International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Emotionally Intelligent Music Player for Mood Improvement based on Text Emotion Recognition using Deep Learning Approach

Shrikala Deshmukh *[1], Preeti Gupta[2]

Submitted: 16/07/2023 **Revised**: 09/09/2023 **Accepted**: 26/09/2023

Abstract*:* This study shows a unique approach of Mood elevating music player based on Text emotion recognition. Emotions play a very vital role in everyday life. In this internet era, textual data is mainly designed for communication. Natural language processing is designed for textual data such as messages, emails, articles, reviews, posts, etc. Sentiment analysis is used in various fields. For emotion recognition from text, Deep learning with machine learning approach is used. CNN(Convolutional Neural Network) with a multiclass support vector machine algorithm is used. One vs Rest approach is used for multiclass SVM classifier. Lexicon database and BBC database are operated. Proposed system is compared with K-nearest Neighbour (KNN), Random Forest (RF), Naïve Bayes (NB) algorithms. Results show the accuracy of around 86.88% using BBC database with and approximately 91.2% using Lexicon database, which is higher than other classifiers. Other classifiers such as Random Forest (RF) shows the accuracy of 68.44% for lexicon and 62.44% for BBC, Naïve Bayes (NB) shows the accuracy of 62.56% for lexicon and 59.28% for BBC, K-nearest neighbour (KNN) shows the accuracy of 74.12% for lexicon and 69.28% for BBC. As a result, CNN with multiclass SVM gives 91.2% accuracy using lexicon database.

Keywords: *Deep learning, Machine learning, Lexicon database, BBC database, Convolutional neural network, Multiclass Support Vector Machine.*

1. Introduction

Sentiment analysis is a technique for determining how people feel about certain things. It is also called as opinion mining. This uses natural language processing (NLP) that identifies the emotion behind text.

Emotion detection is a subset of sentiment analysis. Sentiment analysis (SA) is an entire project of emotion recognition. It has applications in business, social science, politics, entertainment, etc. [3]. Sentiment Analysis is the procedure of discovering and classifying judgments from text. In other words, it is a set of methods and practices for the automatic classification of sentiment polarization in texts [17,18,19,20].

Human-machine interaction has been explored for several years. Currently, more importance is given to data such as voice, face, hand gestures, body movements, text for emotion recognition [4].

Emotions play a significant responsibility in communication in our everyday lifespan. Emotion recognition is a part of human-computer communication. A system that recognizes, interprets and processes human emotions is called a successful human-computer interaction system. Human Emotion Recognition also supports Affective Computing [2]. Emotions effect on decision-making ability of human beings. This truth is considered by affective computing. The main aim of affective computing is to provide decision support to all emotions [9].

Currently most of the researchers are focus on speech and face for emotion recognition Nevertheless, unlike speech, where indicators like tonal accent, facial expression, pitch, etc. are present, emotion identification in text is a laborious task.

For extracting emotions from text, various natural language processing (NLP) methods such as keyword approach, lexicon-based approach, and the machine learning approach are used.

However, due to their emphasis on semantic relations, keyword- and lexicon-based techniques have some drawbacks. In order to recognise emotions in text, we have proposed a hybrid model in which machine learning and deep learning model is combined.

Text emotion recognition is the latest research area in Natural Language Processing (NLP). Nowadays, the text contains posts on social media, blogs, articles, reviews, etc.; these texts can be a valuable source to discover various facets of emotions [5]. Scientists are utilizing the Twitter network for analysis and calculations. By using various tweets, retweets and posts, influence detection and recommendation generation has experimented by applying various methods [10].

Emotion detection from speech, face and multimodal emotion detection are having a wide knowledge base, but

There is a great rarity in texts research. Emotion detection from short texts is a main stumbling block in Text emotion

[1] *Amity University, Mumbai, India and College of Engineering, Bharati Vidyapeeth, Pune, India*
E-Mail: shrikaladeshmukh89@gmail.com
[2] *Amity University, Mumbai, India*

recognition.

Various social media post, comments are used for analysis. Maximum citizens are involved in various public networks as a member of various platforms like Facebook, Twitter, Instagram, YouTube, etc.

With the development of cyberspace, textual information is the essential link in human-machine interaction [25]. To improve user, experience such interactions are used to provide a starting point that can distinguish the emotions in the communication [6]. For emotion recognition from text, a multiclass support vector machine algorithm is used. One and the rest approach is used for multiclass SVM classifier. Lexicon database and BBC database are used. Random Forest (RF), Naïve Bayes (NB), K-nearest neighbour (KNN), and support vector machine (SVM) classifiers are used for comparison.

The uniqueness or novelty of this research is, for mood enhancement or to change mood from negative to positive, mood elevating music player is implemented. Songs database is created. Songs database contains Hindi positive songs which uplifts the mood of individual.

This paper is structured as follows: in Section 2, literature review on emotion detection is presented. Section 3 explains the proposed system. Results and analysis of the suggested work are presented in Section 4. Article's concluding recommendations are given in section 5.

