A

Synopsis/Project

Report On

FACE – EMOTION RECOGNITION (FER) AND DROWSINESS DETECTION

Submitted in partial fulfillment of the requirement for the 5TH semester.

Bachelor of Technology

In Computer Science Engineering (AI and ML)

By

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Under the Guidance

of

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DISTRICT- NAINITAL-

263132 2023- 2024

STUDENT'S DECLARATION

We, **HARSHIT WALDIA** here by declare the work, which is being presented in the project, entitled "**FACE – EMOTION RECOGNITION (FER) AND DROWSINESS DETECTION**" in partial fulfillment of the requirement for the award of the degree **B. Tech** in the session **2023-2024**, is an authentic record of my own work carried out under the supervision of "**Prof. Dr. Shilpa Jain", Professor, Department of CSE, Graphic Era Hill University, Bhimtal.**

The matter embodied in this project has not been submitted by us for the award of any other degree.

Date: **Harshit Waldia**

CERTIFICATE

The project report entitled " **Face Emotion Detection (FER) And Drowsiness Detection** " being submitted by **Harshit Waldia** to Graphic Era Hill University Bhimtal Campus for the award of bona fide work carried out by them. They have worked under my guidance and supervision and fulfilled the requirement for the submission of report.

(Prof. Dr. Shilpa) **(Prof. Dr. Ankur Bisht)**

Project Guide **(HOD, CSE Dept.)**

ACKNOWLEDGEMENT

We take immense pleasure in thanking Honorable **"Prof. Dr. Shilpa"** (**Professor, CSE, GEHU Bhimtal Campus**) to permit me and carry out this project work with his excellent and optimistic supervision. This has all been possible due to his novel inspiration, able guidance and useful suggestions that helped me to develop as a creative researcher and complete the research work, in time.

Words are inadequate in offering my thanks to GOD for providing me everything that we need. We again want to extend thanks to our President **"Prof. (Dr.) Kamal Ghanshala"** for providing us all infrastructure and facilities to work in need without which this work could not be possible.

Many thanks to Professor **"Dr. Manoj Chandra Lohani"** (Director Gehu Bhimtal), other faculties for their insightful comments, constructive suggestions, valuable advice, and time in reviewing this thesis.

Finally, yet importantly, we would like to express my heartiest thanks to our beloved parents, for their moral support, affection and blessings. We would also like to pay our sincere thanks to all our friends and well-wishers for their help and wishes for the successful completion of this research.

Harshit Waldia

ABSTRACT

Face Emotion Detection:
Face Emotion Detection is an interdisciplinary domain at the intersection of computer vision, machine learning, and affective computing. The primary goal is to equip machines with the ability to perceive and interpret human emotions through facial expressions. Advanced algorithms analyze facial features, such as the curvature of the lips, eyebrow positioning, and eye movements, to infer emotional states like happiness, sadness, anger, surprise, and more. This technology has wide-ranging applications, from human-computer interaction and sentiment analysis in social media to market research and personalized user experiences. In healthcare, it also holds promise for assisting in the diagnosis and treatment of mental health conditions by providing quantitative insights into emotional well-being.

Drowsiness Detection:
Drowsiness Detection involves the deployment of machine learning algorithms and computer vision techniques to assess and monitor signs of drowsiness or fatigue in individuals, particularly in scenarios like driving. By analyzing facial expressions, eye closure patterns, and head movements, these systems can gauge a person's level of alertness in real-time. In the context of road safety, drowsiness detection systems play a pivotal role in mitigating the risks associated with driver fatigue. Timely warnings or interventions, such as alerts or seat vibrations, can be triggered to prevent accidents caused by impaired attention and delayed reaction times. The technology contributes significantly to enhancing overall safety and addressing a critical aspect of transportation-related challenges.

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INTRODUCTION

Introduction to Face Emotion Detection:

In the realm of artificial intelligence, Face Emotion Detection stands as a captivating endeavor that seeks to imbue machines with the ability to discern and interpret human emotions through facial expressions. Human communication is inherently rich in non-verbal cues, with facial expressions serving as a profound indicator of underlying emotional states. Recognizing the significance of this visual language, the intersection of computer vision, machine learning, and affective computing has given rise to sophisticated algorithms capable of decoding the intricate nuances of human emotion.

The core methodology involves leveraging computational techniques to analyze facial features dynamically. Key markers, including the subtle movements of eyebrows, variations in lip curvature, and the dynamics of eye expressions, are scrutinized to classify and understand emotions such as happiness, sadness, anger, surprise, and more. Face Emotion Detection technology transcends traditional boundaries, finding applications in diverse domains. It plays a pivotal role in revolutionizing human-computer interaction, enabling machines to respond to users with empathy and awareness of their emotional states. Furthermore, it proves invaluable in fields like market research and healthcare, where nuanced insights into emotional responses contribute to more informed decision-making.

As the capabilities of Face Emotion Detection continue to evolve, the potential for improving mental health diagnostics and personalized user experiences becomes increasingly apparent.

Introduction to Drowsiness Detection:

In the landscape of intelligent transportation systems and driver safety, Drowsiness Detection emerges as a critical technology aimed at averting the dangers associated with driver fatigue. The consequences of drowsy driving are well-documented, ranging from impaired cognitive abilities to delayed reaction times, making it a significant contributor to road accidents. Recognizing the imperative to address this issue, Drowsiness Detection harnesses the power of machine learning and computer vision to monitor and analyze vital indicators of driver alertness in real-time.

The essence of Drowsiness Detection lies in its ability to interpret visual cues indicative of drowsiness, such as changes in facial expressions, eye closure patterns, and head movements. By continuously assessing these parameters, the system can dynamically gauge the driver's level of alertness. In the event of detected drowsiness, timely interventions are triggered, ranging from audible alerts to physical stimulations like seat vibrations, thereby mitigating the potential risks of accidents due to driver fatigue.

Beyond the realm of transportation safety, the applications of Drowsiness Detection extend to various industries where sustained attention is paramount. From enhancing workplace safety to preventing accidents in critical operations, technology serves as a sentinel against the pervasive threat of diminished alertness. As we delve deeper into the complexities of human-machine interaction, Drowsiness Detection emerges as a sentinel technology, safeguarding lives and reshaping the contours of safety in an increasingly interconnected world.

OBJECTIVE

Objectives of Face Emotion Detection:

1. **Enhance Human-Computer Interaction**:
- Develop algorithms that enable machines to perceive and respond to human emotions, fostering more natural and empathetic interactions in various digital interfaces.

2. Facilitate Sentiment Analysis in Social Media:
- Apply Face Emotion Detection to analyze and understand user sentiments expressed in images shared on social media platforms, providing valuable insights for businesses and researchers.

3. **Improve User Experience in Entertainment**:
- Implement emotion-aware systems in entertainment platforms to tailor content delivery based on the audience's emotional responses, creating a more immersive and personalized experience.

