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Detecting Stress in Software Professionals: A Machine Learning and Image Processing Approach

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Abstract: ***Stress can be defined as a state of worry or mental tension caused by a difficult situation. Stress is high in software profession because of their nature of work, target, achievements, night shift, over work load. This may lead to disease, chronic backache, headache, high BP, insomnia etc. No person can continue under stress for too long. By timely detection, it is possible to detect stress and take necessary action to overcome it. This paper suggests a method to detect stress using machine learning and image processing techniques. There are various stress detection systems available today. All stress detection systems have 3 basic steps: image preprocessing, Feature selection and classification. In this paper some of the methods are analysed. In the proposed methodology the image is preprocessed using gain and bias parameters. PCA is used as feature selection. The features are then used in the automatic classifier such as SVM for the automatic classification***

Keywords: Stress, support vector machine - SVM Principal component analysis - PCA

1. Introduction

"Stress" is generally saying that a mental condition, it is defined as a state of worry or mental tension caused by a difficult situation. Stress is a universal experience that affects people to varying extents. It is also referring to as a natural human response that apt us to address challenges and overcome the obstacles. Stress can be short term or long. It both have different symptoms. Sometimes the stress mistaken as anxiety. There are mainly 3 types of stress conditions they are Acute stress, Chronic stress and Eustress.

Mainly an unhealthy working environment leads to the existence of stress. Rapidly stress has become common among the IT employees due to the high demands and long working hours of their jobs. According to WHO (world health organization) says that stress is a mental health problem to affecting the life of one in four citizens. There are many reasons in our surroundings to feel uncomfortable like work load, health issues, financial problems etc. It is very difficult and sometimes not possible to detect and handle stress. In other words, it is impossible to eliminates stress.

The traditional stress detection method is questionnaire. The questionnaire is a series of questions for the purpose of gathering information from the employee. It can be thought of as a kind of written interview. They can be carried out face to face, by telephone or post. This is a manual process and there is less scope for employee to supply answers that reflect their true feelings. so, the conclusion of this stress detection method is not valuable and reliable. Prior research has shown that analysing physiological signals is a reliable predictor of stress. Such signals are collected from sensors that are attached to the human body. Researchers have attempted to detect stress by using traditional machine learning methods to analyse physiological signals. Results, ranging between 50 and 90% accuracy, have been mixed. A limitation of traditional machine learning algorithms is the requirement for hand - crafted features. Accuracy decreases if features are misidentified. Chronic stress results in cancer, cardiovascular disease, depression, and diabetes, and thus is deeply detrimental to physiological health and psychological wellbeing. Developing robust methods for the rapid and accurate detection of human stress is of paramount importance.

2. Overview

Stress identification and classification system consist of basic three steps: - Image acquisition, Stress detection module, Classifier module. In Image acquisition stage, an image is captured, then the captured image is preprossed. In preprocessing step all the unwanted information is removed and this makes the image suitable for further steps. In Stress detection module, the important features are extracted and the important features are selected. Depending upon these features the classification is done. The features should be extracted from all the images and we will get different result for each class. For these two steps, different image processing techniques are used. The final step is classification. According to the features extracted, the classifier classifies the images into different classes. For that different artificial intelligence and neural network techniques are used. These are the three common steps mainly used in stress detection and classification.

3. Literature Survey

In [1], gain and bias parameters is used to increase the brightness of the captured image and it is converted to grey scale and the important features are selected using PCA. Then KNN classifier is used to classify the stress.

In [2], Image processing is at the initial stage for detection. By taking input as image and output may be image or characteristics associated with those images. Here eyebrow coordinates are detected and variance of displacement is

calculated then the image is classified using KNN classifier. In [3], the Galvanic Skin Response (GSR) and Electrocardiogram (ECG) sensors were used to collect data from 252 participants. After pre - processing the raw data from MYSignal, the Mean, Median, Standard deviation, Minimum reading, Maximum reading, Max Ratio, and Min Ratio are extracted to obtain the best features. Classification algorithm been used in this paper are Multilayer Perceptron (MLP), Decision Tree (DT), K - Nearest Neighbour (KNN), Support Vector Machine (SVM) and Deep Learning (DL).

