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Research Article

Artificial Intelligence Based Emotion Identification Using Analog Waves

PIN-YU HUANG[1], PEI-HSUAN YANG[2], SHIH-YIN HUANG[3], YUE-NUO YAN[4]
[1,2,3,4]Dept. of Electrical Engineering, National Taiwan University of Science and Technology (Taiwan Tech) Taipei, Taiwan, R. O. C
Email: Pin-yi.huang@mail.ntust.edu.tw[1], pei-hsuan@mail.ntust.edu.tw[2], shih-yin.h@mail.ntust.edu.tw[3], yan.yue-nuo@mail.ntust.edu.tw[4]
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ABSTRACT
In this paper, we propose a system that will analyze the speech signals and gather the emotion from the same efficient solution based on combinations. This system solely served to identify emotions present in the signal or speech using concepts of deep learning and algorithms of machine learning (ML). Using the above mentioned, the system will determine the eight emotions present in the speech signal; anger, sad, happy, neutral, calm, fearful, disgust and surprised. The system is built with the language python and librosa, sound file libraries, which are part of the more extensive scikit library used for specific applications of audio analysis. The system will receive the sound files from the dataset present on the internet called RAVDESS. It will then analyze the audio files' spectrograms in WAV format and return us the efficiency of the system, which is the intended Outcome. We have achieved an efficiency rate of 81.82%.

Keywords: Librosa; SciKit; Sound File; Spectrogram

Introduction

Speech Emotion Recognition (SER) is the process or approach of gathering human emotions from a delivered speech signal [1]. This is capitalizing on the very known fact that a person's tone and pitch of voice often reflects the emotion that he/she is going through [2]. Animals like dogs and horses also employ this phenomenon to understand human emotion. SER is harsh feelings emotions are subjective, and annotating audio is challenging. However, speech analysis has a significant advantage [3]-[8]. They can be used to design intelligent systems that are effortlessly integrated with our lives as a part of smart-living. It is the background for technologies like voice recognition, voice control, command capabilities and many more provided by tech-giants like Google, Microsoft in the form of Alexa, Cortana, and Samsung's Bixby and other artificial intelligence (AI) programs [9]-[14].

Emotions can be incurred via multiple techniques or approaches like facial expressions, calligraphy analysis, and psychological evaluations performed on the subject [15]-[18]. Nonetheless, speech is the most intrinsic form of communication between any two individuals at any given point in time [19]. This has inspired many people in many research areas to analyze, experiment, and draw favourable results in the field of speech analysis, which resulted in multiple models and theories over time [20]-[24]. This became popular in the fifties. The help of knowledge from the previous people and their publications helped the analysts form a theoretical procedure or a formula to convert speech into a set of words for supposedly pattern prediction to apply in several application areas [25]. This procedure couldn't procure satisfactory results and didn't get the necessary support for continual research on it [26]-[28]. So, we have decided to work on this area of study. There could be a way to determine what prediction model to be used to classify and analyze speech emotion detection. The prominent ones are hidden Markov models, Gaussian mixture models, neural networks, support vector machine, multiple classifier systems, and hierarchical emotional classifications [29]-[32].

Literature Survey

Speech and communication among two beings, whether they are humans or otherwise, have always been given utmost regard and importance. It helps them mutually in several ways, which can't be explained in detail [1], [18]. Since the paramount of time, speech analysis has been given priority because just by instead talking, we cannot determine the dialogue's actual intent. This has been a pressing topic among the intellectuals and philosophers since thinkers [33]-[36].

When two persons interact with each other, they can detect the underlying emotions within them. This can be used in any number of sociological applications. In the present generation of machines, an essential and vital communication gap is observed, which results in

the observed improper efficiency and not perfectly able to reach the goals it is designed for [37]-[39].
We are purely working at this point of the area to provide the people working on it, to give a better, efficient system with greater Accuracy and simple-to-use design. Although many models in the world are offering to do the same task, we have designed this system with quite features and advantages, many of them are certainly lacking in performance [40]-[43].

Architectural Description

The speech emotion recognition model is designed using the knowledge and working of deep learning concepts and ML algorithms. We will be using python language due to its relatively significant and unique benefits explained in below Table 1, where we can observe the uniqueness of the language and the reason to use it in our paper [44].

