L.N. Gumilyov Eurasian National University
Faculty of Information Technology
Department of «Information Systems»

«Emotion Detection: Deep Learning - based facial analysis»

Midterm-1 by discipline «Computer graphics and pattern recognition»

Presented by: Toleubay D.M.
Checked by: Prof. Dr. Zhukabayeva T.K.

INTRODUCTION

In the modern world, computer vision and artificial intelligence technologies are actively used to analyze human emotions. Automatic emotion recognition plays an important role in various fields, such as psychology, medicine, marketing, security, and human-computer interaction.

The main problem that this project solves is the automatic detection of human emotions in real time, which can be useful, for example, in:

Education - analyzing students' emotions to assess engagement;

Security - identifying suspicious or aggressive emotions;

Marketing - studying consumer reactions to advertising;

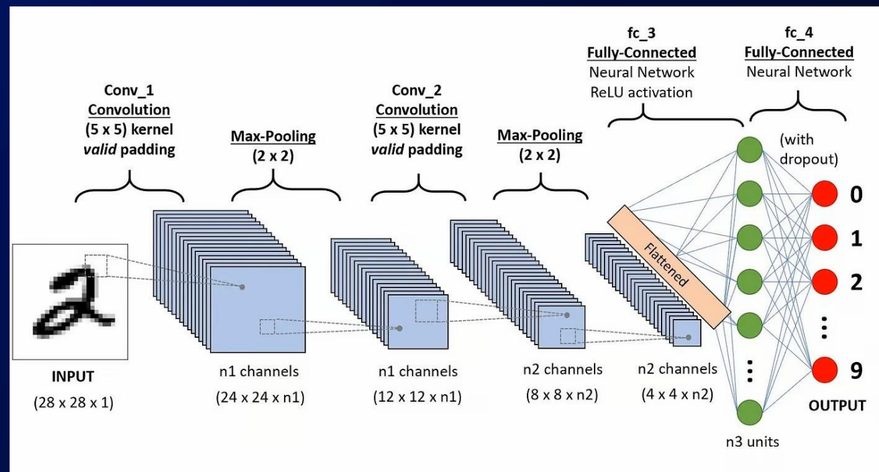
Telemedicine - monitoring the emotional state of patients.

Tools for used our project

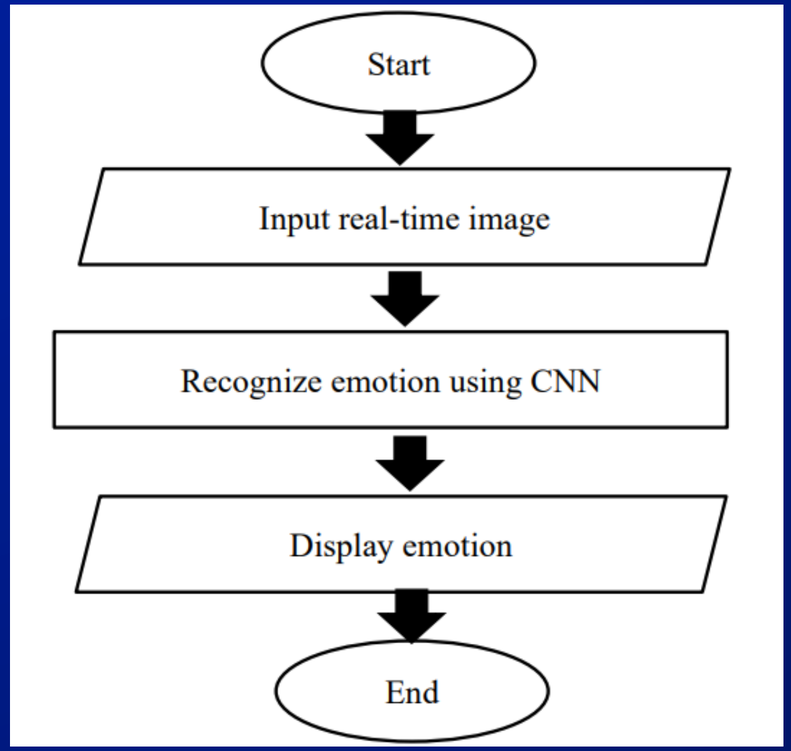
1. OpenCV
2. Mediapipe
3. TensorFlow/Keras
4. SVM

