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Artificial Intelligence in Human Activity Recognition with Anomaly Prediction for Healthcare systems

Ayasha Siddiqua
College of Engineering, Jazan University
Jazan, Saudi Arabia

Abstract
Understanding human behavior is a complex task that requires careful analysis. Researchers have been exploring various machine learning techniques to gain insights into human nature, but achieving high accuracy has been challenging. In our study, we propose using deep learning techniques to address this issue. To conduct our research, we collected a public dataset using EEG and HRV sensors. To ensure data quality, we applied a median filter to remove noise, specifically salt and pepper noise in the collected images. Next, we employed feature extraction techniques, specifically Genetic Algorithm, to reduce the dimensionality of the datasets and improve accuracy. Finally, we applied classification techniques to further analyze the data. Our proposed approach utilizes an Enhanced Convolutional Neural Network (ECNN) to improve the accuracy of classifications. Finally, we compare our results with the existing approach based on their accuracy. This method helps to detect one's stress level, happiness, and mood swings, among other things.
Keywords: EEG and HRV sensor, Median filter, Genetic algorithm, Enhanced Convolutional Neural Network

Review of literature

[1]. Parab A.N et.al (2020) This paper explores the implementation of stress and emotion analysis using IoT and Deep learning. It focuses on identifying electro-dermal activity and conducting emotional and sentimental analysis through the amalgamation concept. This concept explores the identification of stress levels based on different states of mind. The paper introduces various methods such as emotional sensation, speech recognition using advanced technology, and deep neural networks, all in the context of IoT.

[2]. Mozafari M et.al (2020) This paper discusses the implementation of IoT-enabled technology. Monitoring mental stress using multiple modes For this paper, we are implementing a system that detects human stress levels using Artificial Intelligence (AI) and the SVM algorithm. We extract the features using the fisher method and handle the classification technique without the need for the PCA method. Using this method, the paper aims to detect and classify multimodal emotions based on their accuracy level.

[3]. Verma P et.al (2019) This paper presents a comprehensive framework for monitoring student stress in a fog-cloud IoT environment. For this project, a Bayesian belief network is implemented to classify input data. The data is divided into normal and abnormal categories based on analysis. The student data is then inserted into a two-stage temporal Dynamic Bayesian network (TDBN). This predictive model includes four parameters for further analysis: leaf node evidences, context, student health trait, and the workload context. The paper aims to analyze the precise level of emotions in individuals.

[4]. The study conducted by Padmaja N et.al (2020) This paper discusses the implementation of an IoT-based stress detection and health monitoring system. This paper focuses on the implementation of stress level detection using various equipment. However, accurately predicting stress levels has proven to be a significant challenge. It is important to note that individuals may appear healthy but still suffer from stress, which should be recognized as a chronic illness. To address this issue, the Internet of Things (IoT) has introduced sensor devices that aid in accurately detecting stress levels.

[5].Rachakonda L et.al (2019) This paper presents the implementation of a deep neural network integrated into an edge device for stress level detection in the Internet of Medical Things (IoMT). The study involves collecting a dataset of three waveforms (2000, 4000, and 6000) and conducting

tests and evaluations on the training and testing datasets. Thus, the final results demonstrate improved accuracy and superior classification outcomes.

[6] Uday S et.al (2018) This paper focuses on the implementation of stress detection using wearable sensors on an IoT platform. This paper utilizes sensor devices such as HRV, Galvanic skin response, and electro-dermal activity to detect different forms of stress evaluation in the human body. Additionally, the paper introduces the use of MATLAB visualization to enhance the setup of specifications in the Internet of Things. This aids in identifying more accurate and precise measurements of emotional and stress levels in individuals.

[7]. Raval D (2021) This paper discusses the implementation of stress detection using a convolutional neural network and the Internet of Things. This paper discusses the implementation of the Convolutional Neural Network (CNN). In previous instances, the utilization of Artificial Intelligence in the Internet of Things has greatly improved the accuracy and classification of emotional identification and stress detection. Thus, this paper implements the CNN for improved image classification. It is widely acknowledged that CNN produces superior classification results compared to other techniques.

[8].Shon D et.al (2018) This paper focuses on implementing the detection of emotional stress states using a feature selection technique based on genetic algorithms. This paper discusses the implementation of a genetic algorithm for feature extraction and the use of the K nearest neighbor algorithm for classifying a given dataset. The DEAP dataset, which contains a public collection of EEG signals, is used for this purpose.

