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IT PROFESSIONALS STRESS DETECTION BY IMAGE PROCESSING USING DEEP LEARNING

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Abstract: The goal of the project is to use image processing and machine learning to detect stress in IT professionals. The goal is to monitor a person's emotional state while working in front of a computer for an extended period of time in order to detect and reduce stress and provide a more comfortable work environment for IT personnel. This approach primarily focuses on stress management and creating a healthy and spontaneous work environment for employees in order to get the most out of them during working hours. The study's overall goal is to suggest a detection system that is reliable, convenient, and accurate. The study's precise objectives are to forecast stress in a person based on symptoms determined through monitoring, to examine stress levels in employees, and to offer information.

1. INTRODUCTION

These days, the IT industry is creating a new standard in the market by introducing new technology and goods. Employee stress levels were also found to raise the bar high in this study. Despite the fact that many companies offer mental health benefits to their employees, the problem remains out of control. In this study, we attempt to go deeper into the topic by attempting to detect stress patterns in working employees in businesses. We plan to use image processing and machine learning techniques to evaluate stress patterns and narrow down the factors that greatly influence stress levels.

To classify stress, machine learning algorithms such as KNN classifiers are used. The employee's image is snapped by the camera, which serves as input, and image processing is used at the initial step for detection. Image processing is used to improve an image or extract relevant information from it by converting the image to digital form and executing operations on it. By taking an image from video frames as input, and producing an image or attributes related with that image as output. The three phases that make up image processing are as follows:

- Using picture acquisition tools to import the image
- Examining and modifying the image
- An image that has been edited or a report based on image analysis as a result of the output.

Machine learning, which is an application of artificial intelligence, gives the system the ability to automatically learn and develop from self-experiences without being explicitly designed (AI). Machine Learning creates computer programmers that can access data and utilize it to learn for themselves. Using Machine Learning, explicit programming creates a mathematical model based on "training data" to do the task based on predictions or judgements. Image Mining is used to extract hidden data, associate image data, and find additional patterns that aren't obvious in the image. Image Processing, Data Mining, Machine Learning, and Datasets are all part of this field.

Stress is said to be the cause of 50-80% of all physical ailments, according to cautious estimations in medical publications. The leading cause of cardiovascular disease is thought to be stress. Diabetes, ulcers, asthma, migraine headaches, skin problems, epilepsy, and sexual dysfunction are all linked to stress. Each of these disorders, as well as a slew of others, is psychosomatic in nature (i.e., induced or exaggerated by mental factors like stress). There are three impacts of stress:

- Guilt, humiliation, anxiety, anger, and frustration are some of the subjective symptoms of stress. Individuals may also experience fatigue, tenseness, nervousness, irritability, moodiness, or loneliness.
- Behavioral impacts of stress represent visible changes in a person's conduct. Increased accidents, drug usage, and alcohol use are all signs of behavioural stress.
- Cognitive stress can cause a decline in mental ability, impaired judgement, impulsive decisions, forgetfulness, and/or hypersensitivity to criticism.

1. Need of Work

Stress is referred to as the first stage of depression. Finances, employment, relationships, and other factors can all contribute to stress. Employees in the business sector are ignorant of stressful working conditions. Chronic stress is frequently found, especially among IT personnel. Companies used to offer employees a survey form to fill out, and then use that information to estimate stress levels. It took not only a long time but also a lot of effort because the forms had to be delivered manually.Stress Detection System assists employees in dealing with issues that cause stress through preventative stress management solutions aimed at reducing stress and enhancing employee health. In our job, we created a system that will take pictures of employees at regular intervals and then provide them traditional survey forms. This will cut down on physical labor and save time. Through the use of our carefully prepared Questionnaires, this organizational strategy can be used to assist improve employee stress.

2.Objectives

- Monitored symptoms can be used to predict a person's stress level.
- Determine the employee's stress levels.
- To help the person recuperate from his or her stress by providing solutions and cures.

