Developing a Hybrid Approach for Enhanced Sentiment Analysis Integrating Textual and Audio Data Streams

Rashi Jain[1], Saumya Yede[2], Rahul Patel[3], Prof. Chetan Gupta[4], Dr. Ritu Shrivastava[5]

B.Tech. Scholar, Dept. of CSE, SIRT, Bhopal, India[1,2,3]

Asst Prof., Dept. of CSE, SIRT, Bhopal India[4]

HOD Dept. of CSE, SIRT, Bhopal India[5]

Abstract: We are living in the era where social media plays a vital role. Online social networking sites like Facebook, YouTube, and Twitter have gained popularity as the number of social media technologies has expanded because they enable people to discuss and express their ideas about numerous life events. The bulk of people spend most of their time on social media sites every day. Using a dataset of 27481 records from Kaggle, we trained our deep learning model. We predict the sentiment into 3 classes with positive, negative or neutral polarity for the opinions expressed in the form of either text or audio. Additionally, our proposed technique has various practical applications and improves the accuracy of sentiment prediction.

Keywords: Sentiment Analysis, Neural Network, Natural Language Toolkit (NLTK), Twitter sentiment analysis, Natural Language Processing (NLP), Text based Sentiment Analysis

I.   INTRODUCTION

Sentiment analysis is a method for interpreting the emotions and thoughts of individuals on digital platforms that blends computational linguistics, natural language processing, and machine learning [1]. Sentiment analysis uses phrase, record, and attribute levels to classify this data into positive, negative, and neutral sentiment. Sentiment analysis is the technique of examining digital text to ascertain whether the communication's emotional tone is neutral, positive, or negative [2][3].

Sentiment analysis is the process of identifying and obtaining the writer's feelings from a written work, such a tweet, by utilizing text analysis and natural language processing (NLP) technologies. These emotions or ideas could be neutral, negative, or pleasant [6]. The sentiment of the author is the fundamental idea underpinning sentiment. These could vary from person to person.

More people than ever before are utilizing social media platforms, and a vast quantity of text, picture, audio, and video content is being shared. Sentiment analysis divides this data into three categories: positive, negative, and neutral sentiment. It does this by using phrase, record, and attribute levels. Social media platforms are the most comprehensive and effective means for someone to share their opinions on a certain topic [3][6].

There are many different forms of social media technology, such as blogs, social networks, forums, micro blogs, photo sharing, and business networks. Social media's ability to promote discussion and idea sharing on a wide range of life events has led to the rise in popularity of online social networking sites like Facebook, YouTube, and Twitter.

You can analyse your target market's attitudes—which have the potential to either positively or negatively affect the reputation of your brand—with the help of sentiment analysis tools. Sentiment analysis is a social media monitoring technique that helps businesses understand their consumers' attitudes on a range of topics and spot major issues before they get out of control.[2] Sentiment analysis will, however, advance beyond the simple categorization of positive, negative, or neutral in the future in order to properly appreciate the significance of understanding conversations and the information they offer about consumers. Sentiment analysis helps you keep an eye on and assess each communication that takes place between your company and its customers, so you can take care of the most important issues first [7][9].

Sentiment analysis use word polarity, word dictionaries, and lexicons among other tools to uncover writers' attitudes through their use. The only factor that determines an item's polarity is whether its creator meant to send a positive, negative, or neutral message.

Sentiment analysis can be divided into groups according to a number of factors, including the kind of data that is utilized as input, the techniques employed, and the particular uses.