[9].Chakladar D et.al (2020) This paper presents a method for estimating mental workload using a deep BLSTM-LSTM Network and Evolutionary algorithm. The study utilizes EEG and ERP signals to measure mental stress and applies multilevel alignment to accurately detect values in the input data. This paper demonstrates the implementation of the STEW dataset and the Grey wolf optimized technique, which has shown superior optimization compared to the GA and the PSO feature extraction technique. Using a multi-level hybrid algorithm, the bidirectional long-short term memory and long short term memory models are employed to assess mental stress.

According to a source [10]. In a study conducted by Santhoshkumar S et.al in 2017, This paper discusses the implementation of a fast time scale genetic algorithm for image segmentation, utilizing a cellular neural network (CNN). This paper explores the implementation of the genetic algorithm and the CNN technique, which are both considered advanced methods for evaluating brain stress. One of the key benefits of the genetic algorithm is its ability to predict and convert images into binary values. CNNs are employed to detect image recognition by analyzing pixel values.

The reference [11] is from the study conducted by Yatbaz et al. in 2021. This paper presents the implementation of activity recognition and anomaly detection in E-health applications using color-coded representation and lightweight CNN architectures. Human activity recognition is becoming increasingly important, as early detection of human activity can help identify the individual's mental state at an earlier stage.

[12]. In a recent study conducted by Miranda L et.al (2022) This paper discusses a survey on the utilization of machine learning methods in context-aware middlewares for human activity recognition. It explores how these methods can predict and detect human activity in the network. The paper specifically focuses on the implementation of convolutional neural networks for classification techniques, which have shown improved accuracy compared to existing methods.

[13].Santamaria A F et.al (2018) This paper discusses the implementation of a real IoT device deployment for e-health applications using lightweight communication protocols. It focuses on the use of activity classifiers and edge data filtering to enhance accuracy detection. The paper also includes a comparison with existing approaches.

3.Overview of the proposed approach

The overview of the proposed approach implies that input image, Pre-processing technique, segmentation, Feature extraction, and finally classification process takes place.

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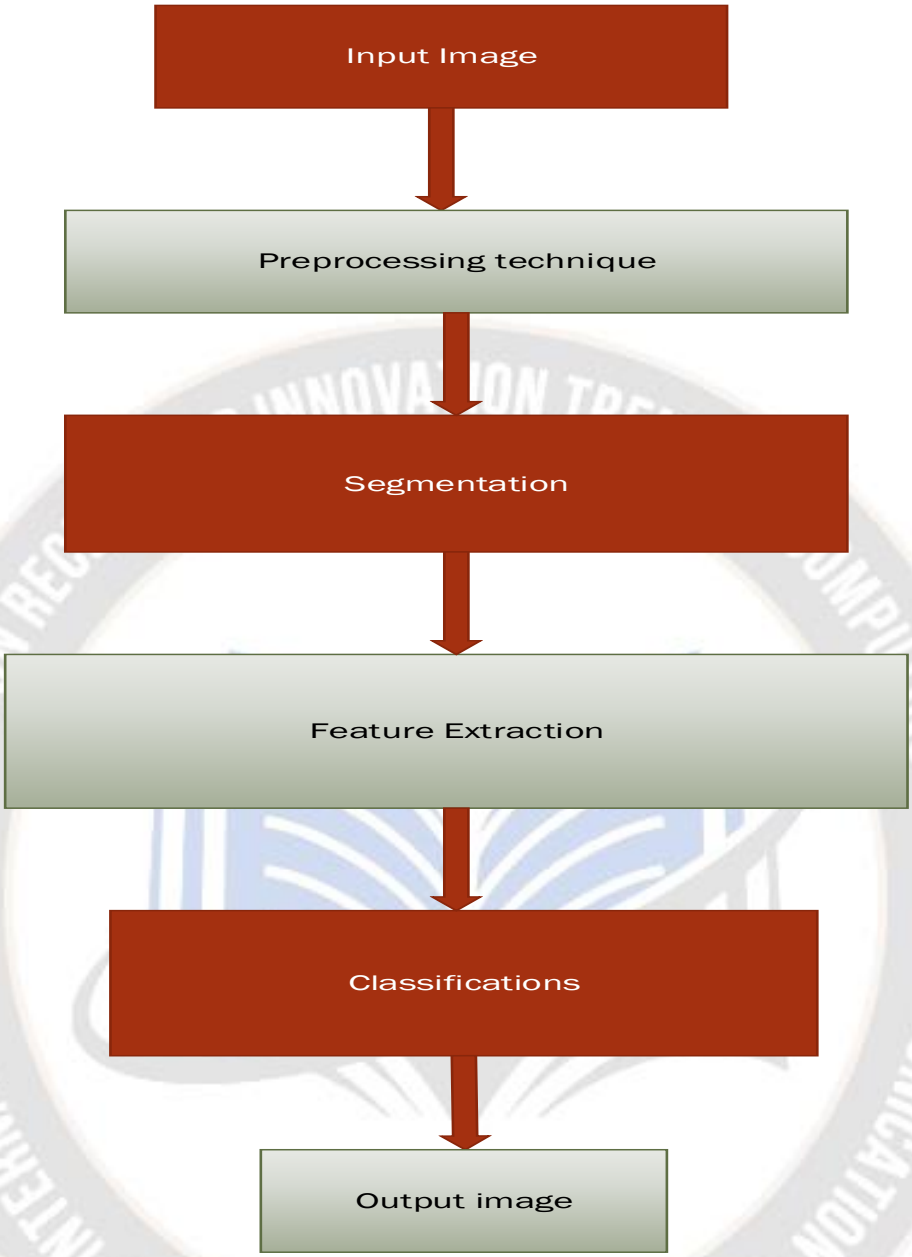