4. Support Mental Health Diagnostics:
- Investigate the potential of Face Emotion Detection in aiding mental health professionals by providing objective data on facial expressions, contributing to the diagnostic process and treatment monitoring.

5. Enable Emotional Well-being Apps:
- Develop applications that utilize real-time emotion detection for tracking and promoting emotional well-being, offering users personalized insights and interventions.

6. Optimize Human-Robot Collaboration:
- Integrate Face Emotion Detection in robotics to enhance human-robot collaboration, allowing machines to respond appropriately to human emotions in various contexts, including healthcare and customer service.

Objectives of Drowsiness Detection:

1. Enhance Road Safety:
- Develop robust algorithms for real-time monitoring of driver drowsiness to provide timely alerts, mitigating the risks associated with impaired attention and reaction times on the road.

2. Prevent Accidents Due to Fatigue:

- Implement Drowsiness Detection systems in vehicles to detect signs of driver fatigue and trigger interventions, such as alarms or seat vibrations, to prevent accidents caused by drowsy driving.

3. Improve Workplace Safety:

- Extend Drowsiness Detection technology to industrial settings, enhancing workplace safety by alerting personnel when signs of fatigue are detected, reducing the likelihood of accidents in critical operations.

4. Optimize Transportation Efficiency:

- Explore the integration of Drowsiness Detection in logistics and transportation systems to optimize scheduling and route planning, considering the alertness levels of drivers.

5. Enable Wearable Drowsiness Detection:

- Develop wearable devices with integrated drowsiness detection capabilities, offering a portable solution for individuals in various professions where sustained attention is crucial.

6. Facilitate Research on Sleep Patterns:

- Contribute to sleep research by utilizing drowsiness detection technology to collect data on sleep patterns and fatigue, providing valuable insights for medical professionals and researchers.

- **TOOLS/ PLATFORM, HARDWARE AND SOFTWARE REQUIREMENT SPECIFICATIONS**

Tools :
Python IDE (Vs-Code)

Platform :
Windows 7/8/10/11

Criterion	Description
Disk - space	2GB Minimum disk space for program.
RAM	4GB Minimum / 8GB Recommended
Python - Version	3.11.1

Software Requirement Specification:

Python3 version of Python.

- Python: Python is a high-level, interpreted, interactive and object-oriented scripting language.
- Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages.
- Python is Interpreted − Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
- Python is Interactive − You can actually sit at a Python prompt and interact with the interpreter directly to write your programs.
- Python is Object-Oriented − Python supports Object-Oriented style or technique of programming that encapsulates code within objects. 10
- Python is a Beginner's Language − Python is a great language for the beginner-level programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.

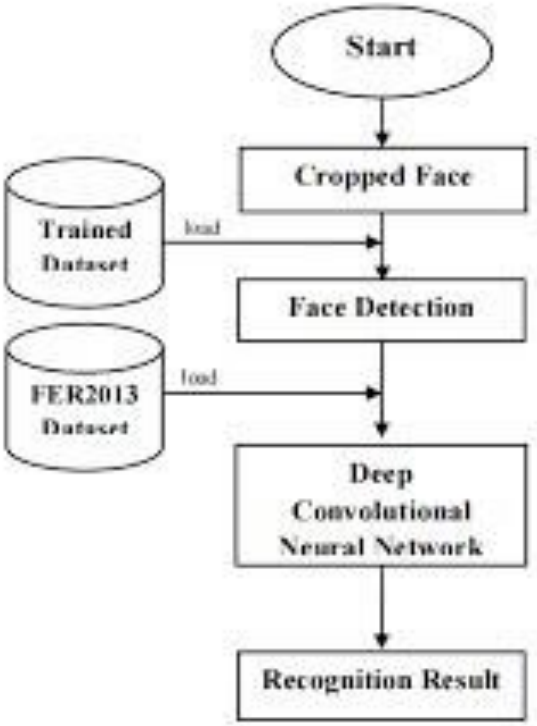
Python Features:

- Python's features include – Easy-to-learn − Python has few keywords, simple structure, and a clearly defined syntax. This allows the student to pick up the language quickly.
- Easy-to-read − Python code is more clearly defined and visible to the eyes.
- Easy-to-maintain − Python's source code is fairly easy-to-maintain.

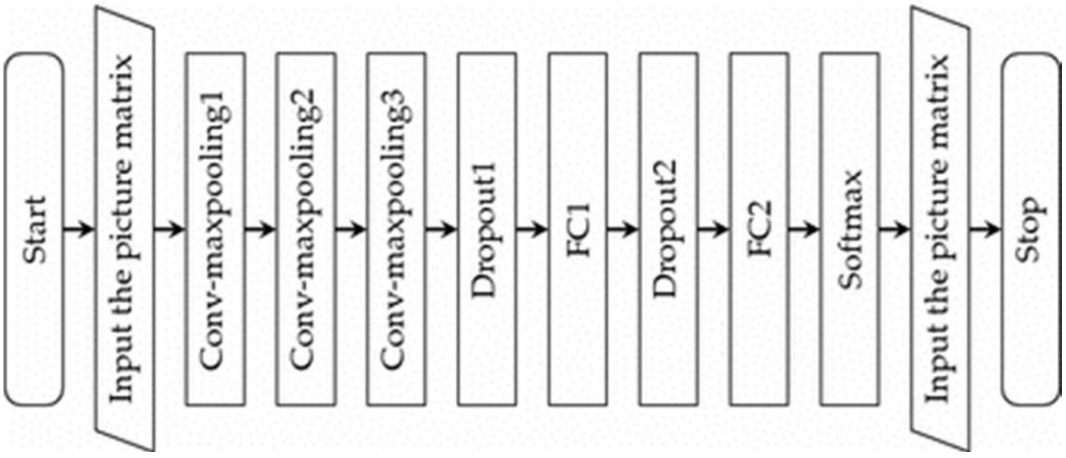
- A broad standard library − Python's bulk of the library is very portable and cross-platform compatible on UNIX, Windows, and Macintosh.
- Interactive Mode − Python has support for an interactive mode which allows interactive testing and debugging of snippets of code.
- Portable − Python can run on a wide variety of hardware platforms and has the same interface on all platforms.
- Extendable − You can add low-level modules to the Python interpreter. These modules enable programmers to add to or customize their tools to be more efficient.
- Databases − Python provides interfaces to all major commercial databases.
- GUI Programming − Python supports GUI applications that can be created and ported to many system calls, libraries and windows systems, such as Windows MFC, Macintosh, and the X Window system of Unix.

