ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double-Blind Peer-Reviewed, Open-Access, Multidisciplinary Online Journal

Volume 3 | Issue 3 | June 2024

www.ijirid.in

A Framework 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 have gained significant attention in the community. This research examines and evaluates different techniques for detecting stress using machine learning technologies.*

Keywords: *Mental Stress, Hazardous, Machine Learning, Stress Detection, Anticipating Mental Stress*, etc.

I. INTRODUCTION

Stress is a pervasive problem in contemporary culture, impacting individuals' psychological well-being and the entire state of being. Prompt identification and efficient handling of stress is 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. [4]

- **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.

 DOI: 10.5281/zenodo.11255715

ISSN (Online): 2583-648X

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- **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 an 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. [6]

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 affect the students often go unnoticed. We will perform an analysis of 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 the Vimala College (Autonomous), Thrissur students through the surveys in online mode which consist data for of 954 student 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 levels of stress in students. We were asked basic questions about their feelings in situations and analysed their answers using Machine Learning techniques to 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

ISSN (Online): 2583-648X

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Volume 3 | Issue 3 | June 2024

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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 labelled 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 has 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 faces 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 a deep learning algorithm for distinguishing facial expressions. This model aims to evaluate previously stored images 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 differences among students include parental pressure, peer pressure, health concerns, and financial conditions. The coronavirus epidemic has had an additional effect, disrupting the routine of students' lives and subjecting 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 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.

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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. [7] 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 durations.[8] 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 prolonged exposure to stressors, which persist over a protracted period. 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. [9]

IV. OBJECTIVES

- To predict stress in a person by the symptoms calculated by monitoring.
- To analyze the stress levels of a human being.
- To identify the facial points which help to detect stress
- To implement the live feeding system for detection

V. TYPES OF STRESS

Stress is a widespread problem in contemporary culture, impacting individuals' psychological well-being and the entire state of being. Prompt identification and efficient handling of stress is 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. The primary categories of stress encompass:

- **Acute Stress:**
  Acute stress refers to immediate and brief stress reactions that are prompted by specific events or circumstances. Typical situations that provoke acute stress include giving speeches in front of

ISSN (Online): 2583-648X

IJIRID

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an audience, taking tests, or facing unexpected difficulties in the workplace or at home. Acute stress is a common occurrence and can even serve as a source of motivation. However, if one is continuously exposed to acute stressors without possessing good coping mechanisms, it can result in adverse health consequences.

- **Chronic Stress:**
  It refers to a state of ongoing, long-lasting stress that arises from continuous challenges, demands, and adversities in one's life. Typical causes of long-term stress include financial difficulties, discontent with one's career, troubles in relationships, or ongoing health ailments. Persistent stress can have harmful consequences on both physical and emotional well-being, elevating the likelihood of developing cardiovascular disease, depression, anxiety, and impaired immune system functioning.

- **Eustress:**
  It refers to a type of stress that is advantageous and constructive, as it serves to inspire and invigorate individuals in their pursuit of objectives, participation in demanding tasks, and adjustment to novel encounters. While distress is detrimental, eustress is linked to emotions of exhilaration, expectation, and satisfaction. Illustrations encompass commencing a fresh occupation, organizing a wedding ceremony, and getting ready for a contest. Eustress can bolster resilience, foster personal development, and contribute to overall well-being.

VI. METHODOLOGY

This research presents the notion of stress detection through facial landmarks and examines the importance of tailored program suggestions. [10][11]

- **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

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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.

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Detection Methods of Stress Level

Stress levels can be identified by considering the 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 considered to customize recommendations according to individuals' 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.

- **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. Stress management programs can be enhanced with the integration of novel treatments and approaches derived from cutting-edge research in the field.

VII. PROPOSED SYSTEM

The 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

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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 a Controlled Environment

Step 8: Gather User Feedback for Optimization

VIII. FLOWCHART

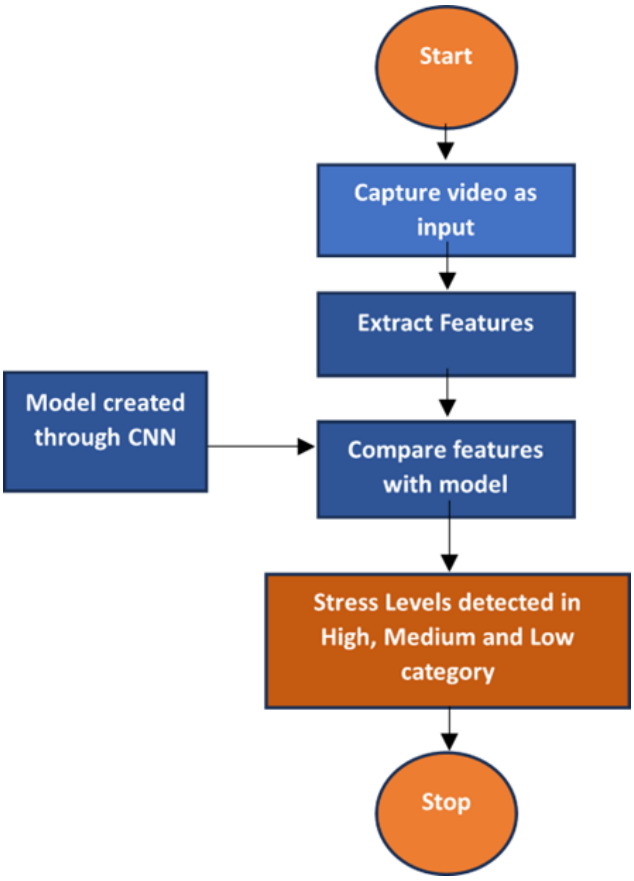

Figure 1: Flow Diagram of the Proposed Concept

ISSN (Online): 2583-648X

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IX. RESULT

The result that will be generated will have some unique features of detection of stress by facial appearance and this feature will play a vital role in the final output. The accuracy is considered to be higher as compared to the previous system which helps to determine some accurate results.

A. Stress Level Detected High With a Stress Value: 79

Figure 2: High-Stress Level Detected

B. Stress Level Detected Low With Stress Value: 62

Figure 3: Low-Stress Level Detected

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Volume 3 | Issue 3 | June 2024

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C. Stress Level Detected Low With Stress Value: 52

Figure 4: Low-Stress Level Detected

X. CONCLUSION

We will aim to forecast the stress levels of emotion based on the algorithm that we have suggested and the model that we have developed by putting it to the test with real-world data. These seven types of emotions are examined in relation to three types of emotions (i.e. Weak Stress, No Stress, Strong Stress). The following are the Test case outcomes after supplying real-world inputs: If the subject is in the second stage of stress. It indicates that the person is experiencing minor stress and should take precautions before it progresses to the final degree. If not addressed, it begins to manifest symptoms such as weariness, headaches, and mental instability, which are all signs that a person is in the last stages of stress. From an implementation standpoint, we must continuously monitor the subject's stress level by collecting an average report on the subject on a weekly, monthly, or even yearly basis based on the subject's conditions, and these data must be provided to the concerned doctor for analysis.

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