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Electrocardiogram signals and Psychological Disorder level Prediction using Machine Learning

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1st A Yashudas
Department of Physiotherapy
School of Allied Medical Science
Lovely Professional University
Phagwara, Punjab – India
dr.anthoni@gmail.com

2nd Enjula Uchoi
Departmen of Computer science and Engineering
Lovely Professional University
Phagwara, Punjab – India
enjulapaintoma@gmail.com

***Abstract*— Given the current generational trends, stress is becoming an increasingly important component of people's life nowadays. Nobody on the planet is immune to the negative consequences of stress and despair. We proposed in this study that the electrocardiogram can be utilised to predict and detect differences in human heart rate, rhythm, and electrical activity caused by psychological issues using a machine learning approach. Additionally, particular ECG patterns are utilised to indicate mental health issues such as panic disorder, bipolar disease, and weaknesses. Electrocardiogram (ECG) data records the heart's electrical activity and is usually used to diagnose and treat a variety of heart problems as well as to detect psychological illnesses. Mental stress has a significant impact on the human body, particularly the cardiovascular system. In this paper we have used the Hidden Markov Model (HMM) to train ECG dataset. The dataset was compiled from multiple health care facilities and hospitals, and it included 876 people of various ages as well as an ECG pattern report. We employed HMM classifiers to classify the accuracy, precision, and recall properties. The accuracy of HMM is (91.75%).**

Keywords—Hidden Markov Model, Psychological disorder, Support Vector Machine, Random Forest, Electrocardiogram,

I. INTRODUCTION

Stress is amongst the major psychological problems across all country due rapid changes in today's lifestyle. Sources of the stress are the work place and change to the new environment. Nevertheless, continuous pressure of highly stress occupations or any stressed environment consequently gives rises to chronic psychological conditions. Persisting mental stress also effects physical pathologies like muscular pain, suppresses immunity and mentally effecting sleeplessness, forgetfulness and undue anxiety.

The mental health problems compromise the wellbeing and the standard of living of the population. Mental stresses are considered important route cause in the decline of the mental good health and wellbeing. These days, discrepancy in social oneness due to anti social groups discomforts the consumer. The incidence of new cases and rapidly increasing prevalence of mental stress has become the challenging test to overcome in every point and course of life. Pressure, discomfort, unease and distress are often contrast or used interchangeably. They fundamentally differ in that unease is often a feeling that isn't directly and plainly are the distress response or target hazards. However, stress unconscious and instant response against daily challenges and additionally regarded as more adaptable than anxiety. Similar physical symptoms, such as a faster heartbeat, sweaty palms, and a racing stomach, are frequently shared by anxiety and stress. These symptoms are brought on by neuronal circuits that are heavily covered when the brain fails to distinguish between an apparent and a real threat. These similarities extend to the outward manifestations associated with each stage.

II. RELATED WORK

Studies so far postulates that stress severity is perceived by the electrocardiogram electrode receiving the changes in biological impulses like Heartbeat Rate, Inspiration and expiration rate and movements of limbs. Different studies featured in certain different time Interval all the biological impulses related to stress. Various machine learning techniques for determining the stress classification with fine precision were incorporated. Adnan Ghaderi et.al [1] Using the study of supervised and algorithms of Nature-Inspired have provided analysis thoroughly of the number of psychological disorders that can be detected. There have primarily been three strategies introduced: those for diagnosing disorders, finding diseases, and classifying them. The researchers first discussed the impact that race has on people who suffer from psychological disorders. Kaur and Sharma (2019) [2]

Vinaya et al. (2014) concentrated their research in the same year on finding arrhythmia caused by human stress. In order to de-noise the ECG potential keeping the integrity of ECG electrode potential changes of ECG, the features of stress were retrieved using the DWT technique. Hidden Markov Model was later used for ECG signal categorization [3]. A classification approach using kernel SVM and Genetic Algorithm (GA) was put out. The three essential components of the technique are lead-fall detection, feature extraction, and classification. For a training dataset of 1000 records, the approach has shown 92% true positive detection, 5.68% false positives, and 94% classification accuracy. by Zhang et al. (2014) [4]. An ECG graph features in duration in millisecond and millivolt and classify in time interwal and segments design utilising circuit of neural networks, optimal subband tree structuring and GA was proposed. While analysing 25

