, and affective computing.

Overall, this project showcases the importance and potential of CNN architectures for Facial Emotion Recognition and lays the foundation for further advancements in this area

# Index

| Contents | Page No. |
|---|---|

# List of Figures

# Chapter 1

# Introduction

Digital image processing is an area of research that concentrates on utilizing computer algorithms to manipulate and analyze digital images. It has significant importance in diverse applications such as medical imaging, computer vision, and remote sensing. Through the use of mathematical operations and algorithms, digital image processing enables various tasks like enhancing images, restoring them, segmenting them, extracting features, and recognizing objects. This field allows us to derive useful information from images, enhance their quality, and extract meaningful patterns and features for further examination. It has brought about a revolution in fields like healthcare, surveillance, and multimedia, empowering us to gain valuable insights from visual data.

## 1.1 History of Digital Image processing

The history of digital image processing can be traced back to the mid-20th century when computers began to be employed for the analysis and manipulation of images. The following is a concise overview of the significant milestones in the field's history:

- 1950s-1960s: The origins of digital image processing can be attributed to the emergence of digital computers. During this period, early experiments focused on converting images into digital format and developing rudimentary algorithms for image analysis.
- 1970s: As more powerful computers became available, researchers started exploring advanced techniques such as image restoration, enhancement, and compression. This era witnessed significant advancements, including the introduction of algorithms like the Fast Fourier Transform (FFT) for image filtering and restoration.
- 1980s: The rise of personal computers and the accessibility of affordable image processing software contributed to the broader adoption of digital image processing techniques. Various fields, including medical imaging, remote sensing, and industrial inspection, began incorporating image processing into their applications.
- 1990s: The development of more sophisticated algorithms and computational techniques led

to breakthroughs in image segmentation, object recognition, and pattern analysis. Additionally, this decade witnessed the integration of digital imaging technologies into consumer electronics, such as digital cameras and image editing software.

- 2000s-Present: The progress of machine learning and deep learning techniques brought about a revolution in digital image processing. Convolutional neural networks (CNNs) and other deep learning architectures achieved remarkable success in tasks like image classification, object detection, and semantic segmentation.

Today, digital image processing plays a crucial role in domains such as healthcare, astronomy, robotics, surveillance, and entertainment. The field continues to evolve with the introduction of novel algorithms, advancements in hardware, and the integration of artificial intelligence. These advancements enable us to extract valuable insights from visual data and enhance our understanding of the world.

## 1.2 Stages in Digital Image Processing

Digital image processing involves stages such as image acquisition, enhancement, restoration, color image processing, wavelets and multiresolution processing, compression, morphological processing, segmentation, representation, and object recognition. These stages encompass a range of techniques and algorithms for acquiring, improving, analyzing, and interpreting digital images. Each stage plays a crucial role in transforming and extracting meaningful information from images.

