speech-emotion-recognition

May 17, 2023

1 @**CodeClause Project : Speech Emotion Recognition**

1.1 Summary To Explain Project (Keypoints)

1. Importing the required libraries
2. Importing datasets & Labels
3. Plotting the audio file's waveform and its spectrogram
4. Spectogram
5. Trim the Audio
6. Waveform of the noise in the audio
7. Feature Extraction
8. RMSE
9. Spectral Bandwidth (Incomplete)
10. Delta MFCCS
11. Delta Delta MFCCs

[1]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

1.1.1 1. Importing the required libraries

[2]:
```
import os
import random
import sys

import warnings
warnings.filterwarnings('ignore')

import glob
import keras
import IPython.display as ipd
import librosa
import librosa.display
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import plotly.graph_objs as go
```

```python
import plotly.offline as py
import plotly.tools as tls
import seaborn as sns
import scipy.io.wavfile
import tensorflow as tf
py.init_notebook_mode(connected=True)

from scipy.fftpack import fft
from scipy import signal
from scipy.io import wavfile
from tqdm import tqdm

import sklearn
import soundfile as sf
import sklearn.preprocessing
```

1.1.2 2. Importing datasets & Labels

[3]:
```python
# Data Directory
# Please edit according to your directory change.
Ravdess_paths= np.array(("/content/drive/MyDrive/Speech Emotion Recognation/
 ↪audio_speech_actors_01-24/","/content/drive/MyDrive/Speech Emotion␣
 ↪Recognation/audio_speech_actors_01-24"))
# Ravdess_paths = r"/content/drive/MyDrive/Speech Emotion Recognation/
 ↪audio_speech_actors_01-24"
# print(Ravdess_paths)
dir_list = os.listdir(Ravdess_paths[0])
dir_list.sort()
print (dir_list)
```

```
[b'Actor_01', b'Actor_02', b'Actor_03', b'Actor_04', b'Actor_05', b'Actor_06',
b'Actor_07', b'Actor_08', b'Actor_09', b'Actor_10', b'Actor_11', b'Actor_12',
b'Actor_13', b'Actor_14', b'Actor_15', b'Actor_16', b'Actor_17', b'Actor_18',
b'Actor_19', b'Actor_20', b'Actor_21', b'Actor_22', b'Actor_23', b'Actor_24']
```

[4]:
```python
ravdess_db = pd.DataFrame(columns=['path','source','actor', 'gender',␣
 ↪'emotion','emotion_lb'])
count = 0

for data_path in Ravdess_paths:
    dir_list = os.listdir(data_path)
    dir_list.sort()

    for i in dir_list:
        i = i.decode('utf-8')  # Convert bytes to str if needed
        file_list = os.listdir('/content/drive/MyDrive/Speech Emotion␣
 ↪Recognation/audio_speech_actors_01-24/' + i)
```

```
    for f in file_list:
        nm = f.split('.')[0].split('-')
        path = data_path + i + '/' + f
        src = int(nm[1])
        actor = int(nm[-1])
        emotion = int(nm[2])
        source = "Ravdess"

        if int(actor) % 2 == 0:
            gender = "female"
        else:
            gender = "male"

        if nm[3] == '01':
            intensity = 0
        else:
            intensity = 1

        if nm[4] == '01':
            statement = 0
        else:
            statement = 1

        if nm[5] == '01':
            repeat = 0
        else:
            repeat = 1

        if emotion == 1:
            lb = "neutral"
        elif emotion == 2:
            lb = "calm"
        elif emotion == 3:
            lb = "happy"
        elif emotion == 4:
            lb = "sad"
        elif emotion == 5:
            lb = "angry"
        elif emotion == 6:
            lb = "fearful"
        elif emotion == 7:
            lb = "disgust"
        elif emotion == 8:
            lb = "surprised"
        else:
            lb = "none"
```

```
            ravdess_db.loc[count] = [path,source,actor, gender, emotion,lb]
            count += 1
```

[5]:
```
print (len(ravdess_db))
```

```
2880
```

[6]:
```
ravdess_db.sort_values(by='path',inplace=True)
ravdess_db.index =  range(len(ravdess_db.index))
ravdess_db.head()
```

[6]:
```
                                              path   source  actor gender  \
0  /content/drive/MyDrive/Speech Emotion Recognat…  Ravdess      1   male
1  /content/drive/MyDrive/Speech Emotion Recognat…  Ravdess      1   male
2  /content/drive/MyDrive/Speech Emotion Recognat…  Ravdess      1   male
3  /content/drive/MyDrive/Speech Emotion Recognat…  Ravdess      1   male
4  /content/drive/MyDrive/Speech Emotion Recognat…  Ravdess      1   male

   emotion emotion_lb
0        1    neutral
1        1    neutral
2        1    neutral
3        1    neutral
4        2       calm
```

1.1.3 3. Plotting the audio file's waveform and its spectrogram

[7]:
```
# Load the audio with sampling rate(sr) = 44100 ( which is the standard sr for
 ↪high quality audio)
sampling_rate = 44100
```

[8]:
```
filename = ravdess_db.path[2]
print (filename)
```

```
/content/drive/MyDrive/Speech Emotion
Recognation/audio_speech_actors_01-24/Actor_01/03-01-01-01-02-01-01.wav
```

