OriginalArticle

Speech Emotion Recognition in Machine Learning to Improve Accuracy using Novel Support Vector Machine and Compared with Decision Tree Algorithm

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Abstract

Aim: The aim of this research is to improve accuracy for speech emotion recognition using SVM algorithm and DT algorithm. **Materials and Methods:** The research contains two groups namely SVM algorithm is developed in the first group and DT algorithm is developed in the second group contains 104 samples. The DT algorithm has a sample size of 52 whereas the SVM algorithm has a sample size of 52 and G power (value = 0.8). **Results:** The performance has been improved in terms of accuracy for the SVM algorithm with 91% while the DT algorithm has shown an accuracy of 62%. The mean accuracy detection is ±2SD and the significant value is 0.0415($p<0.05$) from an independent sample T test, which is statistically significant between two groups. **Conclusion**: The final outcome of the SVM (91%) algorithm is found to be significantly more accurate than the DT algorithm(62%).

Keywords: Speech Emotion, Novel Support Vector Machine algorithm, Machine Learning, Decision Tree algorithm, .wav audio, Feature Extraction.

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INTRODUCTION

Speech emotion recognition has been increasingly popular in the field of human-computer interaction in recent years. Emotion identification aids machines in comprehending and learning about human emotions (Koolagudi and Rao 2012). However, the emotion recognition performance falls short of the researchers expectations. The primary challenges in speech emotion detection are how to uncover effective speech emotion characteristics and how to build an appropriate speech emotion recognition model (Ananthakrishnan, Vembu, and Prasad 2011). The speaker's emotional arousal is accompanied by spontaneous physiological changes that alter breathing, phonation, and articulation, according to the acoustic feature-based SER (Bozkurt et al. 2009). As a result, emotion-specific patterns of auditory characteristics emerge. When auditory and verbal information were integrated to improve the results in the detection of specific emotions were found (Peter and Beale 2008). Recognising suspicious behaviour, personal assistants, Education, online tutoring, evaluating people's emotions are some of the applications used in speech emotion recognition (Abhang, Gawali, and Mehrotra 2016).

Many articles were published on Speech emotion recognition using machine learning like ScienceDirect 1,899 articles, IEEE Xplore 370 journals, Google scholar 17,100 articles over the past 5 years. Speech-related studies were primarily considered in this research; Papers dealing with other physiological signals such as EEG, heart rate variability, or a fusion of several modalities were not addressed in this research. In categorization and prediction, machine learning is extremely important (Koduru, Valiveti, and Budati 2020). In the classification of emotions, SVM, a supervised machine learning algorithm, was crucial. They are highly good at dealing with numerical data in the pre-processing stage (Li, Ye, and Shi 2002). Librosa capabilities such as chroma and mfcc are used to convert wav files to matrix format to read .wav audio files, the sound file module was used (Karpov and Potapova 2021). There are 24 folders in the dataset, each of which contains 50 .wav audio files. Emotion analysis and sentiment analysis, both of which are based on machine learning, play a significant role. Voice analysis has already been accessed. Based on frequency and pitch range, we discovered the emotions (Schuller and Batliner 2013). Previously, voice-based tests were available. Based on the frequency and pitch diversity, we were able to detect the emotions.Our team has extensive knowledge and research experience that has translate into high quality publications(Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)

The research gap identified for many articles was not able to detect human emotions and feature extraction, classification of emotions accurately because of the background noise in the input (Irene et al. 2021; V et al. 2020). So, the proposed work is made to work accurately even in the presence of the background noise in the input. The main objective of this research is to predict human emotion and analyse human behaviour by comparing with Novel Support Vector Machine algorithm and Decision Tree algorithm to improve accuracy.

MATERIALS AND METHODS

This research was conducted at DBMS Laboratory, Department of Computer Science and Engineering, Saveetha School of Engineering. Saveetha Institute of Medical and Technical Sciences. This research article has two groups and group 1 is SVM algorithm (91%) and group 2 is DT algorithm (62%). The total number of samples are 104, out of which 52 are the samples for the first group and the remaining 52 are used as samples for the second group.(Noroozi et al. 2017). Group one refers to the existing system, and Group two refers to the proposed system. There are a total of 104 samples, with 52 being as samples for the first group and the remaining 52 serving as samples for the second group. Size was estimated in clinical.com based on prior research articles (Langari, Marvi, and Zahedi 2020) by using a threshold of 0.05 G power of 80 percent, a confidence interval of 95 percent, and an enrollment ratio of one and data repository is open to the public.

