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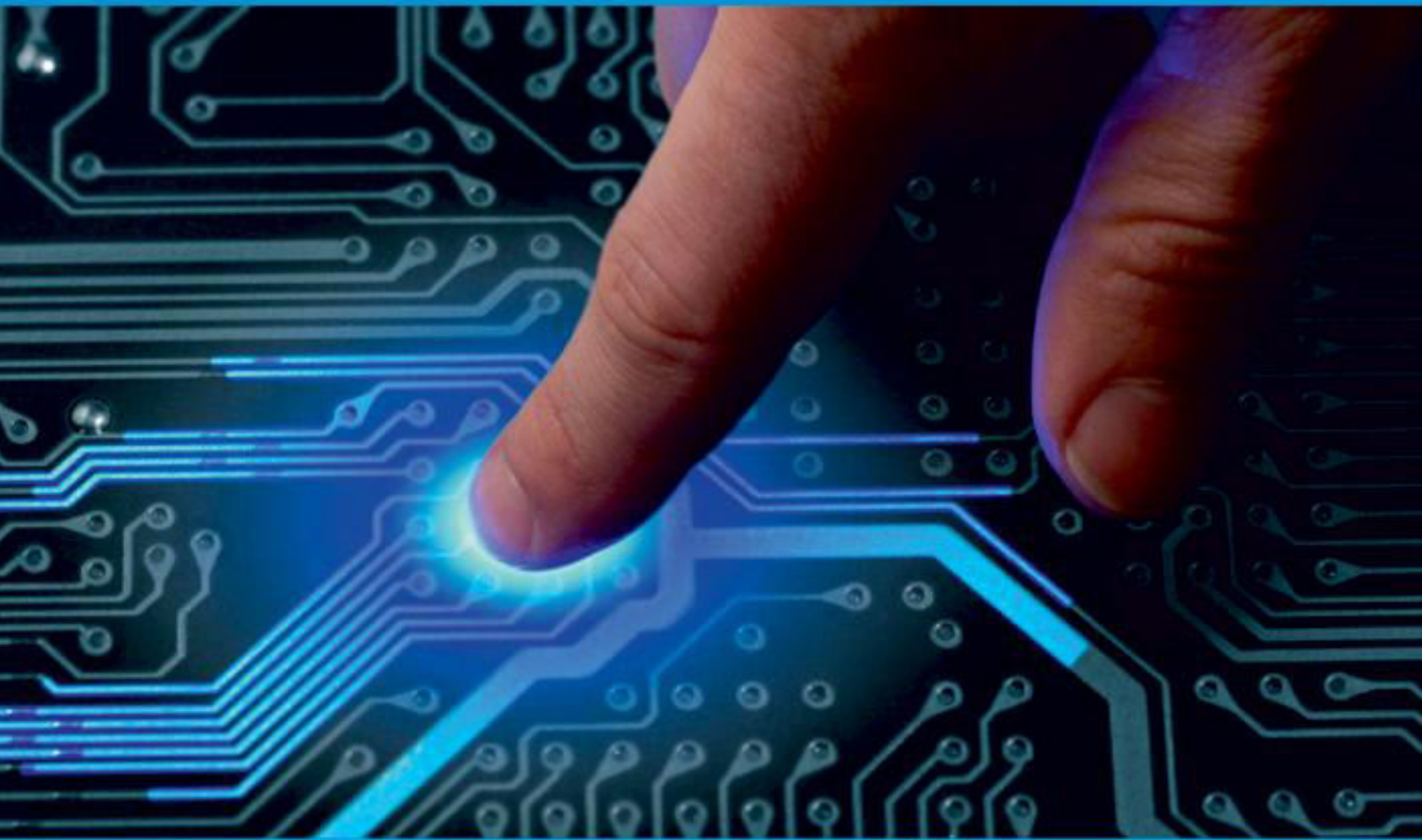

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Psychological Stress Detection using Machine Learning

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ABSTRACT: In this world of virtual life everything happens online and it is very important to keep a track of a person's mental health due to the monotonous and pressurized routine.This not only affects the physical health but also the mental health. Mental health is a very important health factor which has to be maintained very well. The stress becomes a major factor of the mental health. Due to increased stress, it leads to many physiological health problems like heart problems, blood pressure, and respiratory problems and so on. It is very much necessary to detect this stress at the initial stage. Not only the detection but also the cause for stress has to be found out. The lines around the eyes, nose, lips, forehead and the movement of eyeballs, lips and head gives a clear picture about what is going on in the persons mind. By using these factors the stress can be detected easily. In this paper we propose an approach for the detection of stress along with the cause of stress by using the haar cascade algorithm for face detection, facial landmarks algorithm for the recognition of lines on the face, CNN a deep learning approach for the classification of stress based on the emotions which gives the cause of stress. Our system can be used for the real life applications like assessing the candidate's reactions and presence of stress during an online class or an interview.

