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Stress therapy: detection and analysis using Artificial Intelligence & Machine Learning and Deep Learning

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ABSTRACT

Concerns about stress have far-reaching implications for physical and mental health. Manual treatments, self-assessment questionnaires, or portable sensors are the mainstays of traditional stress identification and management approaches. Unfortunately, the accuracy of current emotion recognition systems is limited since they often depend on a single modality, such text-based mood analysis or facial expressions. These systems are less effective in practical settings and have trouble adapting to changes in user representation and misunderstanding arising from context. Since emotions are multi-faceted and may manifest in many ways depending on the person and context, this restricts the accuracy. Using AI, ML, and DL technologies, the suggested system builds a multimodal emotion identification platform, which gets around these problems. With the platform's analysis of facial expressions, voice tone, and text mood, stress identification becomes more accurate and reliable. Using this strategy, we may get a more comprehensive picture of the user's emotional state while lowering the likelihood of mistakes caused by the constraints of the individual model. To guarantee a solid emotional forecast, the system employs a deep learning model that draws insights from many data inputs. An accessible and user-friendly web application built on the Flask framework is offered. As soon as the platform detects that you're feeling stressed, it will present you individualized remedies like breathing exercises and music therapy.

Keywords - Multimodal Emotion Recognition, Stress Detection, Deep Learning, AI, Mental Health, Personalized Music Therapy.

INTRODUCTION

Stress has grown into a worldwide epidemic, impacting people's emotional and physical well-being. Anxiety disorders, heart diseases, and cognitive impairments are just a few of the major health concerns that may arise from chronic stress. Maintaining a healthy lifestyle heavily relies on being able to identify stress and effectively manage it. There is a gap in the current state of stress detection technology when it comes to developing individualized plans for managing stress. Tools like wearable sensors and self-report questionnaires only provide limited real-time monitoring. the third When it comes to stress management, these approaches often fail because they fail to account for the complexity and dynamic nature of human emotions.

Improvements in emotion identification accuracy and efficiency have been made possible by the rapid development of AI, ML, and DL in recent years. [4] Modern models, on the other hand, tend to focus on only one modality, including facial expression detection, text sentiment analysis, or audio tone recognition. When it comes to variations in emotional displays, single-modality techniques encounter difficulties. Both accuracy and classification mistakes are reduced as a consequence of this [8]. This study proposes a system that addresses these issues by analyzing stress via text emotion, facial expressions, and voice tone.

An accurate and comprehensive assessment of a

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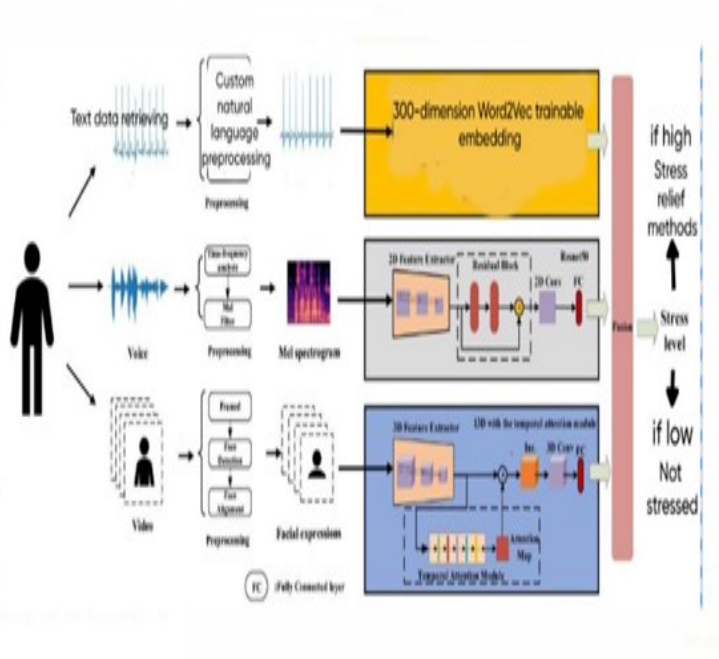
person's emotional state may be achieved using this. In order to examine different kinds of data and make better predictions, this system employs a mix of deep learning approaches. Also, it's built as a flask-based web app, so it's simple to use and offers results quickly. Music therapy and breathing exercises (such as deep breathing, box breathing, and the 4-7-8 method) are among the individualized therapeutic modalities suggested by the platform after stress detection. To top it all off, the system is designed using a Flask-based web application. Simple access and processing in real-time are both aided by it. Music therapy and guided breathing exercises like Deep Breathing, Box Breathing, and the 4-7-8 approach are among the individualized therapeutic modalities offered by the platform after stress detection. Scientific research have shown that these tactics are effective in lowering stress levels. [1] A user-friendly solution for stress management may be developed via the integration of real-time methods and multimodal emotion identification in this research. Affective computing and mental health both stand to benefit greatly from this.