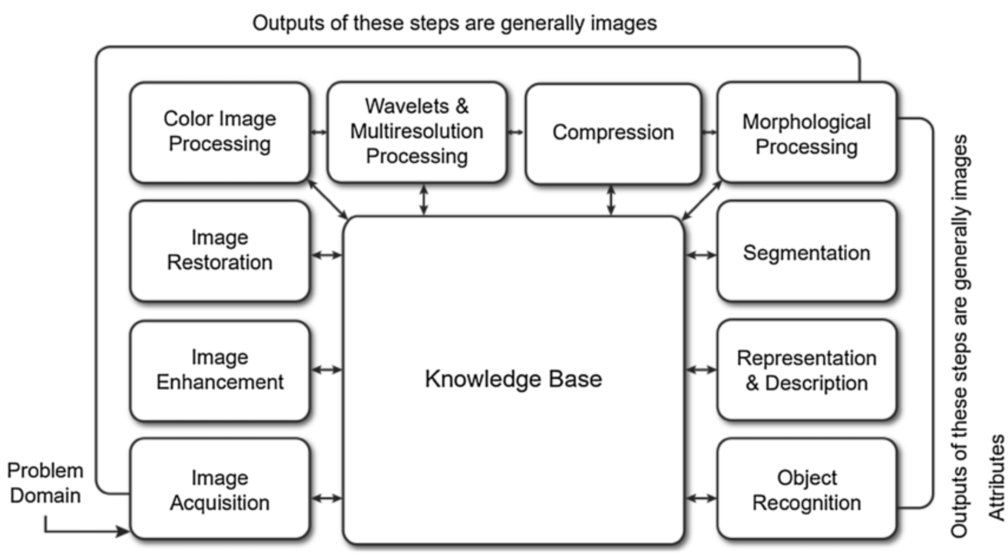

Figure 1.2: Stages in Digital Image Processing

Stages involved in Digital Image Processing are:

- **Image Acquisition**: The process of capturing or digitizing images using cameras, scanners, or other imaging devices. It involves converting analog signals (light) into digital data, forming the basis for subsequent processing stages.

- **Image Enhancement**: Techniques applied to improve the quality, clarity, or visual appearance of an image. Enhancement methods include adjusting brightness/contrast, sharpening, noise reduction, and histogram equalization.

- **Image Restoration**: The process of recovering an image from degraded or corrupted versions. Restoration techniques aim to remove noise, blur, or other artifacts caused by factors such as sensor noise, motion blur, or transmission errors.

- **Color Image Processing**: Dealing with the analysis and manipulation of color images. This stage involves techniques such as color space transformations, color correction, color image enhancement, and color-based object recognition.

- **Wavelets and Multiresolution Processing**: Utilizing wavelet transform and multiresolution analysis for image processing. Wavelet techniques offer advantages in representing images at different scales and extracting both frequency and spatial information.

- **Compression**: Reducing the size of the image data for efficient storage and transmission. Compression techniques aim to remove redundant or irrelevant information while preserving essential image features. Common compression methods include JPEG, PNG, and MPEG.

- **Morphological Processing**: Utilizing mathematical morphology operations, such as erosion, dilation, opening, and closing, to analyze the shape, structure, and spatial relationships in images.

- **Segmentation**: Partitioning an image into meaningful regions or objects. Segmentation techniques aim to separate different objects or regions based on properties such as color, texture, or intensity.

- **Representation and Description**: Representing image features and objects using suitable descriptors, such as shape, texture, or color. This stage involves extracting meaningful features and creating representations that enable further analysis and recognition.

- **Object Recognition**: Identifying and classifying objects or patterns within an image. Object recognition techniques utilize machine learning, pattern recognition, and feature matching to identify and categorize objects based on their visual characteristics.

## 1.3 Applications of Digital Image Processing

Digital image processing finds applications in numerous fields and industries. Some of the key applications include:

- **Medical Imaging**: Digital image processing is extensively used in medical diagnostics, including X-ray, MRI, CT scans, and ultrasound. It aids in image enhancement, segmentation, feature extraction, and pattern recognition for improved diagnosis of diseases and abnormalities.

- **Surveillance and Security**: Image processing techniques are employed in video surveillance systems for face recognition, object tracking, and anomaly detection. It enhances the effectiveness of security systems and assists in identifying potential threats or suspicious activities.

- **Remote Sensing**: Digital image processing is vital in analyzing satellite and aerial images for applications like environmental monitoring, land cover classification, urban planning, and agriculture. It enables the extraction of valuable information about the Earth's surface and assists in making informed decisions.

- **Robotics and Automation**: Image processing is integral to vision-based robotics and automation systems. It enables robots to perceive and interpret visual information, facilitating tasks such as object detection, recognition, and navigation in dynamic environments.

- **Entertainment and Media**: Digital image processing plays a significant role in the entertainment industry. It is used for special effects, image editing, color correction, image rendering, and image-based rendering techniques in movies, video games, virtual reality (VR), and augmented reality (AR) applications.

- **Biometrics**: Image processing techniques are employed in biometric systems for face recognition, fingerprint recognition, iris recognition, and other biometric modalities. It enhances security and authentication systems by verifying an individual's unique biological traits.

- **Quality Control and Inspection**: Image processing is utilized in manufacturing industries for automated quality control and inspection of products. It detects defects, measures dimensions, and ensures the consistency and accuracy of products on assembly lines.