A.   Based on input data

a)   Text-Based Sentiment Analysis: It uses written text-such as reviews, articles, and messages on social media-to analyse sentiment. Methods include lexicon-based techniques such as SentiWordNet, AFINN, and VADER, which are dictionaries with predefined sentiment scores. Machine learning techniques use characteristics like Bag of Words (BoW), TF-IDF, or word embeddings (e.g., Word2Vec, GloVe) to train algorithms like Naive Bayes, SVM, and Random Forest. Neural networks, such as LSTMs, RNNs, CNNs, and Transformers like BERT and GPT, are used in deep learning techniques to learn complex patterns and increase the accuracy of sentiment classification [4][8].
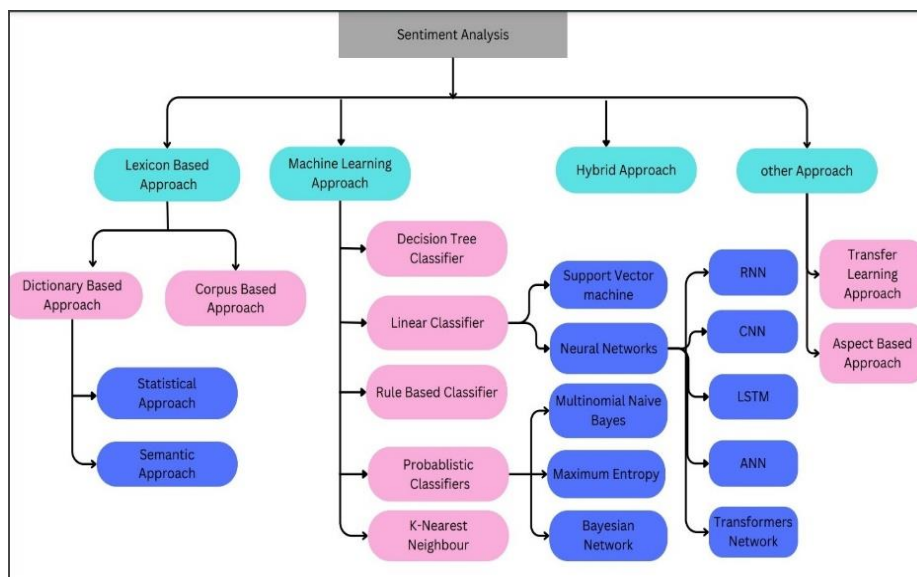

Fig 1. Sentiment Analysis Classification Algorithms

b)   Audio-Based Sentiment Analysis: To extract sentiment from spoken words, voice content and acoustic features are analysed in audio-based sentiment analysis. The first stage in this process is speech recognition, which converts spoken words into text using Automatic Speech Recognition (ASR) systems. Pitch, tone, loudness, and speech rate are examples of prosodic elements that are studied in attempt to capture the subtle emotional fluctuations in speech [11] . Then, by using machine learning and deep learning techniques on these audio properties, the sentiment expressed in the audio data is classified. This technique involves the employment of models such as Support Vector Machines (SVMs), Hidden Markov Models (HMMs), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs).

c)   Visual Based Sentiment Analysis: Sentiment can be inferred from visual indicators including body language and facial expressions in visual-based sentiment analysis. In order to identify emotions from facial movements, this analysis uses computer vision algorithms for facial expression detection. It also deciphers postures and fluctuations that reflect emotional states. Multimodal techniques are used to improve the reliability and precision of sentiment recognition by integrating visual data with voice or text for a more thorough analysis [5] .

B.   Based on Application

a)   Social media sentiment analysis: This entails examining comments made on sites like Facebook, Instagram, and Twitter. Tracking political sentiment, monitoring brands, and gauging public opinion all require this kind of information.

b) Sentiment analysis of customer feedback: This approach evaluates sentiment in reviews and feedback to enhance customer satisfaction, spur product development, and direct efforts in market research [12] .

c) Financial Sentiment Analysis: Financial sentiment research looks at the sentiment expressed in financial news, reports, and social media in order to anticipate fluctuations in stock markets and assist in making financial choices.

d) Medical sentiment analysis: Sentiment analysis using patient reviews, health forums, and medical data is used to monitor public health trends and enhance patient treatment [4].

e) Political sentiment analysis: It is the process of exploring points of view expressed in speeches, debates, and social media in order to predict elections, assess the outcomes of policies, and quantify public opinion [13].