Fig 1 Overview of Proposed Approach

The fig 1 implies that the overview of the proposed approach, In very first stage the collected dataset are inserted to the input image. This image goes through the pre-processing technique, this technique helps to reduce the noise in the filter and improve the image quality. The main function of the pre-processing technique helps to converts the image into RGB to Grey Scale image.

Segmentation technique involves breaking down large amounts of data into smaller parts to improve the accuracy of classification. As an IT project manager, I understand the importance of feature extraction in dimensional reduction and enhancing image quality. It plays a crucial role in smoothening images and sharpening edges. Dividing the input data into more usable groups is crucial for enhancing classification in image processing. The feature extraction plays a key role in this process. Then the classification technique is used to classify the image based on the stress level in the human body. In this paper, the utilization of three sensor devices is explored for the purpose of classifying various sensor device classifications. When it comes to detecting accuracy, comparing algorithms can be quite useful.

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4. Proposed Approach

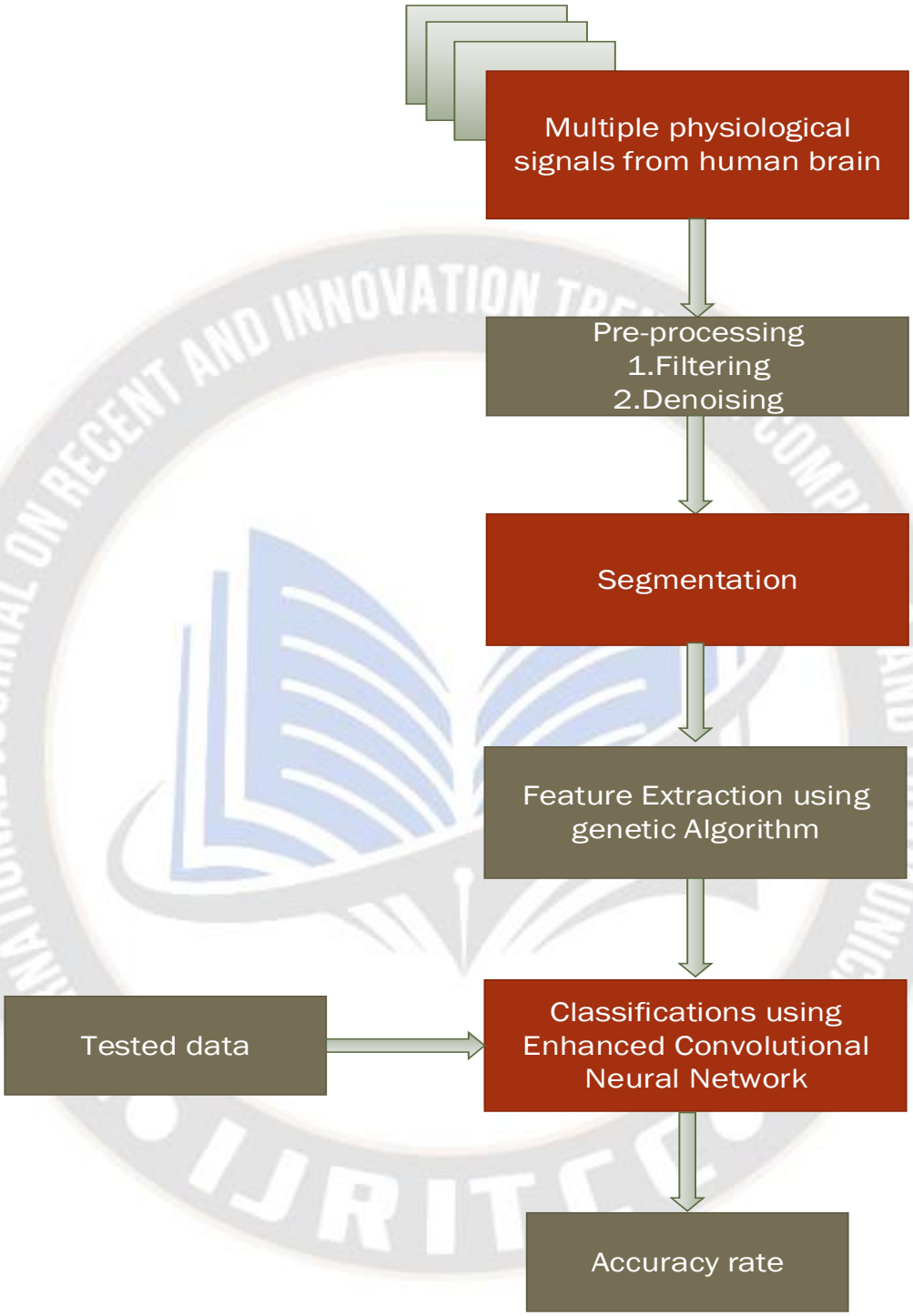

Fig 2 Proposed Approach

Figure 2 demonstrates the implementation of the proposed method for detecting and classifying mental stress using a deep learning network. The pre-processing technique involves applying a filter and de-noising technique to gather the necessary data. The segmentation technique is then used to divide the large amount of input data into organized groups. Once the segmentation technique is complete, the feature extraction technique is performed using a genetic algorithm. The genetic algorithm demonstrates superior accuracy in reducing image dimensionality compared to PCA or any other available technique [8].

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4.1 Datasets

The DEAP dataset is implemented in our paper [15]. When it comes to the function of detecting mental stress utilizing EEG, PPG, and GSR devices, the public dataset is utilized for the purpose of gathering the various sorts of physiological signals that are generated by EEG, PPG, and GSR sensor devices. Therefore, the 32 healthy samples who participated in the study are provided as the input for our method of detecting mental stress. During this time period, they are all listening to forty different kinds of audio songs. The amount of mental stress and the level of calmness may be determined by utilizing three different kinds of sensors that are integrated on this paper. These sensors are the EEG, the PPG, and the GSR.