2. LITERATURE SURVEY

. In [1], the authors would like to apply machine learning techniques to analyze stress patterns in working adults and to narrow down the factors that strongly determine the stress levels. Towards this, data from the OSMI mental health survey 2017 responses of working professionals within the tech-industry was considered. Various Machine Learning techniques were applied to train our model after due data cleaning and preprocessing. The accuracy of the above models was obtained and studied comparatively.

In [2], the authors aim to develop a wearable device to measure stress levels in children. This would assist parents and teachers to notice a change in stress during children' study or performing any activities. To estimate stress levels, we processed the pulse rate variability (PRV) which extracted from photoplethysmogram (PPG) signals. We employed the optical reflection sensors to obtain the PPG signals on the wrist area. The ESP32 microcontroller was programmed to acquire and process such PPG signals. Quantitative stress levels were then calculated from the average distinct frequency (f_d) of the PRV in the range of 0.04 - 0.15 Hz which reflects by the parasympathetic and sympathetic nervous systems when perceived stress.

.In this study, we studied the changes in four physiological signals caused by (MWL) mental workload related stress of 26 participants. The four physiological signals studied were electrodermal activity (EDA), Breathing rate (BR), Skin temperature (ST) and blood pressure (BP). Stress was induced in subjects by different methods previously used in literature as `public speaking', `smelling different odors' and `playing stressful games'. Results indicated that EDA changes rapidly with changing stress levels, whereas public speaking changed the value of EDA the most, with an average change of up to 8 micro siemens. Skin temperature also increased with increasing stress, with about 0.8 degree centigrade on average. Once the skin temperature rose, it did not come down with decreasing stress level, instead it took some time to cool down.

In this study, we evaluated the feasibility of detecting stress using deep learning, a subfield of machine learning, on a small data set consisting of electrodermal activity, skin temperature, and heart rate measurements, in combination with self-reported anxiety and stress. The model was able to detect stress periods with 96% accuracy when using the combined wearable device and survey data, compared to the wearable device dataset alone (88% accuracy). Creating multi-dimensional datasets that include both wearable device data and ratings of perceived stress could help correlate stress-inducing events with feelings of stress at the individual level and help reduce intra-individual variabilities due to the subjective nature of the stress response.

This paper represents appearance based facial expression recognition system using Convolutional Neural Network (CNN). The Local Binary Pattern (LBP) was used to extract the appearance features. The CNN is trained to categorize into four basic facial expressions (anger, fear, unhappy and non-stressed expressions). This system was experimented with Indian and Cohn-Kanade database.

This study analyzes data from diverse sensing modalities with signal processing techniques and advanced machine learning approaches in order to unobtrusively recognize stress and negative emotions. We investigate the performance of - easy to obtain in ambulatory settings - heart rate signal and juxtapose it against multi-modal information from electrophysiological signals, facial expression features and body posture.

This paper describes a study for evaluating mental stress using changes in heart rate and facial expressions due to over usage of Internet. The setup was composed of heart rate measuring device and capture of facial expressions. A group of 100 volunteers (80 boys and 20 girls) were tested for two different situations, first situation was usage of digital systems with no Internet, second situation consisted of usage of digital systems with Internet, the results showed that the stress levels during second situation were considerably high than the first one. Clinical research shows heart rate variability as a better indicator for measuring stress levels, in our approach even facial expressions along with heart rate were captured for better efficiency. All sorts of things can cause stress, however there is 'good' stress like receiving good grades in exam, and there is 'bad' stress like mental pressure due to work. For the purposes of this discussion, 'stress' means bad stress.

This stress detection can be done from textual data , facial expression , video and audio. This paper reviews the research approaches used in stress detection using social media. In this paper we are focusing on stress detection using textual data such as tweet, comments ,chats etc. This work focuses on techniques used for stress detection using textual data. [1][2]In this paper, we find Bidirectional Long Short-Term Memory (BLSTM) with attention mechanism to classify psychological stress and categorize the tweets based on their hashtag content gives the best performance.