Sentiment Analysis Challenges
1. With respect to the situation, words and phrases might mean different things.
2. Analysis becomes more challenging when contextual cues like sarcasm, irony, and social allusions are present.
3. For training, sentiment analysis models frequently need a lot of labelled data.
4. Sentiment is subject to change over time as a result of changing public opinions, trends, and events.
5. Analysis results may contain biases and inaccuracies due to noisy data, which includes grammatical errors, spelling issues, and irrelevant information [8] .
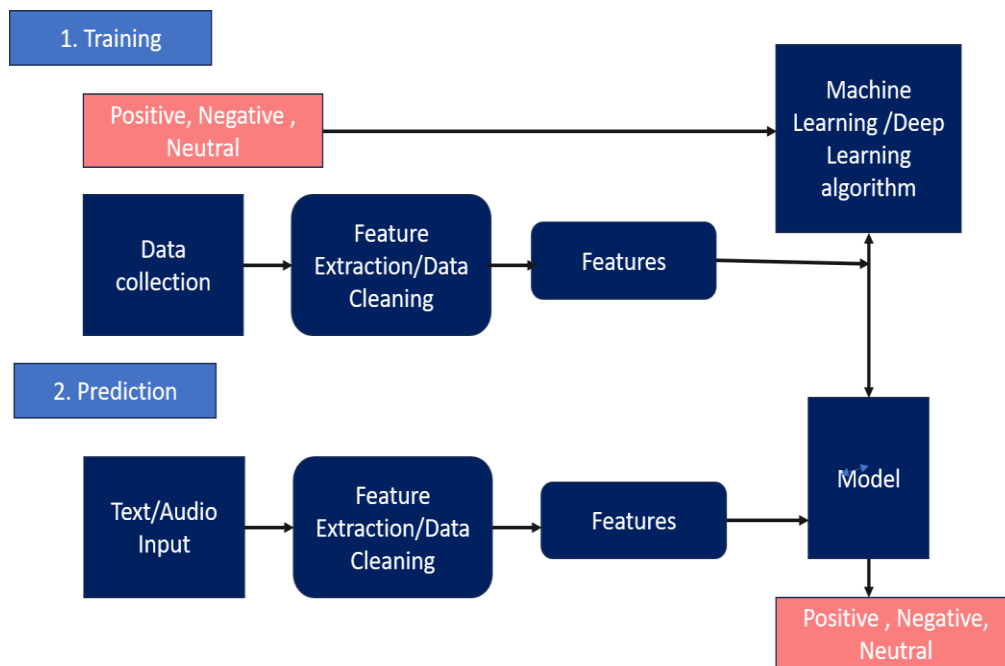

Fig 2. This figure illustrates the working process of sentiment analysis.

II. LITERATURE REVIEW

In this paper [1], author proposed a novel method for categorizing Twitter texts into many sentiment classes that goes beyond binary and ternary classifications. Although this research focuses on seven sentiment classes, the proposed approach can be expanded to classify texts into more categories. SENTA provides an easy-to-use graphical user interface that allows users to pick and categorize the most relevant features for their application. SENTA is used for our own multiclass classification tests.

In this paper [2], author proposed to develop a real-time sentiment analysis system for social media content. Natural language processing techniques are used to determine whether a sentence is positive, negative, or neutral. The study also investigates the use of topic modeling to monitor current issues and identify potential threats to brand reputation. The technique is evaluated using a big dataset of tweets from various brands and themes.

The proposed system accurately recognizes emotion in social media messages and monitors trending subjects. Research findings can help firms improve their brand and address difficulties.

In this paper [3], author presents a Sentiment Analysis study conducted on over 1000 Facebook posts about newscasts, contrasting sentiment for Rai, the Italian public broadcasting network, with the rising and more vibrant commercial business, La7. This study also considers. Auditee's broadcast audience figures, merging social media analysis, particularly on Facebook, with publicly available measurable data.