2. Literature Review

Emotion recognition from text is done in [1], [3], [5], [6]. A survey of emotion recognition from text is done in [7], [21]. Emotion classification of news is done in [2]. Multi modal emotion recognition by text and speech is done in [4],[22]. Emotion recognition using Youtube comments is done in [12]. Sentiment Analysis and it's techniques are explained in [17],[18],[19],[20].

In paper [1], authors created a database using students expressions. Mainly 3 emotions: Happy, Sad and neutral are considered. In paper [2], authors proposed a technique which will automatically classify reader's emotions. Authors used 6 emotions namely: anger, disgust, fear, joy, sad and surprise. Word Net Affect dataset is used. Support Vector Machines are used for classification. Total 1000 news headlines are used.

In paper [3], authors implemented emotion recognition from text, It is called as EmoTxt, question, answers, and comments from online interactions are used as a dataset.

In paper[4],authors implemented emotion recognition from speech and text. PCA and SVM models are used. Around 33 features are extracted from speech. In paper [5], authors proposed neural network architecture, called SENN, BiLSTM and CNN is used.

In paper [6], authors used machine learning and rule-based classifiers, The mean F-Score is 84%. In paper [7], [21], [22] and [23] authors have done survey on emotion recognition in Text. In paper [8], authors have implemented emotion detection from text, authors have designed their own algorithm for emotion recognition from text. In paper [9], For Decision making, Text based emotion recognition is used, Deep Learning is used for affective computing. In paper [10], authors proposed a hybrid system which consists of two methods: keyword-based and machine learning method. authors implemented text emotion recognition using knowledge based Artificial Neural Networks. In paper [11], LSTM based text emotion recognition using various vectors is implemented. In paper [12], authors have used YouTube comments to detect emotions. In paper [14], authors implemented text emotion recognition which is based on social media. It is designed for Vietnamese. In paper [15], authors used Support vector machines for emotion recognition through text. In paper [17],[18],[19] and [20] authors worked sentiment analysis. In paper [24], Different machine learning approaches are used for emotion recognition from text. In paper [25], authors explained Text-based emotion detection, its Innovations, tasks, and chances are shown very well. In paper [26], multiclass support vector machines are explained. In paper [27], A Deep neural network model for detection of emotion from text is explained. In paper [28], Twitter data is used for text emotion recognition. In paper [29], multiple languages are used for cyber abuse detection.

Literature review states that, All Text emotion recognition systems recognizes emotion behind text. For Text emotion recognition various algorithms are used. As per the literature review not a single system shows accuracy above 90%.

The novelty of this research is Emotionally intelligent music player based on Text Emotion Recognition which elevates users mood from negative to positive. Deep Learning and Machine Learning approaches are combined.

3. Proposed System

A. Text Emotion Recognition Architecture

Figure 1 is the system architecture of Text emotion recognition using Deep Learning Models and Machine Learning Classifier. CNN(Convolutional Neural Network) of Machine Learning and Multiclass Support Vector Machines algorithm of Machine Learning are used.

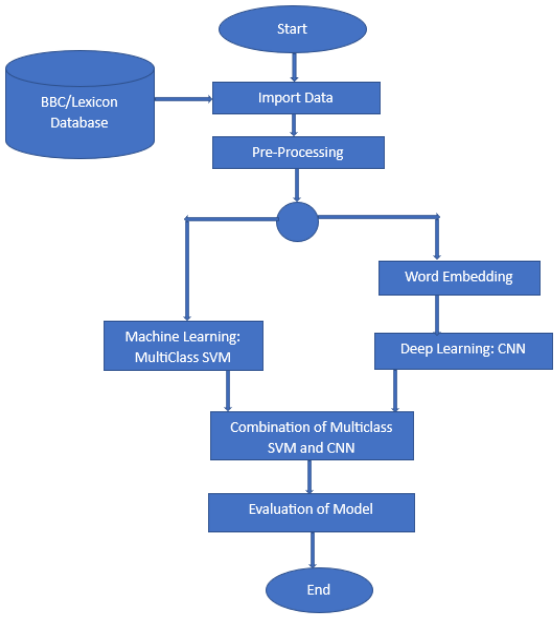

Fig 1 System Architecture

Pre-Processing, Feature extraction, Use of classifier and emotion detection are the major steps in Text Emotion Recognition. Pre-processing contains Punctuation removal, repeated character removal, negative expression replacer and stop word removal. For feature extraction Bag of words technique is used. Count vectorizer is also used for feature extraction. For classification, Random Forest (RF), Naïve Bayes (NB), K-nearest neighbor (KNN), and support vector machine (SVM) algorithms are used.