- Scalable − Python provides a better structure and support for large programs than shell scripting

DATA FLOW DIAGRAM



CNN MODEL:



PROBLEM STATEMENT

The need for developing face emotion detection arises from a variety of potential benefits across various fields. Here are some key reasons why we might want to develop this technology:

Improved Human-Computer Interaction:

Personalization: Tailoring computer interfaces and responses to a user's emotional state can create a more natural and engaging experience. Imagine learning software that adjusts its difficulty based on your frustration level, or a smart home system that dims the lights and plays calming music when you seem stressed.
Accessibility: Emotion recognition can assist people with communication difficulties, such as those with autism or speech impairments, by translating facial expressions into speech or text.
Safety and Security: Detecting emotional cues like drowsiness or distress in drivers, operators, or security personnel can help prevent accidents or security breaches.

Enhanced Education and Healthcare

Personalized learning: Adapting teaching methods to students' emotional states can improve learning outcomes by catering to their attention levels and emotional engagement.
Mental health diagnosis and treatment: Recognizing emotional expressions in patients can aid in diagnosing mental health conditions and monitoring their progress during therapy.
Early intervention: Detecting signs of distress or emotional dysregulation in children or vulnerable individuals can lead to early intervention and preventative measures.

Market Research and Business Applications

Customer satisfaction: Analyzing customer facial expressions during interactions can provide valuable insights into their satisfaction and inform product development or marketing strategies.
Targeted advertising: Understanding viewers' emotional responses to advertisements can help companies create more effective and engaging campaigns.
Recruitment and assessment: Analyzing candidates' emotions during interviews or simulations can provide additional insights into their personality and suitability for a role.

However, it's important to acknowledge the potential drawbacks and ethical considerations of face emotion detection technology:

Privacy concerns: Collecting and storing facial data raises concerns about privacy and potential misuse.
Accuracy and Bias: Facial expressions can be ambiguous and culturally influenced, and algorithms may be biased based on the data they are trained on.

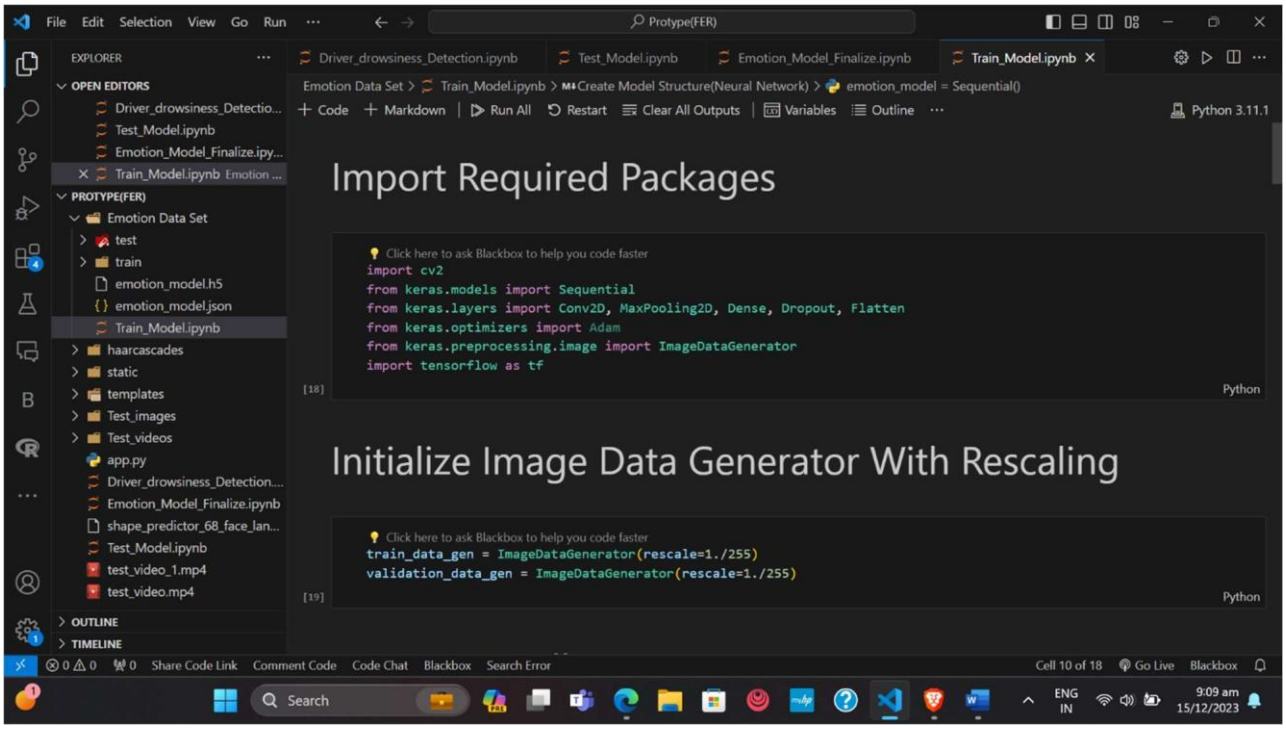
Misinterpretation and Manipulation: Emotion recognition technology could be misused to manipulate people's emotions or make unfair judgments based on perceived emotional states.

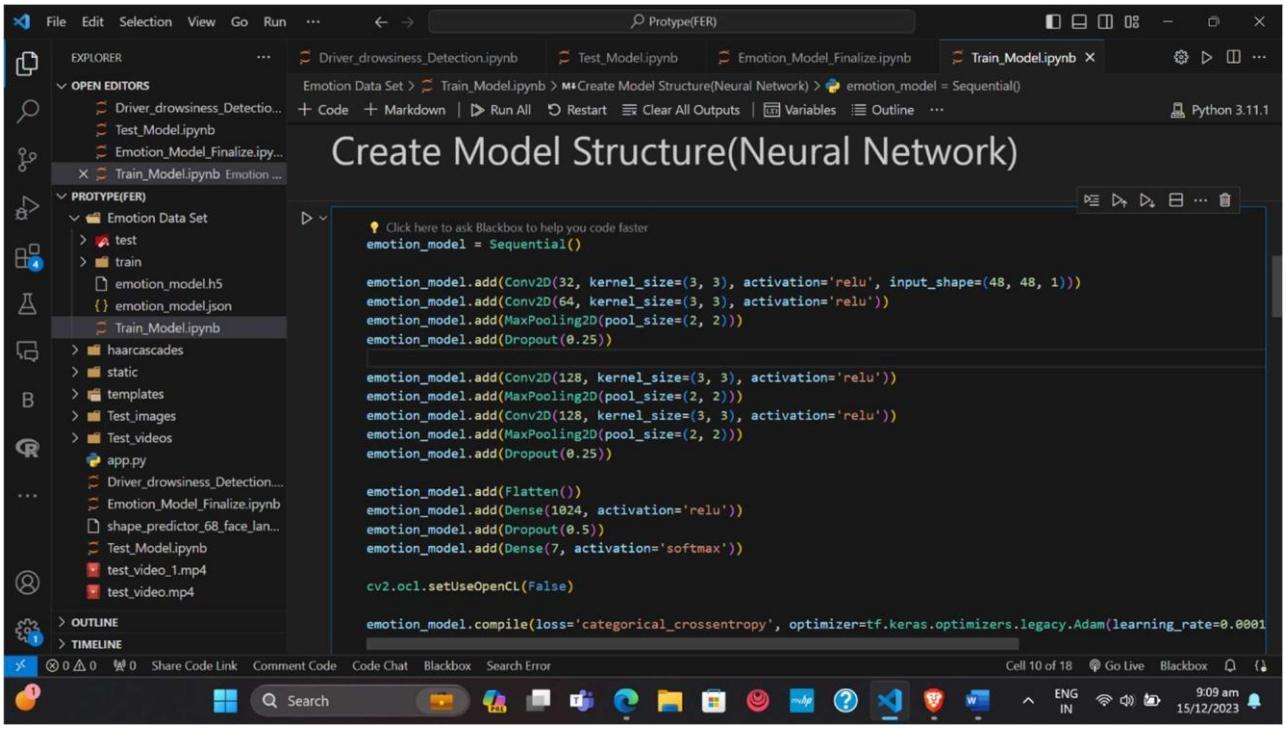
Therefore, developing face emotion detection responsibly requires addressing these challenges and ensuring ethical implementation with proper safeguards and regulations.