KEYWORDS*:* stress detection; cause for stress, faceimage; faciall and marks; deep neural network; haar cascade; LBPH;

I. INTRODUCTION

In the beginning, stress detection was essentially a research topic for psychologists. However, recent progresses in image processing and pattern recognition have motivated significantly research works on automatic stress recognition. Previously a lot of researchers used still images for this purpose. For this purpose, many techniques have been applied: neural networks, Gabor wavelets and active appearance models, HMM, wavelengths and many more methods. It is found that it is insufficient to describe all facial expressions and the mental health status as these are just by taking the still images into account.Detecting face and recognizing the facial expression is a very complicated task when it is a very important to take into consideration of the components of face such as the face lines, configuration, location where the face is present, movement of eyes.

In this paper we propose an efficient method for the detection of stress and to give the cause for this stress in people. The cause of stress is given by different emotions. When a person is very angry or sad or very scared he will be prone to high level of mental stress and similarly when he is happy or has no emotions on face he will be in a good mental state and when he is surprised or disgusted he will be prone to have a lower level of mental stress. Here a real time analysis of a person is done for this detection. This real time stress analysis can be done by taking the video sequences from the general camera. The eye and lips movements also play a major role during stress detection.So this system tries to take these factors also along with the facial lines and landmarks into consideration.

The Section 2 of the paper gives a brief on the relatedworks; the Section 3 gives an idea on how our proposed system works; the Section 4 gives the experimental results that are obtained in this process of stress detection and finally this work is concluded in Section 5.

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II. RELATEDWORK

In this section, the other methodologies for this problem of stress detection are given.

A. Stress detection using facial image sequences

Metaxas et al. used the Hidden Markov Models for the purpose of stress detection [1].The amount of attention given during the stress recognition from the facial sequence for a host of applications such as security and human-computer interaction is very less.This class of problems and the related software are instances of Dynamic Data Driven Application Systems (DDDAS).This research presents a method to detect stress from dynamic facial image sequences. The image sequences of people were subjected to various psychological tests that induced high and low stress situations. The Hidden Markov Model system was trained and using these parameters for stressed and unstressed situations and use this trained system to do recognition of high and low stress situations for an un labeled video sequence. Hidden Markov Models (HMMs) was an effective tool in the stress detection.

B. Stress detection using PCB

Sharawi et al. designed a stress detection system using the PCB's and LCD's. The design and mechatronics implementation of a human stress detection system (HSDS) using a biomechanics approach [2]. A two layer PCB was built for the purpose of stress detection. It was a very simple, compact and was a system which was easy to develop and use. An algorithm was developed to classify the human stress condition based on the measurements after characterizing the two transducers where these two transducers measured the force or pressure by the human tip. An LCD was used to display the stress analysis. There was a key pad for taking the bio metrics. The major application for HSDS could be in the automotive industry which was to find the driver condition, and if a stress state was detected then the driver could be notified to stop the car and relax. The operation algorithm of the HSDS is proposed and performed using C language then loaded into the micro-controller.

C. Stress detection using speech

Lech et al. presented a new system for automatic stress detection in speech. In the process of feature extraction speech spectrograms were used as the primary features [3]. The sigma-pi neuron cells were then employed to derive the secondary features. Analysis was performed using there frequency bands critical bands, Bark scale bands and equivalent rectangular bandwidth (ERB) scale bands. The stress level classification was done using the GMM and KNN classifiers. The ERB scale provided the highest classification results ranging from 67.84% to 73.76%. The classification results did not differ between data sets containing specific types of vowels and data sets containing mixtures of vowels. This indicates that the proposed method can be applied to voiced speech in speech independent conditions. Speech signals were composed of acoustic patterns which vary in frequency, time and intensity. In order to show these variations simultaneously, a display known as spectrogram was introduced. Pectrogram played a major role in observing the spectrum of speech completely. It can show acoustic information such as the glottal pulses of voiced speech, distribution of energy in specific frequency bands, formants and harmonics.

