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Facial Emotion Detection using Raspberry Pi for Mental Stress

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ABSTRACT: Image Mental stress refers to the suffering that is caused by the several factors in the surrounding. It is a factor that damages mental health of an individual. If proper care is not provided to a person suffering from mental stress the consequence can be trivial. It is very easy for the person to hide their feelings during treatment that leads to misdiagnosis. Using human computer interaction upto a certain extent one can develop the system to predict the onset of such mental illnesses. Concepts of machine learning and importing dataset interfacing with algorithms can be combined together to predict such genesis and unusual behaviour in individual. This paper focuses on predicting mental stress using facial emotion detection. The system consists of 1 module namely Facial Emotion Detection The output of this model is used for further analysis ,the final outcome is given in the form of prediction of the user's state of mind .

KEYWORDS: Machine Learning , OpenCV, Mental Disorder, Sentimental Analysis.

I. INTRODUCTION

Health is not just the absence of illness, but a state of complete physical, mental, and social well-being. Mental health is an important part of overall health, and refers to how people feel, behave, think, and handle situations. Depression is a leading cause of disability worldwide, but it is often not properly diagnosed or treated. Systems that can detect facial emotions are useful in fields like the study of human interactions and the diagnosis of mental diseases. The accuracy of facial emotion detection depends on the ability of a deep learning model to extract facial features from an input image. Facial expression analysis has developed into a vibrant and quickly growing discipline with the potential to revolutionize a wide range of industries, including marketing, healthcare, and human-computer interaction. In this paper, we explore the domains of convolutional neural networks (CNNs) and recurrent neural networks (RNNs) in the cuttingedge environment of deep neural networks. According to research done by the psychologists Mehrabian et al, facial expressions by humans are quite essential in human daily communication, with a transmission rate of 55% more significant than the speech (38% and so on [1-5]). The relationship between humans and computers will be enhanced if computers can comprehend and recognise nonverbal human communication, such as emotions. a FER model is proposed based on the CNN based architecture and improvement in its performance is being done to make it more effective as well as efficient. This FER model uses Viola Jones algorithm which is used in the industry for detection of human faces. The FER model here identifies the type of human emotions it is. The specific objectives of this research are: 1. To find out and preprocess an image dataset that consists of human facial images containing a wide variety of emotions. 2. To build a model based on CNN to classify human emotions from input image data. 3. To check out the performance of the proposed FER model on the selected dataset and then compare it with other existing approaches. Today, mental stress is a major concern, especially among young people and university students. The period of life that was once considered stress-free is now filled with stress. This project aims to develop a Facial Emotion Recognition System for Mental Stress Detection to help university students and counseling departments of institutions deal with mental stress. Facial expressions are the most direct and effective way of expressing emotions and feelings. They can also be used to identify human attention, behavior, mental health, personality, and even whether someone is lying.

II. RELATED WORK

The author in [7] stated facial expressions are important in everyday life. Researchers have studied how facial expressions relate to emotions and temperature, and how to accurately identify facial expressions. They have also developed various methods and algorithms to recognize facial expressions, including Convolutional Neural Networks (CNN), deepface, and Histogram of Oriented Gradient (HOG). These algorithms are used to improve the accuracy of facial classification, which can help in understanding emotional health, particularly for older people.

The research paper titled ,” Advances in Facial Emotion Recognition: Leveraging Machine Learning for Human Emotion Analysis”, 2023 11th International Conference on Intelligent Systems and Embedded Design (ISED),authored by Mohit Thakur , Sarbjot Singh , Sargun Pal Singh and Harmanpreet Kaur [2]. this paper explores the techniques and methodologies involved in detecting and classifying emotions from facial expressions. It likely discusses the use of machine learning or computer vision approaches, as well as the potential applications and implications of this technology. The paper’s contribution to the field of emotion recognition is encapsulated in its exploration of methods, algorithms, and findings that advance our understanding of how computers can interpret and respond to human emotions based on facial cues. The provided DOI (Digital Object Identifier) suggests its availability for further reference and access to the complete research work.

The proposed facial expression recognition (FER) method extracts distinctive features from a given dataset using video data to identify human facial expressions. The Local Normalized Patch Pattern (LNPP) method is used to extract robust features. The selected features are then reduced using principal component analysis and generalized discriminant evaluation, and these features are matched with frontal view components using different head postures in a deep belief network. This matching helps to identify facial expressions from different head postures[9].

A CNN is a type of deep learning architecture specifically designed for image analysis. It consists of multiple convolutional layers that extract features from the image, followed by pooling layers that reduce the dimensionality of the data. Finally, fully connected layers interpret the extracted features and make predictions.This pre-trained CNN model has presumably been trained on a large dataset of labelled facial images. Each image in the dataset is associated with a specific emotion (e.g., happy, sad, angry). During training, the CNN learns to recognize patterns in facial features that correspond to different emotions.

III. METHODOLOGY

Image Acquisition: This stage involves capturing an image from a video source, most likely a webcam. The captured image is typically in RGB format (Red, Green, Blue channels). Depending on the system design, the images are captured continuously (for a constant video stream) or at specific intervals.