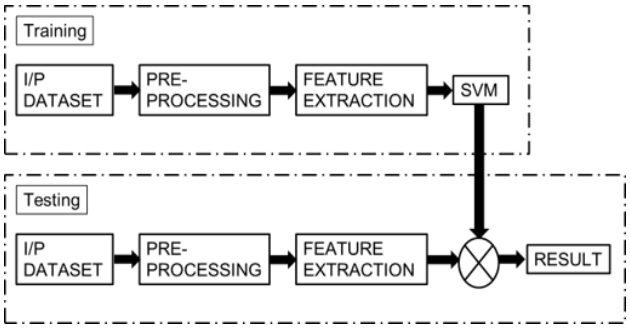

Fig 2 Flowchart Of Text Emotion Recognition

Figure. 2 shows flowchart of Text Emotion Recognition. It is divided into two: Training and Testing. 70% data is used for training and 30% for testing. Pre-processing, Feature Extraction and use of classifier steps are used in Training and Testing.

B. Pre-Processing

The data must be preprocessed because it is currently in raw form and contains extraneous text and symbols. It is a data mining method for transforming unusable data into an efficient format [20]. It increases ML and DL model efficiency while minimizing computing usage. Our findings show that there are numerous different preprocessing techniques available. Tokenization, stop word removal, stemming, and lemmatization are the processing techniques we used. Tokenization, lemmatization, stop word removal, etc. are just a few of the preprocessing processes in this study that we employed the Natural Language Toolkit (NLTK) tools for. To make data easier to read and comprehend, it is converted from one format to another considering that the data must be integrated and originates from many sources.

Pre-processing mainly consists of following steps such as,

I. Punctuation removal:

The punctuations are tokens that are of no use, so it has to be removed. For punctuation removal, divide the input into texts by white space and string conversion to substitute all punctuation.

II. Repeated character removal:

If there is any repeated character in a sentence. This method removes these repeating characters

III. Negative expression replacer: This removes the negative expression.

IV. Stop word removal: It is used to remove unwanted words which do not have any significance.

V. Stemming: Stemming removes suffixes and prefixes and changes them to their stem word.

C. Feature Extraction

For feature extraction of textual data, Bag of words technique is used. This approach is a flexible and straightforward way of extracting features from documents. In Python, the Scikit-Learn library is used for feature extraction. Sklearn library has a high-level component that creates feature vectors - 'Count Vectorizer.' Word vectorization converts text into feature vectors.

D. Use Of Classifier

Here, a hybrid model is used which is a blend of Deep learning and Machine Learning models. For Machine Learning, classifiers like Multiclass Support Vector Machine, Naïve Bayes, and Random Forest are used, and for Deep learning, Convolutional Neural Network (CNN) algorithm is used.

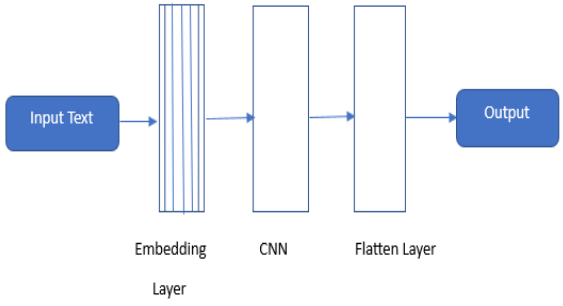

Fig 3 CNN Model

As shown in fig. 3, Convolutional Neural Network (CNN) model is used as a form of Deep Neural Network. Embedding layer and flatten layer is used in CNN Model. Text input is given, and output will be the emotion.
Multiclass Support Vector Machine (SVM) algorithm is used for text emotion recognition. For multiclass classification, SVM supports a binary classification. It separates data points into two classes. For multiclass classification, multiclassification problems are converted into several binary classification problems. There are mainly two types: OvA (One-vs-One) and OvR (One-vs-Rest).
Here, One-vs-rest (OvR) method is used as binary classification algorithms for multi-class classification.

For the r -th classifier:

Prediction: $f(r) = \text{argmax}\ r\ f_r(a)$
Where,
$f_r(a)$: the decision value for the r -th classifier.
(large value of $f_r \Rightarrow$ higher probability that a is in the class r)

In the OvR approach, a hyperplane is used to distinguish between a class and all others at once is defined. Partition divides all points into two groups; One group is of class points, and another group is of all other points. For example, as shown in Fig. 3, the blue line separates blue points and all other points at once.

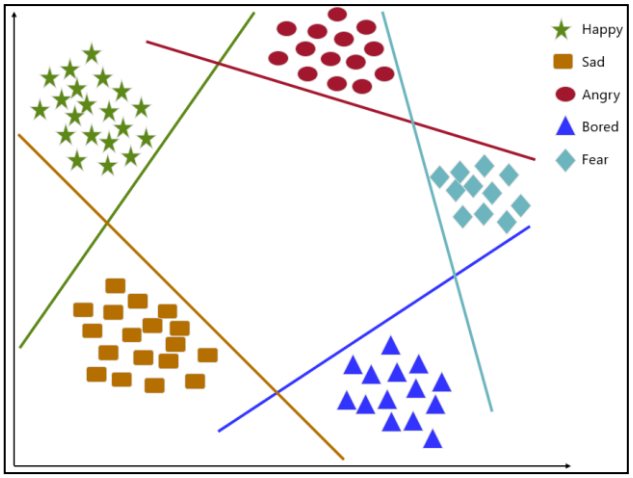

Fig 4 Svm Classifier - Multiclass Classification

One vs Rest Approach (OVR)
In this technique, if we have R class problem, then we learn R SVMs:
Here, our classification is divided further into five binary classification datasets such as:

Table 1. Binary Classification Problems

Binary Classification Problem 1	Happy	vs	[sad, fear, angry, bored]
Binary Classification Problem 2	Sad	vs	[happy, fear, angry, bored]
Binary Classification Problem 3	Fear	vs	[happy, sad, angry, bored]
Binary Classification Problem 4:	Angry	vs	[happy, sad, fear, bored]
Binary Classification Problem 5	Bored	vs	[happy, sad, fear, angry]

The OVR technique is used to mix together all individual binary SVM classifiers. It will then merge into single classifier for many classes. The main benefit of this method is, It is easy to execute in the lead of an existing binary SVM. The main disadvantage of this method is if all binary classifiers are stable, the resulting OVR classifier is not stable [26].
For training of multiclass SVM, all-in-one approaches are formulated. By using this, OVR approach gives better accuracy on a benchmark set of datasets [26].
Below form is used for classification decision:

$$C \longrightarrow \arg\max r \in \{1,..,d\} \ (w\ T\ r\ \varphi(c) + br) \qquad (1)$$

here $\varphi(c) = k(c, \cdot)$

Here in figure. 5, Hybrid model(CNN+ Multiclass SVM) is used. Figure shows hybrid model which is combination of Convolutional Neural Network (CNN) and Multiclass SVM.

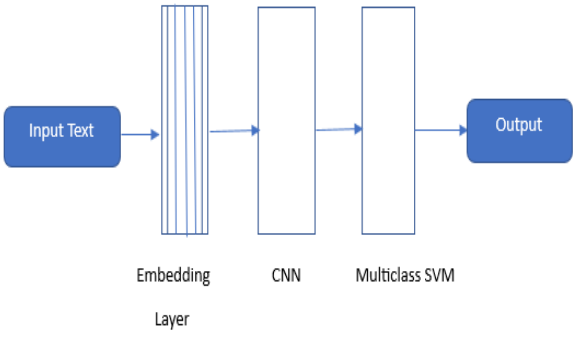

Fig 5 Hybrid (CNN+ Multiclass SVM) Model

E. Training And Validation

The quantity is fragmented into two data sets - Training and Validation. The training dataset fits the model, and the

calculations are made on the validation data set.
In python, the train_test_split of the sklearn library is used for training and testing.
70% of the corpus is utilized as training data, and the remaining 30% is worked as Validation data.

Model selection=Train P, Test P, Train Q, and Test Q. (2)

train test split (Corpus['train']['test'], test size=0.3)

Training Data Predictors (Train_P)
Test Data Predictors (Test_P)
Training Data Target (Train_Q)
Test Data Target (Test_Q)

The loss is expected to decrease during the training and increase as the number of epochs increases.

4. Results And Discussion

A. Text Emotion Recognition Using Bbc Database

The above is the confusion matrix table for Text Emotion Recognition using BBC database. Mainly 5 emotions are used: Happy, Sad, Angry, Fear and Bored.

Table 2. Cnn+ Multiclass Svm Using Bbc Database Confusion Matrix

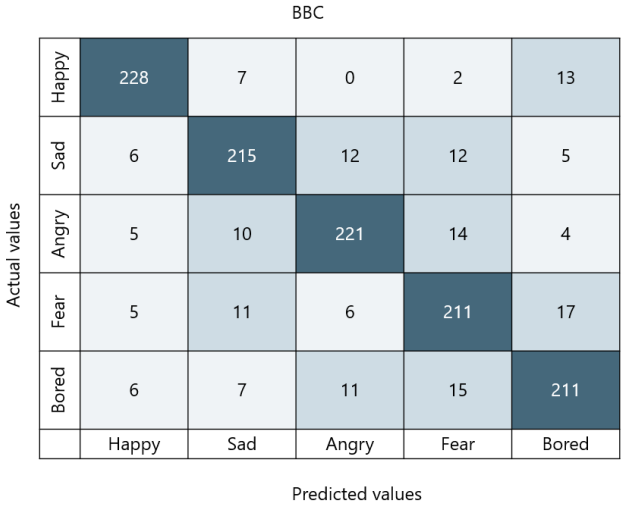

Table 2 shows confusion matrix of CNN+ Multiclass SVM using BBC database
Table 3 shows accuracy values for CNN+ Multiclass SVM using the BBC database.