In this paper [4], author presents study is to assess tweet sentiment using Logistic Regression, VADER, and BERT sentiment analysis methodologies. The presented analysis methodologies are sensitive to sentiment expressions in social media environments and can be applied across domains. Despite employing three different methods, all preprocessing and subsequent operations, with the exception of sentiment analysis, will be similar. Using the identical processing steps, we can compare the three proposed sentiment analysis algorithms. This study has a variety of applications, including gathering public opinion for government and health officials to utilize in decision-making processes.

In this paper [5], author focused on audio sentiment analysis. As research into audio sentiment analysis advances, new methods for analyzing audio data are emerging. We utilize machine learning to categorize audio based on feelings. This study used both audio sentiment and multimode analysis.

Multimodal sentiment analysis categorizes emotions across many data kinds, including text, audio, and video. Our audio sentiment analysis technique, which combined individual modality and attention networks, yielded good results. The goal was to develop a system capable of recognizing six emotions in audio files: anger, joy, disgust, sorrow, fear, and surprise.

In this paper [6], author proposed sentiment analysis on speaker discriminated voice transcripts to estimate the emotions of the various speakers in the conversation. We examined various methodologies for speaker discrimination and sentiment analysis in order to create efficient algorithms for these tasks.

In this paper [7], author proposed an approach that takes paragraph of sentences provided by the client is accepted, and after extracting each word, it is compared to the stored (database has been preserved here) parts of speech, articles, and negative terms. After testing against the database, CFG is utilized to ensure that the sentences are properly formed. Each statement is separated by '.', '?', or '!'. Emotions are identified as positive, negative, or neutral sentences.

III.   PROBLEMS STATEMENT

From the literature review presented above various approaches have been used in Sentiment Analysis models like:

1.   Offer a sentiment analysis tool for assessing the opinions that people and businesses are expressing on social media.
2.   Recognize the significance of social media for fostering one's personal and an organization's reputation and stress the importance of evaluating the tone of posts, comments, and interactions on these sites.
3.   Sentiment analysis is the process of automatically determining the sentiment or emotional tone present in audio or textual data.
4.   Emphasize the value of sentiment analysis in enlightening public opinions, consumer attitudes, and credibility of brands in the social media setting.
5.   Stress the ways in which sentiment analysis may help individuals and organizations identify broad sentiment patterns, identify issues, and take the required action to maintain or enhance their online presence.
6.   Talk about the creation of a sentiment analysis tool that examines text data from social media sites using machine learning algorithms and natural language processing (NLP) methods.
7.   Examine subjects including noisy data, subjectivity and ambiguity in information on social media, and the dynamic nature of social media debates.
8.   Take into account the ethical and privacy consequences, making sure that the rules and regulations governing the gathering and use of social media data are followed, and respecting user permission and privacy.
9.   Describe the sentiment analysis system's possible benefits, which include giving people and organizations access to meaningful data to improve their online presence and reputation management.

IV.   RESEARCH OBJECTIVES

Sentiment analysis is well suited for real-world situations, where the opinions shared by individuals and organizations via social media postings, comments, and interactions have become vital. Various objectives are met:

1.   It includes audio-based sentiment analysis and multilingual text-based sentiment analysis.
2.   People can express their emotions in whichever language they feel comfortable speaking, including English, Hindi, Marathi, Gujarati, Tamil, Kannada, Telugu, Punjabi, and others, in order to address the challenging issue of linguistic diversity.
3.   To achieve thorough sentiment analysis that accurately reflects the diversity of your consumer base, respond to customer feedback in a number of languages.

V.   PROPOSED WORK

The intended objective of the proposed research is to create and put into use a sentiment analysis system that can handle inputs in both text and audio formats. The software will use deep learning models and natural language processing (NLP) techniques to predict the sentiment of user-provided data. The system makes use of a neural network for sentiment analysis, Google's Speech Recognition API for audio transcription, and Google's Translation API for multilingual support.

The output layer of the multilayer perceptron model is a dense layer that has three neurons each for negative, neutral, and positive sentiment, or the number of classes in your sentiment classification task.