[9]:
```
samples, sample_rate = sf.read(filename)
```

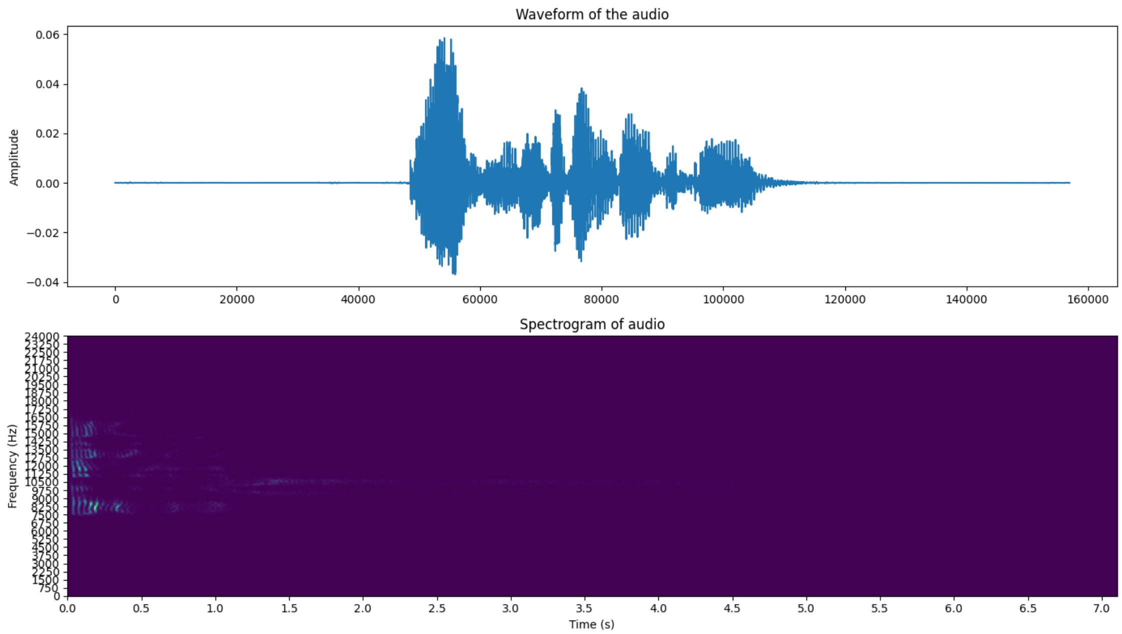
[10]:
```
ipd.Audio(samples,rate=sample_rate)
```

[10]:
```
<IPython.lib.display.Audio object>
```

1.1.4 4. Spectogram

[11]:
```
def log_specgram(audio, sample_rate, window_size=20,step_size=10, eps=1e-10):
    nperseg = int(round(window_size * sample_rate / 1e3))
    noverlap = int(round(step_size * sample_rate / 1e3))
    freqs, times, spec = signal.spectrogram(audio,
                                    fs=sample_rate,
                                    window='hann',
                                    nperseg=nperseg,
                                    noverlap=noverlap,
                                    detrend=False)
    return freqs, times, np.log(spec.T.astype(np.float32) + eps)
```

[12]:
```
# Compute spectrogram
spectrogram = np.abs(librosa.stft(samples))

# Get the frequencies and times for the spectrogram
freqs = librosa.fft_frequencies(sr=sample_rate)
times = librosa.frames_to_time(np.arange(spectrogram.shape[1]))

# Plot waveform and spectrogram
plt.figure(figsize=(14, 8))

# Plot waveform
plt.subplot(211)
plt.title('Waveform of the audio')
plt.ylabel('Amplitude')
plt.plot(samples)

# Plot spectrogram
plt.subplot(212)
plt.imshow(spectrogram.T, aspect='auto', origin='lower',
           extent=[times.min(), times.max(), freqs.min(), freqs.max()])
plt.yticks(freqs[::32])
plt.xticks(np.arange(0.0, times.max(), 0.5))
plt.title('Spectrogram of audio')
plt.ylabel('Frequency (Hz)')
plt.xlabel('Time (s)')

plt.tight_layout()
plt.show()
```



1.1.5 5. Trim the Audio

[13]:
```
samples_trim, index = librosa.effects.trim(samples,top_db=25)
samples_trim.shape, index
```

[13]: ((59392,), array([48128, 107520]))

[14]:
```
ipd.Audio(samples_trim,rate=sample_rate)
```

[14]: <IPython.lib.display.Audio object>

[15]:
```
Difference_in_length = len(samples)-len(samples_trim)
Difference_in_length
```