Table. 3 Cnn + Multiclass Svm Using Bbc Database

	Accuracy
Accuracy	86.88%
Precision	86.88%
Recall	87.16%
F-score	87.02%

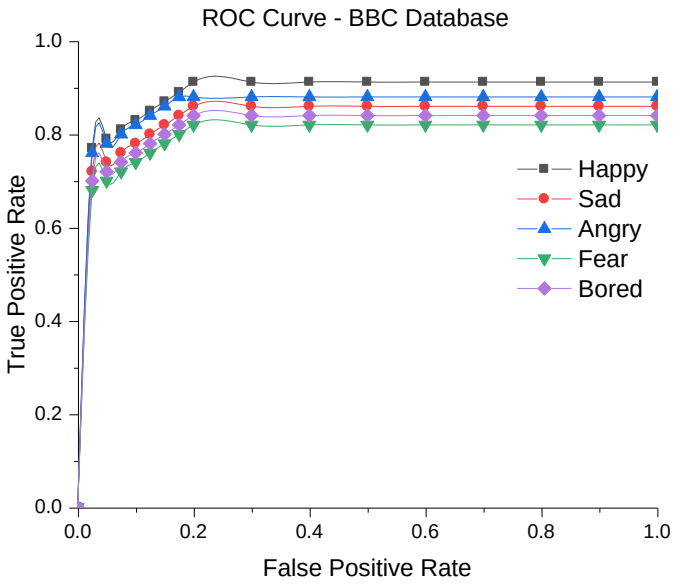

Fig 6. ROC Curve of CNN+ Multiclass SVM using BBC Database**.**

Table 4 Comparison Of Accuracy Of Different Algorithms And Bbc Dataset.

BBC

	Random Forest	**Naïve Bayes (NB)**	**K-Nearest Neighbor (KNN)**	**CNN+ Multiclass SVM**
Happy	69.60%	64.40%	79.60%	89.40%
Sad	60.20%	58.80%	72.40%	88.80%
Angry	61.00%	61.20%	69.20%	85.80%
Fear	59.20%	56.60%	66.80%	82.60%
Bored	62.20%	55.40%	61.20%	87.80%
Avg	62.44%	59.28%	69.84%	86.88%

Table 4 shows the accuracy of Text emotion recognition (TER) with various algorithms such as Random Forest (RF), Naïve Bayes (NB), K-nearest neighbor (KNN), and CNN+ Multiclass SVM(support vector machine). Here we have used the BBC database. Random Forest (RF) shows overall accuracy of 62.44% Naïve Bayes (NB) offers accuracy of 59.28%, K-nearest Neighbor (KNN) shows an accuracy of 69.84%, and CNN+ Multiclass Support Vector Machine (SVM) shows an accuracy of 86.88%.

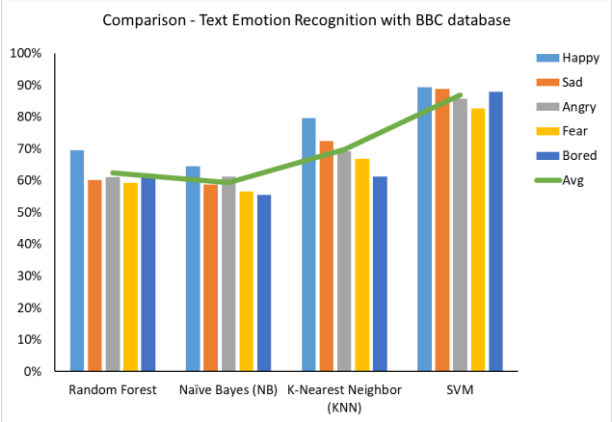

Fig 7. Comparison using BBC Database**.**

Figure 7 shows the accuracy of Text emotion recognition (TER) with various algorithms. Here we have used the BBC database. CNN+ Multiclass Support Vector Machine (SVM) shows highest accuracy of 86.88% than other algorithms.

B. Text Emotion Recognition Using Lexicon Database

Table 5. Cnn+ Multiclass Svm Using Lexicon Database Confusion Matrix

Actual values \ Lexicon	Happy	Sad	Angry	Fear	Bored
Happy	235	3	2	7	3
Sad	3	222	5	12	8
Angry	1	5	227	14	3
Fear	4	12	6	225	3
Bored	2	7	4	5	232

Predicted values

The above is the confusion matrix table for Text Emotion Recognition using Lexicon database. Mainly 5 emotions are used: Happy, Sad, Angry, Fear and Bored.