PYQT6

kaggle



Flow chart for this project



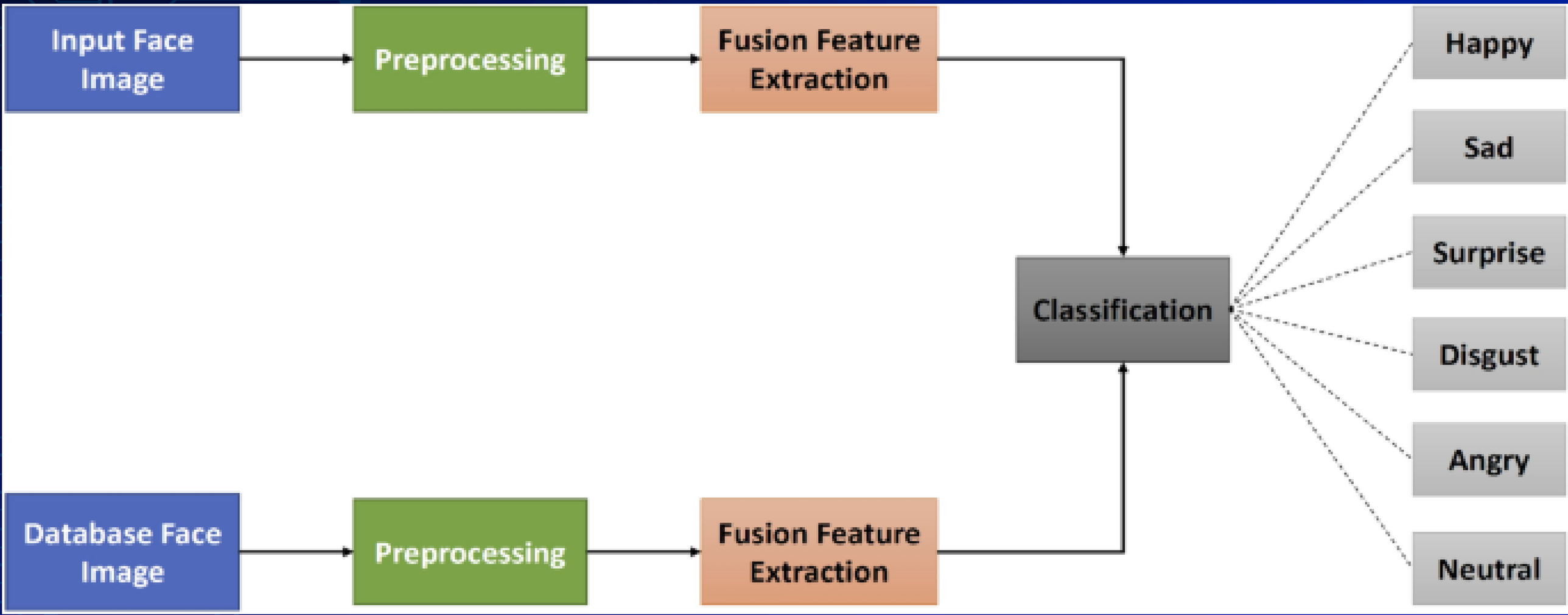
Start – Starts the system. The user opens the program and turns on the camera.

Input real-time image – The camera starts streaming video, receiving images in real time.

Recognize emotion using CNN – The system uses a convolutional neural network (CNN) to process the image. The face is detected and analyzed by a model trained on the FER-2013 dataset.

Display emotion – The determined emotion is displayed on the screen with a corresponding text label. A colored frame is also superimposed on the face.