There are nearly 7,000 .wav audio files in the Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS) dataset which is downloaded from www.kaggle.com. This dataset consists of expressions that are calm, joyful, sad, furious, afraid, surprise, and disgusting (Livingstone and Russo 2018). From the RAVDESS dataset feature extraction has to be done in order to classify the emotions in the dataset.

The implementation of speech emotion analysis is done in Google colab by importing datasets, Data cleaning, splitting datasets into train, test datasets and calculating the performance metrics such as accuracy, precision, recall, F1-score and this experiments were conducted during the classification phase on a computer with an i5 2.3GHz processor and 8 GB of random access memory (RAM).

Algorithms for Speech Emotion prediction

The task of speech emotion recognition (SER) is to recognise the emotional components of speech regardless of the semantic content. While people are capable of performing this activity efficiently as a natural aspect of voice communication, the capacity to do so automatically using programmable devices is still a continuing process. Adding emotions to machines has been identified as a vital step in achieving a human-like appearance and behaviour.

In this study, the SVM and DT algorithms are used. The SVM technique is typically used to classify human emotions.

Support Vector algorithm

Support Vector Machine algorithm is under supervised learning. Support vectors are the points in space that are generated by combining the attributes of a data point. In an N-dimensional dataset, each and every data point is plotted on an N-dimensional space using all its feature vector values as a coordinate point. Finding a hyperplane in space that clearly separates the distinct classes is how the classes are classified. SVM is most effective when you have a lot of data.

Finding the hyperplane is a crucial part of implementing the SVM algorithm. When determining the proper hyperplane, two conditions must be met in the order specified.

1. The hyperplane should appropriately classify the classes.
2. The margin distance between the hyperplane and the nearest data point must be as little as possible.

Pseudocode

```
Data: .wav audio files
Result: To estimate the accuracy of speech emotion
Begin
        For each speech in the database R
                Feature extraction of each speech
                For each feature extract the emotions
                    Append all features and map emotions according to the extracted features
                Endfor
               Split the dataset into two sections are training and testing datasets
                Train the data by svm classifier by importing from scikit learn
        Endfor
        Make svm predictions by using svm linear predict function and then calculate the accuracy to our
        prediction values
End
```

Decision Tree Algorithm

In the Decision Tree algorithm, To assess whether splitting is "Best" in individual classes, decision tree methods are employed to separate the qualities to test at any node. The resultant partitioned at each branch is as PURE as feasible, which necessitates the use of the same splitting criteria (Sun et al. 2019). The Decision Tree algorithm visualises the complete dataset as a tree, with the classification issue loosely translated as determining the path from root to leaf based on various decision conditions at each sub-tree level (Patel and Prajapati 2018). At the sub-tree level, each feature in the dataset is regarded as a decision node. The variables from the training sample are used to create the first tree. The values of a new data point are tracked from root to leaf on the constructed tree, with the leaf node representing the goal or anticipated class.

Pseudocode

```
Data: .wav audio files
Result: To estimate the accuracy of speech emotion
DT(dataset,list of features)
        Testdata, Traindata = Data[1:n]
DecisionTable=[]
For each element in featureset:
        Classify the emotions and add column to DecisionTable
Endfor
For each record in Traindata:
        If speech emotion match with features:
                DecisionTable.append(record)
Endfor
For each record in Test Data:
        If record matches DecisionTable:
                Name the predicted class as a majority class label
      Based on the test data matches then calculate the accuracy of each record.
```

Statistical Analysis

The software used for the purpose of statistical analysis is IBM SPSS version 26. The Independent T- test is carried out for analysing. The independent variables for this research is pitch of the audio and the dependent variables are accuracy and precision.

RESULTS

The accuracy is used as a main parameter when comparing the Novel Support Vector Machine algorithm to the Decision Tree algorithm. The RAVDESS dataset is essential for both comparing and analysing algorithms. The results reveal that the Novel SVM algorithm outperforms the DT algorithm model in terms of accuracy. The mean accuracy of the Novel Support Vector Machine algorithm is 91% and the mean accuracy of the Decision Tree algorithm is 62%.
Table 1 compares the performance metrics of SVM and DT algorithms, including precision, recall, and F1 score values of train and testing datasets as a percentage. On par for SVM algorithm the precision value is 0.87, Recall value is 0.84, F1 score is 0.81 and DT algorithm the precision value is 0.5, Recall value is 0.52, F1 score is 0.50.
Table 2 represents the computations of statistical analysis for independent sample T tests for SVM and KNN samples. SVM has a mean accuracy of 91.0769 while DT has a mean accuracy of 62.9038. SVM has a standard deviation of 1.34085, while DT has a standard deviation of 1.44520.
Table 3 shows the independent sample T- test with confidence intervals lower and upper of 95% for comparing the Novel Support Vector Machine algorithm mean accuracy and Decision Tree algorithm mean accuracy and For accuracy, the significance value is calculated as 0.0001 ($p<0.05$) for both SVM and DT algorithm.