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ECG characteristics, the structure obtained with accurate classification of 97% for data set of small groups by Li et al. (2017) [5] For the identification of stress and sleepiness, multi-objective GA (MOGA) in addition to MKL-SVM was used. All findings indicate that, while detecting driver drowsiness and stress, respectively, 97.1% and 96.9% in final outcome of the accuracy with Receiver Operating Characteristic (ROC) have been achieved by Chui et al. (2020) used [6]. By utilising the Swarm Intelligence (SI) system were able to identify cardiac arrhythmia as a condition affecting the heart. An ideal set of features of ECG interval and segment diagnoses cardiac arrhythmia have been found using the SI concept. The Satin bird Optimization technique appeared to perform better based on the results Sharma and Singh (2020) [7]. They studies using the persistent recording of the ECG with happy state of mind and unhappy state induced by the sad auditory signals and disturbing images. Preferred outcome is provided by the channel of worldly pair over any other pair does, considering the channel pair different recurrence group gave desired outcome was seen in group of high recurrence than the group of low. This helps in improvement in continuous format different emotional sets when implementing different courses of EEG. Using one channel set for the continuous design frame for the biometric bliss processing based on outcome. Noppadon Jatupaiboon et.al.[8].

The data set of Automobile Driver (DRIVEDB) is incorporated. Incorporating the grouping techniques classifier like, RBF, KNN, and SVM-RBF were examined. Mental Stress with 83% accuracy rate were predictrd by the SVM-RBF classifier. NermineMunla et.al.[9] Assessment of mental stress and anxiety uses multimodal sensors tracing the changes in biological impulses. Electroencephalogram, Electrocardiogram, oxygen saturation in blood, Blood Presure, and Respiratory Rate sensors, with all these the severity of the mental stress and anxiety were measured. The anxiety level category was classified by SVM classifier. Yuchae Jung et al.'s [10]

Yoshiki Nakashima et. al. has explained the categorization of stress in three different state namely first calm, second focused, and third level of choice in combination [11] According to Prasanna Vadana et. al.analyse the stress levels of workers using a variety of sensors and categorise each person's level of stress using SVM and KNN algorithms. Extract the SWELL-KW dataset for this study to get the most accurate results possible. Prasanna Vadana et. al. [12] study of stress level in 206 college students' of various stress characteristics, such as exam stress and recruitment stress. The dataset from Jaypee Institute of Information Technology were used for classification by NB, LR, SVM, and RF. Alisha Banga,et.al [13] presented a design for a stress detection system that uses machine learning to collect numerous human body signals and used MATLAB programme for simulation and implementation. The training and testing phases made use of the Physionet Drivedb dataset. The accuracy of the stress level classification using the SVM algorithm was demonstrated. Rayed Farhad ,Md Fahim Rizwan, et.al.[14] Along with biomedical-based analysis work, researchers from many domains, particularly those focusing on application development, devote their time to image and signal analysis. The most common signals used to reveal how well the heart is functioning are electrocardiogram (ECG) signals [15].

In recent years, the detection and classification of ECG signals have generally been separated into two components of adaptive investigations. The goal of detection studies is to identify the heart rate from the ECG data spam that was acquired over a specific period [16–17] were applied to find the heartbeat. A crucial phase in the ECG bio-medical study is ECG signal categorization. The heartbeat signal might be automatically identified thanks to this approach. Signals of ECG peculiarly have distinctive structural characteristics, seen in PR interval –QRS complex ST segment peaks with different time duration. These structural alterations analysed visually to determine a variety of heart disorders [18].

Therefore, it is crucial to create an automatic monitoring system that can identify sickness with the least amount of calculation time. Heart disease classification using supervised and unsupervised machine learning techniques is being researched. One of the best methods for automatically detecting heartbeats is SVM. However, creating an effective ECG monitoring system is a difficult undertaking due to signals that differ depending on gender, age, and many other characteristics.Consequently, a static design cannot be used because of the dynamic nature of the ECG signal [19]. Karthikeyan and Murugappan et al. (2014) employed the stroop test with words in different colour to add the stress depending upon the ECG signal graph that was generated and later used to determine the stress level. The DWT technique is used to extract the features from the ECG data. The right wavelet function selection is crucial for feature extraction. The mother wavelet transform provides the best wavelet function required to completely cover ECG data during the feature extraction step. With a 94.5% accuracy rate, the signals were identified as stress or normal [20].