Ultimately, the decision of whether or not to develop face emotion detection technology comes down to weighing its potential benefits against its risks and ensuring it is used responsibly and ethically in a way that respects human dignity and privacy.

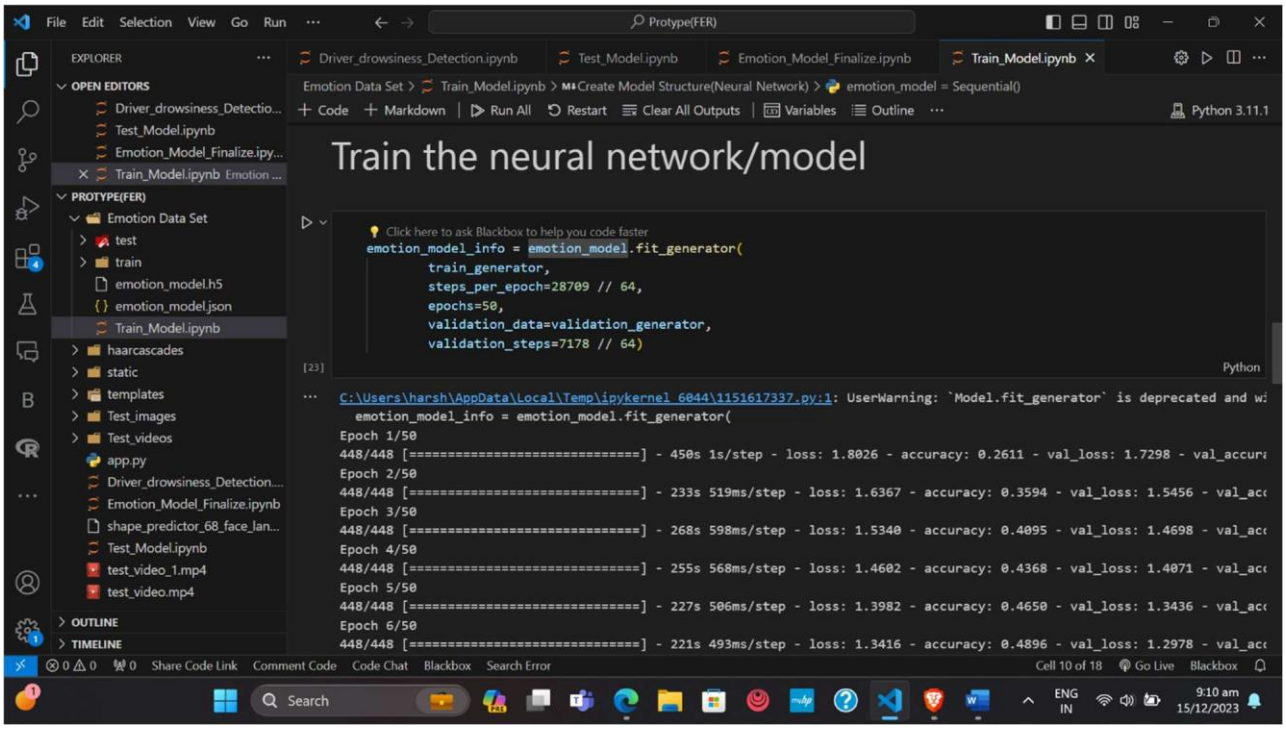
I hope this explanation provides a more nuanced understanding of the motivations and considerations behind developing face emotion detection technology.