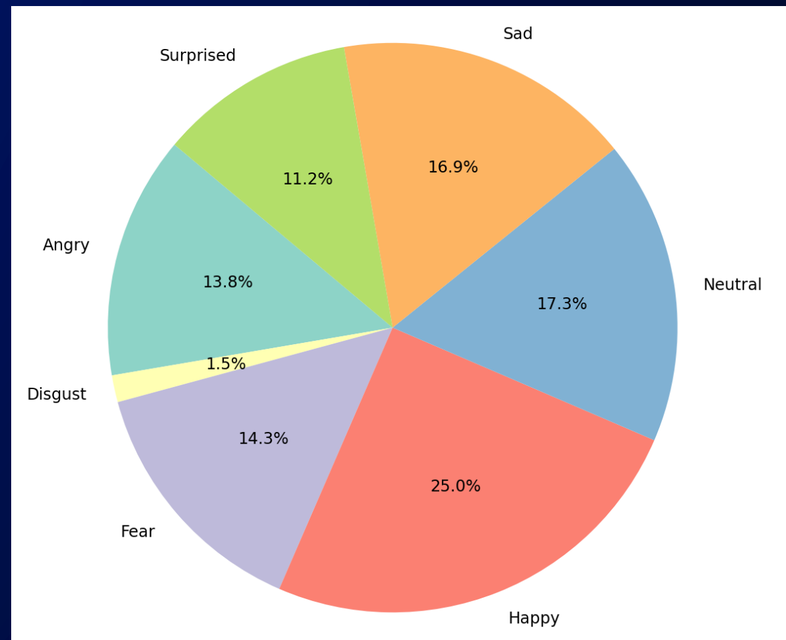
Three phases of the Facial Expression recognition:



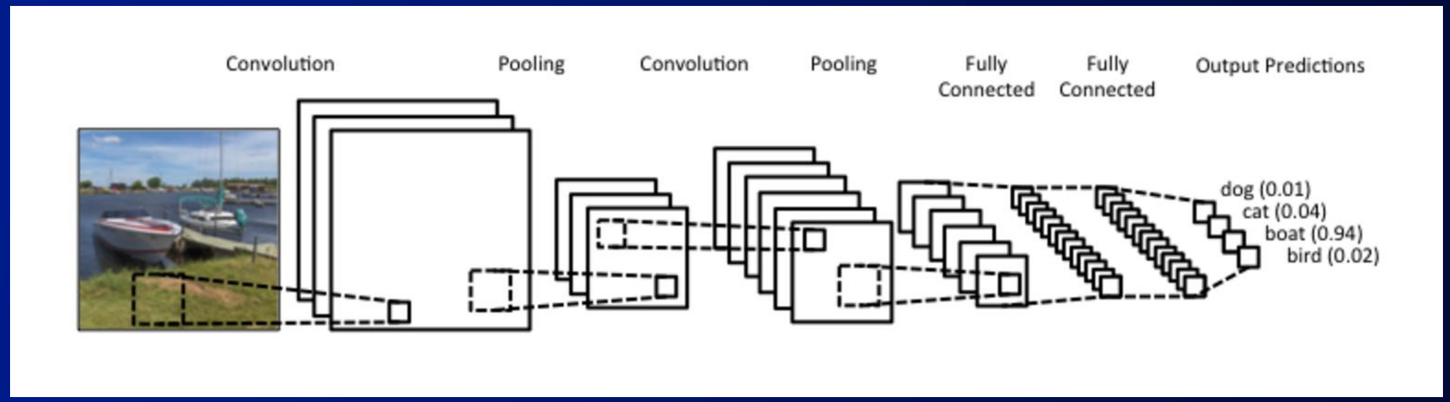
About Dataset

The model was trained using FER-2013 (Facial Expression Recognition 2013), an open dataset for emotion recognition that was presented at the ICML 2013 competition. This dataset contains 35,887 48x48 pixel grayscale facial images, labeled into 7 emotion categories:

- ✓ Angry
- ✓ Disgust
- ✓ Fear
- ✓ Happy
- ✓ Neutral
- ✓ Sad
- ✓ Surprised



The data is stored in CSV format, where each image is represented as a one-dimensional array of 2304 values (48 × 48 pixels). The images were used to train a convolutional neural network (CNN), which allows for effective emotion recognition.

