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Neural Network model for Identification of Stress using HRV

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ABSTRACT: We face various pressures in our daily chores, all sections of our society, being victims. Stress is a feeling of emotional or physical tension. Stress is your body's reaction to a challenge or demand. Stress causes disorder which can be fatal and can be avoided if identified at an early stage through proper observation leading to mental wellbeing. Stress observation is learning body response in stressful state. During this time, heart rate and blood pressure will rise and several hormones enter our bloodstream. We may be able to bring out the best performance under the influence of these hormones. Different people respond in different manner to stress and we cannot categorize all stress as negatively affecting. A person enjoying a certain stress or pressure may not enjoy another stress or pressure in the same manner and this is different from person to person. The symptoms shown when in stress vary in individuals. Frequency and excitation of a speech signal can be used to recognize stress area as biomedical signals relate to central nervous system, physiological parameters being the best way to decode human emotions.

Current work aims on stress identification from HRV using HRV physiologic net database, then entire environment of HRV signal characteristics i.e mean heart rate variability (HRV), standard deviation of all R-R interval (SDNN), square root mean of sum of the square difference between R-R interval (RMSSD) and a number of consecutive R-R interval variations greater than 50ms (NN50), Pan-Tompkins algorithm being used to extract these features, back-propagation algorithm being used to train and validate in neural network model. Stressful state of an individual can be analysed using these features (mean HRV, SDNN, RMSD and NN50). Thus we obtain subjective information helping doctors to find out whether a person is under stress or not.

Keywords – Stress detection, Human emotions, Physiological signals, Neural Network and Pan-Tompkins algorithm.

I. INTRODUCTION

The pressurized situation which a person has to handle during their day to day life is enormous. Stress has traditionally been described as action from a calm state to an emotional state in or to preserve the organism's integrity [1]. In the psychobiological level, stress is considered as a sequence of psychological, cognitive and behavioral complications regulated by the human central nervous system (CNS) and the peripheral nervous system (PNS). [2]. Some stress assists us in going through certain situations and we need not avoid them. In case of negative stress, it stress starts hurting and it can cause side effects such as mental and physical issues. Stress causing harm is usually termed as 'stress' generally. It has been discovered that if the stress acquired from family or working environment continues to appear, it will have serious effects on everyone [3].

The researcher found that chronic stress can lead to different mental and physical problem, including cardiovascular disease and immune deficiency. [4]. The researcher later discovered that physiological reactions, facial characteristics (facial expressions, eye gaze and eye blinks) and voice could be the channels for studying the emotional state of the person. [5]. Thus, the body expressions' features were examined. Usually, physiological responses were investigated by estimating the characteristics of an individual's physiological signals such as electrocardiography (HRV), electromyography (EMG) and electrodermal activity (EDA) under various affective states [6]. Sensors, usually cameras, are used for collecting videos or facial pictures, which was later used for examining characteristics such as facial expression, eye motions and dilation. Vocal parameters viz.: loudness and basic speech frequency were used for evaluation of voice. Prospective of adopting stress identification expressions of the body was looked into and some detection techniques were suggested. Physiological signals defining a person's stress is

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not a simple task. No such brilliant rules have been discovered and validated and recognizing stress from heterogeneous information, managing through and probability of which suggest an approach to the identification method.

On the other hand, paper spare is structured as follows: work linked in chapter II, pre-processing containing current stress identification, extraction characteristics, resemblance measures and classification. In section III, the suggested framework and classification algorithm are explained in detail. Experimental outcome is represented with debate in chapter IV and finally concluded with future improvement scope in section V.

II. RELATED WORK

Total performance of relative characteristics is found in [7]. Six classifier types are used for rearrangement: 1) Support vector machine with linear kernel 2) SVM with radial base function kernel 3) k-nearest neighbor (K=1-4) 4) Principal component analysis and SVM with linear kernel 5) PC and SVM with RBF kernel 6) PCA and neighbor closest. In [8], physiological information of humans is obtained with Smart Mobile Health Monitoring system using the advantage of bio-sensors. Internet of the sensor collects the information and a precise form of the information is sent to the personal computer of a patient, which in turn is transmitted to the medical server for determination. Here the data is analysed after which the medical server sends response to the patient's private computer, based on which patients can take necessary measures and precautions. The IMHMS consists of three parts. They are wearable network of Body Sensors: Private Home Server and Smart Medical Server for patients. Wearable bio-sensors are networked to form a sensor network in the body of the patient. The sensor detectors carry out the collection of significant information.