D. Stress Detection using eye video sequences

Mokhayeri et al. proposed a novel approach for mental stress recognition through automatic analysis of eye video sequences [4].There were stages during the detection of stress in this system: first was video capturing, image processing using fuzzy, signal processing, feature extraction and the process of classification. They took the factors of pupil into consideration in this research. The major pupil factors were Pupil Diameter and Pupil Dilation Acceleration. These pupil factors were measured and acted as the deciding factor for stress detection. The pupil parameters are measured using soft computing techniques wherein the eye region is detected using the genetic algorithm (GA) and a fuzzy filter is designed for noise reduction. Fuzzy reasoning is used for edge detection and linking is done using Hough transform. Signal processing technique is used to extract pupil parameters. For the classification process, the Fuzzy SVM (FSVM) is applied. In order to induce the stress in subjects, a Stroop color-word test is designed.

E. Stress Detection Using Social Media Data

Mogadala et al. proposed a system that takes the thoughts of people and are captured in the form of text and that is used for the purpose of stress detection [5]. Mining inherent mood information can help us understand the psychological and health behaviour of an individual. It can also provide a path for predicting the future moods which has lot of applications in psychology, medicine and other economic transactions where user mood play a significant role in decision making. Tweets may be regarded as microscopic instantiations of mood. Surveys of communication on MySpace and Twitter were done to get user moods. They analyzed broader social and economic trends, such as the relationship between Twitter mood and consumer coincidence and political opinion. Lin et al.[6] designed an automatic stress detection method from cross-media micro blog data. A three-level framework was constructed to formulate the problem. A set of low-level features from the tweets was obtained after that they defined and extracted the middle-level representations which were based on psychological and art theories: At the end, a Deep Sparse Neural Network was designed in order to learn the stress category incorporating the cross-media attributes. But these thoughts on the social media were not always accurate as it usually was to get more of likes or so on.

F. Stress detection using Sensors

Salai et al. presented the concepts and results of two studies targeted at stress detection with a low cost heart rate sensor, a chest belt. In the device validation study (n = 5), they took heartbeat and other features from the belt to those measured by a gold standard device to assess the reliability of the sensor [7]. With simple synchronization and data cleaning algorithm, they could select highly correlated and a very low average error in data segments of considerable length from the chest data. The protocol for the clinical study (n = 46) included a relax phase followed by a phase with provoked mental stress, 10 minutes each.

G. Stress detection through thermal imaging

Youngjun Cho research focused on the use of mobile thermal imaging, a new and less explored sensor, to merge the measurement of multiple physiological signatures into one sensor and to build a reliable mental stress automatic recognition model [8].This Mobile thermal imaging has greater potentials for real-world even if it is of a small weight, and requires low computation cost. Biomedical thermal image processing was done by tracking the ROI values, physiology measurements which had ubiquitous settings with an mental stress recognition model which was automated. This type of an automated system was based on the uni-modal and the multi-modal models.The physiology measurements stage aims at proposing new physiological signatures that facilitate the capturing of the relationship between stress and respiratory, cardiac, eye blinks and skeletal muscle activations. In particular, we aim to identify thermal signatures that can be reliably extracted during everyday tasks with dynamic temperature environments.

2.1.8 Stress detection using bio-signals

Giannakakos et al. investigated the effects of psychological stress on the human body measured through bio-signals [9]. When a potentially threatening stimulus is perceived, a cascade of physiological processes occurs mobilizing the body and nervous system to confront the imminent threat and ensure effective adaptation. Bio-signals that can be measured reliably in relation to such stressors include physiological (EEG, ECG, EDA, EMG) and physical measures (respiratory rate, speech, skin temperature, pupil size, eye activity). The fundamental objective in this area of psychophysiological research is to establish reliable bio-signal indices that reveal the underlying physiological mechanisms of the stress response. The impacts of stress to multiple bodily responses are surveyed. Emphasis is put on the efficiency, robustness and consistency of bio-signal data features across the current state of knowledge in stress detection.