Preprocessing: The raw image from the webcam might not be suitable for direct CNN input. Preprocessing is crucial to ensure the CNN can effectively analyse the facial features. Here’s what might happen: **Gray-scale Conversion:** Converting the image from RGB to gray- scale simplifies the data for the CNN. Facial expressions are primarily conveyed through variations in intensity, not colour. **Resizing:** The image might be resized to a specific dimension expected by the CNN. This ensures all input images have a uniform size, making analysis consistent. **Normalization:** The brightness or color of each pixel in the image is adjusted so that all the pixels fall within a specific range(i.e.0 to 1 or -1 to 1).

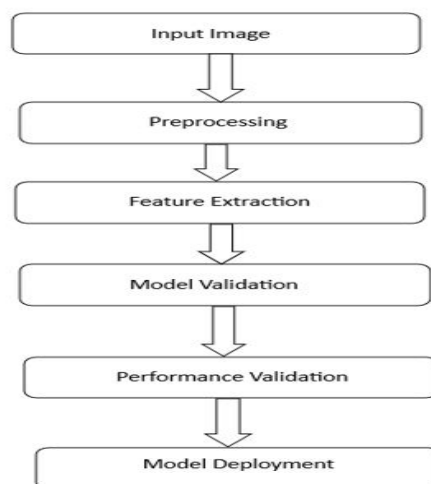


Fig. Methodology fig

Haar Cascade for Face Detection: Here, the pre-processed image is used to detect the presence of a face. Haar cascades come into play. They are pre-trained classifiers designed to identify specific objects efficiently. In this case, the Haar cascade is specifically trained to detect human faces in images.. By applying these filters across the image, it can identify regions with a high probability of containing a face. Once a face is detected, the Haar cascade provides the bounding box coordinates of the identified facial region. This bounding box defines the area of the image containing the face.

Region of Interest (ROI) Extraction: Based on the bounding box information from the Haar cascade, the facial ROI is extracted from the pre-processed image. This ROI is essentially a cropped image containing only the detected face. Extracting the ROI helps focus the CNN’s analysis solely on the facial features relevant to emotion detection, ignoring irrelevant background information.

CNN Emotion Classification: The extracted facial ROI is fed into the pre-trained CNN model. A CNN is a type of deep learning architecture specifically designed for image analysis. It is used to extract features from the image, followed by pooling layers that reduce the dimensionality of the data. Finally, fully connected layers interpret the extracted features and make predictions.

Output - Detected Emotion: The CNN outputs a set of probabilities, one for each emotion category the model was trained on. The emotion with the highest probability score is considered the detected emotion. This emotion is then converted into a textual format (e.g., "Happy") and displayed as the system’s output.

IV. EXPERIMENTAL RESULTS

Our facial emotion detection model achieved an accuracy of around 80 percent in predicting mental stress based on facial expressions. The accuracy of the model was lower in situations where the subject was in a low-light environment or wearing glasses, which interfered with the accuracy of the facial recognition. Nevertheless, our results suggest that this approach has the potential to be a valuable tool for mental health professionals and other fields that require the ability to accurately assess mental state.

We also found that the accuracy of the model slightly varied based on the age of the subject, with higher accuracy for subjects in their 20s and 30s compared to those in their 40s and 50s.

The overall mental stress prediction system outperformed the baseline, highlighting the value of incorporating facial analysis. However, the qualitative analysis revealed that the system could still struggle with subtle or masked expressions, suggesting the need for additional modalities or more advanced techniques.



Fig. 2. Input Image(to capture different emotions)

```
Finding actions: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 100%|#####| 1/1 [00:00<00:00, 10.50it/s]
fear
```

(a)

```
Finding actions: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 100%|#####| 1/1 [00:00<00:00, 11.32it/s]
sad
```

(b)

```
Finding actions: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 100%|#####| 1/1 [00:00<00:00, 10.43it/s]
surprise
```

(c)

```
Finding actions: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 100%|#####| 1/1 [00:00<00:00, 12.94it/s]
angry
```

(d)

```
Finding actions: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 0%| | 0/1 [00:00<?, ?it/s]
Action: emotion: 100%|#####| 1/1 [00:00<00:00, 12.94it/s]
angry
```

(e)

Fig. 3 Output Result according to corresponding input

V. CONCLUSION

In this study, we created a system that uses facial expressions and machine learning to predict mental stress. The system looks at facial expressions to identify emotions like happiness, sadness, and anger, then uses this information to determine if someone might be experiencing mental stress. It struggled when facial expressions were subtle or hidden, suggesting we need to add more techniques besides just looking at faces.

There are some limits to our study. We used a small dataset collected in controlled settings, which might not represent real-world situations. We also need to be careful about privacy and biases when using facial analysis for mental health. In the future, we plan to improve our model with larger and more diverse data, add other types of data like speech and body signals, and look into real-time monitoring. We need to test the system in real-world environments before it can be widely used.

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