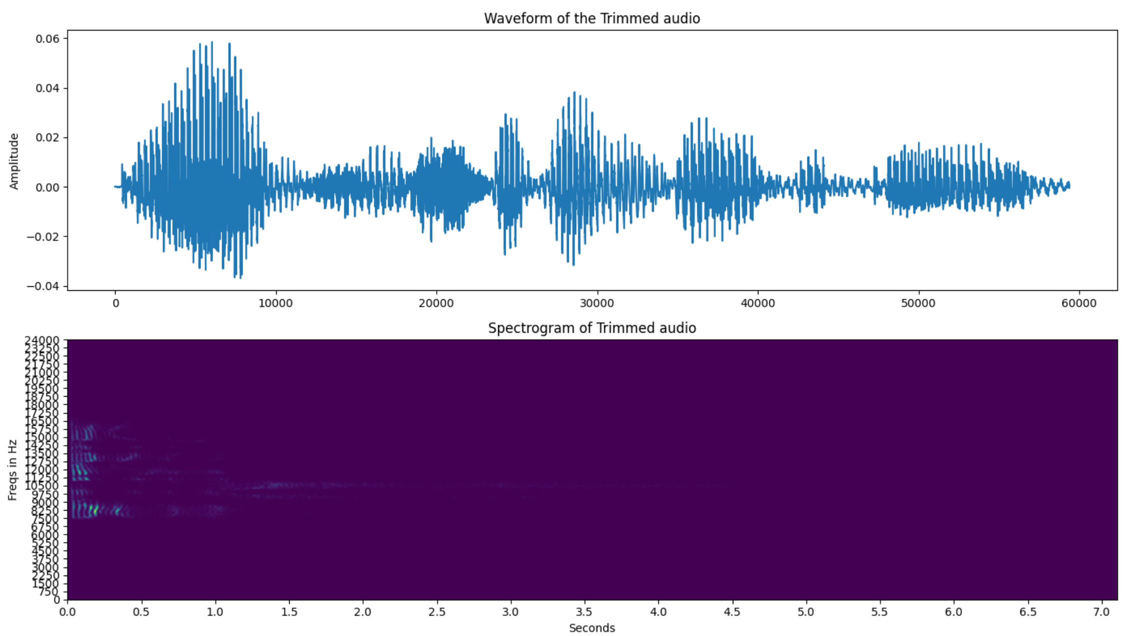
[15]: 97564

[16]:
```
difference_in_duration = len(samples) / sample_rate - len(samples_trim) /␣
 ↪sample_rate
difference_in_duration
```

[16]: 2.032583333333333

[17]:
```
plt.figure(figsize=(14, 8))

# Plot waveform
plt.subplot(211)
```

```python
plt.title('Waveform of the Trimmed audio')
plt.ylabel('Amplitude')
plt.plot(samples_trim)

# Plot spectrogram
plt.subplot(212)
plt.imshow(spectrogram.T, aspect='auto', origin='lower',
           extent=[times.min(), times.max(), freqs.min(), freqs.max()])
plt.yticks(freqs[::32])
plt.xticks(np.arange(0.0, times.max(), 0.5))
plt.title('Spectrogram of Trimmed audio')
plt.ylabel('Freqs in Hz')
plt.xlabel('Seconds')

plt.tight_layout()
plt.show()
```



[18]:
```python
sample_weiner = scipy.signal.wiener(samples_trim)
len(sample_weiner)
```

[18]:
```
59392
```

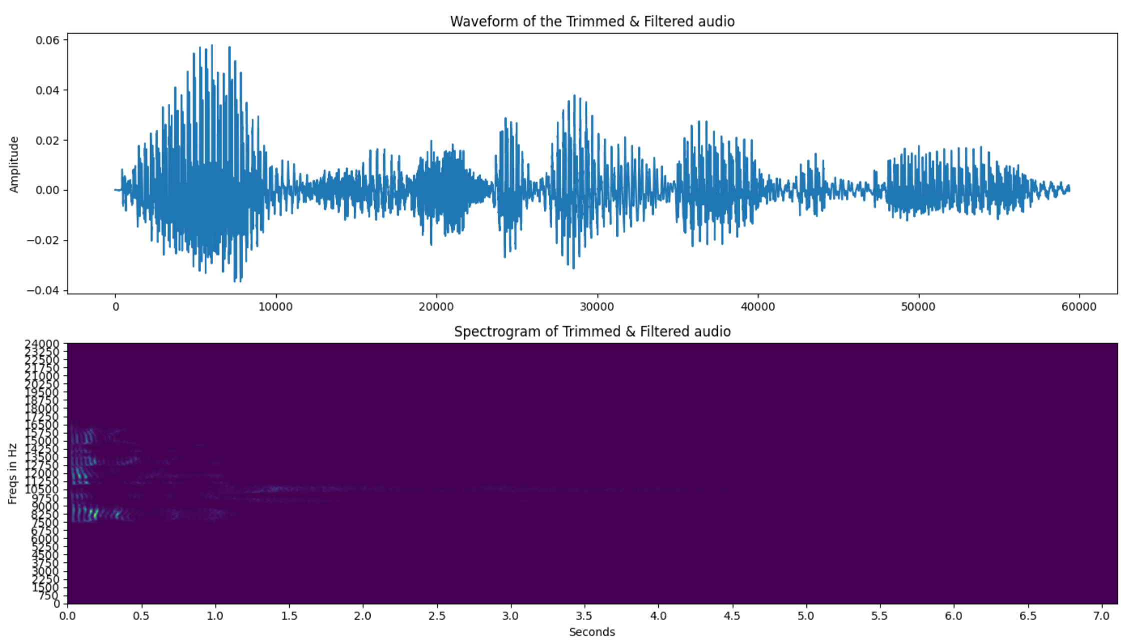
[19]:
```python
ipd.Audio(sample_weiner,rate=sample_rate)
```

[19]:
```
<IPython.lib.display.Audio object>
```

[20]:
```
Diff_noise = sample_weiner-samples_trim
ipd.Audio(Diff_noise,rate=sample_rate)
```