2.1.9 Stress detection using CNN

Jeon et al**.** designed a stress recognition algorithm using the CNN algorithm and detected the presence of stress. In this research a system is proposed for detection using face images and face landmarks [10]. This algorithm detected the images from the general camera. And mainly took into considerations of the facial landmarks into account for stress detection.Shortcut-mapping and bottleneck architecture to optimize neural network structure. By applying this, the shortcut mapping to the neural network structure is deepened due to the numerous layers, the could simplify the learning process and determine the direction of the learning. This made it possible to easily optimize the deep neural network and improve the accuracy due to the increased depth. By applying the bottleneck architecture, the number of internal parameters was reduced while increasing the number of feature maps, which increased the performance and reduced the amount of computation. The performance of the proposed algorithm was measured by k-fold cross validation method. First of all, after one subject data was selected as test data, and the network with the other 49 subjects' data and measured the accuracy.

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III. PROPOSED SYSTEM

In this particular section, we try to give the complete overview of how ourPsychological Stress Detection detection system works.

A. Overall framework

The process of stress detection is done step by step as shown in the Figure 1.

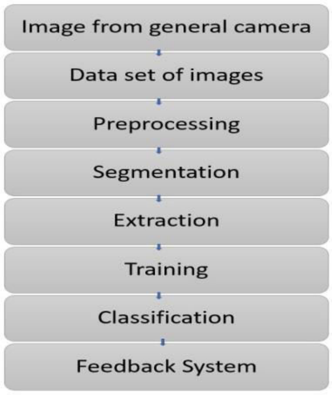

Figure 1.Overall System Framework

Our system works in different modules majorly in 6 different modules,
The dataset for the real-time analysis is taken using the normal camera and the images are captured from the video sequences. The images captured through the general camera are converted into gray scale images for increasing the accuracy of the system. The images are divided into small parts of face, facial lines, lips and other marks so that the detection of emotion is done accurately. The different features of the captured images are extracted for the purpose of detection of emotions accurately.These images are then fed to a CNN model for training the images. Then the classification is done for the stress detection.

B. Working of the system

The complete working of how the stress detection and how the cause for stress is explained in this section.

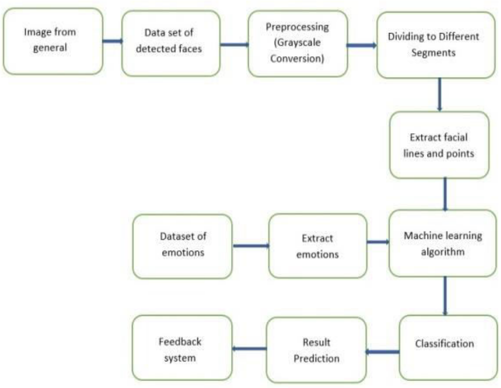

Figure 2. Detailed Working

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The candidate's image is captured from the general camera where these images are captured through the real-time video streaming of the candidate. The face recognition algorithm along with Haar cascade algorithm is used for this purpose. Then the images are trained by adding labels to them and converted into the gray scale image by the local binary pattern histogram algorithm and are divided into different parts like eyes, lips and so on so that the detection of emotions can be done accurately. Then these images are stored into a dataset folder.
The dataset for emotion detection is FER-2013 this dataset is trained using the CNN algorithm giving an accuracy of 70.13%.This trained model is next used for the detection and classification of stress levels. Based on the classification that is done using CNN, the stress levels will be classified into three levels namely, high stress, low stress and no stress.

IV. EXPERIMENTAL RESULTS

Many of the authors like Giannakakos [9]. investigated the effects of psychological stress on the human body by using the bio signals and inducing stressors, but in real life conditions, stressors are very complex to be used which increases the overall mechanism of stress detection. When stress detection was done using facial landmarks by Jeon[10]. Could detect stress with a maximum accuracy of 64.63 %even though the accuracy seems to be good enough, this system couldn't give the cause for stress which becomes the major limitation of this system. When the emotion detection system was taken into consideration,method by Arriaga, O. et. al.[11] gave an accuracy of 65% but this system could not provide proper support during the real time analysis. This became a major issue as the emotions detection required continuous monitoring in order to detect accurately. In this paper we have tried to take these limitations into consideration and developed a stress detection system.