In this study, keyboard and mouse data from 62 volunteers were experimentally collected in-the-wild using a purpose-built Web application, designed to induce stress by asking each subject to perform 8 computer tasks under different stressful conditions. The application of Multiple Instance Learning (MIL) to Random Forest (RF) classification allowed the devised system to successfully distinguish 3 stress-level classes from keyboard (76% accuracy) and mouse (63% accuracy) data. Classifiers were further evaluated via confusion matrix, precision, recall, and F1-score.

This paper aims to identify the stress levels of students in Massive Open Online Courses(MOOCs). Research shows that there is a lack of sentiment analysis for online classes and hence a higher attrition rate. We thus aim to help instructors identify the stressed students. Using student posts from online platform "Piazza" as input, we perform various stress detection analysis methods like Naive Bayes, ANEW, VADER and SentiWords. These stressed posts from each method are extracted to compare accuracy with baseline dataset. This research provides unique solutions to detect the student sentiment in formal environment which can help reduce stress and improve the students' overall performance.

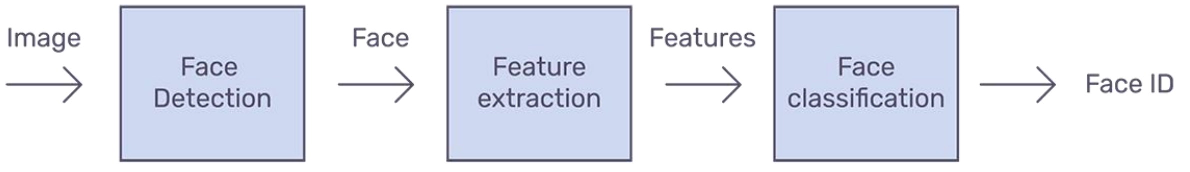
3. METHODOLOGY

This section goes over the specifics of each module's implementation. This contains the detection target specification as well as the techniques:

Deep learning advancements in recent years have enabled widespread use of face recognition technology. This article tries to explain deep learning models used for face recognition and introduces a simple framework for creating and using a custom face recognition system.

Formally, Face Recognition is defined as the problem of identifying or verifying faces in an image. How exactly do we recognise a face in an image?

Face recognition can be divided into multiple steps. The image below shows an example of a face recognition pipeline.



- Face detection — Detecting one or more faces in an image.
- Feature extraction — Extracting the most important features from an image of the face.
- Face classification — Classifying the face based on extracted features.

There are various ways to implement each of the steps in a face recognition pipeline. In this post we'll focus on popular deep learning approaches where we perform face detection using MTCNN, feature extraction using FaceNet and classification using Softmax.

MTCNN

MTCNN or Multi-Task Cascaded Convolutional Neural Networks is a neural network which detects faces and facial landmarks on images. It was published in 2016 by Zhang et al.

MTCNN is one of the most popular and most accurate face detection tools today. It consists of 3 neural networks connected in a cascade.

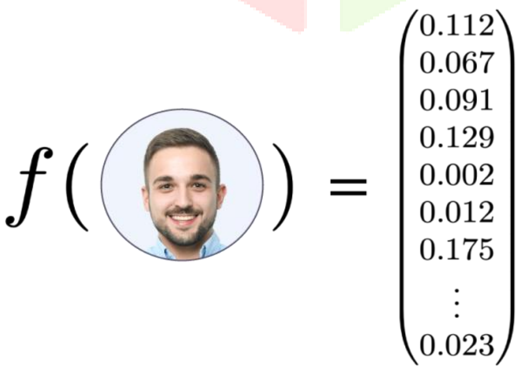
Embeddings are vectors and we can interpret vectors as points in the Cartesian coordinate system. That means we can plot an image of a face in the coordinate system using its embeddings.

One possible way of recognising a person on an unseen image would be to calculate its embedding, calculate distances to images of known people and if the face embedding is close enough to embeddings of person A, we say that this image contains the face of person A.

In order to train FaceNet we need a lot of images of faces. To keep things simple we'll assume we only have a couple of images from two people. The same logic can be applied if we have thousands of images of different people. At the beginning of training, FaceNet generates random vectors for every image which means the images are scattered randomly when plotted.