Table 6. Cnn+ Multiclass Svm Using Lexicon Database Accuracy

Accuracy	91.28%
Precision	91.28%
Recall	91.28%
F-score	91.28%

Table 6 shows accuracy, precision, recall and F-score for CNN+ Multiclass SVM using the Lexicon database. It has shown in figure as:

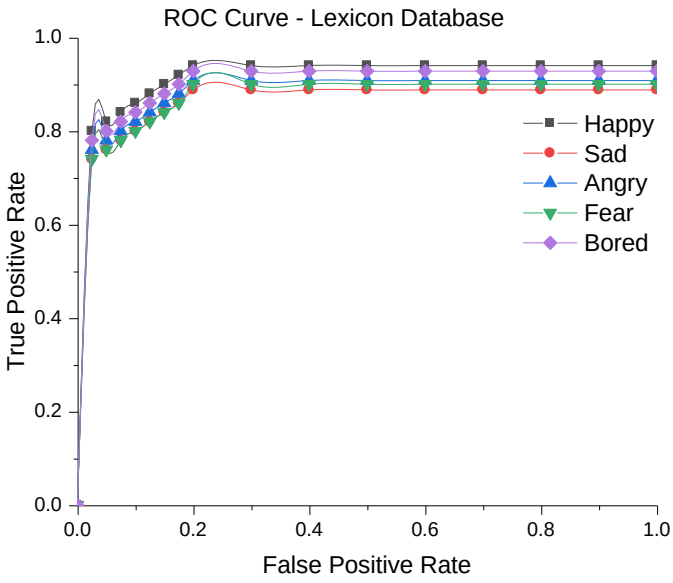

Fig 8. ROC Curve of CNN+ Multiclass SVM using Lexicon Database**.**

Figure.8 shows ROC curve of Convolutional Neural Network and Multiclass Support Vector Machine using Lexicon Database

Table 7. CNN+ Multiclass SVM WITH LEXICON DATABASE USING VARIOUS ALGORITHMS

LEXICON

	Random Forest	**Naïve Bayes (NB)**	**K-Nearest Neighbor (KNN)**	**CNN+ Multiclass SVM**
Happy	75.60%	69.60%	80.20%	94.20%
Sad	65.60%	60.20%	69.80%	88.60%
Angry	68.40%	61.00%	74.40%	91.60%
Fear	66.80%	59.80%	72.60%	89.80%
Bored	65.80%	62.20%	73.60%	92.20%
Avg	68.44%	62.56%	74.12%	91.28%

Table 7 shows the accuracy of Text emotion recognition (TER) with various algorithms namely Random Forest (RF), K-nearest neighbor (KNN), Naïve Bayes (NB) and CNN+ Multiclass SVM (support vector machine) classifiers. Here we have used the Lexicon database. Random Forest (RF) shows overall accuracy of 68.44% Naïve Bayes (NB) shows an accuracy of 62.56%, K-nearest neighbor (KNN) shows an accuracy of 74.12%, and CNN+ Multiclass Support Vector Machine (SVM) offers accuracy of 91.28%.

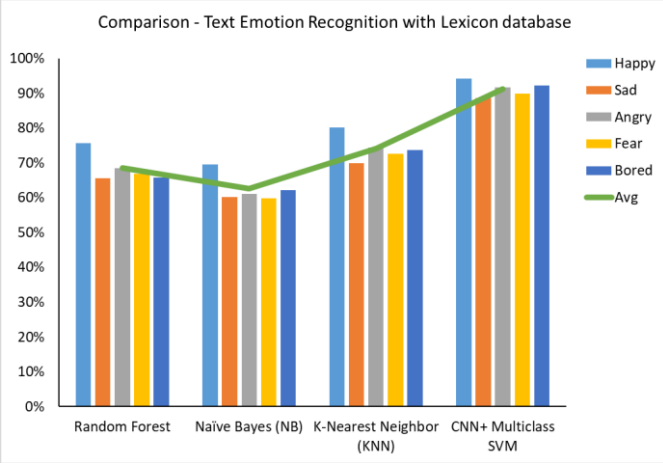

Fig 9. Comparison CNN+ Multiclass SVM using Lexicon Database**.**

Figure. 9 shows the CNN+ Multiclass SVM using Lexicon database in comparison with other algorithms. CNN+ Multiclass SVM shows an accuracy of up to 91.28%, while other algorithms show less accuracy.

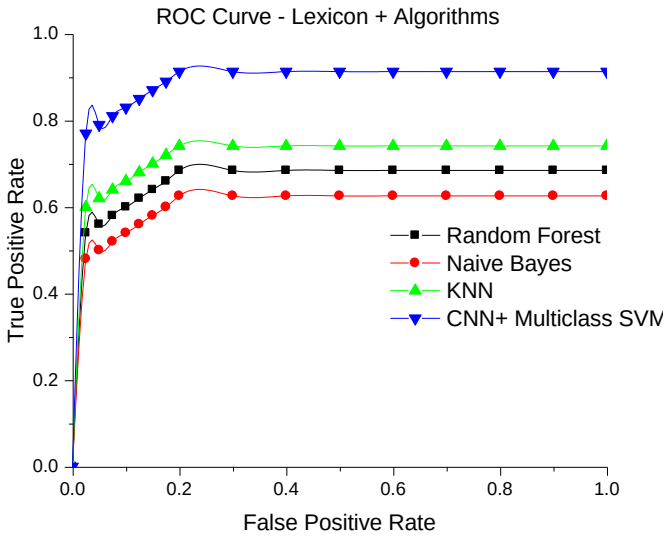

Fig 10. ROC Curve of CNN+ Multiclass SVM in comparison with other algorithms using Lexicon Database.