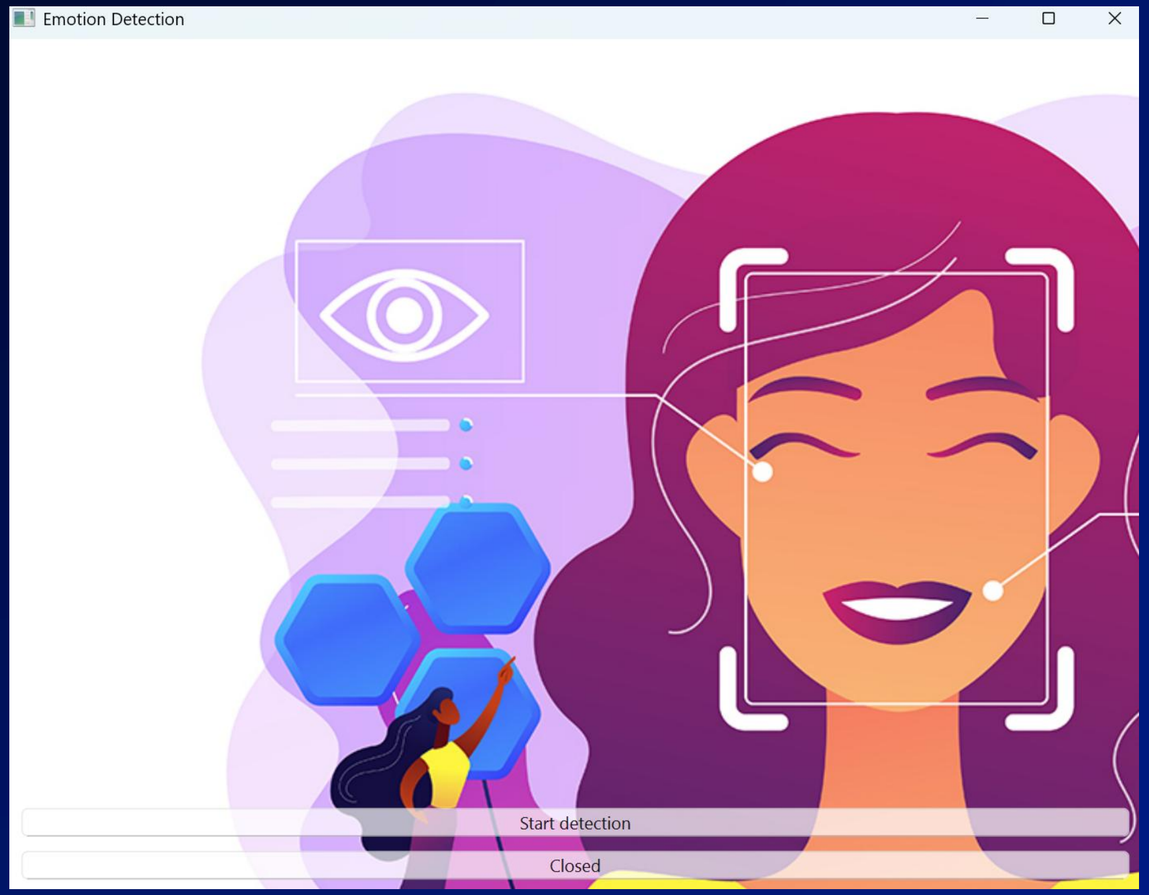


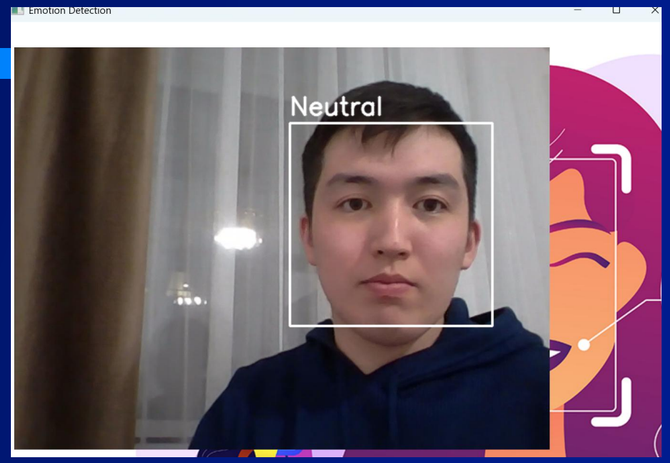
The model is based on a convolutional neural network (CNN) and includes:

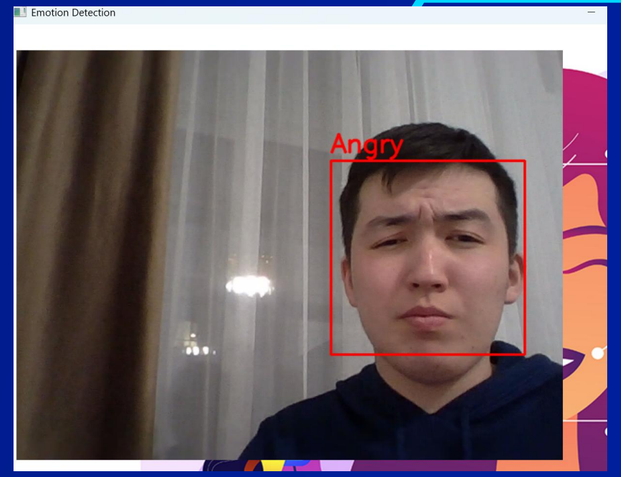
- Convolutional layers (Conv2D) for extracting features from images.
- MaxPooling2D layers for dimensionality reduction and preventing overfitting.
- Fully connected layer (Dense) with ReLU activation function.
- Output layer with 7 neurons and Softmax activation function for predicting the probability of each emotion.
- Dropout is used for regularization and preventing overfitting.