The electroencephalogram (EEG) is nothing more than the brain activity that may be detected by the utilization of methods that are both cost-effective and considered to be such sorts of EEG signal devices; alternatively, it is referred to as one of the electrodes that detects brain activity. One of the emotional recognition signal devices that is used to evaluate the human present and past state comparison in the form of human biological activities is the PPG. This device is considered to be one of the electronic devices. There is no such thing as the galvanic skin response; rather, the GSR is regarded as the epidermal conductance that assists in determining the level of stress that the human body is capable of experiencing.

4.2 Preprocessing technique

A high pass filter is implemented in this work to remove the error or attack effect in the form of power line interference in sensor devices such as EEG, PPG, and GSR. The pre-processing technique is used to detect errors in the image by adding some filter. In this paper, the high pass filter is discussed. The low pass filter is utilized in order to eliminate the gaussian noise that is present in the input image that has been provided. When the frequency is 0.5 Hz, the high pass filter is utilized, and when the frequency is 500 Hz, the low pass filter is being utilized. For the purpose of removing the reverse forwarding action from the data samples that have been provided, the butterworth filter is utilized.

$$\boldsymbol{H(t,u) = \frac{1}{[\frac{D(t,u)}{D_u}]}} \qquad \boldsymbol{(1)}$$

The high pass filter is used to detect the sharpening and smoothening the edges in the given data sample, It gives the brightness for the connection area of the images. The low pass filter also helps to increases the smoothening in the given image and also enhancing the image equality by enhanced the adjacent pixel values. The main function of the low pass filter is helps to reduce the spatial noise in the image. De-noise is nothing but to remove the noise in the image or any other signal. This is one of the major challenges in the dataset.