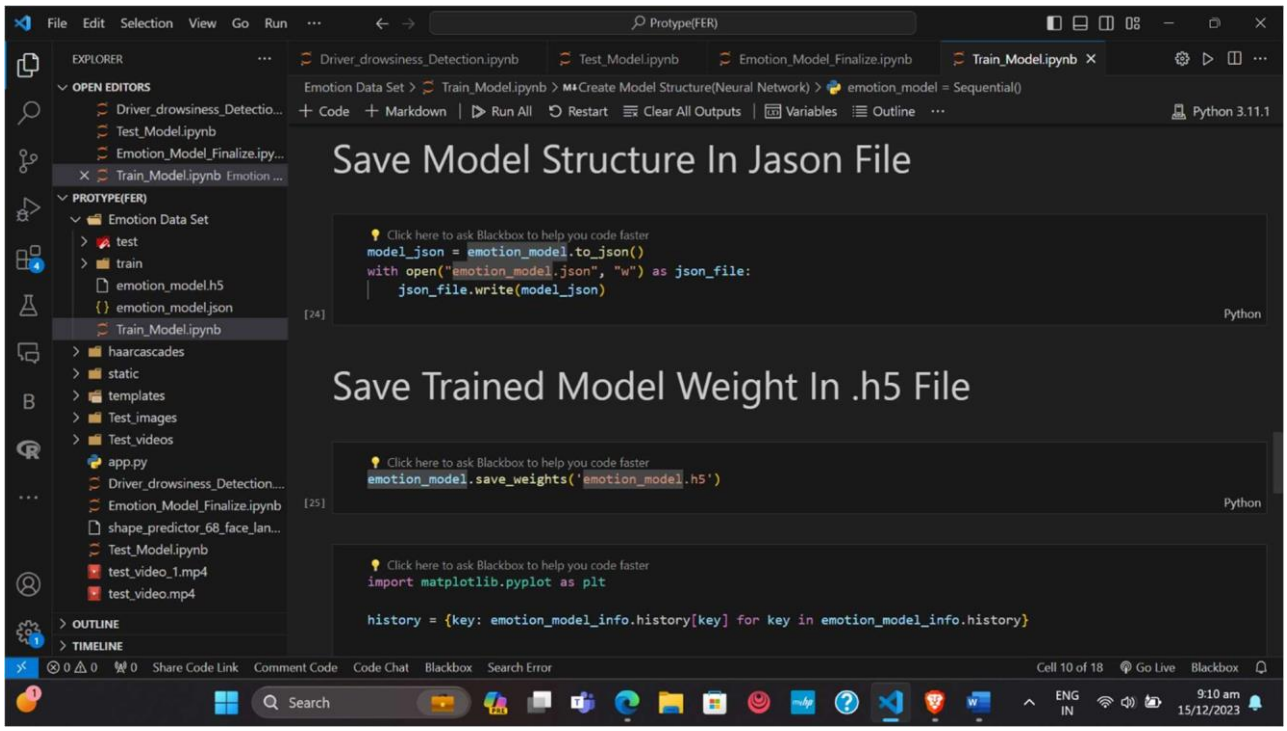
CODE


Import Required Packages
import cv2
from keras.models import Sequential
from keras.layers import Conv2D, MaxPooling2D, Dense, Dropout, Flatten
from keras.optimizers import Adam
from keras.preprocessing.image import ImageDataGenerator
import tensorflow as tf
Initialize Image Data Generator With Rescaling
train_data_gen = ImageDataGenerator(rescale=1./255)
validation_data_gen = ImageDataGenerator(rescale=1./255)

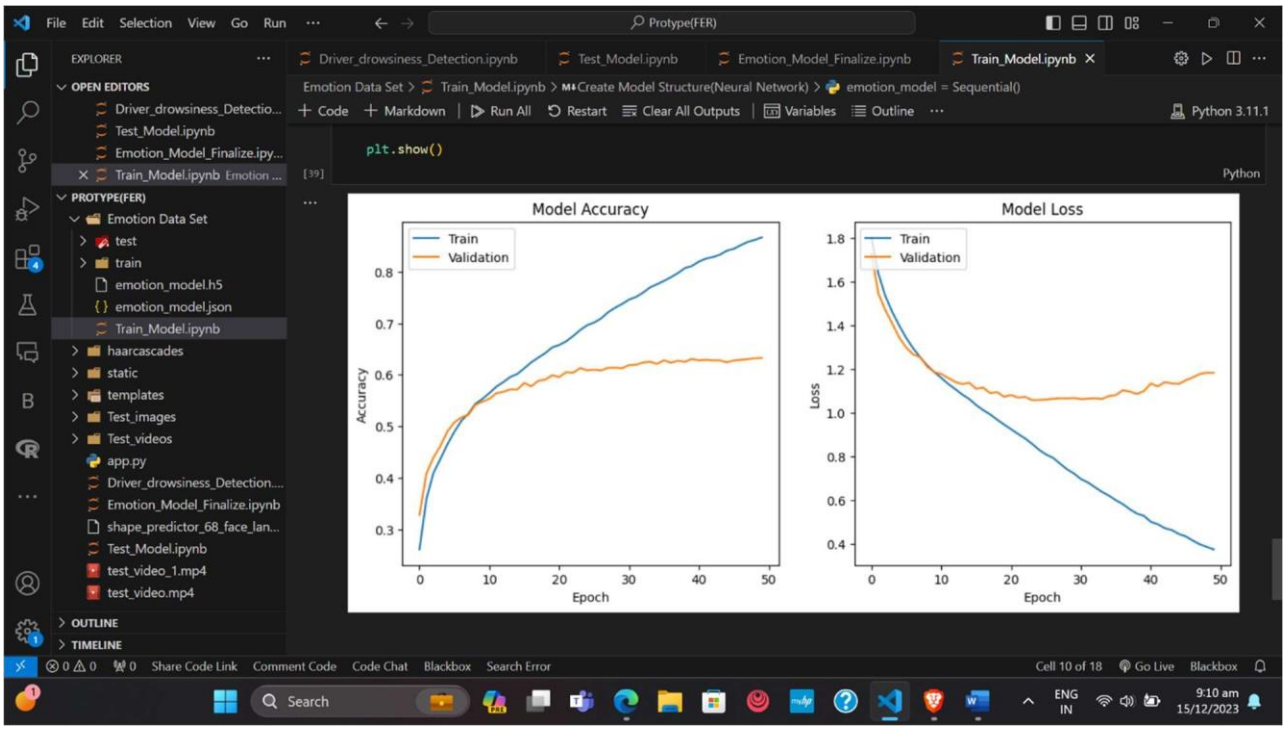

Create Model Structure(Neural Network)
emotion_model = Sequential()
emotion_model.add(Conv2D(32, kernel_size=(3, 3), activation='relu', input_shape=(48, 48, 1)))
emotion_model.add(Conv2D(64, kernel_size=(3, 3), activation='relu'))
emotion_model.add(MaxPooling2D(pool_size=(2, 2)))
emotion_model.add(Dropout(0.25))
emotion_model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
emotion_model.add(MaxPooling2D(pool_size=(2, 2)))
emotion_model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
emotion_model.add(MaxPooling2D(pool_size=(2, 2)))
emotion_model.add(Dropout(0.25))
emotion_model.add(Flatten())
emotion_model.add(Dense(1024, activation='relu'))
emotion_model.add(Dropout(0.5))
emotion_model.add(Dense(7, activation='softmax'))
cv2.ocl.setUseOpenCL(False)
emotion_model.compile(loss='categorical_crossentropy', optimizer=tf.keras.optimizers.legacy.Adam(learning_rate=0.0001