FaceNet learns in the following way:

1. Randomly selects an anchor image.
2. Randomly selects an image of the same person as the anchor image (positive example).
3. Randomly selects an image of a person different than the anchor image (negative example).
4. Adjusts the FaceNet network parameters so that the positive example is closer to the anchor than the negative example.
5. We repeat these steps until there are no more changes to be done ☞ all the faces of the same person are close to each other and far from others.
6. This method of learning with anchor, positive and negative examples is called triplet loss. 2



The image above is a good summary of what FaceNet is. A function which takes an image as the input and outputs the face embedding (a summary of the face). If you are a developer, you can think of FaceNet as a hash function. FaceNet maps images of the same person to (approximately) the same place in the coordinate system where embedding is the hashcode.

Softmax

We mentioned earlier that the classification step could be done by calculating the embedding distances between a new face and known faces, but that approach is too computationally and memory expensive (this approach is called k-NN). Instead, we decided to use the Softmax classifier which memorises boundaries between people which is much more efficient.

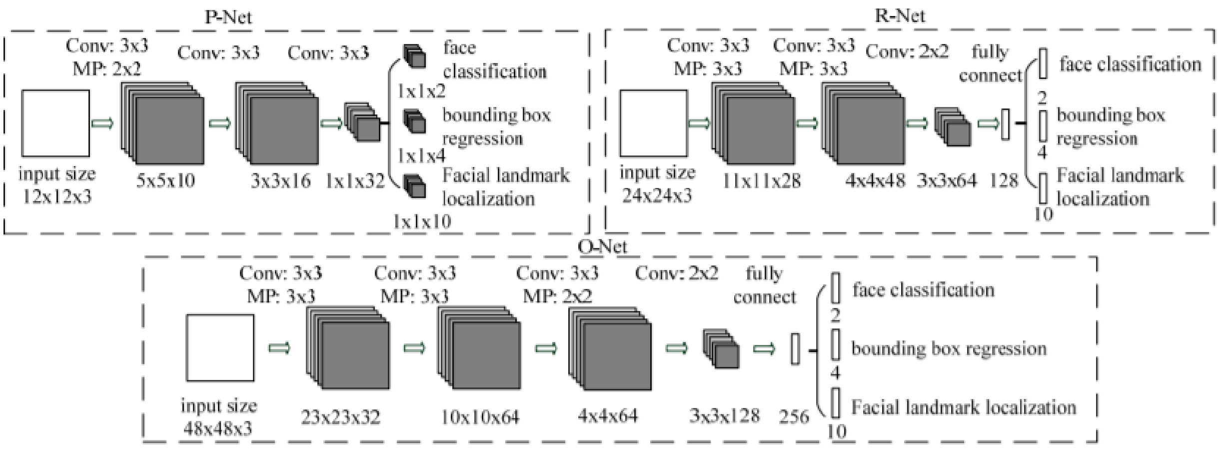
Softmax classifier is used as a final step to classify a person based on a face embedding. Softmax was a logical choice for us since the entire stack is neural networks based, but you can use any classifier you wish such as SVM, Random Forest, etc. If the face embeddings themselves are good, all classifiers should perform well at this step.

Face Recognition Framework

we developed a simple framework for creating and using a Face Recognition system. Our Face Recognition system is based on components described in this post — MTCNN for face detection, FaceNet for generating face embeddings and finally Softmax as a classifier.

Face detection is a must stage for a face recognition pipeline to have a robust one. Herein, MTCNN is a strong face detector offering high detection scores. It stands for Multi-task Cascaded Convolutional Networks.

Model structure



Installation

MTCNN depends on tensorflow and keras installations as a prerequisite. It is heavily inspired from **David Sandberg**'s FaceNet implementation. It is available on PyPI.

```
1	pip install mtcnn
```

Face detection

MTCNN is a lightweight solution as possible as it can be. We will construct a MTCNN detector first and feed a numpy array as input to the detect faces function under its interface. I load the input image with OpenCV in the following code block. Detect faces function returns an array of objects for detected faces. The returned object stores the coordinates of detected faces in the box key.

