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APPLICATION BASED SYSTEM FOR RECOGNISING SPEECH EMOTIONS

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***Abstract*—Businesses often underestimate the power of customer care or customer support to grow their revenues. Customers often receive generic responses that do not address their specific needs or emotions, leading to a lack of connection and dissatisfaction. Long wait times and slow response times can be frustrating for customers and lead to decreased satisfaction. Moreover poorly trained customer service agents can struggle to handle complex customer inquiries and provide adequate support, leading to dissatisfaction. They may not be able to accurately detect the emotional state of the customer, leading to an inappropriate response and further dissatisfaction. This can lead to shutting down of businesses. This paper proposes a system to provide a more personalized and empathetic response to customers by building a model using MLP Classifier. We are optimistic that our system based on MLP Classifier is more reliable as compared to the rest of the models available currently.**

Keywords—MLP, Customer Satisfaction, Speech Signals

I. INTRODUCTION

In the present day, customer satisfaction is a key concern for businesses and organizations. The traditional means of gauging it include conducting surveys and distributing questionnaires. Nevertheless, businesses and marketers are searching for faster and more efficient methods to gather feedback from their potential customers.[1] Customer support is a crucial aspect of any business and plays a vital role in maintaining customer satisfaction and loyalty. However, delivering effective customer support can be challenging, especially when dealing with a high volume of calls. A significant portion of these calls involve customers expressing their emotions, which can be difficult to accurately interpret, leading to misunderstandings and dissatisfied customers. This problem has become increasingly significant with the rise of online commerce and remote customer support services.

The goal is to accurately analyze the emotions of customers from their speech data. The problem is that traditional methods are vulnerable to interference from factors like speaker differences and environmental noise, and the data has unbalanced sample classes.[2]

In this research paper, we propose a speech emotion recognition system based on Multilayer Perceptron (MLP), a type of artificial neural network. The MLP architecture is well-suited for speech emotion recognition because of its ability to learn complex non-linear relationships between the input features and the emotional state of the speaker. The proposed system is trained on a large dataset of speech samples, labelled with the corresponding emotions. The performance of the system is evaluated using standard evaluation metrics such as accuracy, precision, recall, and F1-score.

In detail, our system first preprocesses the speech signals to extract relevant acoustic and prosodic features. These features are then fed into the MLP, which consists of multiple layers of interconnected nodes, to determine the emotional state of the speaker. The MLP is trained using a supervised learning approach, where the network is trained on the preprocessed speech signals, labelled with the corresponding emotions. The parameters of the MLP are optimized using a backpropagation algorithm to minimize the prediction error.

Once the MLP is trained, it can be used to classify speech signals into one of several emotional categories, such as happy, sad, angry, and neutral. The performance of the system is evaluated using a held-out test dataset, which contains speech signals that were not used during the training phase. The evaluation results provide insight into the accuracy and robustness of the proposed system and highlight any areas that need further improvement.

II. LITERATURE REVIEW

In [3] the authors have conducted an in-depth study of the utilized algorithms and found that these algorithms have problems such as too simple feature extraction methods, low utilization of human-designed features, high model complexity, and low accuracy of recognizing specific emotions. For the data processing, the RAVDESS dataset uses additive Gaussian white noise (AWGN) for a total of 5760 audio samples. For the network structure, they build two parallel convolutional neural networks to extract spatial features and a transformer encoder network to extract temporal features, classifying emotions from one of 8 classes.

In [4], authors have proposed a method to calculate the spectrogram of speech and its first-order and second-order difference, stack the three as the input of neural network to reduce the influence of emotion independent factors; they have used CNN and LSTM to extract speech data features, and add attention mechanism to make the model focus on the time-frequency region related to emotion. For the problem of unbalanced sample classes, they have added Focal Loss to reduce the weight of samples which are easy to classify in loss. The results of the experiment shows that the recognition accuracy of our model is 92.60% of weighted accuracy and 92.02% of unweighted accuracy, which is significantly improved compared with the traditional DNN-ELM method. Disadvantage is that if the amount of data is quite large then LSTM takes a lot of time and may cause overfitting. On the other hand DNN does not contain a memory unit; it cannot handle sequences of data.