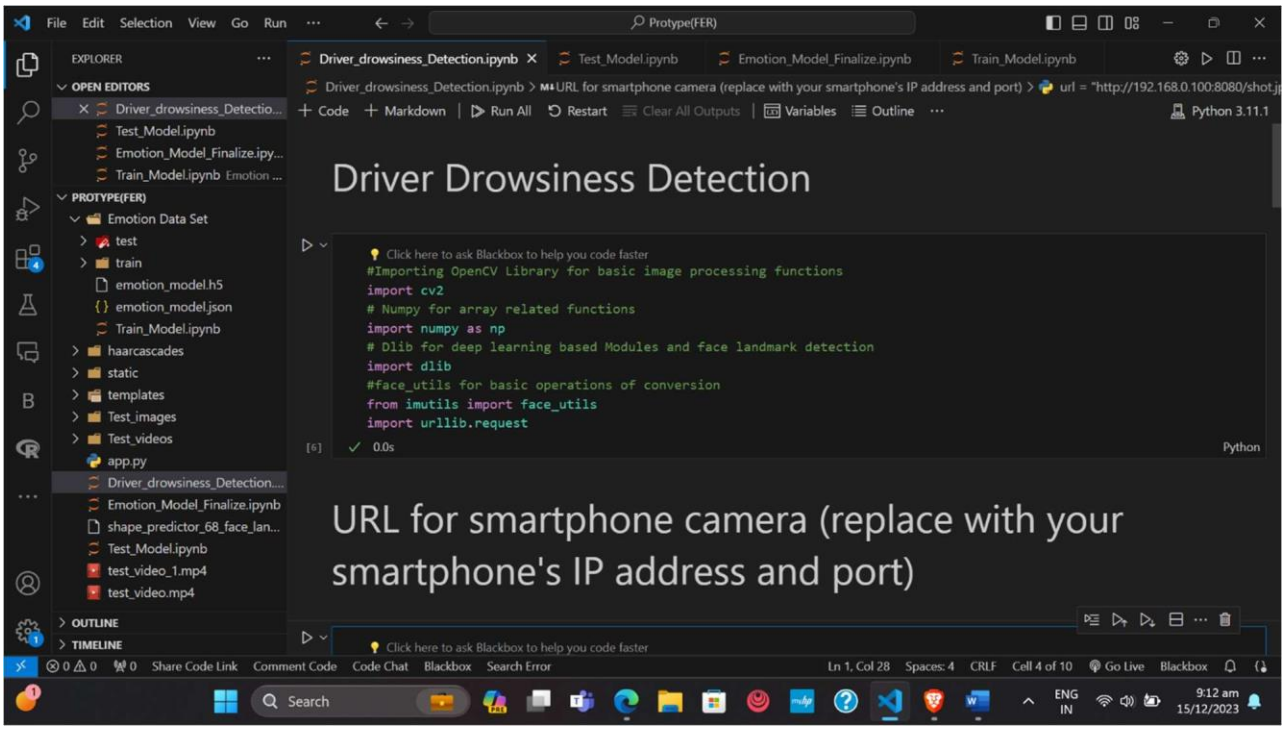
CODE


Train the neural network/model
emotion_model_info = emotion_model.fit_generator(
train_generator,
steps_per_epoch=28709 // 64,
epochs=50,
validation_data=validation_generator,
validation_steps=7178 // 64)
Epoch 1/50
448/448 [==============================] - 450s 1s/step - loss: 1.8026 - accuracy: 0.2611 - val_loss: 1.7298
Epoch 2/50
448/448 [==============================] - 233s 519ms/step - loss: 1.6367 - accuracy: 0.3594 - val_loss: 1.5456
Epoch 3/50
448/448 [==============================] - 268s 598ms/step - loss: 1.5340 - accuracy: 0.4095 - val_loss: 1.4698
Epoch 4/50
448/448 [==============================] - 255s 568ms/step - loss: 1.4602 - accuracy: 0.4368 - val_loss: 1.4071
Epoch 5/50
448/448 [==============================] - 227s 506ms/step - loss: 1.3982 - accuracy: 0.4650 - val_loss: 1.3436
Epoch 6/50
448/448 [==============================] - 221s 493ms/step - loss: 1.3416 - accuracy: 0.4896 - val_loss: 1.2978

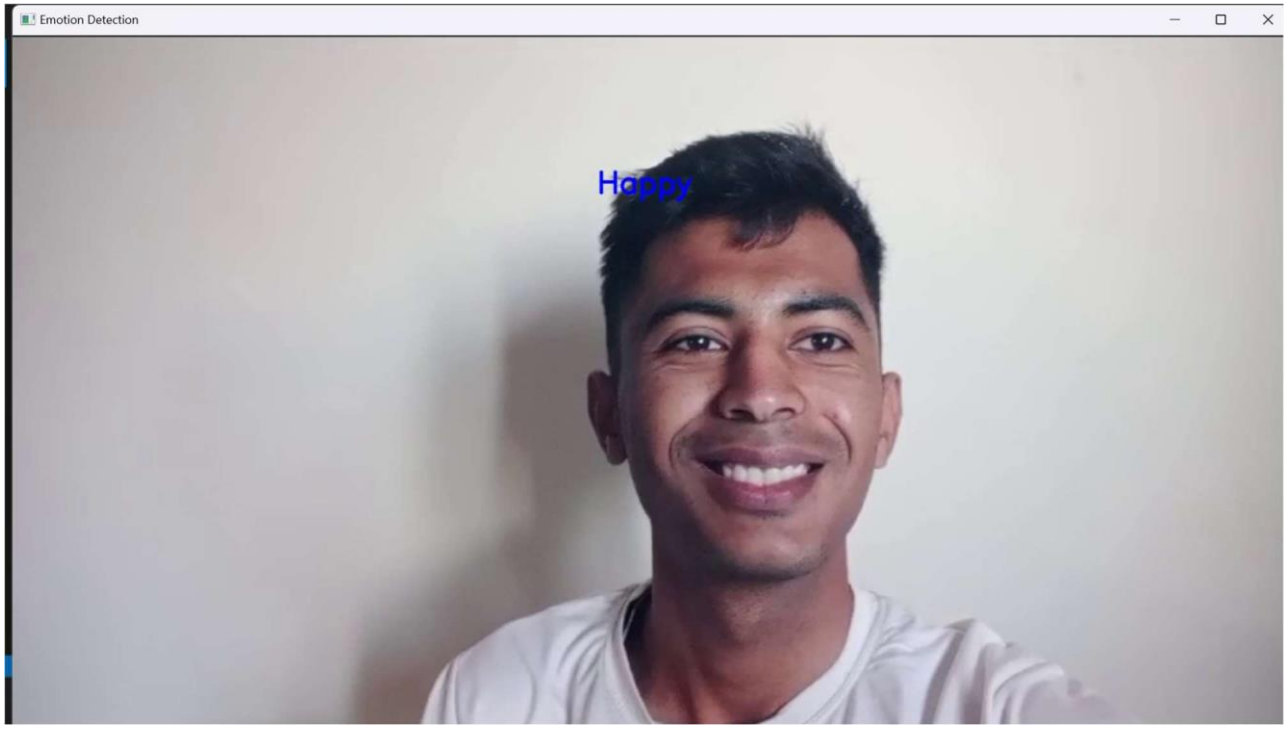

Save Model Structure In Jason File
model_json = emotion_model.to_json()
with open("emotion_model.json", "w") as json_file:
json_file.write(model_json)
Save Trained Model Weight In .h5 File
emotion_model.save_weights('emotion_model.h5')
import matplotlib.pyplot as plt
history = {key: emotion_model_info.history[key] for key in emotion_model_info.history}

CODE


Model Accuracy
Train
Validation
Accuracy
Epoch
Model Loss
Train
Validation
Loss
Epoch

