A review on detection of stress from facial parameters using Machine Learning Techniques

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Abstract: Mental stress is a psychological condition that affects all aspects of life, including sleep. Individuals experience daily mental strain as a result of various factors, including social situations. The sources of stress can include financial constraints, familial and social worries, unfavourable environmental conditions such as inclement weather, heavy traffic, or excessive noise, as well as challenging situations like delivering a presentation to a large audience or organizing a wedding. An optimal level of stress is beneficial for an individual's well-being and can serve as a motivator. However, an excessive amount of stress or an intense response to stress might pose potential risks to one's health. Consequently, the identification and anticipation of mental stress has gained significant attention in the community. This research examines and evaluates different techniques for detecting stress using machine learning technologies.

Key terms: Mental stress, Hazardous, Machine learning, Stress detection, Anticipating mental stress

I. INTRODUCTION

Stress is a pervasive problem in contemporary culture, impacting individuals' psychological well-being and entire state of being. Prompt identification and efficient handling of stress are essential for fostering healthy lives and averting enduring adverse outcomes. Recent breakthroughs in computer vision and machine learning have expanded the potential for stress recognition through the analysis of facial landmarks. In addition, offering individualized advice for stress management programs can provide individuals with practical techniques to properly cope with stress. This research presents the notion of stress identification by facial landmarks and explores the importance of tailored program suggestions.

- Facial Landmark-based Stress Recognition

Facial expressions serve as potent indicators of emotional states, encompassing tension. Facial landmarks are precise locations on the face that indicate the exact location of features like the eyes, nose, mouth, and eyebrows. Computer vision techniques may be used to extract these landmarks, which can then be used as valuable indications for identifying stress. Machine learning models can be trained to reliably classify stress levels by examining the spatial and geometric information obtained from face landmarks. This strategy provides a non-invasive and unbiased tool for evaluating stress levels, allowing for prompt interventions and assistance.

- Importance of Personalized Program Recommendations

Identifying stress levels is merely the initial phase in achieving efficient stress management. People have varying responses to stress, and using a single strategy for everyone may not be the best option. Customized suggestions for stress management programs might offer personalized tactics depending on an individual's distinct requirements, inclinations, and situations. These recommendations may include various therapies such as relaxation techniques, mindfulness exercises, physical activities, therapy sessions, or involvement in hobbies and social contacts. By specifically targeting stress at the individual level, these programs have the capacity to improve overall well-being and resilience.

- Technological and data collection progress

The accuracy and efficiency of stress recognition using facial landmarks have been greatly enhanced by recent breakthroughs in computer vision and machine learning. Facial landmark detection has demonstrated promising outcomes through the utilization of deep learning methods, specifically convolutional neural networks (CNNs). Moreover, the presence of extensive annotated datasets comprising a wide range of facial expressions and stress levels has greatly improved the training and assessment of stress identification algorithms. These advancements have created opportunities for the development of stress

recognition systems that are more dependable and resilient.

II. LITERATURE SURVEY

Paul1 et. al. states that Mental stress is a major issue nowadays, especially among youngsters. The age that was considered once most carefree is now under a large amount of stress. Today's increased stress causes a variety of issues, including depression, suicide, heart attacks, and stroke. Our goal is to examine stress in college students at
various stages of their life. Some of the factors that effect on the students which often goes unnoticed. We will perform an analysis on how these factors affect the mind of a student and will also correlate this stress with the time spent on the internet. In this model the main goal is to use machine learning algorithms to estimate the levels of stress. Data is collected from Vimala College (Autonomous), Thrissur students through surveys in online mode and it consisted of 954 student's data. Our model is a classification type in supervised ML. There are 3 classes a)chronic b) episodic c)acute. Our objective is to detect the different level of stress in students. We were asked basic questions about their feelings in situations and analyze their answers using Machine Learning techniques and make predictions. [1]