In [9], a heart rate monitor (HRM) was used to define mentally stressful event. The method is linked to the main condition of dynamics, after inquiry of the variation of the heart rate. In [10], the Galvanic Skin Response (GSR) is a skin conductivity measurement that his significantly linked to human emotional condition during stress and activation stage. Human skin's electrical behavior can be estimated by skin behavior level or reaction (SCL and SCR) which varies with human mental and emotional state. Research of galvanic skin response is done by positioning two electrodes forming a conductive pathway between them which crosses the hand palm. Skin resistance or reciprocity; this parameter is used for the calculation of skin conductance. According to Ohm's law, the resistance of the skin equal voltage applied by the current passed, between electrode and through skin between the electrodes. Thus, the prospective skin difference is calculated and accomplished through the data acquisition system. In [11], they discover a fresh spectral feature that estimates the equilibrium measure of the self-sustaining nervous system by combining data from the respiration task's power spectral density, i.e. breathing and variability in heart rate.

From the rate and reaction of skin conductivity, characteristics such as mean, median and standard deviation are evaluated. Using the logistic recession pattern, they evaluate outpatient stress. In [12], indicated principle machine learning mode to classify big information of continually acquired, multivariable physiological information, using wearable patient monitors, also provides early warning of serious physiological issue, so that a degree of estimation care can be given. Literature produced on wearable sensors and devices for tracking human actions was examined in the article [13]. It reveals that there will be many more lightweight, high-performance wearable devices available to monitor a wide variety of actions.

An instance could be the work of Cinaz et al. [14], who regarded a 3 classification problem to divide the mental job quantity of the office worker into low, medium and high groups using only an HRV signal and HRV (eight time domain characteristics and LF/HF ratio) to achieve right predictions for 6 out of 7 topics using Linear Discriminant Analysis (LDA) [15] Classified. Wijsman and others. [16] HRV evaluated along with trapezoid muscle conductivity, respiration and EMG. A precision of 80 percent in non-stress detection and 69.1 percent in stress detection was accomplished by them using a decreased set of characteristics (only five characteristics) obtained from those signals, including Heart Rate. HRV, EMG, EDA and ST were evaluated in the research conducted by Palanisamy et al. [17] and a total of 148 characteristics were acquired. Classification accuracy of each of the signals was evaluated instead of establishing a classification scheme based on the whole signal set. Results show that HRV and HRV performed well in the detection of stress relative to other signals. Classification rate for HRV was 93.75%, being the highest. 76.25% for HRV was the next and the minimum classification for EDA signals which was 70.83%. Melillo and others. [18] Evaluation of the effect of

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stress on HRV parameters was done in real-life conditions, unlike most state of the art works that use laboratory settings for testing. Two critical moments were chosen for estimating the HRVs of learners: during an oral examination and after holidays. 13 non-linear HRV and LDA characteristics were used by them to classify stressed and relaxed conditions.

III. PROPOSED WORK

A. Problem description

In cases of certain jobs like fireman or astronaut, who always face challenging circumstances, stress can change their activity and put them in danger. So employee stress is measured and then feedback is provided and solved to regulate this state, which is quite important. For the mental well being and early detection of associated illnesses, stress surveillance is very essential. The present research focuses on identifying stress from HRV signals using back propagation algorithms in neural networks.

B. System architecture

The system architecture in Figure 2 demonstrates the following elements: Pre-processing, feature extraction, training, classification and testing.

1) Pre- processing

Pre-processing is our suggested system's original method.HRV signal is very much influenced by noise which weakens the signal. Here 50 Hz power supply is used which causes an interference like noisy signals, which is the primary digital signal issue. Inhalation muscle interference is also an issue. Before the signal is used in the stress detection phase, this interference such as loud signal should be removed, so notch filter is used for fixed frequency noise source such as line frequency (50 or 60 Hz) noise on the command. Then the interference such as noise is removed and function is extracted.

2) Feature Extraction

Perspectives on the situation of extraction of features is characterized in this phase. It is said that features are characteristics that represent all the biological signals. Employing the Pan and Tompkins algorithm, the QRS complexes are identified where a digital band pass filter is performed. Fake identification induced by the various kinds of interferences in the HRV signal by matching the ordinary QRS complex range is reduced. QRS power is increased in the pass band, ranged within 5 Hz to 35 Hz. The derivative method stops the low-frequency elements of P and T waves and gives the gain to high-frequency elements resulting from the high slopes of the QRS complex, and then the square waveform passes through the motion window integrator, which in turns squares the signal patterns from point to point in nonlinear transformation.