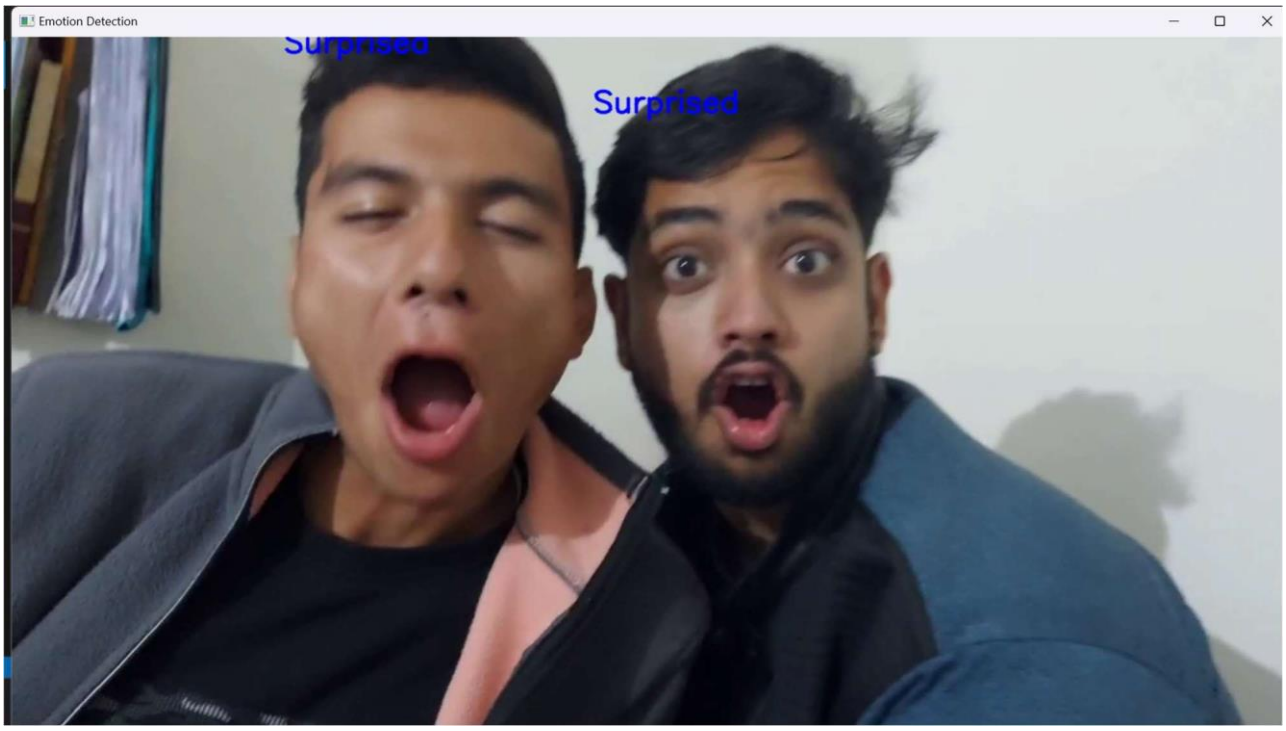

Driver Drowsiness Detection
#Importing OpenCV Library for basic image processing functions
import cv2
# Numpy for array related functions
import numpy as np
# Dlib for deep learning based Modules and face landmark detection
import dlib
#face_utils for basic operations of conversion
from imutils import face_utils
import urllib.request
URL for smartphone camera (replace with your smartphone's IP address and port)

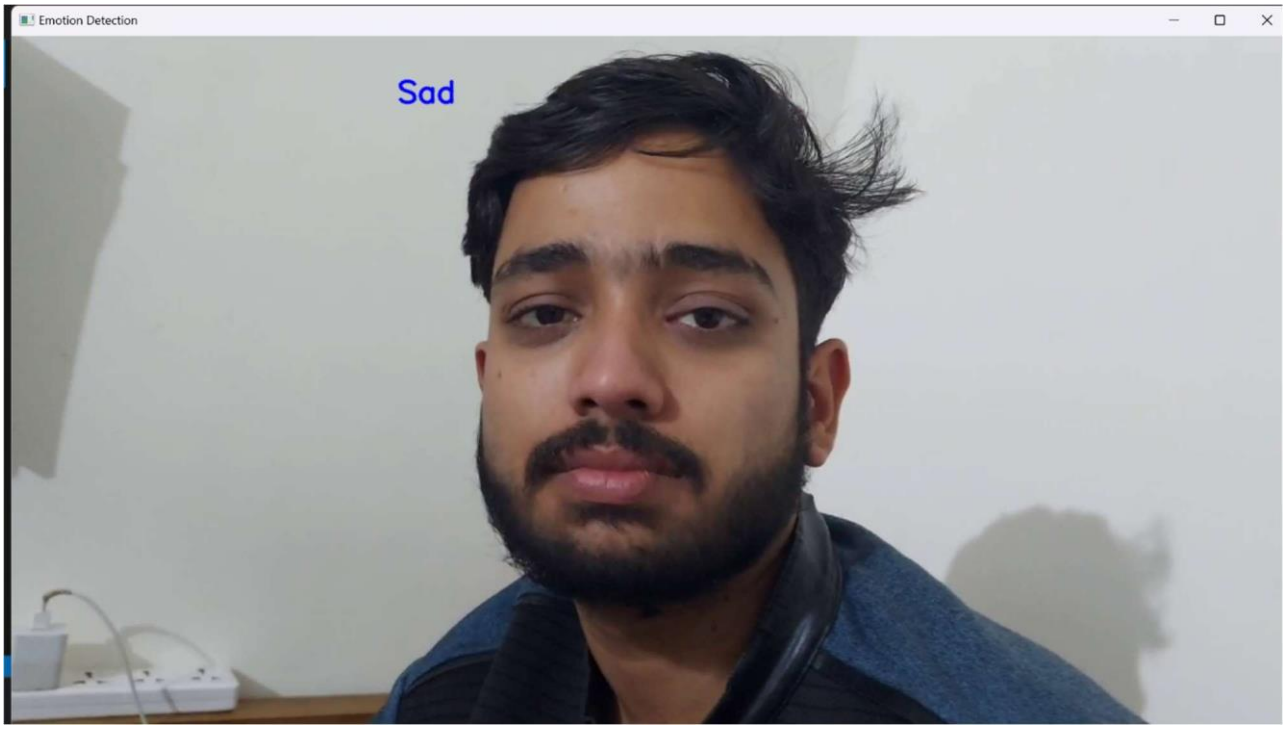
TESTING


Emotion Detection
Happy


Emotion Detection
Fearful
GATE 2022
COMPUTER SCIENCE & IT

TESTING


Emotion Detection
Surprised
Surprised


Emotion Detection
Sad

ENHANCEMENTS

Improving the accuracy of facial emotion detection, especially when the current accuracy is at 65%, involves considering various enhancements in both algorithmic approaches and dataset characteristics. Here are some strategies to enhance the accuracy of facial emotion detection:

1. Diverse and Representative Dataset:
- Ensure that the training dataset is diverse and representative of the population in terms of age, gender, ethnicity, and cultural backgrounds. This helps the model generalize better to a broader range of facial expressions.

2. Fine-Tuning and Transfer Learning:
- Implement fine-tuning or transfer learning techniques using pre-trained models on large image datasets. Leveraging the knowledge acquired from general image features can significantly boost the model's ability to extract relevant features for facial emotion detection.