Facial landmarks

Even though OpenCV based SSD offers a same level accuracy, MTCNN also finds some facial landmarks such as eye, nose and mouth locations. In particular, extracting the eye locations is very important to align faces. Notice that face alignment increases face recognition model accuracy almost 1% based on the Google FaceNet research.

On the other hand, OpenCV finds eye locations with conventional haar cascade method which under-performs. In other words, we have to depend on legacy haar cascade in OpenCV to align faces even if we adopt modern SSD.

The returned object of the detected faces function also stores facial landmarks. I just focus on the eye locations here.

```
keypoints = detection["keypoints"]
left_eye = keypoints["left_eye"]
right_eye = keypoints["right_eye"]
```

Face alignment procedure

We can align faces if we know the exact locations of eyes in the found face

To sum up, we will rotate the base image until the both eye location becomes horizontal. However, I highly recommend you to read the dedicated blog post about face alignment.

MTCNN in deepface

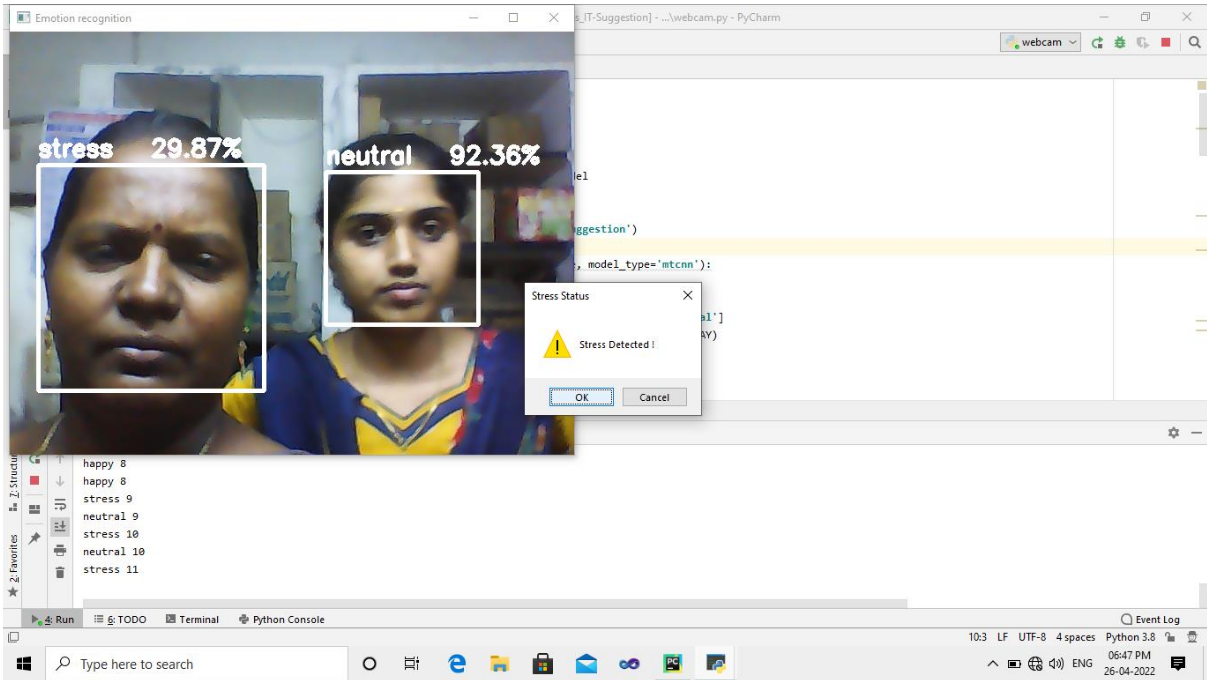
Running detection and alignment respectively might seem complex and it may confuse and discourage you. Herein, deepface wraps OpenCV haar cascade, SSD, DlibHoG and MTCNN detectors.