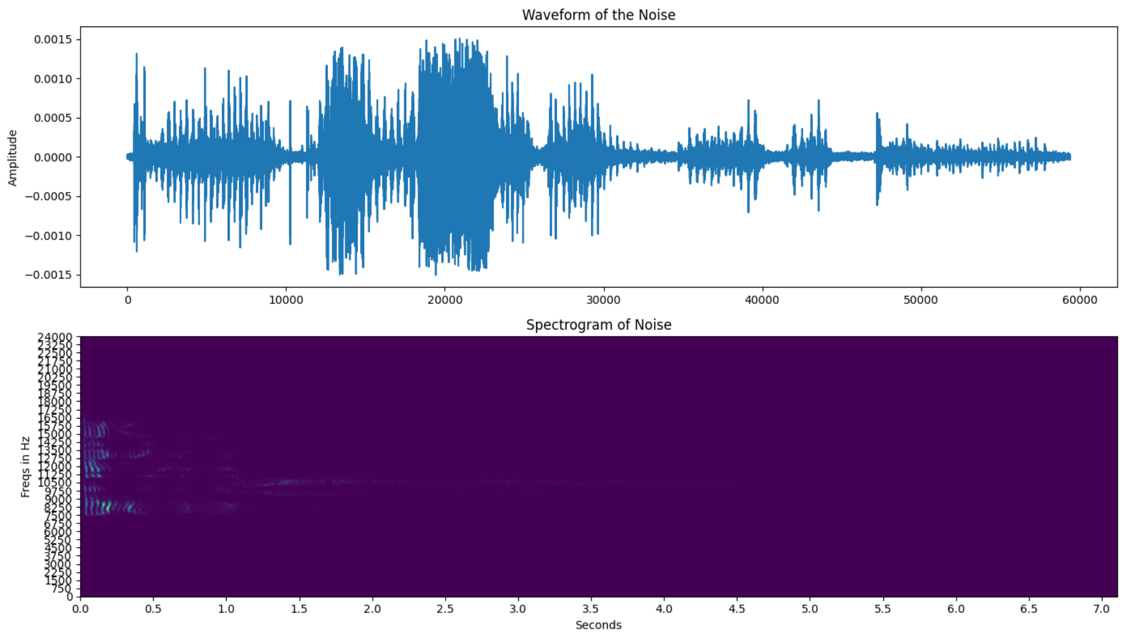
[20]: <IPython.lib.display.Audio object>

[21]:
```
plt.figure(figsize=(14, 8))

# Plot waveform
plt.subplot(211)
plt.title('Waveform of the Trimmed & Filtered audio')
plt.ylabel('Amplitude')
plt.plot(sample_weiner)

# Plot spectrogram
plt.subplot(212)
plt.imshow(spectrogram.T, aspect='auto', origin='lower',
           extent=[times.min(), times.max(), freqs.min(), freqs.max()])
plt.yticks(freqs[::32])
plt.xticks(np.arange(0.0, times.max(), 0.5))
plt.title('Spectrogram of Trimmed & Filtered audio')
plt.ylabel('Freqs in Hz')
plt.xlabel('Seconds')

plt.tight_layout()
plt.show()
```



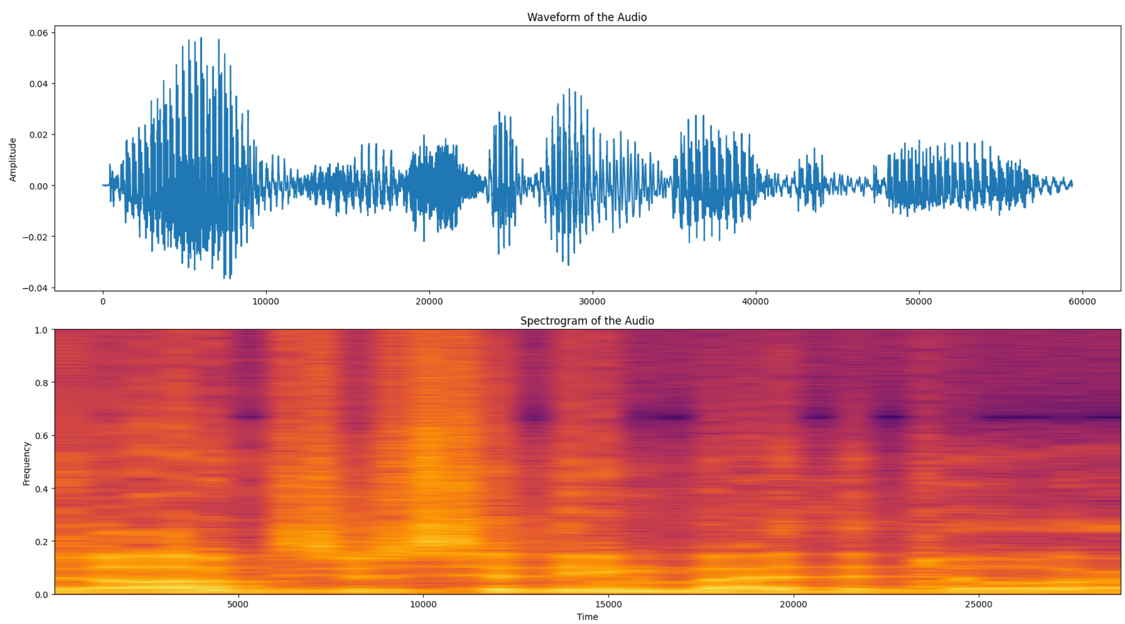
1.1.6 6. Waveform of the noise in the audio

[22]:
```
plt.figure(figsize=(14, 8))

# Plot waveform
plt.subplot(211)
plt.title('Waveform of the Noise')
plt.ylabel('Amplitude')
plt.plot(Diff_noise)

# Plot spectrogram
plt.subplot(212)
plt.imshow(spectrogram.T, aspect='auto', origin='lower',
           extent=[times.min(), times.max(), freqs.min(), freqs.max()])
plt.yticks(freqs[::32])
plt.xticks(np.arange(0.0, times.max(), 0.5))
plt.title('Spectrogram of Noise')
plt.ylabel('Freqs in Hz')
plt.xlabel('Seconds')

plt.tight_layout()
plt.show()
```