The arousal and the valence space are one of the important techniques to predict the signal alignments in the EEG, PPG and the GSR.

4.3 Segmentation

The process of image segmentation is one of the most important techniques that helps to separate the pixels in an image into different meaningful groups. This helps to classify the pixels, and the extraction technique is carried out in a straightforward manner. The primary function of the segmentation process is to help reduce the complexity of the image [17]. The purpose of this paper is to demonstrate how the windows 1s and 4s can be utilized to split the arithmetic task for the mental stress graphical representation.

4.4 Genetic algorithm

In some instances, extended mental stress is produced by genetic problems. In most circumstances, genetic algorithms provide that the better extraction of the given data and diminish the dimensional quality in the image. Therefore, the genetic algorithm plays a significant part in the development of mental stress.

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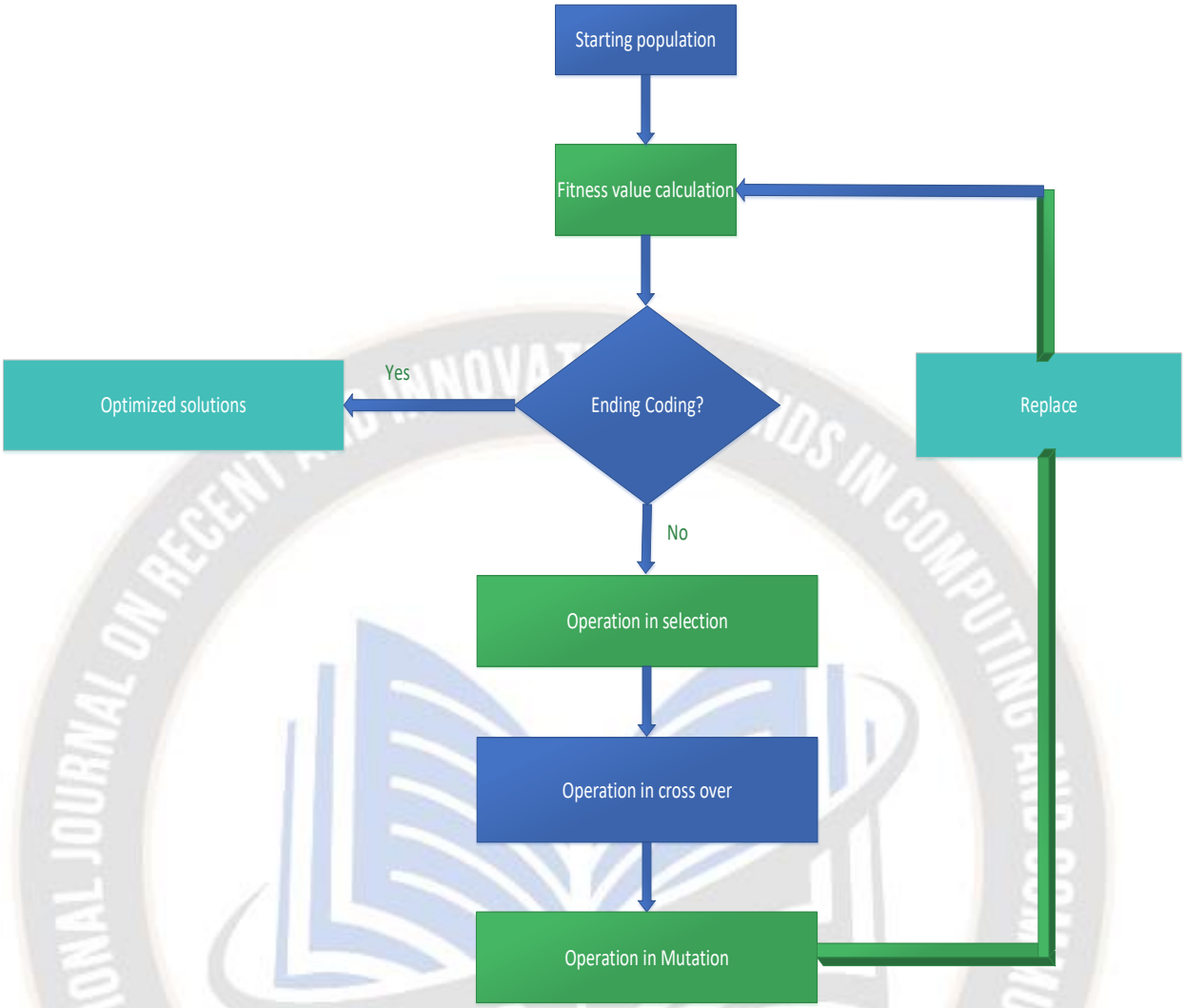