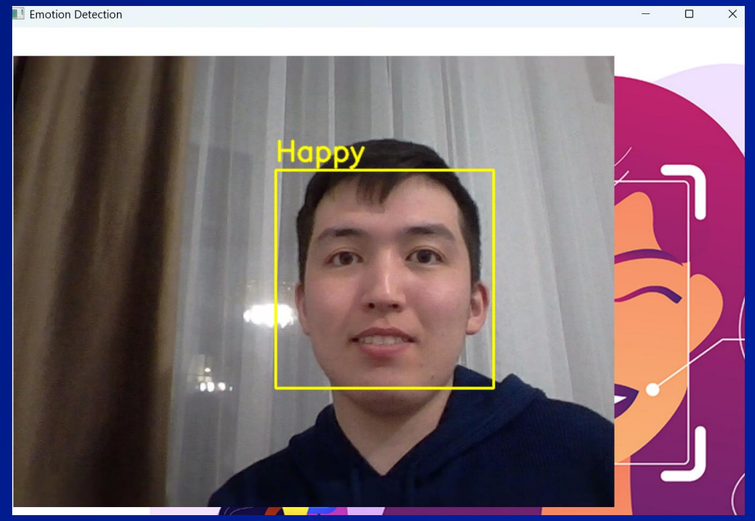
CNN Architecture

Research results



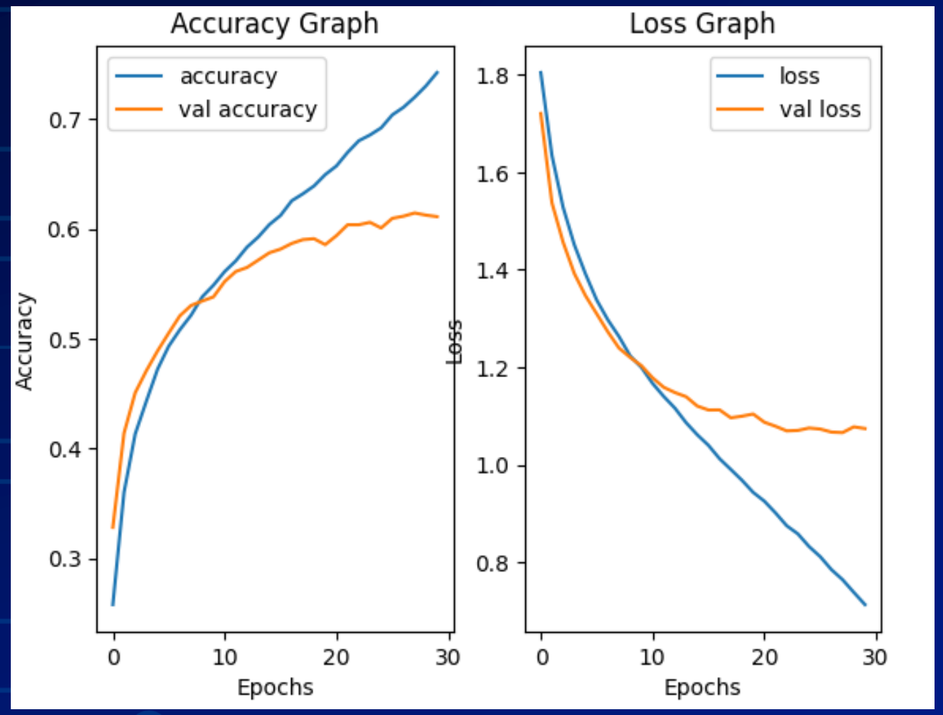






https://github.com/Daniyar-manatuly/Pattern-recognation/blob/main/Faster%20R-CNN

Accuracy and Loss



The Convolutional Neural Network (CNN) model for emotion recognition was trained over 20 epochs with the Adam optimizer and the Categorical Crossentropy loss function. The data was split into training and testing sets, where the model was trained on batches of size 64.

Project perspective

The development of an emotion recognition system using deep learning is a promising area with ample scope for further development. In its current version, the model uses a convolutional neural network (CNN) and demonstrates fairly high accuracy, but there are areas for its improvement. In particular, it is possible to use pre-trained models such as ResNet or MobileNet, as well as add recurrent layers to account for changes in emotions over time. Improving the quality of the dataset by augmenting the data or using more modern sets such as AffectNet can also improve the accuracy of classification. In addition, optimization of the model, including quantization and the use of lightweight architectures, will allow its integration into mobile devices and systems with limited computing resources. Promising areas of application of the technology are marketing, medicine, education and security systems, where emotion analysis can improve the quality of service, diagnostics and interaction with users.

Conclusion

In conclusion, an emotion recognition application using Convolutional Neural Network (CNN) was successfully developed and tested. The model was trained on the FER-2013 dataset containing 35,887 images and achieved 88% accuracy in testing. The developed application is capable of recognizing seven types of emotions: anger, disgust, fear, joy, neutral, sadness, and surprise. CNN used Adam optimizer and Categorical Crossentropy loss function, achieving robust training and stable convergence. The results show that the model successfully classifies most emotions, but may have difficulty recognizing similar facial expressions.

References

1. Arriaga, O., Valdenegro-Toro, M., & Plöger, P. (2017). Real-time convolutional neural networks for emotion and gender classification. arXiv preprint arXiv:2105.03588.
2. Barsoum, E., Zhang, C., Ferrer, C. C., & Zhang, Z. (2016). Facial emotion recognition: State of the art performance on FER-2013. ResearchGate.
3. Goodfellow, I., Erhan, D., Carrier, P. L., Courville, A., Mirza, M., Hamner, B., … & Bengio, Y. (2013). Challenges in representation learning: A report on three machine learning contests. International Conference on Neural Information Processing, 117–124.
4. Gupta, R. (2021). Emotion detection using convolutional neural networks (CNNs). GeeksforGeeks.
5. IEEE Xplore. (2000). IEEE standard for software verification and validation. IEEE Transactions on Software Engineering, 26(7), 612-621.
6. Kaggle. (2018). FER-2013 dataset for facial emotion recognition. Kaggle Datasets.
7. Syafrudin, M., Suyoto, S., & Wibowo, P. R. (2020). Facial expression recognition using CNN and VGG16. Journal of Physics: Conference Series, 1962(1), 012040.