Revathi et al. (2020) used Feedforward Neural network and back propagation and also GA to analyze with temporal, spectral, and statistical features of the ECG signal. The effectiveness has been compared to Support Vector Machine algorithm and K- Near Neighbor approach. The researcher did the signal alteration using the crossover GA operator that dares to improve feed forward back propagation neural network training and classification [21]. Reddy et al. (2020) has discussed about the early stage heart disease prediction, used GA along with fuzzy logic classification. The heart pathology-related feature was chosen using GA, and the disease was categorized using a fuzzy rule system. Using GA, the fuzzy rules have been optimized, and rough theory has been used to choose the key features. GA using a fuzzy rule set has been

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utilised for prediction [22]. They understood that intense emotion and mental stress contribute significantly to severe and deadly ventricular arrhythmias. The cortical and brain stem levels of central processing, the autonomic nerves, and the electrophysiology of the heart are some of the mechanisms. In this paper the entire system is viewed as an interactive brain-heart system that is interconnected which was discussed by Taggart, Peter, et al. 2011[23]

III. METHODOLOGY

The purpose of the current part is to present the suggested work's thorough methodology. The authors first go over the types and sources of the datasets used in the study.

A. ECG and Psychological Dataset

The dataset was collected from various health care centers and Hospitals, with a total of 876 participants of various ages and pattern report of ECG.

B. Support Vector Machine

Support Vector Machine is a machine learning algorithm. Both classification and regression issues can be resolved with this supervised machine learning approach. The SVM classifier, which divides the two classes into a hyper-plane and a line, is a frontier. We give the input of person stress information into this stress detection system. The system will then use an SVM classifier and random forest on the input to determine whether or not the user is stressed.

C. Random Forest

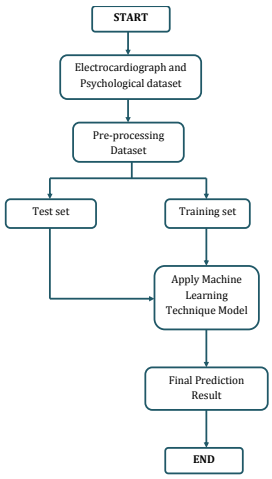
Random Forest is a sophisticated and widely used machine learning technique for classification and regression tasks. It is an ensemble learning method that integrates numerous decision trees to generate a more accurate and robust prediction model. Random Forest is more accurate than individual decision trees, especially on complicated datasets.

D. Hidden Markov Model

Hidden Markov Model (HMM) is a statistical model used in various fields, including speech recognition, natural language processing, bioinformatics, and more. It is particularly useful when working with temporal data, where the underlying system is assumed to be a Markov process with hidden states. The model is called "hidden" because we cannot directly observe the states but can only observe certain outcomes or emissions associated with each state.

The standard framework of detecting system of mental stress, which is divided into different phases like the mental Stress measured from ECG dataset, pre-processing to clean the data , training 80 % data and testing 20 % data, model of mental stress detection, and anticipated outcome, is depicted in Figure 1.

FIGURE 1. FLOWCHART OF ECG AND PSYCHOLOGICAL DISORDER AND STRESS DETECTION

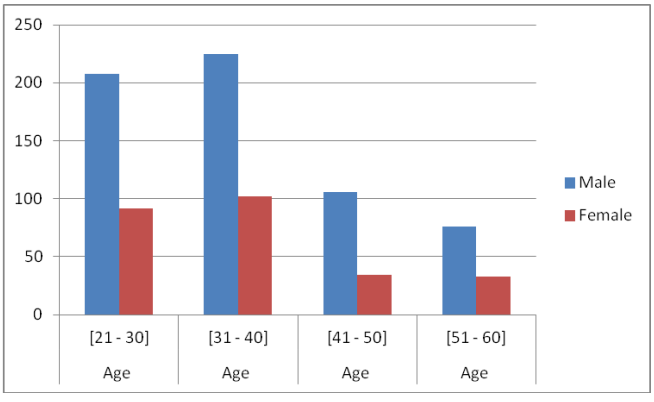


EGC and Psychological Disorder Dataset: During this phase, information is gathered via a variety of sensors unipolor, bi-polor and precordial lead. In present dataset, data attributes and class labels of data are constructed and assimilate mental stress prediction. In present dataset, each and every tuple represents an attribute with an integer value. Psychiatrists assign class label values depending on input values that users submit as the chief complains and demographical data survey data. A total sum of 876 male participant and female participants ECG and Psychological data is used in this study, every participant is within the age range of 21 to 60 as depicted in Table 1.