Literature survey

In their study, Kumar et al. [1] investigated the use of AI for emotion categorization in social media postings. The results showed that sentiment analysis models powered by AI can accurately identify linguistic patterns associated with stress. This research shows that AI-powered methods might be useful for tracking people's mental health via their online activities.
Islam et al. [3] shown that online user-generated material may be a useful dataset for stress detection by analyzing stress-related talks on Reddit's r/stress forum using machine learning. Their results provide credence to the idea that stress detection methods should include text-based sentiment analysis. To improve the accuracy of their real-time speech emotion identification system, El Ayadi et al. [5] used deep learning and data augmentation. Their research backs up the speech-based stress detection part of the study by showing that speech signals have important characteristics associated to stress.

Alterations in pitch and tone are significantly correlated with emotional stress, according to Abadi et al. [6], who conducted more research on stress detection using speech analysis using machine learning approaches. It is in line with the speech recognition model used in this work, which is CNN-LSTM based.
The use of artificial intelligence (AI) in speech-based emotion categorization was further shown by Gupta et al. [8] who created a system for real-time spoken emotion identification using deep neural networks. An important part of this research is the work of Poria et al. [9], who dug further into affective computing and pushed for multimodal emotion analysis that incorporates text, audio, and facial expressions.

Methodology



Proposed diagram

The proposed system presents a platform for multimodal emotion identification powered by artificial intelligence. It supports three distinct types of data:

1. Analysis of Expressions on the Face

When it comes to face emotion classification, it employs Convolutional Neural Networks (CNNs) like ResNet and VGG16. Looks for signs of tension, such as twitching lips, shifting eyes, and other microexpressions. Very accurate at detecting face emotions, trained on datasets such as FER2013.

2. Stress Detection Based on Speech

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Creates spectrograms from audio recordings and analyzes them using CNN-LSTM models. Identifies levels of stress by analyzing changes in pitch, tone, and speech pace. Assists in discernment of tension even when facial expressions remain neutral.

3. Sentiment Analysis Based on Text

Evaluates text-based emotions using Natural Language Processing (NLP) in conjunction with Support Vector Machines (SVM) and CNN models. Identifies instances of stress in user-generated material, such as social media postings or transcribed audio. Works with a variety of training datasets to provide stress detection that is independent of language.

The goal of the web-based software Stress treatment is to assist users in stress management by means of individual treatment sessions powered by artificial intelligence. To determine how much stress a person is under and how best to deal with it, it uses face recognition, audio analysis, and sentiment detection. Emotion categorization based on deep learning [4] and multimodal stress detection via audio, face, and text analysis are all used by the system. It is able to identify the first warning signals of stress, sadness, and anxiety by employing machine learning algorithms.

DATA COLLECTION LAYER

For precise stress identification, the system gathers information from three sources: webcam-captured facial expressions, microphone-recorded voice, and text emotion (user-entered text or transcribed speech). Stress detection is made more reliable in real-world settings by using this multimodal technique, which guarantees it is not reliant on a single input source.