In [5], the authors investigated two distinct methods of feature extraction for effective speech emotion recognition. Initially, they proposed a two-way feature extraction technique that employs super convergence to extract two sets of potential features from the speech data. The first set of features was obtained using principal component analysis (PCA), which was then used as input to a deep neural network (DNN) containing dense and dropout layers. In the second approach, mel-spectrogram images were extracted from audio files and fed into a pre-trained VGG-16 model. The experimental results showed that the proposed models outperformed existing models in terms of various performance metrics. However, there are some limitations to this study that could be addressed in future work. Specifically, the dataset used in the study only included North American speakers, and the proposed approaches may not generalize well to people from different geographical regions.

In [6], the authors provide an overview of Deep Learning techniques and examine recent literature that employs these methods for speech-based emotion recognition. The review encompasses the databases used, emotions identified, and the contributions made towards speech emotion recognition, as well as the limitations associated with it. Deep Learning techniques employ key features in various applications, such as speech emotion recognition (SER) and natural language processing (NLP). This allows for the learning of real-world data without the need for manual human labels. Traditional modeling techniques require a larger dataset to achieve accuracy in emotion recognition, which can be time-consuming. In contrast, Deep Learning methods are composed of various non-linear components that perform computations in parallel, but they require deeper layered architectures to be structured effectively.

In [7], the authors examine recent and relevant literature related to the various design components and methodologies of speech emotion recognition (SER) systems, thereby providing readers with a comprehensive understanding of the latest research on this topic. Moreover, while analyzing the current state of knowledge on SER systems, the authors highlight the need for further research to address the existing research gaps, which could be investigated by other researchers, institutions, and regulatory bodies. One of the primary challenges in SER systems is the difficulty in precisely defining the meaning of emotions, which can be complex and challenging to comprehend. The lack of agreement on the definition of emotions is reflected in the collection of databases. Another challenge is in reducing dimensionality and selecting appropriate features for analysis.

In[8],authors have focused on work dealing with the processing of acoustic clues from speech to recognize the speaker's emotions. The task of speech emotion recognition (SER) is traditionally divided into two main parts: feature extraction and classification. During the feature extraction stage, a speech signal is converted to numerical values using various front-end signal processing techniques. Extracted feature vectors have a compact form and ideally should capture essential information from the signal. In the back-end, an appropriate classifier is selected according to the task to be performed. The attention mechanism can improve the performance of the SER systems; however, its benefit is not always evident. Although AM modules have become a natural part of today's SER systems, AM is not an indispensable element for the achievement of high accuracy or even state-of-the-art results.

III. MODEL ARCHITECTURE

Multilayer Perceptron (MLP) Algorithm

Popular machine learning approach for speech emotion recognition is the multilayer perceptron (MLP). A sort of artificial neural network known as an MLP is composed of numerous layers of interconnected nodes, where each node transforms the input data linearly before applying a non-linear activation function.[9]

Preprocessing: Mel Frequency Cepstral Coefficients (MFCCs), for example, are extracted after the audio signal has been preprocessed to reduce background noise.

Feature extraction: Methods like MFCCs are used to extract pertinent features from the preprocessed audio stream.

Dataset cleaning: A dataset of audio samples is prepared and each sample is labeled with the relevant emotion. Each audio sample's associated emotions serve as the goal output of the MLP, which receives the features derived in step 2 as input.

MLP architecture:An input layer, one or more hidden layers, and an output layer make up the MLP architecture. The number of features retrieved in step 2 is equal to the number of nodes in the input layer. The output layer has as many nodes as there are emotions in the dataset, which is often between 2 and 8 emotions. The model's performance can be improved by adjusting the number of hidden layers and the number of nodes in each hidden layer.[10]

Training the MLP: The labeled speech data is used to train the MLP classifier. To optimize speed on a validation set, the right number of hidden layers must be chosen. The parameters used to assess the test set are used to train the model on a training set.