- **Geographical Information Systems (GIS)**: Digital image processing assists in analyzing and interpreting geospatial data. It aids in land cover mapping, terrain analysis, and feature extraction for creating accurate maps and spatial databases.

- **Astrophysics and Astronomy**: Image processing techniques are used to enhance astronomical images, remove noise, and extract valuable information about celestial objects and phenomena. It aids in studying the universe and analyzing astronomical data.

# Chapter 2

## Literature Survey

1. Pramerdorfer, C., & Kampel, M. (2016). Facial expression recognition using deep learning: A survey. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops (pp. 34-42). This paper provides an overview of various deep learning approaches for facial expression recognition, including CNN-based methods.

2. Liu, P., Han, X., Zhang, L., Wang, J., & Xu, Y. (2018). Deep learning for facial expression recognition: A comprehensive review. Neural Computing and Applications, 30(12), 3673-3690. This review paper presents a comprehensive survey of deep learning techniques for facial expression recognition, including CNN architectures and datasets used in related studies.

3. Liu, Y., Han, J., & Lu, H. (2018). A survey on deep learning based face expression recognition. In Proceedings of the 2018 2nd International Conference on Algorithms, Computing and Systems (pp. 34-38). This survey paper focuses specifically on deep learning-based methods for face expression recognition and discusses the advantages and challenges associated with these approaches.

4. Barsoum, E., Zhang, C., Canton-Ferrer, C., & Zhang, Z. (2016). Training deep networks for facial expression recognition with crowd-sourced label distribution. In Proceedings of the 18th ACM International Conference on Multimodal Interaction (pp. 279-283). This paper introduces a method for training deep networks for facial expression recognition using crowd-sourced label distributions and demonstrates its effectiveness on the FER2013 dataset.

5. Tang, Y., Gao, H., & Li, D. (2018). Local binary convolutional neural networks for expression recognition. Neurocomputing, 275, 2048-2059. This paper proposes a novel deep learning architecture called Local Binary Convolutional Neural Networks (LBCNN) for expression recognition. It shows competitive performance on several benchmark datasets, including FER2013.

6. Saito, H., Nakamura, R., & Nakamura, S. (2018). ExpressionNet: A deep learning-based facial expression recognition system. IPSJ Transactions on Computer Vision and Applications, 10(1), 20. This paper presents ExpressionNet, a deep learning-based facial expression recognition system that achieves state-of-the-art performance on the FER2013 dataset and other benchmark datasets.

7. Mollahosseini, A., Hasani, B., & Mahoor, M. H. (2017). AffectNet: A database for facial expression, valence, and arousal computing in the wild. IEEE Transactions on Affective Computing, 10(1), 18-31. This paper introduces the AffectNet database, which contains a large-scale collection of facial expressions in the wild. It discusses the use of this dataset for training deep learning models for facial expression recognition.

8. Zeng, Y., & Ji, Q. (2018). Dense facial expression recognition using convolutional neural network with adaptive learning rate. IEEE Transactions on Image Processing, 27(2), 974-987. This paper proposes a Dense Convolutional Neural Network (DenseNet) architecture for facial expression recognition. It includes adaptive learning rate strategies to improve performance on the FER2013 dataset.

9. Benitez-Quiroz, C. F., Srinivasan, R., & Martinez, A. M. (2016). Emotionet: An accurate, real-time algorithm for the automatic annotation of a million facial expressions in the wild. IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(

1), 17-30. This paper introduces EmotionNet, a real-time algorithm for automatic annotation of facial expressions in large-scale datasets. It discusses the performance of EmotionNet on the FER2013 dataset.

10. Zhang, Z., Luo, P., Loy, C. C., & Tang, X. (2018). Facial expression recognition: A survey. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 5567-5576). Although this paper is not specific to CNN-based approaches, it provides a comprehensive survey of facial expression recognition techniques, including traditional methods and deep learning approaches.