Baravkar et. al. states that Stress recognition is a vital aspect of mental health monitoring and support systems. In recent years, there has been a growing interest in leveraging facial expressions and landmarks for automatic stress detection. This study proposes a novel approach for stress recognition using facial landmarks. The method involves extracting facial landmarks using computer vision techniques and employing machine learning algorithms to classify stress levels based on these landmarks. First, the facial landmarks are detected and localized using advanced deep-learning models. Next, a set of features is extracted from these landmarks, capturing the spatial and geometric information of key facial regions. These features are then fed into a classifier, such as a support vector machine (SVM) or a convolutional neural network (CNN), which is trained on a labeled dataset of stressed and non-stressed individuals. To evaluate the proposed method, a comprehensive dataset of facial images from individuals under various stress levels is collected and annotated with stress labels. The performance of the stress recognition system is assessed using metrics such as accuracy, precision, recall, and F1 score. The experimental results demonstrate the effectiveness of the proposed approach, achieving high accuracy in stress detection. Furthermore, based on the stress recognition results, personalized recommendations for stress management programs can be generated. By analyzing the stress levels and patterns over time, the system can provide tailored suggestions for stress reduction techniques, relaxation exercises, mindfulness programs, or therapy sessions. These recommendations aim to assist individuals in managing their stress levels and improving their overall well-being. [2]

Gambhir et. al. states that identifying facial expressions that indicate a user's sentiment to specify if the user have any type of stress or enjoyment. Human Beings express their feelings through their emotions. Sometimes it is more convenient for humans to express their feelings through expression rather than words. This can be in the form of smiling or disgusting face and many more. This will help us in various fields, like in customer service applications to detect customer emotions and respond accordingly. It can also be used in hospitals to detect pain in patients who cannot communicate verbally. It can also be used in detection of user's stress in social media platform. It can be used in virtual reality where animated characters can mimic the actual facial expressions. In this project we used deep learning algorithm for distinguishing facial expression. The aim of this model is to evaluate previously stored image in memory or from the current feed given by the system's camera to anticipate a person's facial expression. [3]

III. EXISTING SYSTEM

The existing educational structure, combined with intense competition, contributes to heightened levels of anxiety and stress among pupils. Additional factors that contribute to the mental difference among students include parental pressure, peer pressure, health concerns, and financial conditions. The corona virus epidemic has had an additional effect, disrupted the routine of students' lives and subjected them to increased pressure, ultimately resulting in poor performance. The level of automation for predicting student stress in institutes and educational organizations has been extremely limited. Examining

every kid and their individual profile is a huge undertaking. This obligation falls within the realm of human interaction, which is why our work facilitates the automatic prediction of stress levels in each student based on multiple parameters and provides appropriate solutions for each student. Machine learning and data science techniques are utilized to accomplish this task. Regularly monitoring and managing the stress levels of individual students can significantly enhance their performance within an organization. Stress is the physiological response of the body to the demands and challenges posed by a specific scenario or event. It can manifest as a bodily, mental, or emotional response. Job loss, a family member falling ill, or financial difficulties are among the typical catalysts. When a human encounters stress, their body undergoes a physiological and psychological reaction. This is due to the inherent capacity of the body to perceive and respond to stress. Any stress responses facilitate adaptation to a new environment. Positively, it can enhance our vigilance, drive, and preparedness to evade potential harm. However, it is crucial to understand that stress becomes problematic when stressors persist without any respite or intervals of rest. Acute stress is the physiological reaction of your body to a new or challenging environment. It is the feeling you have when a deadline is approaching or when you narrowly avoid being hit by a car. We may also come across it as a consequence of a pleasurable endeavour. Similar to the exhilarating experience of riding a roller coaster or the extraordinary achievement of a particular goal. Short-term stress is classified as acute stress. The body and emotions generally revert to their natural state within a few duration. Episodic Acute Stress refers to the persistent experience of acute tensions. The reason for this can be attributed to consistently stringent job deadlines. It could also be attributed to the frequent high-stress circumstances that certain occupations, such as healthcare, encounter. The user's text is enclosed in tags. When we experience this level of stress, we are unable to quickly regain a condition of calm and relaxation. Moreover, the consequences of recurring, sudden shocks build up. Consequently, we often perceive ourselves as facing a continuous round of crises. Chronic stress refers to the prolonged exposure to stressors, which persist over a protracted period of time. Residing in a community characterized by a significant incidence of criminal activities serves as an illustration, just as engaging in frequent disputes with your life partner does. This type of stress appears to be perpetual. Often, we find it challenging to identify any means to modify or improve the situation that is the cause of our persistent concern.