4. EXPERIMENT AND ANALYSIS

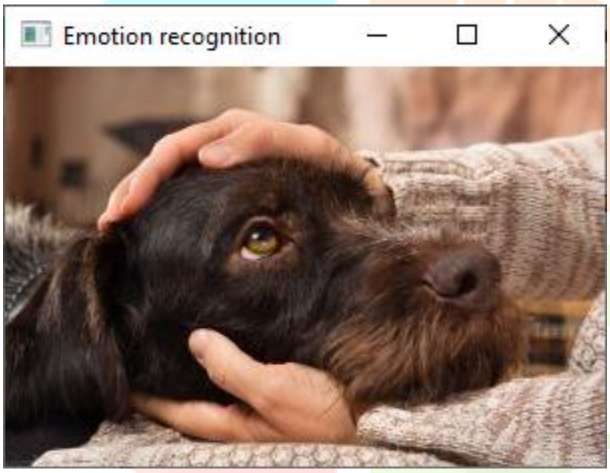
We collected data and conducted a quantitative experimental evaluation to assess the performance of the produced system. This section delves into the findings and explains them:

A. DataCollection

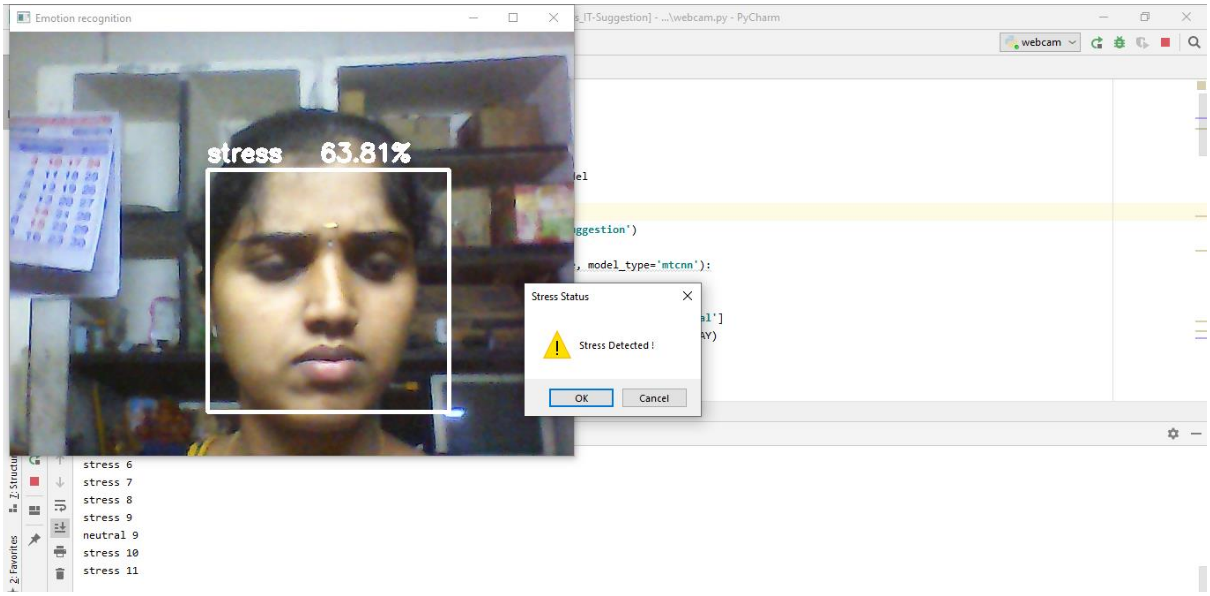
The dataset is made up of a collection of image frames collected from live camera shot at the institution during day time. The videos were shot using a camera mounted on a tripod in front of the subjects during lab hours. There are no professional actors among the people who have been recorded. During lab hours, the subjects work continually in front of the computer on the tasks that have been allocated to them. Our dataset is built on these photographs. The films taken during the sessions are utilized to update the model and analyse it. An individual's video is recorded for three hours during lab hours. Every hour, a set of 6 frames of an individual were extracted from the video, for a total of 18 frames.