Python inculcates' main advantages are simpler code, more extensive libraries, dynamic data, and a location that rules out other languages in modern application-oriented programming. Hence the reason we have used python language. The other significant advantages are explained. Namely, the AI and ML usually have heaps of code to tinker with for basic functionalities. Here Python helps by using smaller codes for designing. Python is entirely open-source; hence we can obtain great support from the community. Also, it is flexible in various platforms, which makes it an instant user-favourite for developing applications. In Python, many libraries are present, which is widely used based on the requirement and application specificity. We will be using Pandas, Librosa, SoundFile and Scikit-Learn libraries as they are the most prominent libraries required for our application [45]

Table 1: Differences between widely used Programming Languages

Parameters	**C**	**JAVA**	**Python**
Development	It was developed by Dennis Ritchie	It was developed by James Gosling	It was developed by Guldo Rossum
Year	1972	1995	1989
Type	It is Procedural Language	It is an Object-oriented Language	It is an Object-oriented Language
Application	System Programming and Hardware Applications	Used in Application Programming	Used in Application Programming
Memory Management	User based Memory Management	Uses Garbage Collector	Uses Garbage Collector
No. of Functions	Limited built-in functions	Large built-in functions	Very large built-in functions
Speed	Faster	Slower	Better
Assignment	Allowed	Error	Allowed

A. Pandas Library

It is a software library designed specifically for data manipulation and analysis. In specific, it provides our data structures and operations for manipulating and developing numerical tables and time-series. It is entirely free, and no additional charges will be present.

B. Librosa Library

It is a python package for audio and music analysis that provides building blocks for creating musical information retrieval systems. It has unique qualities like spectral analysis and feature extraction. It is used to take audio files as input and modify/alter them. It can perform operations like short-time Fourier transform, spectral bandwidth, and spectral flatness and design instantaneous-frequency spectrogram and plot the graph's results.

C. Sound File Library

It is an audio library based on libsndfile, CFFI and NumPy. It can read/write sound files through libsndfile, a free and open-source library for editing different sound files of other formats like mp3, WAV and many more.
It is flexible and supported in many platforms like Windows OS, Linux, MAC etc. It is supported in Python from versions of 3.x and above.

D. Scikit-Learn Library

It is a free open source software ML library specifically for python language. It has many algorithms for ML and deep learning. Some of them are classification, regression, clustering algorithms, Support Vector Machines (SVM), Random Forests etc.
It is written in Python and primarily uses a numpy library for large-performance algebraic expressions, linear and array operations. It is easily flexible and integrates into all platforms. Datasets are a large heap of similar/different data collected for specific

purposes. They are generally huge and sometimes in the order of gigabytes. Some of them are specifically designed for a few applications. Sometimes they are the product of a collection of dynamic data. Generally, the internet is a vast host of these datasets. There are specific websites present that accumulate and store all these datasets in different formats. Many prominent websites collect and have datasets [46].

Among this website, we have chosen the RAVDESS (Ryerson Audio-Visual Database of Emotional Speech and Song) dataset from Kaggle, a large dataset of audio files of speeches in various emotions where actors and actress gave the voice in most of the feelings. This dataset alone is 21Gb long, but we have compressed it into 30Mb. It has 7356 files where there are 60 trials for each actor who lend his voice. 2880 files are Speech files and 2024 Song files; both are audiovisual and video only files and 1440 speech only files, 1012 Song files; both are audio-only files.

After passing this random input, the system will characterize the input type and produce the initial output according to which the final efficiency is deduced. If it is in the specified range as declared above, the system is working effectively, and this is calculated at the last step [47]-[49].

Methodology

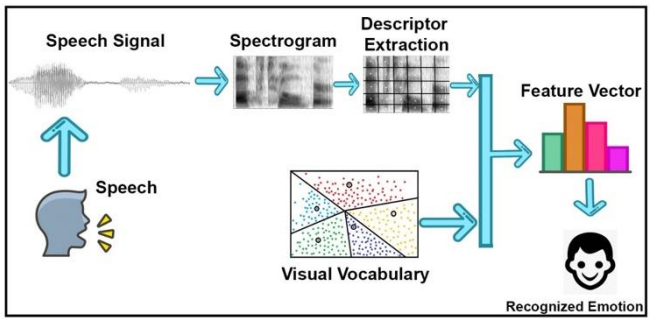

Fig. 1. Basic Methodology

The main aim in drafting this paper is to provide a simple, efficient and handy system with the concepts of ML as their core functionality so that we can rely on the system for accurate and non-faulty results. Designing and executing this project is quite simple with the fundamentals of programming language like Python. This language is used extensively in the functioning of the project. Apart from writing the code, there are several aspects to this project, which are discussed in detail. The whole procedure is simple, and we have designed this project with a learning-on-the-path approach. It means that we have added some functionalities and features, which can be seen in Fig. 1.

There are two outcomes of this project, namely, initial and final. The initial Outcome is the output generated, which is generally the response obtained when the system detects any emotion present in the input provided to it. Based on this response, we have designed the system to analyze this and perform more trials or obtain more samples and analyze them to generate a pattern. From this pattern, the system will be developed. To this system, we will be giving random inputs to check its functioning, response generation, errors and time complexity to learn the system's efficiency.