PREPROCESSING LAYER

Data is preprocessed after collection to eliminate noise and extract useful information. Computer vision algorithms are used to extract, normalize, and analyze face pictures from video frames for important facial traits. Spectrograms are created from audio data by removing background noise and highlighting changes in tone, pitch, and speech tempo. To find out how someone is feeling, we tokenize their text input and run it via Natural Language Processing (NLP). These preparatory procedures guarantee that the AI models are fed only high-quality, relevant data, which improves the accuracy of AI-based stress detection.

AI-BASED FEAUTURE EXTRACTION AND CLASSIFICATION

This layer uses deep learning models to sort stress levels from the preprocessed data. Convolutional Neural Networks (CNNs) such as ResNet and VGG16 are used to interpret data on facial expressions; these networks are able to identify stress-related micro-expressions, eye movements, and lip tremors. In order to detect stress patterns in speech fluctuations, pitch, and tone, CNN-LSTM models are used to analyze speech data. The purpose of text sentiment analysis is to categorize the emotional tone of written text by using Convolutional Neural Network (CNN) and Support Vector Machine (SVM) models.

DECISION MAKING LAYER

The system sorts the user's stress into three groups based on the data it has analyzed: Calm: Recognized by emotions of neutrality or happiness, a voice that is not too sharp, and upbeat tone in the content. Moderate Stress: Indicates apprehension or surprise, moderate changes in vocal intonation, and neutral or slightly negative tone in written communication. High-stress situations may be identified by looking furious or disgusted, speaking quickly or at a high pitch, and writing strongly negative attitude.

THERAPY RECOMMENDATION LAYER

Users are able to effectively manage their stress levels with the help of the system's real-time, personalized therapy recommendations. It recommends music therapy, in which one can unwind to the sounds of nature, gentle instrumental music, or binaural beats. Deep breathing, box breathing, and 4-7-8 breathing are just a few of the guided breathing exercises that are available in the system.

DEPLOYMENT AND USER INTERFACE LAYER

Using a Flask-based web app, the system can identify stress in real-time and suggest treatments. Flask powers the backend, which processes user inputs and API requests. Using an interactive interface built with HTML, CSS, and JavaScript, users may submit films of their faces, audio recordings of their voices, or text inputs to help in stress detection. Because these

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Vol 19, Issue 2, 2025

inputs are processed quickly by the system, stress detection is quick, easy to obtain, and simple to utilize.

OUTPUT AND REAL-TIME FEEDBACK LAYER

Quickly after user input, the system indicates if the user is experiencing low, medium, or high stress and offers treatment suggestions. Based on their stress level, users get individualized music or breathing exercises that they may start doing right away. A very precise, easily accessible, and engaging solution for mental health is guaranteed by the system's integration of multimodal stress detection with real-time treatment ideas powered by artificial intelligence.

Implementation

Data collection

Facial expressions, audio of spoken words, and text emotion are the three main sources from which the system gathers data. Using convolutional neural network (CNN) models, which examine face characteristics to identify patterns associated with stress, facial expressions may be retrieved from videos. In order to detect signs of vocal tension, speech data is analyzed using deep learning methods and spectrogram features. In order to estimate the amount of stress, text sentiment analysis is carried out using natural language processing models. These algorithms evaluate the emotional tone of textual inputs.

Machine Learning models:

For categorization, many ML models are used. For text-based stress detection, we use Support Vector Machine (SVM) to classify stress levels using sentiment analysis. In order to train and transform audio inputs into spectrograms, Convolutional Neural Networks (CNNs) are used for speech analysis and facial expression recognition using datasets such as FER2013. A more dependable stress detection system is produced via an ensemble model technique, which combines the results of SVM, CNN, and NLP-based models to increase accuracy.

SVM:

First, we implemented support vector machine (SVM) classifiers without dimensionality reduction or gender discrimination, utilizing linear, polynomial, and RBF kernel functions. According to the data in the table below, the accuracy of speech emotion identification was not very high. The RBF kernel-based SVM outperformed the other two with a 56.51% accuracy rate.
To further narrow the features, we used a combination of feature modification and feature selection methods. We removed 75 features using the Chi-squared test with a 1% threshold for feature selection. We utilized principal component analysis (PCA) to convert features and examined three different explained variance levels (90, 95, and 98 percent). These were the 100th, 120th, and 140th feature dimensions, correspondingly.