TABLE 1 AGE WISE PARTICIPANTS

Gender	***Age [21 - 30]***	***Age [31 - 40]***	***Age [41 - 50]***	***Age [51 - 60]***
Male	208	225	106	76
Female	92	102	34	33

FIGURE 2. MALE AND FEMALE PARTICIPANT



D. Pre-processing

This stage involves a number of processes on the incoming data to eliminate any information that is not relevant for detecting the mental stress. When collecting the data the participant's name, age, gender, literacy qualification, residential address, occupation, and workplace environment are all required. Such information is not taken in previous studies dataset in several areas. These dataset has been executed by pre-processing to get rid of unclean data.

E. Data Division

In this phase, the dataset is pre-processed followed by splitting it into two halves since 80% of the dataset will be utilized for training and 20% for testing

D. ECG and Psychological classification using SVM

The part is devoted to assessing the present study work's performance in parameters like accuracy, precision, recall, and specificity performance metrics. The following formulas are used to determine these parameters while taking into account in the parameters of confusion matrix to assess the comprehensive accuracy of the prediction:

$$\textbf{Recall} = \frac{\text{True}_{\text{positive}}}{\text{True}_{\text{positive}} + \text{False}_{\text{Negative}}} \quad (1)$$

$$\textbf{Accuracy} = \frac{\text{True}_{\text{positive}} + \text{True}_{\text{negative}}}{\text{True}_{\text{positive}} + \text{True}_{\text{negative}} + \text{False}_{\text{positive}} + \text{False}_{\text{Negative}}} \quad (2)$$

$$\textbf{Precision} = \frac{\text{True}_{\text{positive}}}{\text{TRUE}_{\text{POSITIVE}} + \text{FALSE P}_{\text{OSITIVE}}} \quad (3)$$

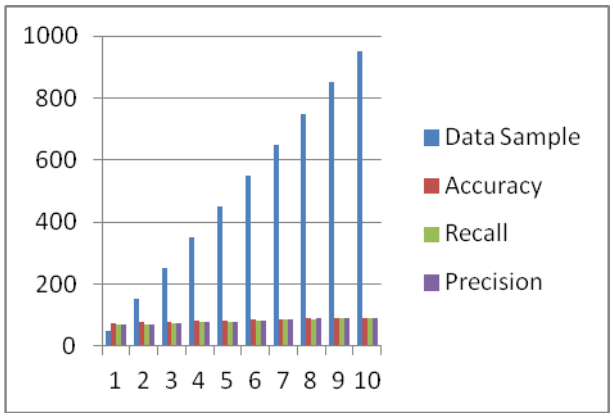
IV. RESULT

The outcome of the prediction is in a parameter of confusion matrix represented in expression of true positive and negative false positives and negatives. Recall, accuracy, and precision, are additional performance criteria that are used to describe these factors. Table 2 lists the results of 876 ECG samples predictions along with percentage values for recall, specificity, precision, and accuracy variations. Column 1 of the list contains the variation seen in ECG samples.

TABLE 2 PERFORMANCE OF ACCURACY, RECALL AND PRECISION

Data Sample	***Accuracy***	***Recall***	***Precision***
50	74.65	67.13	67.31
150	76.39	70.35	68.34
250	78.43	73.29	73.04
350	82.56	75.89	75.98
450	83.45	78.78	79.45
550	84.68	82.87	82.86
650	87.71	86.56	86.38
750	88.79	87.45	88.36
850	89.65	89.79	89.89
876	91.75	91.45	91.59

FIGURE 3 PERFORMANCE PARAMETER



V. CONCLUSION AND FUTURE SCOPE

In activity of daily living and day today life, psychological disorder and stress are the major concern. Evidently several methods are brought to diagnose the stress. Furthermore, numerous datasets can be employed in detecting stress. Distinct classifiers are employed and displayed the accuracy. Hence feasibly recognise the stress. As indicated in the study's methodology, stress is detected through the interview, other interactions, facial expression reading and studying one another individuals. This present study machine learning is employed for detecting and predicting mental stress of participants. Using Hidden Markov Model algorithm classifier, all of the collected data was classified to predict the mental stress. Evidently in this study the Hidden Markov Model algorithm provides better accuracy. In future we can work to determine the precise stress level and to anticipate the disease, for this a variety of machine learning algorithms and deep learning approaches can be combined. A deep learning system called the convolution neural network can be utilised to forecast users' levels of stress. Several machine learning methods can be incorporated to predict severity of stress, participant's anxiety, and classification of Psychological disorder, including K-Near Neighbors (KNN) and Naive Bayes

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