IV. TYPES OF STRESS

A. Parameters for Analysing stress through face

Stress is a widespread problem in contemporary culture, impacting individuals' psychological well-being and entire state of being. Prompt identification and efficient handling of stress are essential for fostering healthy lives and averting enduring adverse outcomes. Recent breakthroughs in computer vision and machine learning have expanded the potential for stress recognition through the analysis of facial landmarks. In addition, offering individualized advice for stress management programs can provide individuals with practical techniques to properly cope with stress. This research presents the notion of stress detection through facial landmarks and examines the importance of tailored program suggestions.

- Facial Landmark-based Stress Recognition:

Facial expressions serve as potent indicators of emotional states, encompassing tension as well. Facial landmarks are precise locations on the face that indicate the exact location of features like the eyes, nose, mouth, and eyebrows. Computer vision techniques may be used to extract these landmarks, which can then be used as valuable indications for identifying stress. Machine learning models can be trained to reliably classify stress levels by examining the spatial and geometric information obtained from face landmarks. This strategy provides a non-invasive and unbiased technique for evaluating stress levels, allowing for prompt interventions and assistance.

- Importance of Personalized Program Recommendations:

Identifying stress levels is merely the initial stage in achieving efficient stress management. People have varying responses to stress, and using a standardized strategy may not be the most effective. Customized suggestions for stress management programs might offer personalized tactics depending on an individual's distinct requirements, inclinations, and situations. These recommendations may include many therapies, such as relaxation techniques, mindfulness exercises, physical activities, therapy sessions, or participation in

hobbies and social contacts. By targeting stress at an individual level, these programs have the capacity to improve overall well-being and resilience.

- Data Collection and Preprocessing:

In order to create a precise stress identification system that utilizes facial landmarks, a comprehensive and inclusive collection of facial photos is gathered. The collection should consist of individuals displaying a range of stress levels, recorded under diverse lighting situations, angles, and backgrounds. Subsequently, the gathered photos undergo preprocessing to standardize lighting conditions, adjust image size, and align the facial features.

- Facial Landmark Detection:

Facial landmark detection is an essential process in identifying and analyzing stress levels. Precision in detecting and locating facial landmarks is achieved by the utilization of advanced computer vision techniques, including deep learning-based models like facial landmark localization networks. These landmarks consist of specific locations on the eyes, eyebrows, nose, mouth, and other areas of the face.

- Feature Extraction:

The spatial and geometric aspects associated with stress are captured by extracting a collection of relevant features from the observed face landmarks. These features may encompass measurements of the distances between prominent points, the angles formed by different facial regions, and the differences in facial shape. In addition, elements related to appearance, such as texture, can be obtained from the areas surrounding the landmarks.

- Machine Learning Models:

Machine learning models are trained to categorize stress levels by utilizing extracted i6nformation. The CNN (Convolutional Neural Network) model can be used to classify stress. The dataset is partitioned into training and testing sets, and the models are trained using labeled instances of stressed and non-stressed facial photos. The performance of the model is assessed using suitable assessment metrics, including accuracy, precision, recall, and F1 score.

- Stress Recognition and Validation:

The model that has been trained is subsequently employed to identify stress levels in facial photographs captured in real-time. The input photos are analyzed to identify facial landmarks, and a trained model uses these landmarks to forecast the stress level based on the extracted features. The efficacy of the stress identification system is verified by comparing its predictions with the ground truth labels obtained from a separate test set. Supplementary examinations, such as a confusion matrix and receiver operating characteristic (ROC) curve, might offer valuable information regarding the precision and effectiveness of the system.

B. Detection methods of stress level

Stress levels can be identified by considering following factors:

- Customized Program Recommendations:

Tailored program recommendations are developed based on the identified stress levels to aid individuals in effectively managing their stress. These tips can be obtained from a database of stress management approaches and interventions. The stress level, in addition to other contextual factors such as age, gender, and lifestyle, is taken into account in order to customize recommendations according to individuals' personal requirements. The suggested programs may encompass relaxation exercises, mindfulness techniques, physical activities, counselling services, or self-help tools.