Fig 3 genetic algorithm

The figure 3 represents that the genetic algorithm, It represents that the basic concepts of the genetic algorithm [18].

The GA consist of the major operations namely selection cross over and the and the mutations technique, The input dataset are considerable with this algorithm with the help of the sensor devices namely EEG, PPG and the GSR that shows the exact dimensional reduction value to the classifier, Thus it provides the better enhanced result of extraction when compared to the other technique [19].

4.5 Enhanced convolutional neural network-LSTM

The enhanced convolutional neural network with LSTM classifier used to classify the given mental stress image based on the dataset. The EEG, PPG and the GSK are used to collect the data from human being

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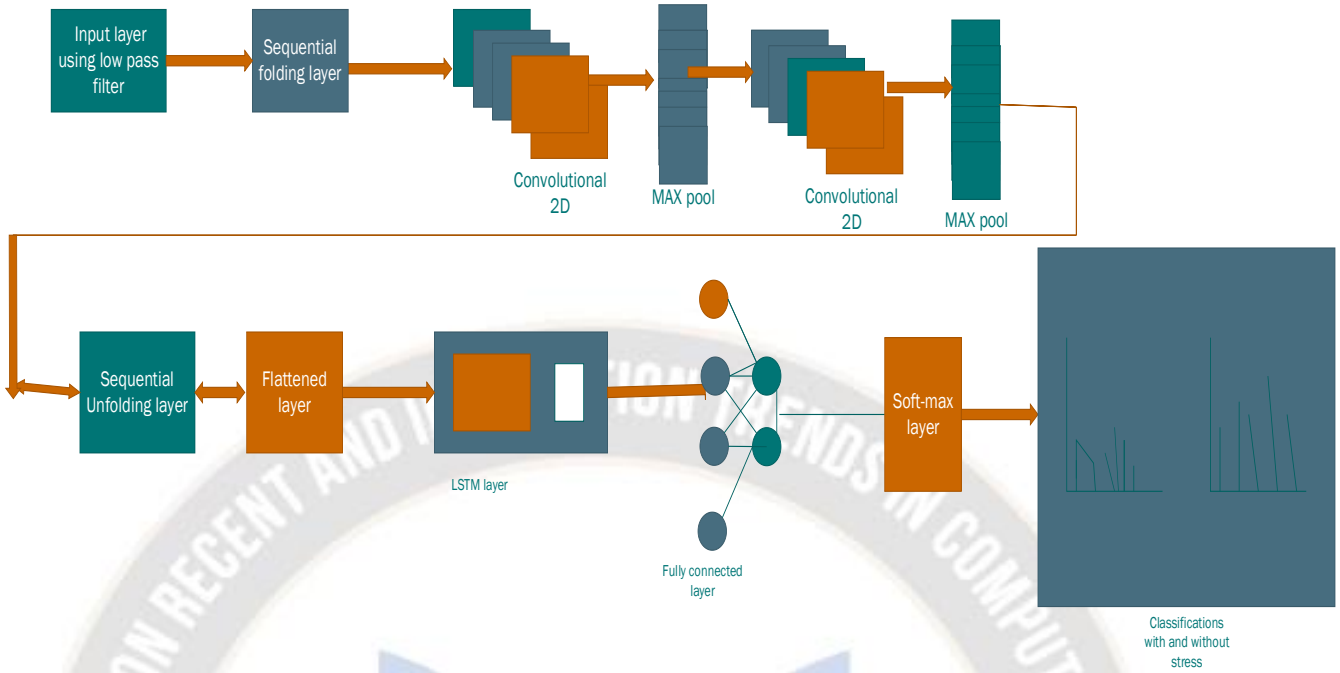