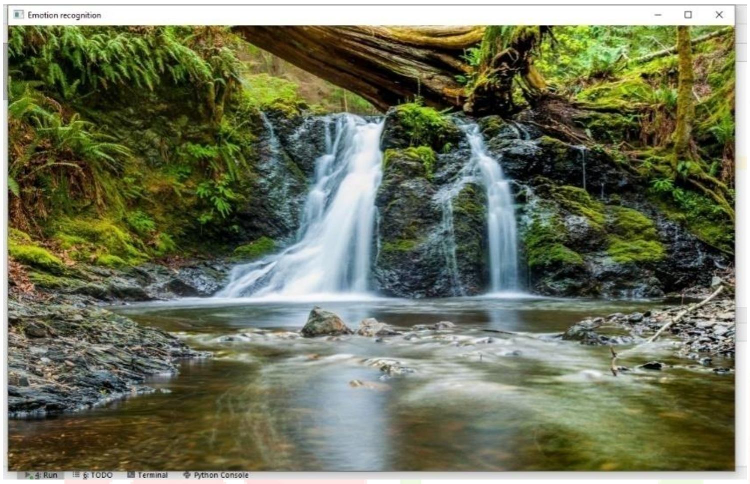
After predicting the stress, this system suggests the stress relief images such as take a cup of coffee, chat with your friends, love with your pets, natural scene atc.



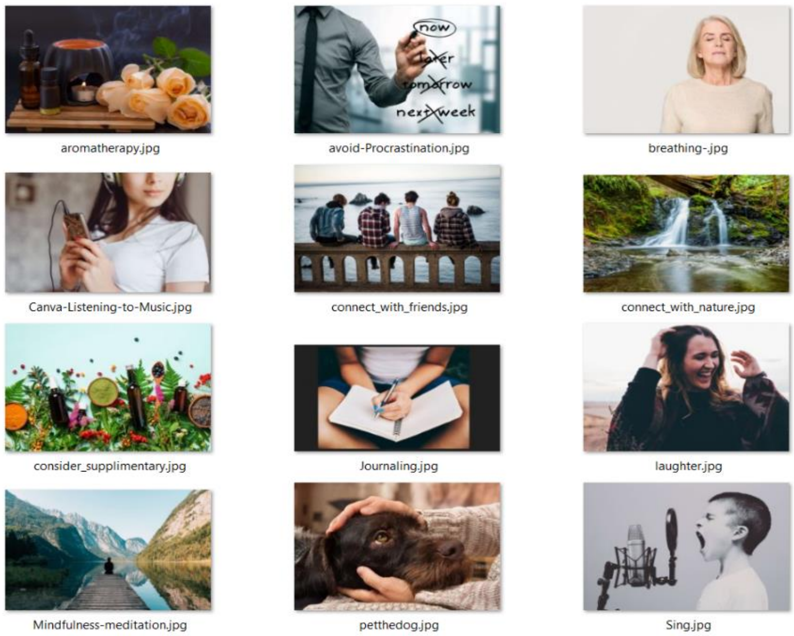
The entire dataset, which is separated into training and testing datasets, comprises of video recordings and the associated frames of (many individuals). The training dataset contains all of the samples from the complete dataset, while the testing dataset contains all of the examples needed to test the trained model.



The above figure shows the employee stress detection using MTCNN algorithm.



After detecting the stress, the random suggestion is displayed as images.



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5. CONCLUSION

Thus, we have implemented this work, "IT PROFESSIONALS STRESS DETECTION BY IMAGE PROCESSING USING DEEP LEARNING", to execution and end to foresee pressure in the workers by noticing the caught pictures of verified clients which makes the framework secure. The picture is caught consequently when the validate client is signed in light of some time span. The caught pictures are utilized to identify the pressure of the client in view of some standard transformation and picture handling components. Then, at that point, the framework will examine the feelings of anxiety by utilizing Machine Learning calculations which creates the outcomes that are more proficient.

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