- Assessment of Program Efficacy:

The efficacy of the suggested stress management programs is evaluated by user feedback, surveys, or longitudinal research. An assessment is conducted to evaluate the effects of the programs on the reduction of stress, improvement of well-being, and enhancement of general mental health in individuals. Feedback mechanisms and data gathering tools can be integrated into the stress recognition system to collect user experiences and assess the efficacy of the program.

- Iterative Refinement:

The stress recognition system and individualized program recommendations undergo ongoing improvement through the incorporation of user feedback and insights obtained from program assessments.

Additional data can be used to retrain the models, resulting in improved accuracy and generalization. The stress management programs can be enhanced with the integration of novel treatments and approaches derived from cutting-edge research in the field.

V. PROPOSED SYSTEM

Proposed system for stress detection can be achieved by following the proposed steps:
Step 1: Data Collection (Facial Images/Videos)
Gather Dataset with Annotated Stress Levels

Step 2: Data Preprocessing
Normalize and Standardize Facial Images/Videos
Convert to Model-Readable Format (e.g., Grayscale, RGB)
Facial Feature Extraction
Detect Facial Landmarks (e.g., Eyes, Nose, Mouth)
Calculate Relevant Features (Distances, Movements, Texture)
Model Selection and Training
Choose ML Model (e.g., CNN)

Step 3: Split Data into Training and Testing Sets
Train Model on Facial Features

Step 4: Model Evaluation
Evaluate Model Performance (Accuracy, Precision, Recall)
Use Cross-Validation for Robustness
Real-time Stress Prediction

Step 5: Deploy Model for Real-time Facial Analysis
Extract Facial Features from Live Data Streams
Feed Features into Model for Inference

Step 6: User Interface and Feedback
Develop User Interface for Facial Data Capture
Display Real-time Stress Levels/Emotional States
Provide Personalized Feedback/Recommendations

Step 7: Integration and Deployment
Integrate with Devices (Webcams, Smartphones)
Deploy in Controlled Environment

Step 8: Gather User Feedback for Optimization

VI. FLOWCHART

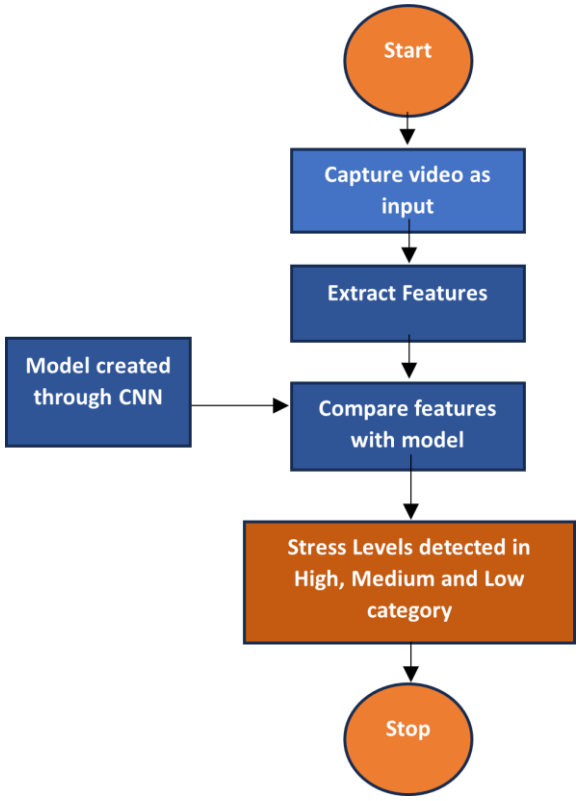

Fig. 1 Flow diagram of the proposed concept

VII. CONCLUSION

The Image Processing process is employed to obtain an enhanced image and extract valuable data. It is an efficient method for converting a photograph into a digital format and subsequently carrying out diverse operations on it. This is a signal processing technique where the input is a two-dimensional image with pixel values ranging from 0 to 255, representing the intensity of each pixel. Preprocessing is a crucial stage that involves several techniques like as resizing and cropping images to save training time, and introducing pixel changes to enhance visual variety and prevent overfitting. Pictures were taken in OpenCV either from a live feed or from previously stored data. The photographs are subsequently converted into grayscale images with dimensions of 48x48 pixels. The grayscale image is subsequently compared to the trained model.

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