Fig 4 ECNN-LSTM

The fig 4 implements that the ECNN- LSTM classifier used to classifying the given input it gives the better accuracy, specificity and the sensitivity when compared the existing technique, The given input data are convolute to remove noise then this image goes through the MAX pooling, The max-pooling helps to reduce the over-fitting in the image, The Long short term memory network is considered as the noise removal technique it helps to remove the spatial noise in the given dataset [20].

$$\textbf{ACCURACY} = \frac{RP+RN}{RP+RN+FP+FN} \quad (2)$$

$$\textbf{SENSITIVITY} = \frac{FP}{RP+RN} \quad (3)$$

$$\textbf{PRECISION} = \frac{RP}{RP+RN} \quad (4)$$

$$\textbf{NEGATIVE PREDICTIVE VALUE} = \frac{RN}{RN+FN} \quad (5)$$

The above equation which shows that the accuracy, sensitivity, Precision and the Negative predictive value based on The ECNN-LSTM classifier

5. Comparison analysis

In our paper provides 99.9 % accuracy when compared to the existing technique The existing technique contains Support vector machine, Random forest method, KNN, Cubic SVM and the CNN. The overall comparison of the results shown in the graph the comparison results based on the classification accuracy, sensitivity and the precision value [21], In our paper implements enhanced output when compared to the existing technique.

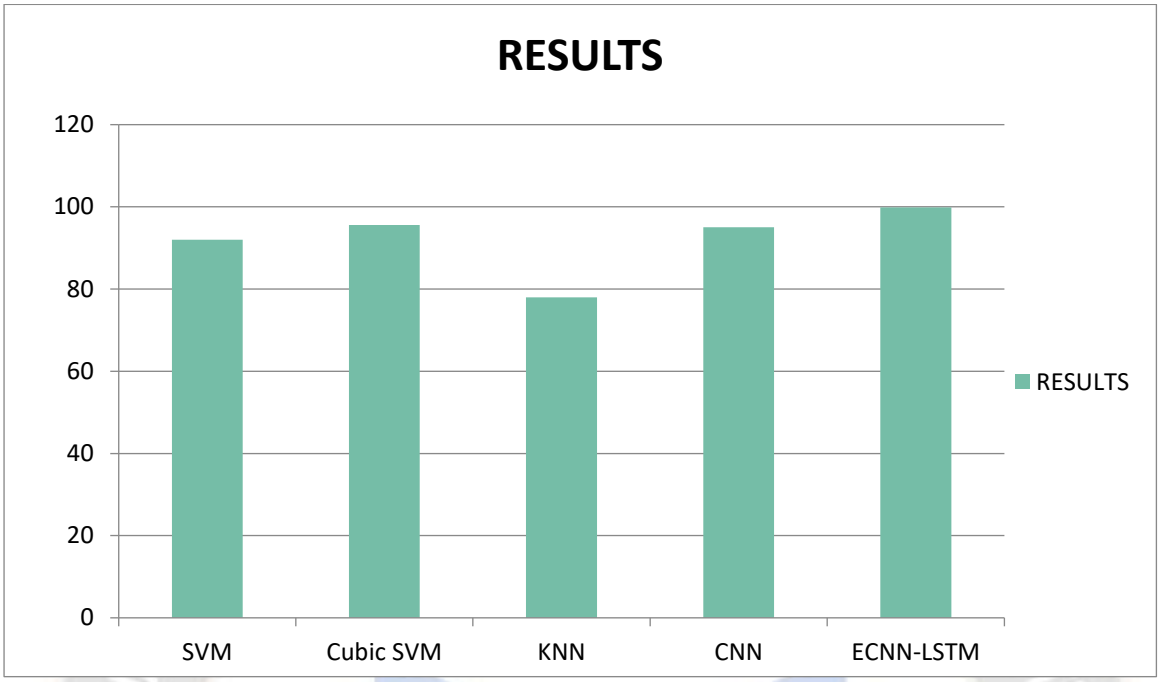

Fig 5 RESULTS

Fig 5 shows the results for the comparison analysis based on the classification accuracy.

6. Conclusion and future work

In this paper implements the ECNN- LSTM classifications technique results shows the perfect accuracy of the given input data, It helps to predict the calm and the stress stage of the human being based on their emotion, it was calculated by using EEG, GSR, and the PPG sensor devices.

Our future work based on the comparison of the enhanced technique in the SVM and the ECNN-LSTM with MTH feature extraction, to predict the classification accuracy.

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