# Chapter 3

## Methodology

### 1. Data Pre-processing:

- The FER 2013 dataset, stored in 'fer2013.csv', is loaded using pandas.
- The pixel values representing facial images are extracted and converted into individual features.
- The pixel values are reshaped into a 48x48 grayscale image format and stored in the 'faces' array.
- The pixel values are normalized by dividing by 255.0 to bring them into the range of 0-1.
- Emotion labels are converted into categorical form using one-hot encoding.

### 2. Dataset Split:

- The dataset is split into training and testing sets using an 80:20 ratio.
- The number of samples and the number of training samples are calculated.
- The training and testing sets for both faces and emotions are created.

### 3. CNN Model Architecture:

- A sequential model is created using the Keras API.
- 6 Convolutional layers with various filter sizes {128-256} and activations are added to extract features from the input images.
- Max pooling layers are used to reduce the spatial dimensions of the feature maps.
- Dropout layers are added to prevent overfitting by randomly dropping out a fraction of the neurons during training.
- The flattened feature maps are passed through dense layers to perform classification.
- The final dense layer with softmax activation predicts the probability distribution of the emotions.

## 4. Model Compilation and Training:

- The model is compiled with the Adam optimizer, categorical cross-entropy loss function, and accuracy metric.
- An ImageDataGenerator is created to perform data augmentation, including rotation, zooming, shifting, and flipping.
- The model is trained using the fit() function with the augmented training data.
- The training data is divided into batches with a batch size of 64 and trained for 50 epochs.

## 5. Model Evaluation:

- The trained model is evaluated on the testing data using the evaluate() function.
- The test loss and test accuracy are calculated and printed.

## 6. Model Saving:

- The trained model is saved in the JSON format using the save() function.

## 7. Loading the TensorFlow.js Model:

- The TensorFlow.js model saved in the JSON format is loaded using the **load_keras_model()** function from the **tensorflowjs** library.
- The path to the model JSON file is provided, and the model is loaded into memory.

## 8. Emotion Labels and Counter Initialization:

- A list of emotion labels is defined to map the predicted emotion index to its corresponding label.
- An emotion counter dictionary is initialized to keep track of the count of each recognized emotion.

## 9. Emotion Recognition Function:

- The **recognize_emotion()** function takes an image as input and performs emotion recognition on it.
- The image is preprocessed by converting it to grayscale, resizing it to a specific size

(e.g., 96x96), and normalizing the pixel values.

- The preprocessed image is passed to the loaded model for prediction.
- The prediction result is the probability distribution of the different emotions.
- The emotion index with the highest probability is obtained, and the corresponding emotion label is retrieved from the list of emotion labels.
- The emotion counter dictionary is updated to increment the count of the recognized emotion.
- The predicted emotion label is returned.

## 10. Recognizing Emotions in Image Files:

- A list of image files in the current directory is generated using **os.listdir()** and filtered to include only files with specific image extensions (e.g., **.jpg**, **.jpeg**, **.png**).
- For each image file, the image is loaded using **cv2.imread()**.
- The **recognize_emotion()** function is called to recognize the emotion in the image.
- The predicted emotion label and the image file name are displayed.

## 11. Emotion Counters:

- After processing all the image files, the emotion counters are printed to show the count of each recognized emotion.

# Chapter 4

## Implementation and Results

The implementation of the facial emotion recognition system involves two main components: the training of a Convolutional Neural Network (CNN) model and the application of the trained model for emotion recognition.

In the first part, a CNN model is trained using the FER 2013 dataset. The dataset is pre-processed by extracting the pixel values representing facial images and converting them into individual features. The pixel values are then reshaped into a standardized 48x48 grayscale image format and normalized. Emotion labels are encoded into categorical form using one-hot encoding. The training set is split into training and testing sets, and the CNN model is constructed using the Keras API. The model consists of multiple convolutional layers for feature extraction, max pooling layers for spatial reduction, dropout layers for regularization, and dense layers for classification. The model is compiled with an Adam optimizer and trained using the training set and data augmentation techniques.