If the system generates appropriate responses for the given inputs, we will be assuming that the system is functioning significantly as per the requirements. This functioning is measured by using the efficiency percentage. Based on this, one can classify any system's efficiency, functioning and reliability. A general efficient system will have an efficiency percentage of 75-99%. If it reaches 100%, we can assume two things. The system couldn't handle the inputs, and output generation capacity is halted/reduced to an unacceptable level. Second, the system is a deficit or not recommended.

Considering all these factors, we have designed our system or model by following these factors, and it is explained in the coming sub-chapters, where all the components or blocks like the language used, libraries, datasets/input and Outcome.

Multi-layer Perceptron (MLP)

MLP is a type of deep, artificial neural network (ANN). The general artificial neural networks have a single perceptron, whereas the multilayer perceptron is composed of more than a single perceptron. Hence the name multilayer.

These multilayer perceptron classifiers are similar to regular artificial neural networks. A primary MLP classifier has an input layer to accept the signal and an output layer which is used to make the prediction about the received input, and in between these input and output layers, there is one or a random number of hidden layers that can predict any continuous function. These MLP classifiers were quite popular since the 1980s and had an extensive reach as they

were used in various fields to solve numerous problems, while one of them was speech recognition.
This classifier has the ability to understand and learn how to make things work according to the data given for training. This is one of the most preferred techniques which are used to recognize patterns of speech. This classifier doesn't have any restrictions on its input variables. An MLP classifier can give the desired prediction when the provided data is highly volatile and with non-constant variance. All these advantages make the MLP classifier efficient and useful. In our model, we have the unique usage of just initializing the MLP Classifier for preparing the model before the testing and training procedure.

Working

Firstly, we must choose an environment for writing the code of execution of the project. For that, we have two options, namely

1. Python IDLE
2. Anaconda Cloud

a. Jupyter Lab

We will deal with Python IDLE. It is an environment designed by Python for designing new code, edit the existing ones and furthermore. After choosing the environment, we will be moving on to designing and implementing the code in this stage. For that, we need input, which is our dataset. So, download the dataset from the website into a primary location, where the file we code is saved. This is for easy access to the dataset for the system during compilation.
In the code file, first, import the libraries required for execution. Although they are installed on our computer, we must import them into the program. Save them with a name. Now, we need to access the audio files we have collected for analysis. For that, create a function with arguments as filename, mfcc, chroma and mel. The files taken as input will be a tad challenging to analyze. So we will be using for loop to read each audio file clearly. I will take a variable X which will read them using float32 format.
Based on the chroma and the mfcc values obtained for each signal, we will be using an If loop for the result obtained and will be considered for the system pattern design. The result from the If loop will be stored in an array created.

Results

The final Outcome is the efficiency of the system we designed using an MLP classifier.
After printing the Accuracy, we will be getting the following result, as shown in Fig. 2.

```
>>>
 RESTART: C:\Users\Abhishek\Desktop\PROJECTS\Project FSI\Version 1.0\test.py
hello< CNN FIT >
Please wait </>
(698, 70)
==========
Features extracted: 180
CNN  == End the FIT
=======
Accuracy: 82.86%
              precision    recall  f1-score   support

        calm       1.00      0.86      0.92        21
     disgust       0.76      0.80      0.78        20
     fearful       0.75      0.67      0.71         9
       happy       0.78      0.90      0.84        20

    accuracy                           0.83        70
   macro avg       0.82      0.81      0.81        70
weighted avg       0.84      0.83      0.83        70

>>>
                                                                    Ln: 87  Col: 4
```

Fig. 2. Final Outcome i.e., Efficiency of the Model

As you can observe from the output image tab, you can see three different things, which are listed below

1. Accuracy Percentage
2. Percentage of Accuracy of Emotions detected
3. Average and various sub-components

As you can observe, the Accuracy of the system designed is 82.86%, which is more than enough to say that the system is working in excellent condition and is reliable. We can also observe that the emotions are being detected with the given percentage below. We have considered these primary emotions in one iteration because these emotions are very hard to detect by other models. Ours with the efficiency yielded simply states that it is successful in detecting them precisely.
Finally, coming to the parameters of the average section, it simply states the average deduced from the input parameters previously assumed. The concepts involved in this approach are integrated in the best way possible to produce maximum efficiency and Accuracy. Our system's final Outcome reported 82.86% accuracy, which is more than satisfactory and is the perfect proof for the efficiency and Accuracy of the system and its reliability in real-time applications.

Conclusion

We are expecting it to be implemented in medical and law-enforcement divisions, as previously discussed. With further technical skills, we will modify and try to implement a speech and visual emotion detection model so that the discussed scopes of applications will

have much further ease of access. There are the main areas of deployment we are considering implementing, and one can say it is designed to process and work under similar constraints. Another reason is also to implement our knowledge and skills gained through the college to be useful to society in a way through our paper.

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