3) Train to Machine learning

They train to SVM after extracting the features because it is a basic classifier, but it can't correctly classify because the dissimilarity in patient's stressed and unstressed information is very minute, then train to the neural network using back propagation algorithm. The weights of the inputs are adapted with supervised learning to train back propagation. In the teaching strategy of neural networks, the training set's input values are rated with necessary output. Initialization of weight is performed at random speed during the past. Each training data set provides the perceptron output, which is compared with input dataset for obtaining the necessary output.

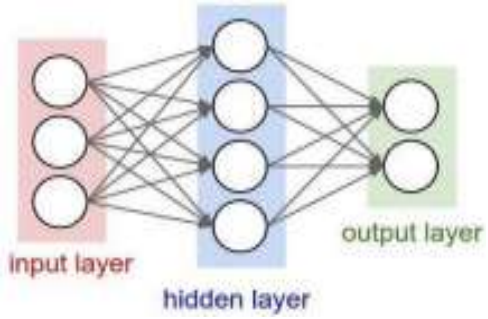

Figure-1: Neural network architecture

A. Back propagation algorithm

The back propagation algorithm is now widely used to train neural networks. The scheme operates by estimating the non-linear relationship between input and output values internally by tuning weights on the connector.

Algorithm: Back propagation **Input:** Data setting for the sample of training and appropriate destination outputs.
Output: Trained neural network.
Enter bias and weights to tiny random numbers. // Sending input vector: For every neuron a input layer,

$O_A = I_a$

for every neuron a in the hidden and output layer,

$Ia = \sum_b W_{ab} O_b + {}_a$

$O_A = 1/1+e^{-Ia}$

//Propagating error back to front: for every neuron a in output layer,

$Error_a = O_a(1 - O_a)(\sum_m Error_m W_{am})$

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For weight linked with every edge in the network,
$\Delta W_{ab} = (1)\ Error_a O_b$
$W_{ab} = W_{ab} + \Delta W_{ab}$
for rest of bias $_a$ in network,
$\Delta_a = (1)\ Error_a$
$_a = _a + \Delta_a$

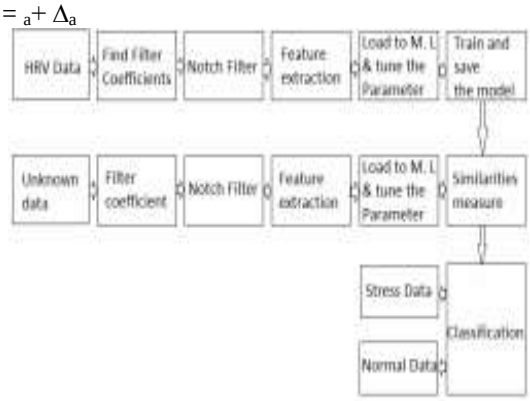

Figure – 2: System architecture

4) Testing Strategy
The approach used for testing is described below:
a) **Features to be tested** – The features to be tested, most importantly include the estimation of Mean HRV, SDNN, RMSSD, NN50 of an individual patient for the proper execution of the entire model.
b) **Items to be tested** – The unknown HRV data to be tested with include all the features of individual patient, which together form the whole model.
c) **Purpose of testing** – Identifying whether a patient is under stress or not is the main source of the project.

IV. RESULTS AND DISCUSSION

To conclude whether an individual is suffering from stress or is normal can be arrived at through the following process. A model being taken from the training database to which test data is fed generating test information results to calculate the outlook effectiveness, for arriving at the conclusion.

Experiments are performed for the stress identification using HRV physioNet database which are trained by the neural network using back propagation algorithm in Matlab software. Graphical user interface is used for representing the gain results. Thus how it helps to classify, if a person is under stress or not, for mental well-being and early detection of associated illnesses, this is crucial. The simulation below provides the stress plot of the normal person.

V. CONCLUSIONS

We conclude that the training set region can be bundled into standardized groups based on self – reported feelings and train and test the regions of the same group constructing the pattern to differentiate the nature of that stimulus, so how the model is created to know from the training information set and is tested with another set of information for the test stage with assisted vector machine and neural network classifier model for identification of stress. Whether a person is under stress or not can be analysed easily with our study. In the proposed method, HRV signals are employed efficiently to indicate whether a person is suffering from stress or not, which helps the doctors for further diagnosis and treatment procedure.

Refining the model, in future, focus should be concentrated on stress level of the subject under study. People who deal with highly precise data are under immense pressure putting them under stress. Hence it is important to obtain an individual's stress level and to prescribe a solution as it is very essential to detect stress levels early.

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