In [4], after the image is acquired, the image is preprocessed using two transformations. They are pixel transformation and binary transformation. The gain and bias parameters is used to increase the brightness. Then the eyebrow is detected and the image is classified based on this by using linear regression algorithm.

In paper [5] "Prediction of mental stress based on machine learning" penned by Akshada Kene, Dr. Shubhada Thakare the implementation is done in two ways where the stress levels are analyzed by using Single Processing and another way by using Image & Video Processing. They took a Stress Dataset where the data is a combined entry from various sensors or online stress scale questionnaires etc. In this paper they took a comparison of SVM and RF the SVM stood as the best suitable model for their implementation

4. Methodology

This section explains the proposed system design and methodology. The proposed method consists of number of phases which are dataset acquisition, feature extraction and classification.

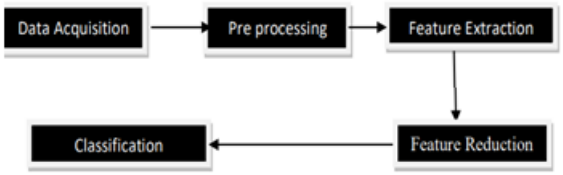

Figure 1: Flowchart

When the authenticated user logs in, the image capture is performed automatically depending on the period time. The pre - processing of the image for subsequent analysis in the further modules is done. Preprocessing of the image include two transformations. First one being the pixel transformation and other one is binary transformation. Pixel transformation as an image preprocessing is a technique of transforming a pixel value. Each ouput pixel value depends on only the corresponding input pixel value, which helps alter the brightness and contrast of an input image. Two commonly used point processing are multiplication and addition with a constant G (i, j) = α. F (i, j) + β, the parameters α > 0 and β are called as gain and bias parameters, these are used to bright and contrast the image. Here G (i, j) is output image pixel and F (i, j) is input image pixel where the (i, j) indicate that the pixel is located at i^{th} row and j^{th} column. The pixel transformation of an image is done to make the model generic and more diverse.

Now the image is converted into Gray scale image that is a color image is converted into black and white or in shades of grey. Threshold of the image is found which is used to convert gray scale image into binary form, If the pixel value is greater than threshold pixel value is set to 1 otherwise 0, hence in this way the image is converted into binary form.

Figure 2: Image preprocessing

After data Pre - processing, raw dataset contains numerous unusable properties like Temporal Demand, Heart Rate, Effort, Mental Effort, Nasa TLX, Mental Demand etc

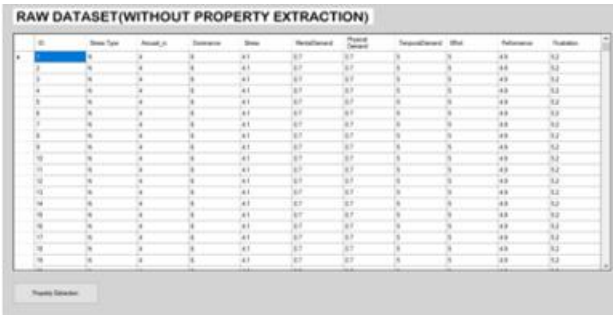

Figure 3: Dataset without property extraction

Essential properties namely Condition (No stress, Time pressure, Interruption), Stress, Physical Demand, Performance and Frustration from raw dataset are extracted to build a new property extracted dataset. For this Principal Component Analysis feature selection is used, which transforms to six principal components: Condition (No stress, Time pressure, Interruption), Stress, Physical Demand, Performance, and Frustration.