3. Data Augmentation:
- Apply data augmentation techniques during training to artificially increase the size and diversity of the dataset. This can include random rotations, flips, and zooms, helping the model become more robust to variations in facial expressions.

4. Ensemble Learning:
- Explore ensemble learning methods by combining predictions from multiple models. This can enhance the overall accuracy and robustness of the system by leveraging diverse perspectives and mitigating individual model biases.

5. Attention Mechanisms:
- Implement attention mechanisms within the model architecture to focus on specific facial regions that are more indicative of emotional expressions. This allows the model to allocate more resources to relevant features during the learning process.

6. Temporal Information Incorporation:
- Consider incorporating temporal information by using video sequences instead of static images. Analyzing the temporal evolution of facial expressions over time can provide a more comprehensive understanding of emotions.

7. Hyperparameter Tuning:
- Systematically explore and optimize hyperparameters, including learning rates, batch sizes, and model architectures. Hyperparameter tuning can significantly impact the model's learning dynamics and overall performance.

8. Post-Processing Techniques:
- Implement post-processing techniques to refine predictions, such as filtering out improbable transitions between emotions over consecutive frames. This can improve the coherence and stability of the predicted emotional states.

9. User Feedback Loop:
- Implement a user feedback loop to continuously improve the model. Collect feedback on misclassifications and use this information to iteratively update and fine-tune the model.

10. Domain-Specific Training:
- If the application is domain-specific (e.g., healthcare or education), consider training the model on a dataset specifically curated for that domain. Domain-specific features and expressions may vary, and a specialized model could improve accuracy in those contexts.

Regular evaluation and adaptation of these strategies, combined with a thorough analysis of model misclassifications, can contribute to a substantial improvement in the accuracy of facial emotion detection systems.

FUTURE SCOPE

The future scope of facial emotion detection is promising and spans across various domains, driven by advancements in technology and increasing demands for emotionally aware systems. Here are key aspects of the future scope:

1. Advanced Algorithmic Approaches:

- Future research will likely focus on developing more sophisticated algorithms for facial emotion detection. Deep learning architectures, such as transformer-based models, and attention mechanisms will continue to evolve, potentially leading to enhanced accuracy and better handling of nuanced expressions.

2. Multimodal Emotion Recognition:

- The integration of multiple modalities, such as voice, text, and physiological signals, along with facial expressions, will be explored. Multimodal emotion recognition systems can offer a more holistic understanding of a person's emotional state, leading to more robust applications in human-computer interaction.

3. Real-Time and Edge Computing:

- There will be a growing emphasis on real-time facial emotion detection, especially in applications like virtual reality, augmented reality, and live video streaming. Edge computing solutions will become more prevalent, enabling on-device processing for quicker and more responsive emotion analysis.

4. Cross-Cultural and Cross-Demographic Adaptability:

- Future advancements will aim to improve the adaptability of facial emotion detection models across diverse cultural and demographic contexts. Training datasets will become more representative, ensuring that the models generalize well to a wide range of populations.

5. Ethical and Privacy Considerations:

- As facial emotion detection technology becomes more pervasive, there will be an increased focus on addressing ethical and privacy concerns. Stricter regulations and guidelines may emerge to govern the responsible use of this technology, particularly in areas like surveillance and data security.

6. Applications in Mental Health and Well-being:

- Facial emotion detection has the potential to play a significant role in mental health applications. Future developments may lead to tools and applications that assist in early detection of mental health conditions, provide emotional support, and contribute to personalized mental health care.

7. Human-Robot Interaction and Social Robotics:

- Facial emotion detection will continue to be crucial in the field of human-robot interaction, enabling robots to understand and respond to human emotions more effectively. Social robots equipped with advanced emotion recognition capabilities may find applications in education, healthcare, and companionship.

8. Education and Learning Enhancement:

- In educational settings, facial emotion detection can be leveraged to gauge student engagement, assess emotional responses during learning, and provide personalized educational interventions. This can contribute to creating more adaptive and effective learning environments.

9. Crisis Intervention and Public Safety:

- Facial emotion detection technology could be integrated into systems for early detection of distress or emergency situations. For instance, it may be employed in public spaces to identify individuals in need of assistance or intervention.

10. Augmented Reality (AR) and Virtual Reality (VR) Experiences:

- Facial emotion detection will enhance the immersive quality of AR and VR experiences by allowing virtual avatars or characters to respond dynamically to users' emotional states. This could find applications in gaming, training simulations, and virtual communication platforms.

The future of facial emotion detection holds exciting possibilities, with potential impacts on various aspects of daily life and technology-driven interactions. Ongoing research and development will play a crucial role in unlocking these potentials and addressing the evolving needs of diverse applications.

CONCLUSION

In conclusion, the evolving landscape of facial emotion detection presents a compelling trajectory for the integration of artificial intelligence into our daily lives. The journey from recognizing basic emotions to understanding nuanced expressions reflects the strides made in computer vision, machine learning, and affective computing. While the current accuracy stands at 65%, the future holds immense promise for refinement and expansion.

As we peer into the future, advanced algorithmic approaches, multimodal integration, and real-time processing will likely shape the next generation of facial emotion detection systems. The ethical dimensions of privacy and responsible use will become paramount considerations, guiding the development and deployment of this technology.

Beyond the realms of human-computer interaction, applications in mental health diagnostics, education, crisis intervention, and augmented reality underscore the transformative potential of facial emotion detection. The collaboration of this technology with emerging fields like social robotics and edge computing heralds a future where machines not only perceive but also respond with an unprecedented level of emotional intelligence.

However, as we anticipate these advancements, it is crucial to navigate the ethical considerations surrounding privacy, consent, and the potential biases embedded in facial emotion detection systems. Responsible innovation and a commitment to addressing these concerns will be essential in fostering widespread acceptance and ensuring the positive impact of this technology on society.

In essence, the journey of facial emotion detection is not merely about decoding expressions; it is about crafting a future where technology harmoniously integrates with human emotion, enriching our interactions, promoting well-being, and contributing to a more empathetic and connected world. The continued collaboration between researchers, developers, and ethical practitioners will be instrumental in shaping this future and unlocking the full spectrum of possibilities embedded in the nuanced language of human emotions.

REFERENCES

DATASET :

https://www.kaggle.com/datasets/rkuo2000/fer2013

HAARCASCADE :

https://docs.opencv.org/4.x/db/d28/tutorial_cascade_classifier.html

CNN ARCHITECTURE :

https://medium.com/@draj0718/convolutional-neural-networks-cnn-architectures-explained-716fb197b243

BOOK :

Deep Learning / by Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra & Amlan Chakrabarti.

By: Das, Amit Kumar [author].

Contributor(s): Goswami, Saptarsi [author] | Mitra, Pabitra [author] | Chakrabarti, Amlan [author].

Publisher: Noida. Pearson: 2021Description: 524p.: ill., photographs; 21cm.ISBN: 9789354493874.Subject(s): Artificial Intelligence