Figure 1 depicts the feature extraction and classification of both train and test datasets by using DT classifier, compute confusion matrix and classification report.

Figure 2 depicts the system design flow of the SVM algorithm. The .wav audio file is subjected to feature extraction and then separated into train and test data by using SVM classifier.

Figure. 3 depicts a bar graph to compare the Support Vector Machine algorithm and the Decision Tree Algorithm, with a 95% class interval, error bars, and +/- 2SD. SVM has a mean accuracy of 91 percent, which is higher than the 62 percent accuracy of the Decision Tree Algorithm. The groups (SVM,DT) are on the X-axis, while the mean accuracy is on the Y-axis.

DISCUSSION

The data evaluation was performed using IBM SPSS version 21. To analyse data for performing independent sample T-test and group statistics can be carried out. In previous proposed work for the SVM algorithm which has mean accuracy is 91% and error rate is 9%. Decision Tree algorithm which has mean accuracy 62% and error rate is 38%. The values of the Novel Support Vector Machine algorithm and Decision Tree algorithm are analysed statistically and the difference is found out by plotting the graph.

Similar articles with the Novel SVM algorithm and other featured combinations (Mehboob, Abbas, and Rauf 2018) also perform significantly better when compared to the existing algorithm (Huang et al. 2014). In those articles the RAVDESS dataset is utilised. The dataset's data is cleaned and separated into two groups: train and test datasets. A training dataset is used to train the model after it has been imported (Shah and Suthar 2016). The sklearn model is then executed and the confusion matrix is calculated using a test dataset and prediction values (Pandey, Shekhawat, and Prasanna 2019). The positive points for above articles are that it automatically selects the feature extraction and unimportant features will not affect the result and the negative points are small changes in the dataset will affect the total structure of the optimised decision tree.

One of the limitations with speech emotion recognition is that we have no control over how and when individuals exhibit emotions, or what they say and when they say it. The SVM technique outperforms the DT strategy in predicting speech emotion features in a comparison of the two algorithms. In current research, the feature extraction made out from .WAV files are pitch related characteristics and MFCC’s. In future work, the framework will incorporate different sets of features like intensity, rhythm, and LPCC, to increase accuracy.

CONCLUSION

In this study, the Novel Support Vector Machine algorithm outperformed the Decision Tree algorithm in terms of accuracy. The accuracy of the Novel SVM algorithm is 91% which is higher than the accuracy of the Decision Tree algorithm which is 62%.

DECLARATION

Conflict of Interests
No conflict of interest in this manuscript.

Authors Contribution
Author Jorepalli GMA was involved in data collection,dataanalysis,manuscript writing. Author SMK was involved in the action process. Data verification and validation and criteria review of manuscript.

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TABLES AND FIGURES

Table 1. Comparison between Precision, Recall and F1 score

Emotions	SVM algorithm			Decision Tree algorithm		
	Precision	**Recall**	**F1 score**	**Precision**	**Recall**	**F1 score**
Angry	1.00	1.00	1.00	0.48	0.81	0.60
Happy	0.57	1.00	1.00	0.53	0.42	0.47
Neutral	1.00	0.67	0.80	0.38	0.27	0.32
Sad	1.00	0.50	0.67	0.70	0.58	0.64

Table 2. Calculation of statistics for independent samples tested to samples compared to SVM and KNN. The mean accuracy of SVM is 91.0769 and DT is 62.9038 and Standard Deviation for SVM is 1.34085 and DT is 1.44520

	Groups	N	Mean	std.Deviation	Std.Error Mean
Accuracy	**SVM**	52	91.0769	1.34085	.18594
	DT	52	62.9038	1.44520	.20041

Table 3. Samples that are statistically independent T-test comparing the Novel SVM algorithm and the DT algorithm, with a 95% confidence level. For accuracy, the significance value is calculated as 0.0415 (p<0.05), which is statistically significant between two groups

		Levene's test for equality of variances.		T- test for equality of means						
		F	Sig.	t	df	Sig.(2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
ACCURACY	Equal variance assumed	.669	.0415	103.052	102	.0001	27.630	.27339	27.63082	28.71534
	Equal variances			103.052	101.432	.0001	27.630	.27339	27.63078	28.71537