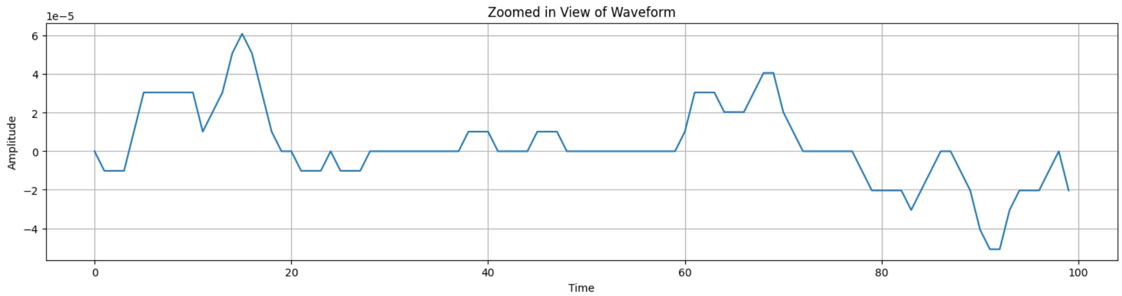
1.1.7 7. Feature Extraction

[23]:
```
plt.figure(figsize=(18, 10))

# Plot waveform
plt.subplot(211)
plt.title('Waveform of the Audio')
plt.ylabel('Amplitude')
plt.plot(sample_weiner)

plt.subplots_adjust(hspace=.5)

# Plot spectrogram
plt.subplot(212)
plt.specgram(sample_weiner, NFFT=2048, Fs=2, Fc=0, noverlap=128,␣
↪cmap='inferno', sides='default', mode='default', scale='dB')
plt.title('Spectrogram of the Audio')
plt.ylabel('Frequency')
plt.xlabel('Time')

plt.tight_layout()
plt.show()
```



[24]:
```
plt.figure(figsize=(18, 4))
plt.plot(sample_weiner[0:100])
plt.xlabel("Time")
plt.ylabel("Amplitude")
```

```
plt.title("Zoomed in View of Waveform")
plt.grid()
```



[25]:
```
zero_crossings = librosa.zero_crossings(sample_weiner[0:100], pad=False)
print(sum(zero_crossings))
```

11

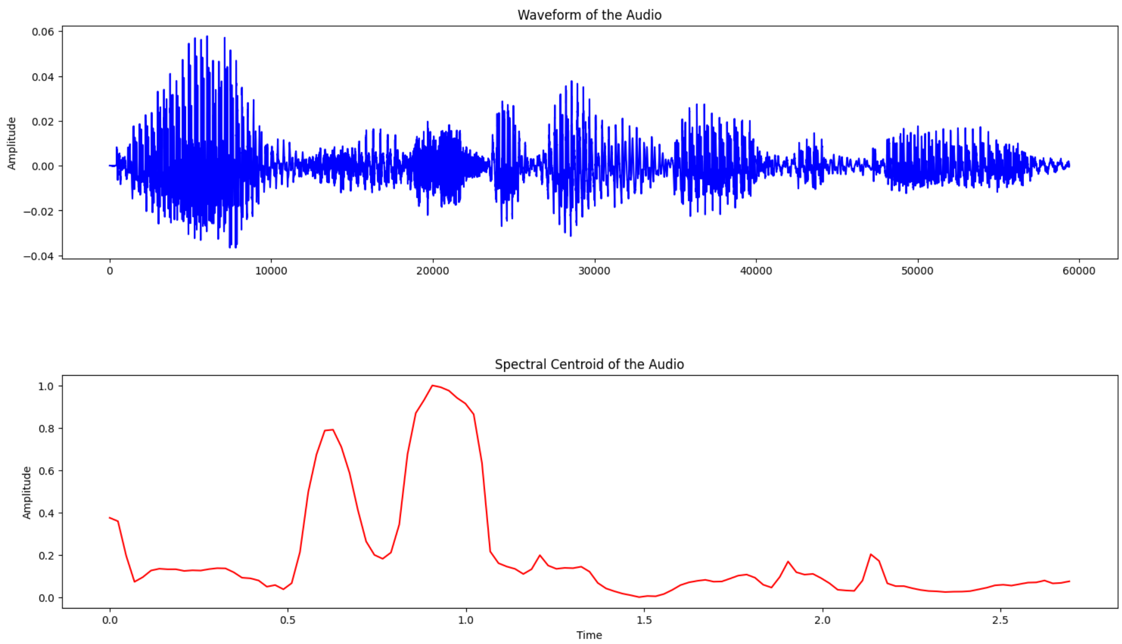
[26]:
```
zero_crossings = librosa.zero_crossings(sample_weiner, pad=False)
print(sum(zero_crossings))
```

2486

[27]:
```
spectral_centroids = librosa.feature.spectral_centroid(y=sample_weiner,␣
 ↪sr=sample_rate)[0]
spectral_centroids.shape

# Computing the time variable for visualization
frames = range(len(spectral_centroids))
t = librosa.frames_to_time(frames)

# Normalizing the spectral centroid for visualization
sc = sklearn.preprocessing.minmax_scale(spectral_centroids, axis=0)
```