The experiment results of our system showed that the stress detection works much better when a video sequence is taken.For the efficient detection of stress, the detection of the faces, the images of the candidates are taken from the general camera and this is the real-time analysis dataset this dataset gets updated automatically when each candidate registers. For the emotion detection dataset taken is FER-2013.This dataset is set of 35,887 examples, with training-set: 80%, validation-set: 10% and test-set: 10%. The classification of the stress by taking the emotions into consideration plays a major role in the system. The classification of emotions is done using the CNN and this predicts the emotions accurately by providing a real-time analysis.

The person with high percentage of emotions of happiness or if the emotion detected is neutral then the person will have no stress as shown in the figure3. If a person has high amount of sadness, anger or sacredness then the person is prone to high stress. Or if the combinations of these three emotions have the highest value then also the person is prone to high stress. This result of high stress is shown in the figure 4 and figure 5.

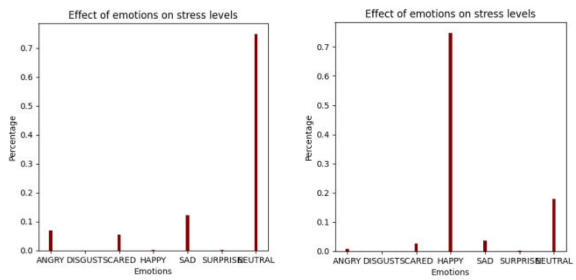

Figure 3. The graph displaying how the emotions neutral and happy have impacted on the stress levels of the person.

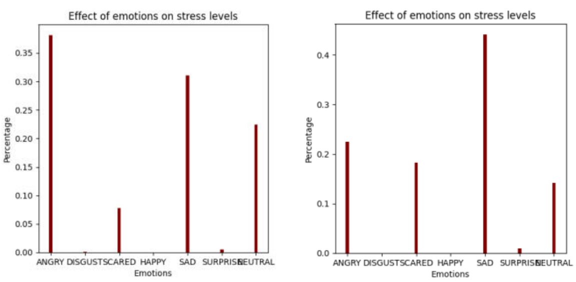

Figure 4. The graph displaying how the emotions anger and sad have impacted on the stress levels of the person.

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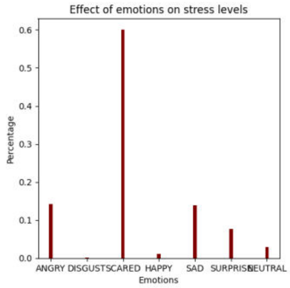

Figure 5. The graph displaying how the emotion scared has impacted on the stress levels of the person.

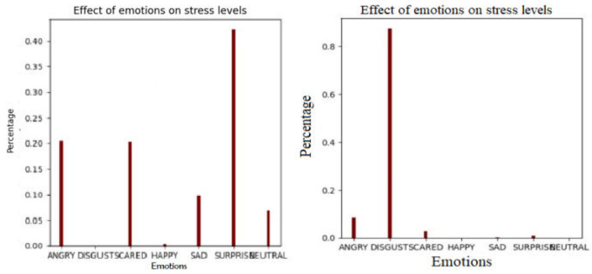

Figure 6. The graph displaying how the emotions surprise and disgust have impacted on the stress levels of the person.
Also the figure 6 shows that the emotions like surprise and disgust too have an effect on the stress level's of a person. But these emotions have a little impact on stress. This indicates that the person with these emotions constantly is in the starting stage or low stress stage . But if these emotions along with the high stress emotion, this also can lead to strong stress. Then our sytem tries to notify the authorities when the session ends.This notifying the authorities plays a major role, as this is helpful for supporting the people under stress to overcome this mental state.

V. CONCLUSION

Here, in our paper we try to detect the stress and also try to give the reason for stress in human beings by continuously capturing the video from the general camera. Our system can be used in this corporate world as well as by the educational institutions as an automatic feedback system is deployed where the information about whether the person is stressed or not stressed is sent to the authorities automatically and in turn can make an effort in solving this mental problem of the person. During the online classes, it plays a major role in detecting the mental health of the students so the system which we have proposed tries to solve such a problem in the early stage only by detecting the stress and also by giving the cause due to which the student or person is under stressor not under stress. Our system detects the stress in a better way by continuously monitoring the action of an individual. The identification of stress related information by using LBPH algorithm for the conversion of the image from RGB format to the gray scale format improved the system's performance.

In the future work, we aim to detect stress in a much more efficient way by evaluating on more number of performance metrics like precision, recall and other parameters and also we aim to classify the stress based on five levels.

VI. ACKNOWLEDGEMENT

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