Testing and evaluation: A collection of audio samples not utilized in training are used to test the trained MLP, and measures like recall, accuracy, and F1-score are used to gauge its performance. This aids in evaluating the model's effectiveness and pointing up potential improvement areas.

Integration: The MLP can be incorporated into an application to recognize and react to users' emotions after being taught and evaluated.

IV. PROPOSED SYSTEM

A) *Dataset Description*

The research project utilized the Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS) as its dataset. RAVDESS comprises 24 actors, each with 60 trials, and encompasses eight distinct emotions, including calm, happy, sad, angry, fearful, surprise, and disgust. The dataset contains a total of 1440 data samples.

B) *Approach*

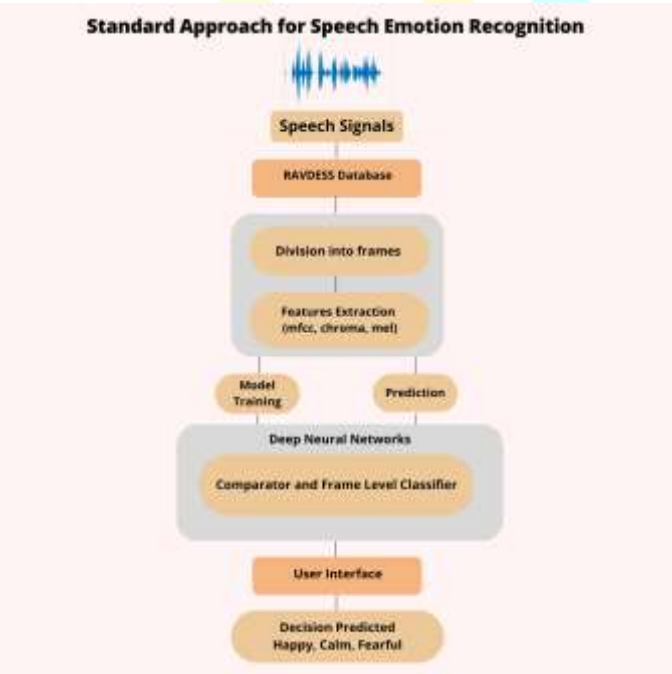
Two feature extraction approaches were proposed in the current study. The first method involved working directly on the audio dataset to derive numerical features, and this section provides additional information on the approach.

a. *Feature Extraction*

In order to predict the emotional content of a given speech, it is necessary to identify and extract meaningful features from the audio dataset. To achieve this, a combination of MFCC, Log Mel-Spectrogram, Chroma, Spectral centroid, and Spectral rolloff features have been extracted using the librosa library. Following feature extraction, each file's features and labels have been transformed into a 2-D feature vector.

b. *Dimensionality Reduction and Preprocessing*

From the audio files, a total of 180 features have been extracted. To address the high dimensionality and sparsity of the dataset, additional pre-processing of the data was performed. The data was first normalized using the MinMaxScaler function from the sklearn library. Moreover, in order to reduce the dimensionality of the data and address issues of overfitting, PCA was employed. By eliminating highly correlated variables, PCA significantly reduced overfitting. A total of 80 important features were then selected using PCA, allowing for effective training and testing.



V. CONCLUSION AND FUTURE SCOPE

In conclusion, the proposed speech emotion recognition system based on MLP provides a promising solution to the challenges faced in customer support. The system has the potential to significantly improve the accuracy of emotion recognition and facilitate more effective customer support. The results of this research will contribute to the growing body of knowledge in the field of speech emotion recognition and provide a foundation for further advancements in this area. As a future system, we plan to add additional features of Facial Recognition in real time to enhance the accuracy of the output.

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