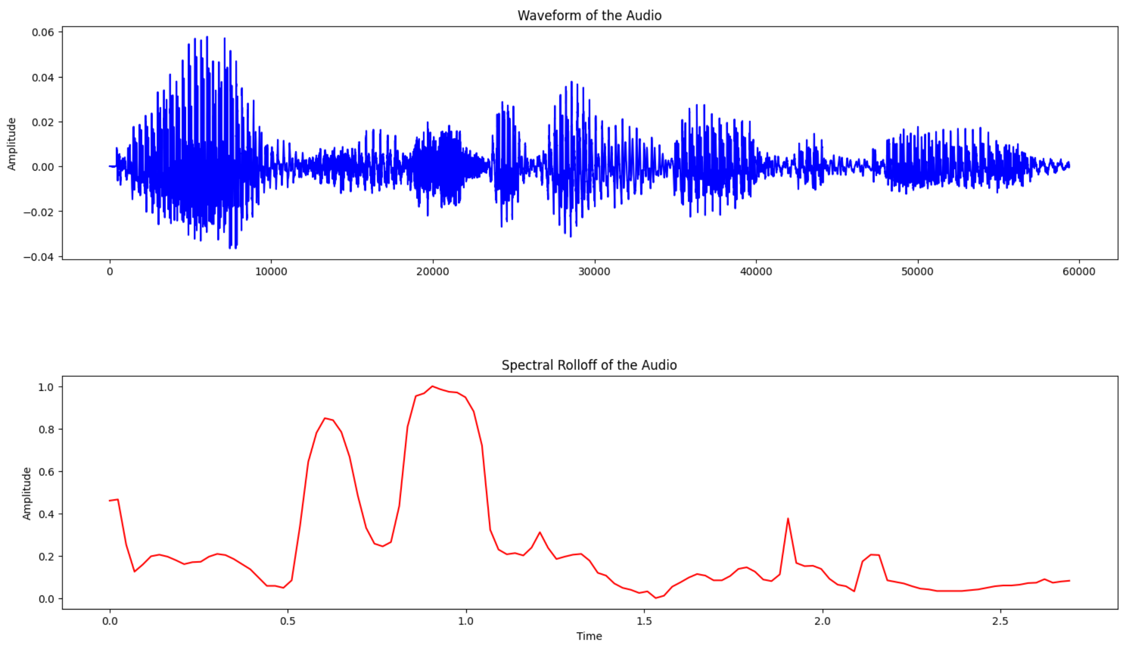
[28]:
```
# Plotting Waveform and Spectral Centroid
fig = plt.figure(figsize=(18, 10))
ax1 = fig.add_subplot(211)
ax1.set_title('Waveform of the Audio')
ax1.set_ylabel('Amplitude')
plt.plot(sample_weiner, color='b')
fig.subplots_adjust(hspace=.5)

ax2 = fig.add_subplot(212)
ax2.set_title('Spectral Centroid of the Audio')
ax2.set_ylabel('Amplitude')
plt.plot(t, sc, color='r')
```

```
ax2.set_xlabel('Time')
fig.subplots_adjust(hspace=.5)

plt.show()
```

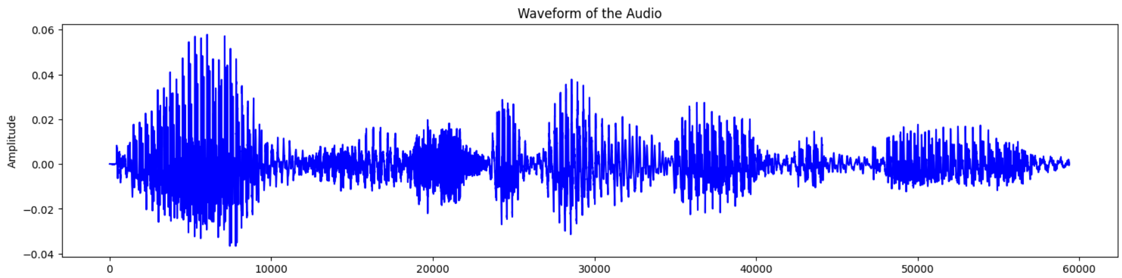


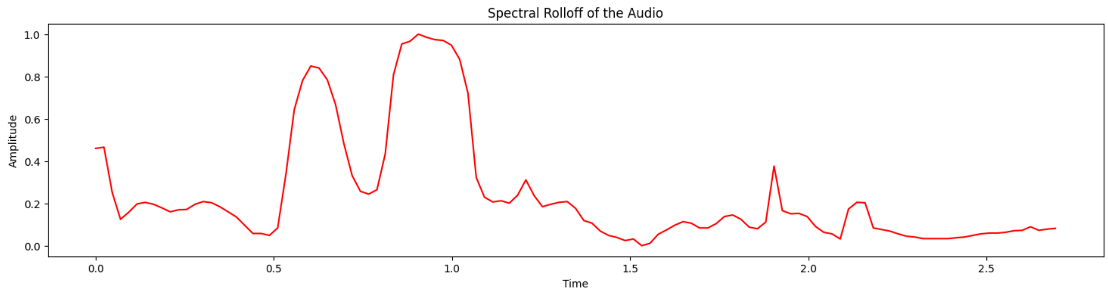
[29]:
```
# Calculate Spectral Rolloff
spectral_rolloff = librosa.feature.spectral_rolloff(y=sample_weiner,␣
↪sr=sample_rate)[0]

# Computing the time variable for visualization
frames = range(len(spectral_rolloff))
t = librosa.frames_to_time(frames)

# Normalizing the spectral rolloff for visualization
sc = sklearn.preprocessing.minmax_scale(spectral_rolloff, axis=0)

# Plotting Waveform and Spectral Rolloff
fig = plt.figure(figsize=(18, 10))
ax1 = fig.add_subplot(211)
ax1.set_title('Waveform of the Audio')
ax1.set_ylabel('Amplitude')
plt.plot(sample_weiner, color='b')
fig.subplots_adjust(hspace=.5)

ax2 = fig.add_subplot(212)
ax2.set_title('Spectral Rolloff of the Audio')
```

```
ax2.set_ylabel('Amplitude')
plt.plot(t, sc, color='r')
ax2.set_xlabel('Time')
fig.subplots_adjust(hspace=.5)

plt.show()
```