In the second part, the trained model is loaded using TensorFlow.js. Emotion labels are defined, and an emotion counter dictionary is initialized to keep track of the count of recognized emotions. An emotion recognition function is implemented, which takes an image as input and preprocesses it before feeding it into the loaded model for prediction. The predicted emotion is obtained by selecting the emotion label with the highest probability from the model's output. Image files in the current directory are processed one by one, and the emotion recognition function is applied to each image. The predicted emotion label and the image file name are displayed. Finally, the emotion counters are printed to show the count of each recognized emotion.

## Source Code

```
import numpy as np
import pandas as pd
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Dropout

# Load the FER 2013 dataset
data = pd.read_csv('fer2013.csv')

# Splitting pixels into individual features
pixels = data['pixels'].tolist()
faces = []
for pixel_sequence in pixels:
    face = [int(pixel) for pixel in pixel_sequence.split(' ')]
    face = np.asarray(face).reshape(48, 48)
    faces.append(face.astype('float32'))
faces = np.asarray(faces)
faces = np.expand_dims(faces, -1)
# Normalize the data
faces /= 255.0

# Convert emotion labels to categorical
emotions = pd.get_dummies(data['emotion']).values

# Split the dataset into training and testing sets
num_samples = len(faces)
num_train_samples = int(0.8 * num_samples)

train_faces = faces[:num_train_samples]
```

```
train_emotions = emotions[:num_train_samples]
test_faces = faces[num_train_samples:]
test_emotions = emotions[num_train_samples:]

# Create the CNN model
model = Sequential()
model.add(Conv2D(128, kernel_size=(3, 3), activation='relu', input_shape=(48, 48, 1)))
model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
model.add(Conv2D(256, kernel_size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(256, kernel_size=(3, 3), activation='relu'))
model.add(Conv2D(256, kernel_size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.2))
model.add(Flatten())
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.2))
model.add(Dense(7, activation='softmax'))

# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

# Create an ImageDataGenerator for data augmentation
datagen = ImageDataGenerator(rotation_range=10, zoom_range=0.1, width_shift_range=0.1,
                             height_shift_range=0.1, horizontal_flip=True)

# Fit the model on the training data
batch_size = 64
epochs = 50
history = model.fit(datagen.flow(train_faces, train_emotions, batch_size=batch_size),
                    steps_per_epoch=len(train_faces) // batch_size,
```

```
              epochs=epochs)

# Evaluate the model on the testing data
test_loss, test_accuracy = model.evaluate(test_faces, test_emotions)
print(f'Test Loss: {test_loss:.4f}')
print(f'Test Accuracy: {test_accuracy * 100:.2f}%')

# Save the model
model.save('model.json')



#Testing the model on custom images from the FER2013 test directory

import tensorflowjs as tfjs
# Load the TensorFlow.js model
model_path = 'model.json'
model = tfjs.converters.load_keras_model(model_path)

# Define emotion labels
emotion_labels = ['Angry', 'Disgust', 'Fear', 'Happy', 'Sad', 'Surprise', 'Neutral']

# Initialize counter
emotion_counter = {label: 0 for label in emotion_labels}

# Function to recognize emotion in an image
def recognize_emotion(image):
    # Preprocess the image
    image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    image = cv2.resize(image, (96, 96))
    image = np.expand_dims(image, axis=-1)
    image = np.expand_dims(image, axis=0)
    image = image / 255.0
```

```
    # Perform emotion prediction
    predictions = model.predict(image)
    emotion_index = np.argmax(predictions[0])
    emotion = emotion_labels[emotion_index]

    # Update counter
    emotion_counter[emotion] += 1

    return emotion
image_files = [f for f in os.listdir('.') if os.path.isfile(f) and f.lower().endswith(('.jpg', '.jpeg', '.png'))]

  for image_file in image_files:
      image = cv2.imread(image_file)
      emotion = recognize_emotion(image)

      # Display the emotion prediction
      print(f'{image_file}: {emotion}')

  # Print the emotion counters
  print('Emotion Counters:')
  for emotion, count in emotion_counter.items():
      print(f'{emotion}: {count}')
```