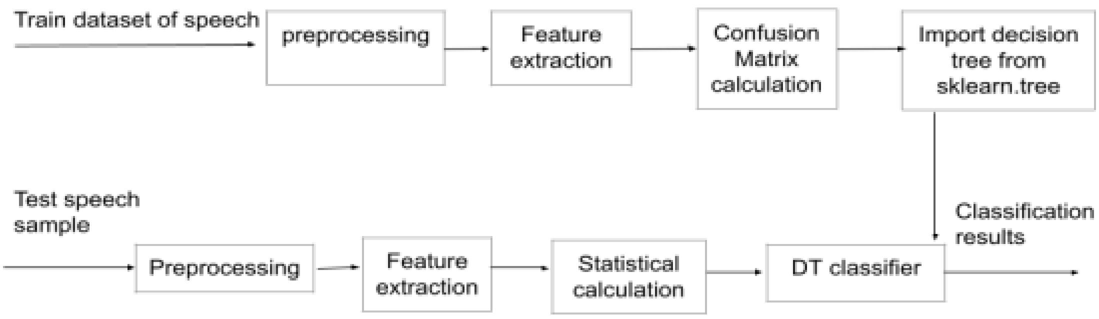

Fig. 1. Speech Emotion recognition based on DT classifier.

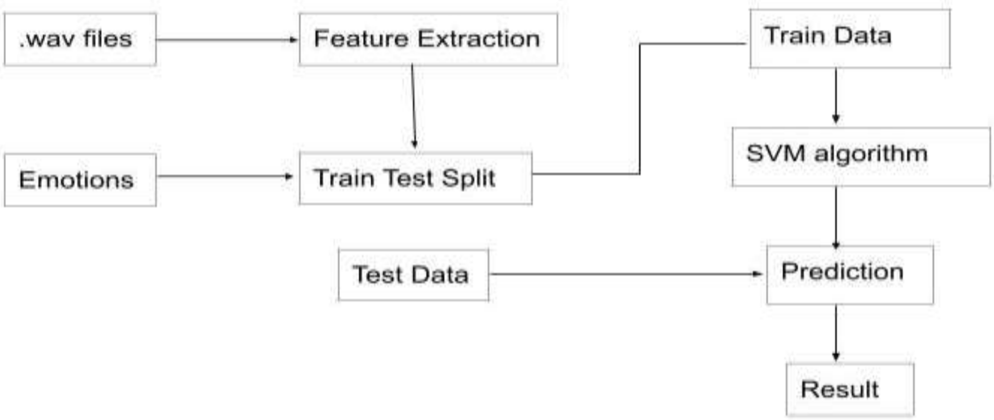

Fig. 2. System design flow of SVM algorithm

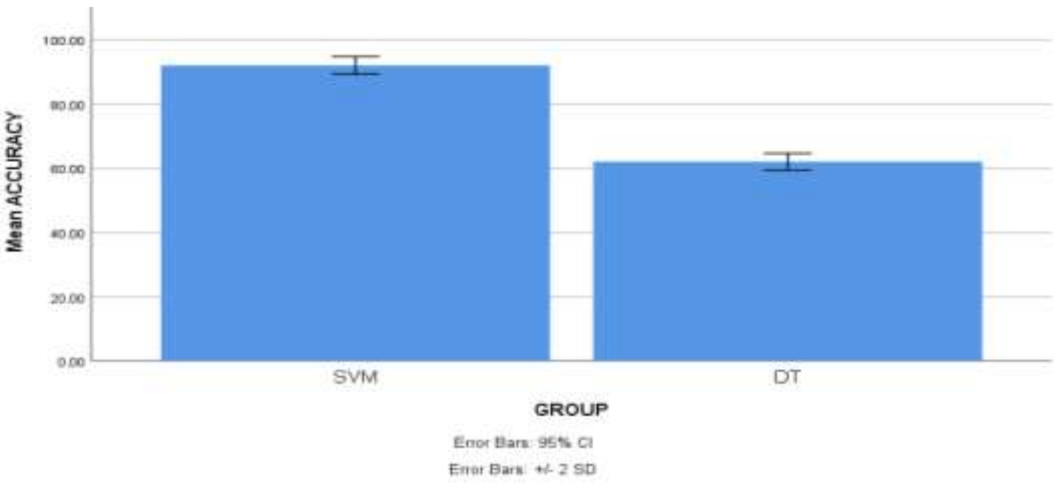

Fig. 3. Simple bar graph for comparison of Support Vector Machine algorithm and Decision Tree Algorithm with class interval of 95% and along with error bars and +/- 2SD. Mean accuracy of SVM is 91%, which is better than Decision Tree Algorithm of accuracy 62%. The X-axis consists of groups (SVM ,DT) and Y-axis consists of Mean accuracy.