Figure. 10 shows ROC Curve of CNN+ Multiclass SVM in comparison with other algorithms such as Random Forest, Naïve Bayes, KNN using Lexicon Database**.**

5. Conclusion

A unique mood elevating music performer based on text emotion recognition using CNN and a multiclass support vector machine (SVM) is presented. Deep Learning and Machine Learning methods are combined. For text emotion recognition, input is processed via phases like pre-processing, feature extraction, and classifier. For pre-processing, steps like stop word removal, punctuation removal, repeated character removal, stemming are applied. In feature extraction, Bag-of-words and vectorization are used. CNN and Multiclass support vector machine algorithm are used. It is compared with other algorithms such as Random Forest (RF), Naïve Bayes (NB), K- nearest neighbor (KNN). Lexicon database and BBC database are used. The result shows the highest accuracy of 91.28% using a lexicon database with CNN and multiclass support vector machine. The article discussed applied methods, datasets and the comparison of other algorithms. Additionally, the paper presents concerns for researchers in text-based emotion recognition.

References

[1] Wu, C. H., Chuang, Z. J., & Lin, Y. C. “Emotion recognition from text using semantic labels and separable mixture models”, ACM transactions on Asian language information processing (TALIP), 5(2), 165-183, 2006.

[2] Kirange, D. K., & Deshmukh, R. R., ”Emotion classification of news headlines using SVM”, Asian Journal of Computer Science and Information Technology, 5(2), 104-106, 2012.

[3] Calefato, F., Lanubile, F., & Novielli, N. “EmoTxt: a toolkit for emotion recognition from text”, In 2017 seventh international conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW) pp. 79-80. IEEE, 2017.

[4] Chuang, Z. J., & Wu, C. H. “Multi-modal emotion recognition from speech and text.”, In International Journal of Computational Linguistics & Chinese Language Processing, Volume 9, Number 2, August 2004: Special Issue on New Trends of Speech and Language Processing, pp. 45-62, 2004.

[5] Batbaatar, E., Li, M., & Ryu, K. H. “Semantic-emotion neural network for emotion recognition from text.” IEEE Access, 7, 111866-111878, 2019.

[6] Shaheen, S., El-Hajj, W., Hajj, H., & Elbassuoni, S. (2014, December). “Emotion recognition from text based on automatically generated rules.” In 2014 IEEE International Conference on Data Mining Workshop (pp. 383-392). IEEE.,2014.

[7] Alswaidan, N., & Menai, M. E. B. “A survey of state-of-the-art approaches for emotion recognition in text.” Knowledge & Information Systems, 62(8), 2020.

[8] Shivhare, S. N., & Khethawat, S. “Emotion detection from text.”, arXiv preprint arXiv:1205.4944, 2012.

[9] Kratzwald, B., Ilić, S., Kraus, M., Feuerriegel, S., & Prendinger, H. Deep learning for affective computing: Text-based emotion recognition in decision support.” Decision Support Systems, 115, 24-35, 2018.

[10] Seol, Y. S., Kim, D. J., & Kim, H. W. Emotion

recognition from text using knowledge-based ANN. ITC-CSCC: International Technical Conference on Circuits Systems, Computers, and Communications (pp. 1569-1572), 2008.

[11] Su, M. H., Wu, C. H., Huang, K. Y., & Hong, Q. B. "LSTM-based text emotion recognition using semantic and emotional word vectors." In 2018 First Asian Conference on Affective Computing and Intelligent Interaction (ACII Asia) (pp. 1-6). IEEE, 2018

[12] Hajar, M "Using YouTube comments for text-based emotion recognition". Procedia Computer Science, 83, 292-299.2018.

[13] Zad, S., & Finlayson, M. Systematic evaluation of a framework for unsupervised emotion recognition for narrative text. In Proceedings of the First Joint Workshop on Narrative Understanding, Storylines, and Events, pp. 26-37, 2020.

[14] Ho, V. A., Nguyen, D. H. C., Nguyen, D. H., Thi-Van Pham, L., Nguyen, D. V., Van Nguyen, K., & Nguyen, N. L. T. (2019, October). "Emotion recognition for vietnamese social media text." In International Conference of the Pacific Association for Computational Linguistics (pp. 319-333). Springer, Singapore.2019.

[15] Teng, Z., Ren, F., & Kuroiwa, S. (2007, August). Emotion recognition from text based on the rough set theory and the support vector machines. In 2007 International Conference on Natural Language Processing and Knowledge Engineering (pp. 36-41). IEEE, 2007.

[16] Chaffar, S., & Inkpen, D. Using a heterogeneous dataset for emotion analysis in the text. In Canadian conference on artificial intelligence (pp. 62-67). Springer, Berlin, Heidelberg., 2011.

[17] Prabowo Rudy, and Mike Thelwall. "Sentiment analysis: A combined approach." Journal of Informetrics 3, no. 2 (2009): 143-157.2009.