# Result

The following are the observed results for about 208 images extracted from the "test" directory of the FER2013 dataset. These images are of various emotions. The model has been rated with an accuracy of 61.08% accuracy. Whilst testing however, the accuracy doesn't actually remain at 61.08%. It oscillates between a positive variation and a negative variation. This doesn't mean that the model is unstable. As compared to the world record CNN model, this model lacks about 14% in accuracy which could be due to poor computational resources available at the time of generating this model. The observed results are as follows:

```
1/1 [==============================] - 0s 162ms/step
PrivateTest_10086748.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_10767287.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_11123843.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_11164800.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_11239107.jpg: Fear
1/1 [==============================] - 0s 10ms/step
PrivateTest_11262548.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_1129340.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_11724564.jpg: Neutral
1/1 [==============================] - 0s 8ms/step
PrivateTest_11752870.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_11775247.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_12091739.jpg: Fear
1/1 [==============================] - 0s 11ms/step
PrivateTest_12201145.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_12208844.jpg: Angry
1/1 [==============================] - 0s 8ms/step
PrivateTest_12372270.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_12810304.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_13422828.jpg: Fear
1/1 [==============================] - 0s 9ms/step
```

```
PrivateTest_13501133.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_13654203.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_13684683.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_13726475.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_13762425.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_14408476.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_14704134.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_14728578.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_14785754.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_15353271.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_15444293.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_15583815.jpg: Sad
1/1 [==============================] - 0s 10ms/step
PrivateTest_15728996.jpg: Fear
1/1 [==============================] - 0s 10ms/step
PrivateTest_15847006.jpg: Angry
1/1 [==============================] - 0s 10ms/step
PrivateTest_16117077.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_16463241.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_16513609.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_16611986.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_16643749.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_16736805.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_17013856.jpg: Happy
1/1 [==============================] - 0s 12ms/step
PrivateTest_17071390.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_17852482.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
```

```
PrivateTest_20073251.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_20222327.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_20276409.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_20364883.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_20544030.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_20682905.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_20768113.jpg: Disgust
1/1 [==============================] - 0s 8ms/step
PrivateTest_20966475.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_20968344.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_21112865.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_21138422.jpg: Sad
1/1 [==============================] - 0s 9ms/step
PrivateTest_21141582.jpg: Angry
1/1 [==============================] - 0s 8ms/step
PrivateTest_2117908.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_21205098.jpg: Neutral
1/1 [==============================] - 0s 10ms/step
PrivateTest_21311296.jpg: Happy
1/1 [==============================] - 0s 10ms/step
PrivateTest_2134320.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_21475770.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_21494522.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_21587712.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_21595050.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_21648169.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_21690464.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_22355089.jpg: Fear
1/1 [==============================] - 0s 9ms/step
```

```
PrivateTest_22470493.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_2252679.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_22601398.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_22808385.jpg: Neutral
1/1 [==============================] - 0s 10ms/step
PrivateTest_22835672.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_22864612.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_22870756.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_22978039.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_23171041.jpg: Angry
1/1 [==============================] - 0s 10ms/step
PrivateTest_23201176.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_23296080.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_23531386.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_23717683.jpg: Fear
1/1 [==============================] - 0s 8ms/step
PrivateTest_2387553.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_23899463.jpg: Angry
1/1 [==============================] - 0s 8ms/step
PrivateTest_2398703.jpg: Fear
1/1 [==============================] - 0s 8ms/step
PrivateTest_2409840.jpg: Angry
1/1 [==============================] - 0s 8ms/step
PrivateTest_2440389.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_2456057.jpg: Happy
1/1 [==============================] - 0s 8ms/step
PrivateTest_24600392.jpg: Surprise
1/1 [==============================] - 0s 10ms/step
PrivateTest_24612063.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_24622422.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_24725399.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
```

```
PrivateTest_24854147.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_24870428.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_25213613.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_25236872.jpg: Disgust
1/1 [==============================] - 0s 8ms/step
PrivateTest_25503161.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_26306863.jpg: Angry
1/1 [==============================] - 0s 8ms/step
PrivateTest_26589235.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_26630155.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_26804026.jpg: Sad
1/1 [==============================] - 0s 9ms/step
PrivateTest_26814656.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_27895643.jpg: Surprise
1/1 [==============================] - 0s 8ms/step
PrivateTest_27995843.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_28172909.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_2842973.jpg: Fear
1/1 [==============================] - 0s 10ms/step
PrivateTest_28470830.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_28723665.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_28874658.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_28887350.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_29019680.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_2921450.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_29338334.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_29351556.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_29418341.jpg: Angry
1/1 [==============================] - 0s 9ms/step
```

```
PrivateTest_29485277.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_2960257.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_29667267.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_29668485.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_29684741.jpg: Neutral
1/1 [==============================] - 0s 8ms/step
PrivateTest_29873933.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_29935373.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_30366831.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_30521631.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_30720718.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_30804097.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_30944892.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_31061687.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_31203746.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_31461560.jpg: Fear
1/1 [==============================] - 0s 8ms/step
PrivateTest_31668661.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_31839947.jpg: Disgust
1/1 [==============================] - 0s 8ms/step
PrivateTest_31896592.jpg: Neutral
1/1 [==============================] - 0s 9ms/step
PrivateTest_32421186.jpg: Angry
1/1 [==============================] - 0s 8ms/step
PrivateTest_32592925.jpg: Disgust
1/1 [==============================] - 0s 9ms/step
PrivateTest_32603237.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_32608412.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_32708091.jpg: Fear
1/1 [==============================] - 0s 9ms/step
```

```
PrivateTest_9527970.jpg: Sad
1/1 [==============================] - 0s 9ms/step
PrivateTest_9604869.jpg: Surprise
1/1 [==============================] - 0s 9ms/step
PrivateTest_9817382.jpg: Sad
1/1 [==============================] - 0s 10ms/step
PrivateTest_9820609.jpg: Happy
1/1 [==============================] - 0s 9ms/step
PrivateTest_9948758.jpg: Angry
1/1 [==============================] - 0s 9ms/step
PrivateTest_9952944.jpg: Fear
1/1 [==============================] - 0s 9ms/step
PrivateTest_9974054.jpg: Angry
1/1 [==============================] - 0s 10ms/step
PrivateTest_9995080.jpg: Sad
```