The Twitter Tweets Sentiment dataset, sourced from Kaggle, is an extensive collection of tweets annotated with sentiment labels. The dataset, created by Abhishek Shrivastava, includes 27481 tweets, with each tweet labeled as either positive, negative, or neutral.

The dataset is especially relevant since it is perfect for training and assessing sentiment analysis models because it includes a significant number of tweets with pre-labeled sentiment. The dataset can be accessed from Kaggle at https://www.kaggle.com/datasets/abhi8923shriv/sentiment-analysis-dataset.

The dataset includes features- textId, text, sentiment, and time of tweet, Age of user, Country, Population, Land area and Density.
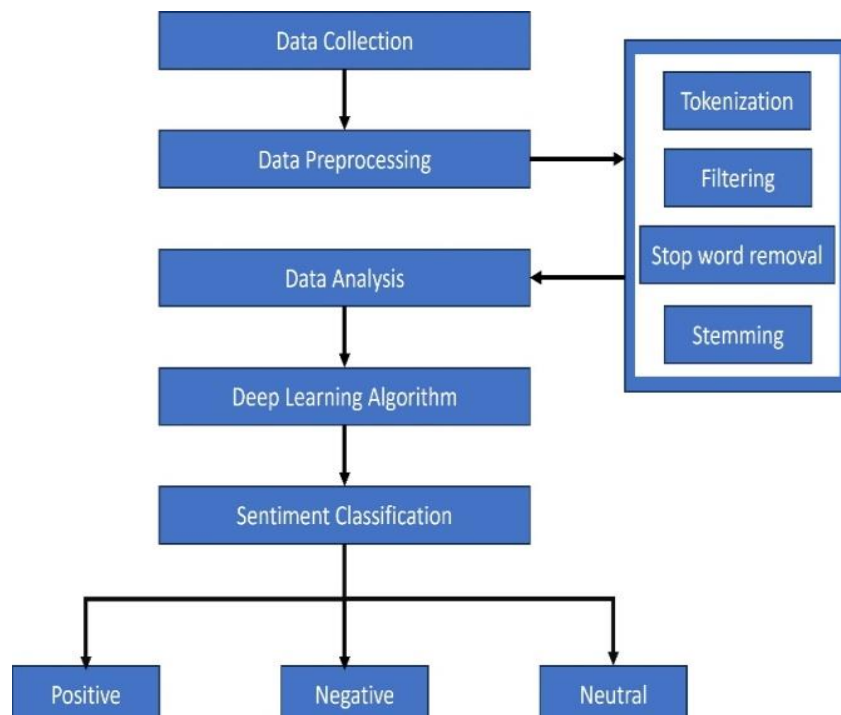

Fig 3. Flowchart for Sentiment Analysis Process

Algorithm:

Step 1: Selection of the random records from the dataset collected.

Step 2: Pre-process the data.

Step 3: Perform data analysis such as tokenization, filtering,   stop word removal, stemming.

Step 4: Train the deep learning multilayer perceptron model using training dataset.

Step 5: Define hyper parameters for the neural network.

Step 6: Accept real time input from the user in the form of text and audio.

Step 7: For text input in language other than English, we utilize translation services to translate text.

Step 8: For audio input, convert audio to text using speech recognition library.

Step 9: Apply the trained model on the real time input to predict sentiments.

Step 10: Final multiclass classification of the input into either of the 3 class:

i.   Positive

ii.   Negative

iii.   Neutral

VI.   RESULT

VII. CONCLUSION

The primary purpose of the sentiment analysis is to analyse the large volume of data present on the social media sites. An efficient technique for classification was required to solve this problem. In this paper we present Artificial Neural Network (ANN) Algorithm along with Natural Language Processing (NLP). In this proposed work, we use the dataset from the Kaggle that has 27481 records, then we classify the sentiments for the real time text and audio input into three classes that are of polarity positive, negative and neutral. Our results shows that it will be better classification achieved. Sentiment analysis using video and emojis has room for development.