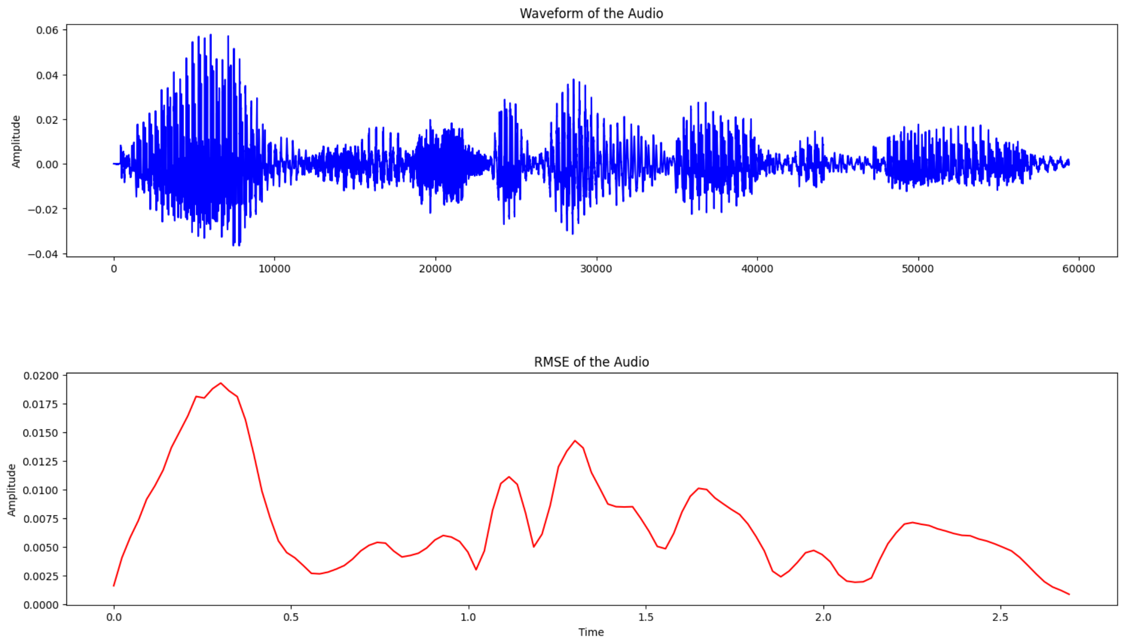
[30]:
```
# Plotting Wave Form and Spectrogram
fig = plt.figure(figsize=(18, 10))
ax1 = fig.add_subplot(211)
ax1.set_title('Waveform of the Audio')
ax1.set_ylabel('Amplitude')
plt.plot(sample_weiner, color='b')
fig.subplots_adjust(hspace=.5)

ax2 = fig.add_subplot(212)
ax2.set_title('Spectral Rolloff of the Audio')
ax2.set_ylabel('Amplitude')
plt.plot(t, sc, color='r')
ax2.set_xlabel('Time')
fig.subplots_adjust(hspace=.5)

plt.show()
```





1.1.8 8. RMSE

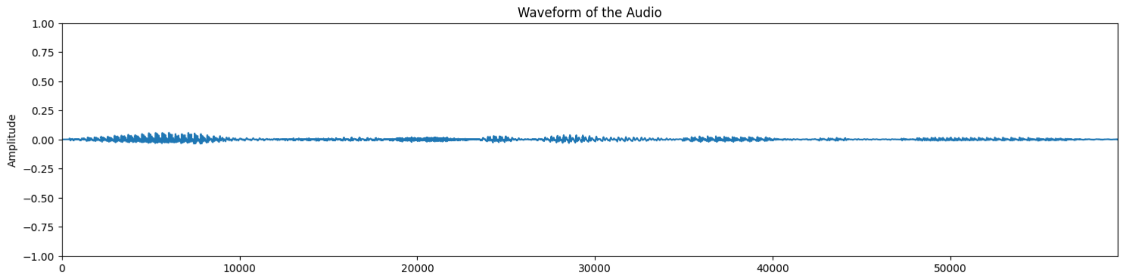
[31]:
```
# Compute RMSE
rmse = librosa.feature.rms(y=sample_weiner)[0]

# Plotting Wave Form and RMSE
fig = plt.figure(figsize=(18, 10))
ax1 = fig.add_subplot(211)
ax1.set_title('Waveform of the Audio')
ax1.set_ylabel('Amplitude')
plt.plot(sample_weiner, color='b')
fig.subplots_adjust(hspace=.5)

ax2 = fig.add_subplot(212)
ax2.set_title('RMSE of the Audio')
ax2.set_ylabel('Amplitude')
plt.plot(t, rmse, color='r')
ax2.set_xlabel('Time')
fig.subplots_adjust(hspace=.5)

plt.show()
```