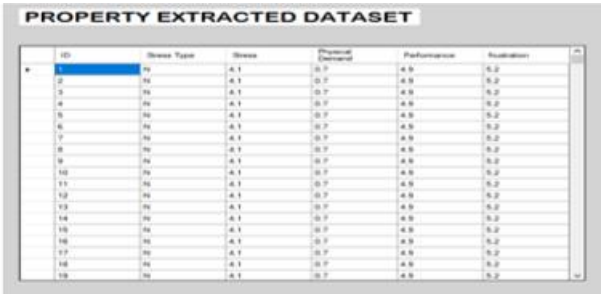

Figure 4: Dataset after property extraction

Excessive features increase computation times and storage memory. Furthermore, they sometimes make classification more complicated, which is called the curse of dimensionality. It is required to reduce the number of features. PCA is an efficient tool to reduce the dimension of a data set consisting of a large number of interrelated variables while retaining most of the variations. It is achieved by transforming

the data set to a new set of ordered variables according to their variances or importance. This technique has three effects: it orthogonalizes the components of the input vectors so that uncorrelated with each other, it orders the resulting orthogonal components so that those with the largest variation come first, and eliminates those components contributing the least to the variation in the data set. It should be noted that the input vectors be normalized to have zero mean and unity variance before performing PCA.

In this research work we are using Support Vector Machine as classifier. This classifier is usually used in several research areas due to its out performance in pattern recognition and image processing tasks. Support vector machine (SVM) is extensively used in pattern recognition and image processing due to their originality of concepts using strong mathematical base and have strong realistic ability. SVM take intelligence from its training set to classify unknown data in testing phase. SVM suits most excellent for classification troubles with small training dataset and high dimensional feature space. Like neural networks, SVM also needs two preparation stages; training and testing stage. SVM trains itself by features given as an input to its learning algorithm. The aim of SVM is to choose the suitable margins between two classes during training. Features are labeled according to class associative with particular class.

The implementation of SVM classifier with RBF kernel provides the accurate detection of mental stress level. The measurement result indicates that the proposed techniques achieve the mental stress classification accuracy of 91%. From the results, it was concluded that the proposed methodology provides a promising way to detect mental stress in an individual.

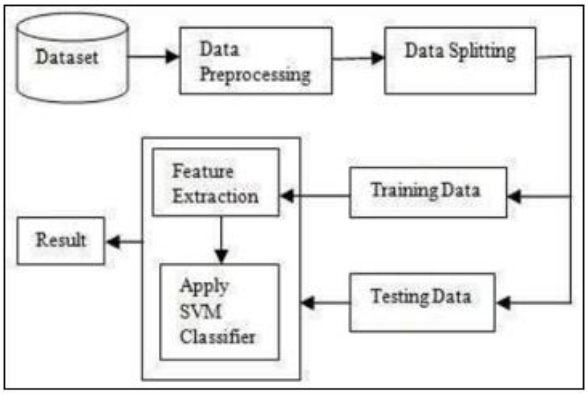

Figure 5: Methodology

5. Result and Discussion

The experimental results obtained from feature extraction and classification are briefly described in this section. Sensitivity, specificity, and accuracy are the 3 evaluation metrics are used to analyse the performance of the system. The evaluation metrics are calculated by using true positive, true negative, false negative and false positive values

Sensitivity: The probability of abnormal images classified as abnormal is given by sensitivity. It also defined as the proportion of true positives are correctly detected by the system

Specificity: Specificity gives the probability of normal images being classified as normal. Which can also be defined as the proportion of true negatives are correctly detected.

Accuracy: Accuracy defines how well the system gives correct results. True Positive (TP) If the actual value is positive and the value predicted by the model is also positive. Then if the predicted value matches the actual value, it is said to be True Positive (TP).

- True Negative (TN) If the actual value is negative and the value predicted by the model is also negative. Then if the predicted value matches the actual value, it is said to be True Negative (TN).
- False Positive (FP) If the actual value is negative and the value predicted by the model is positive, the predicted value is falsely predicted. Then it is said to be a False Positive (FP).
- False Negative (FN) If the actual value is positive and the value predicted by the model is negative, the predicted value is falsely predicted. Then it is said to be a False Positive (FP)

6. Conclusion and Future Enhancements

If the survey is taken at the end of a heavy workday then the results will be more accurate and as predicted. Here, we have considered the working environment to identify stress in the employees. We can also take different types of working environments and prepare questionnaires according to them. We can apply different machine algorithms to that dataset to detect the stress at a particular organization. For further implementation, we can use the image and video processing dataset and apply CNN to it. By doing so, we can identify the individual people who are feeling stressed. .

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