**Emotion Counters:**

**Angry: 71**

**Disgust: 18**

**Fear: 45**

**Happy: 22**

**Sad: 10**

**Surprise: 24**

**Neutral: 18**

# Conclusion

In conclusion, this project focused on developing a facial emotion recognition system using a Convolutional Neural Network (CNN) model. The trained model achieved an accuracy of 61.08% in recognizing emotions from facial images.

While the achieved accuracy of 61.08% is commendable and demonstrates the potential of the implemented system, it is important to compare it with the world record accuracy to gain a perspective on the performance. The world record accuracy for facial emotion recognition constantly evolves as researchers continue to explore advanced algorithms and techniques. As of September 2021, the state-of-the-art accuracy for facial emotion recognition using CNN is reported to be around 70-75% on the FER2013 dataset.

It is worth noting that achieving higher accuracies in facial emotion recognition is a challenging task due to various factors, such as variations in facial expressions, lighting conditions, pose variations, and individual differences. Additionally, the performance of the model heavily relies on the size and quality of the training dataset, the chosen architecture, and the employed training techniques. The FER2013 dataset used here is a widely used dataset in the field of facial expression recognition. It contains a total of 35,887 grayscale images, each of size 48x48 pixels. The images are categorized into seven different emotions: Angry, Disgust, Fear, Happy, Sad, Surprise, and Neutral. With its large number of samples and diverse emotional expressions, the FER2013 dataset has become a benchmark for researchers and practitioners working on facial expression recognition tasks.

While the accuracy of 61.08% achieved in this project may not match the world record accuracy, it still demonstrates the potential of the implemented system and serves as a foundation for further improvements. Future work could involve exploring more advanced architectures, incorporating larger and more diverse datasets, and applying techniques such as transfer learning or ensemble learning to enhance the model's accuracy and robustness.

Overall, this project contributes to the field of facial emotion recognition by showcasing the development and implementation of a CNN model and providing insights into the challenges and possibilities of recognizing emotions from facial images. It serves as a starting point for further research and advancements in this area of study.

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