[18] Liu Bing. "Sentiment analysis and subjectivity." Handbook of natural language processing 2, no. 2010 (2010): 627-666.2010.

[19] Feldman Ronen. "Techniques and applications for sentiment analysis." Communications of the ACM 56, no. 4 (2013): 82-89.,2013.

[20] Jiao Jian, and Yanquan Zhou. "Sentiment polarity analysis based multi-dictionary." Physics Procedia 22 (2011): 590-596.2011.

[21] Chopade Chetan R. "Text-based emotion recognition: A survey." International journal of science and research 4, no. 6 (2015): 409-414.2015.

[22] Sailunaz Kashfia, Manmeet Dhaliwal, Jon Rokne, and Reda Alhajj. "Emotion detection from text and speech: a survey." Social Network Analysis and Mining 8, no. 1 (2018): 1-26., 2018.

[23] Gosai Dhruvi D., Himangini J. Gohil, and Hardik S. Jayswal. "A review on emotion detection and recognization from text using natural language processing." International Journal of Applied Engineering Research 13, no. 9 (2018): 6745-6750., 2018.

[24] Bagde Sarika, and Karwande. V., "Emotion Based Music Recommendation System by Using Different ML Approach." International Journal of Advanced Scientific Research and Engineering Trends, Volume 6, Issue 6 (2021): 181-186., 2021

[25] Acheampong, Francisca Adoma, Chen Wenyu, and Henry Nunoo-Mensah. "Text-based emotion detection: Advances, challenges, and opportunities." Engineering Reports 2, no. 7 (2020): e12189.

[26] Ü. Dogan, T. Glasmachers, and C. Igel. Fast training of multi-class Support Vector Machines. Technical report, Department of Computer Science, University of Copenhagen, 2011.

[27] Asghar, M. Z., Lajis, A., Alam, M. M., Rahmat, M. K., Nasir, H. M., Ahmad, H., ... & Albogamy, F. R. (2022). A Deep Neural Network Model for the Detection and Classification of Emotions from Textual Content. Complexity, 2022.

[28] Hasan M, Rundensteiner E, Agu E. Automatic emotion detection in text streams by analyzing twitter data. Int J Data Sci Anal. 2019; 7(1): 35- 51.

[29] Malte A, Ratadiya P. Multilingual cyber abuse detection using advanced transformer architecture. Paper presented at: Proceedings of the TENCON 2019-2019 IEEE Region 10 Conference; 2019:784-789; IEEE.

[30] Huang C, Trabelsi A, Zaïane OR. ANA at SemEval-2019 Task 3: contextual emotion detection in conversations through hierarchical LSTMs and BERT; 2019. arXiv preprint arXiv:1904.00132.

[31] Huang Y-H, Lee S-R, Ma M-Y, Chen Y-H, Yu Y-W, Chen Y-S. EmotionX-IDEA: emotion BERT–an affectional model for conversation; 2019. arXiv preprint arXiv:1908.06264.

[32] Suhasini M, Srinivasu B. Emotion Detection Framework for Twitter Data Using Supervised Classifiers. New York, NY: Springer; 2020 (pp. 565–576).

[33] Ahmad Z, Jindal R, Ekbal A, Bhattachharyya P. Borrow from rich cousin: transfer learning for emotion detection using cross lingual embedding. Expert Syst Appl. 2020; 139: 112851.

[34] John S, Ederyn W, Bruce C. The Social Psychology of Telecommunication. London, UK and New York, NY: John Wiley & Sons; 1976.

[35] Jayakrishnan R, Gopal Greeshma N, Santhikrishna MS. Multi-class emotion detection and annotation in malayalam novels. Paper presented at: Proceedings of the 2018 International Conference on Computer Communication and Informatics; 2018:1-5; IEEE.

[36] Deshmukh, Shrikala Madhav, and Devulapalli Sita. "Mood enhancing music player based on speech emotion recognition and text emotion recognition." International Journal 8, no. 6 (2020).

[37] Deshmukh, Shrikala, Preeti Gupta, and Prashant Mane. "Investigation of Results Using Various Databases and Algorithms for Music Player Using Speech Emotion Recognition." In Proceedings of the 13th International Conference on Soft Computing and Pattern Recognition (SoCPaR 2021), pp. 205-215. Cham: Springer International Publishing, 2022.

[38] Rambabu, B. ., Vikranth, B. ., Anupkanth, S. ., Samya, B. ., & Satyanarayana, N. . (2023). Spread Spectrum based QoS aware Energy Efficient Clustering Algorithm for Wireless Sensor Networks . International Journal on Recent and Innovation Trends in Computing and Communication, 11(1), 154–160. https://doi.org/10.17762/ijritcc.v11i1.6085

[39] Flores, A., Silva, A., López, L., Rodriguez, A., & María, K. Machine Learning-Enabled Early Warning Systems for Engineering Student Retention. Kuwait Journal of Machine Learning, 1(1). Retrieved from http://kuwaitjournals.com/index.php/kjml/article/view/106