REFERENCES

[1]. Mondher Bouazizi and Tomoaki Ohtsuki, "A Pattern-Based Approach for Multi-Class Sentiment Analysis in Twitter", IEEE Access, vol. 5, pp. 20617-20639, 2017, doi: 10.1109/ACCESS.2017.2740982

[2]. A. Barunaha, M. R. Prakash, and R. Naresh, "Real-Time Sentiment Analysis of Social Media Content for Brand Improvement and Topic Tracking," Department of Networking and Communications, College of Engineering and Technology, SRM Institute of Science and Technology, Tamil Nadu, India.

[3]. F. Neri, C. Aliprandi, F. Capeci, M. Cuadros, and T. By, "Sentiment Analysis on Social Media," in Proceedings of 2012 IEEE/ACM International Conference on Advances in Social Networks Analysis and Minin

[4]. A. J. Nair, A. Vinayak, and V. G, "Comparative Study of Twitter Sentiment on COVID-19 Tweets," in Proceedings of the 5th International Conference on Computing Methodologies and Communication (ICCMC), Amritapuri, India, 2021, doi: 10.1109/ICCMC51019.2021.9418320.

[5]. R. Rathod, R. More, S. Sabde, V. Zadokar, and R. Vhanabatte, "Audio Sentiment Analysis with Different Approach," International Scientific Journal of Engineering and Management, vol. 2, no. 6, June 2023, doi: 10.55041/ISJEM01260.

[6]. M. S. Maghilnan and M. Rajesh Kumar, "Sentiment Analysis on Speaker Specific Speech Data," in Proceedings of the 2017 International Conference on Intelligent Computing and Control (I2C2), Tamil Nadu, India, 2017

[7]. B. Nandi, M. Ghanti, and S. Paul, "Text Based Sentiment Analysis," in Proceedings of the 2017 International Conference on Inventive Computing and Informatics (ICICI), Coimbatore, India, Nov. 23-24, 2017, doi: 10.1109/ICICI.2017.8365326.

[8]. N. Sultana, P. Kumar, M. R. Patra, S. Chandra, and S. K. S. Alam, "Sentiment Analysis for Product Review," ICTACT Journal on Soft Computing, vol. 9, no. 3, pp. 1913-1918, Apr. 2019, doi: 10.21917/ijsc.2019.0266.

[9]. M. Araújo, A. Pereira, and F. Benevenuto, "A comparative study of machine translation for multilingual sentence-level sentiment analysis," Information Sciences, vol. 512, pp. 1078-1102, 2020, doi: 10.1016/j.ins.2019.10.031.

[10]. Z. Jianqiang, G. Xiaolin, and Z. Xuejun, "Deep convolution neural networks for twitter sentiment analysis," IEEE access, vol. 6, pp. 23253-23260, 2018.

[11]. A. M. Ramadhani and H. S. Goo, "Twitter sentiment analysis using deep learning methods," in 2017 7th International annual engineering seminar (InAES), 2017: IEEE, pp. 1-4.

[12]. W. Medhat, A. Hassan, and H. Korashy, "Sentiment analysis algorithms and applications: A survey," Ain Shams engineering journal, vol. 5, no. 4, pp. 1093-1113, 2014.

[13]. S. Zahoor and R. Rohilla, "Twitter sentiment analysis using machine learning algorithms: a case study," in 2020 International Conference on Advances in Computing, Communication & Materials (ICACCM), 2020: IEEE, pp. 194-199.

[14]. M. H. Abd El-Jawad, R. Hodhod, and Y. M. Omar, "Sentiment analysis of social media networks using machine learning," in 2018 14th international computer engineering conference (ICENCO), 2018: IEEE, pp. 174-176.

[15]. H. J. Kaur and R. Kumar, "Sentiment analysis from social media in crisis situations," in International Conference on Computing, Communication & Automation, 2015: IEEE, pp. 251-256.

[16]. S. Bird, E. Klein, and E. Loper, "Natural language processing with Python: analyzing text with the natural language toolkit." O'Reilly Media, Inc.," 2009.