Overall performance was still poor, although there were some noticeable improvements. Both the polynomial and RBF kernels saw a 6% and 3% improvement in accuracy with the 140-feature dimension and 98% variance, respectively. All three kernels were performing well, but the RBF kernel maintained its lead.

Results

Home page

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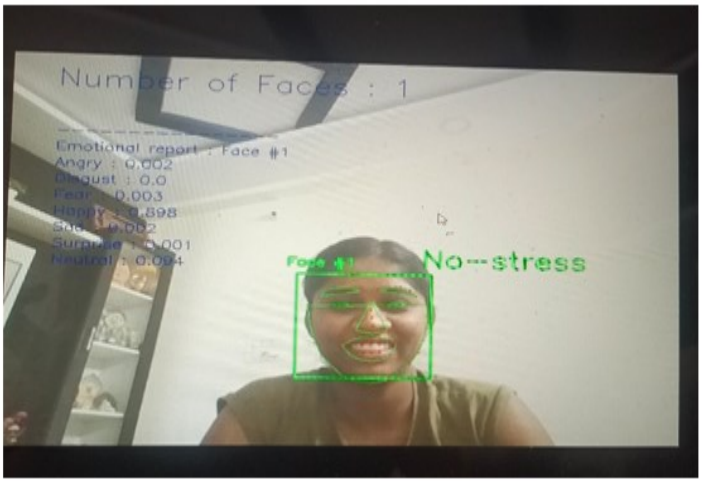
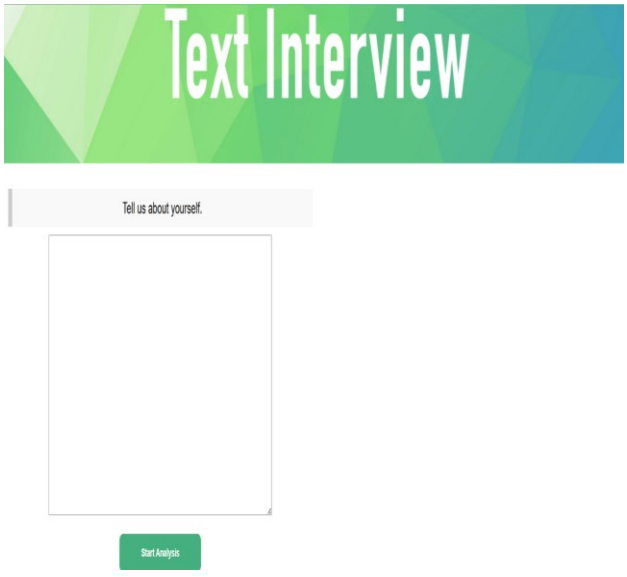
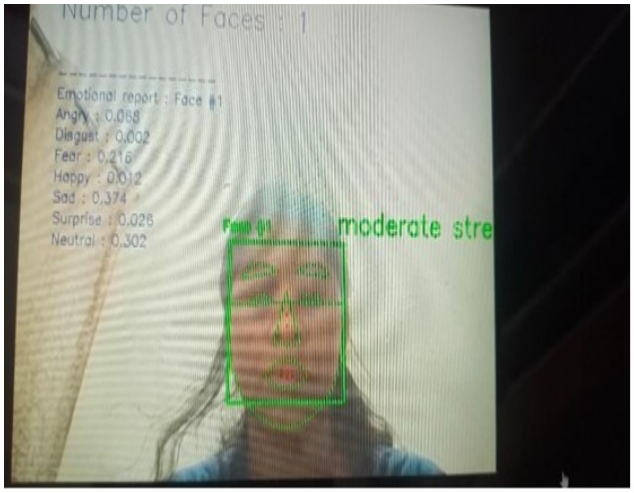
Vol 19, Issue 2, 2025

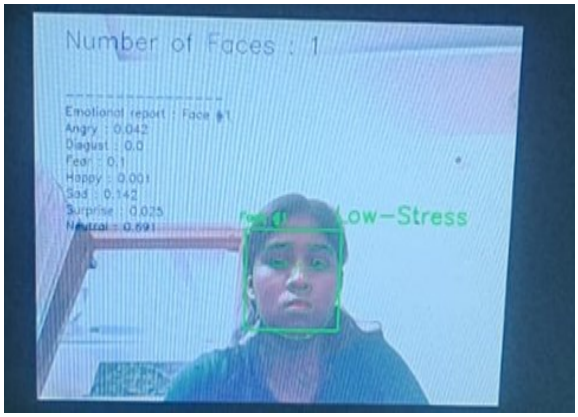


Video results for stress





Video results with stress



Low stress

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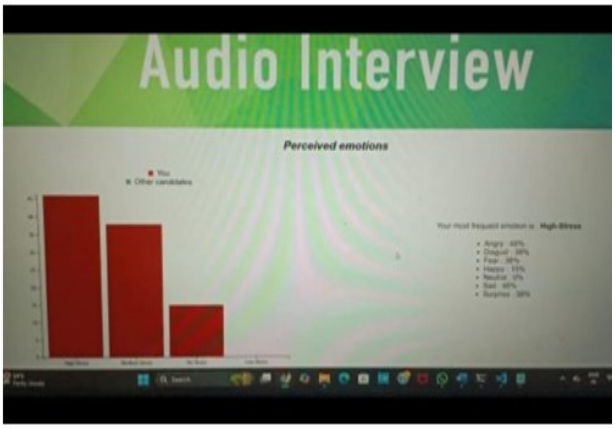
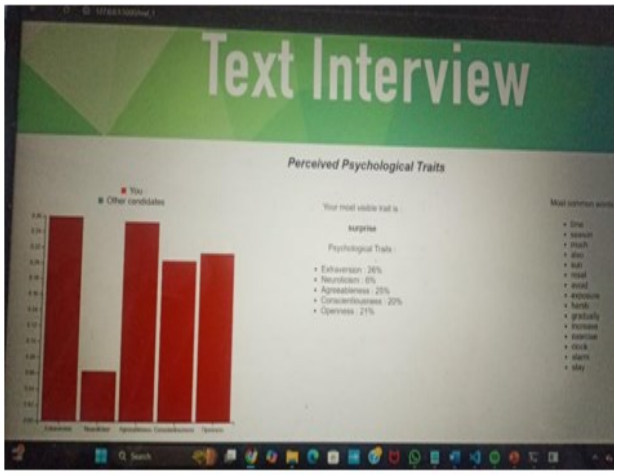
Vol 19, Issue 2, 2025



Audio analysis



Stress analysis

Conclusion

This study introduces a multimodal stress detection system that can identify stress and provide solutions by analyzing facial expressions, voice tones, and text sentiment. This approach improves the system's accuracy and reliability.

The system is implemented as a web application built using Flask. It can identify stress in real-time and provide individualized solutions like music therapy and breathing exercises. The system guarantees an efficient and customized experience for customers seeking relaxation methods and treatment by using a user-friendly interface and a solid backend architecture.

Contributing to the development of affective computing and wellness technologies powered by artificial intelligence, this system automates stress identification and treatment suggestions to provide an accessible, intelligent, and adaptable solution for mental health assistance. Integrating the Internet of Things (IoT), enhancing the user experience using EEG-based stress measurement, and recommending adaptive AI treatment are all areas that might be improved in the future.

Future Scope

Personalized mental health care, in which AI systems learn and adjust according to individual behaviors and requirements, is a hot topic in the dynamic area of digital health. The incorporation of user profile based on machine learning is an encouraging step in the right direction as it enables the system to tailor its suggestions to the individual depending on their feedback, treatment response, and usage habits. For instance, the system might gradually give more weight to music-based treatment if it finds that it is more effective than breathing exercises for the user.

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