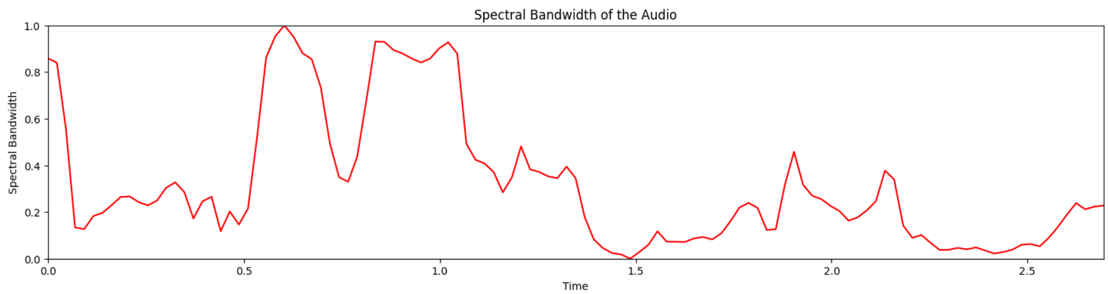


1.1.9 9. Spectral Bandwidth (Incomplete)

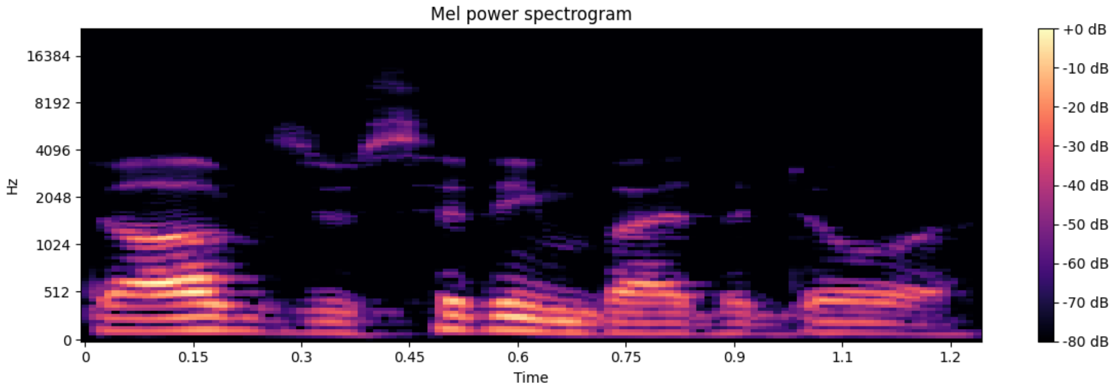
[32]:
```
# Compute the spectral bandwidth
spec_bw = librosa.feature.spectral_bandwidth(y=sample_weiner, sr=sample_rate)[0]
spec_bw = sklearn.preprocessing.minmax_scale(spec_bw, axis=0)

# Plotting Waveform and Spectral Bandwidth
fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(18, 10))

# Waveform
ax1.set_title('Waveform of the Audio')
ax1.set_ylabel('Amplitude')
ax1.plot(sample_weiner)
ax1.set_xlim([0, len(sample_weiner)])
ax1.set_ylim([-1, 1])

# Spectral Bandwidth
ax2.set_title('Spectral Bandwidth of the Audio')
ax2.set_ylabel('Spectral Bandwidth')
ax2.plot(t, spec_bw, color='r')
ax2.set_xlim([0, t.max()])
ax2.set_ylim([0, spec_bw.max()])

plt.xlabel('Time')
plt.subplots_adjust(hspace=0.5)
```

```
plt.show()
```

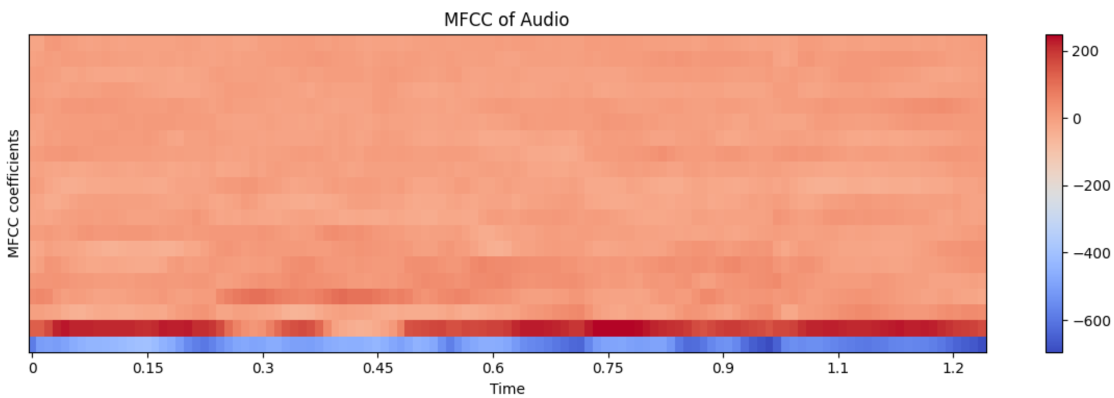




[33]:
```
# Plotting Mel Power Spectrogram
S_sample = librosa.feature.melspectrogram(y=sample_weiner, sr=sample_rate,␣
  ↪n_mels=128, n_fft=2048, hop_length=512)

# Convert to log scale (dB). We'll use the peak power (max) as reference.
log_S_sample = librosa.amplitude_to_db(S_sample, ref=np.max)

plt.figure(figsize=(12, 4))
librosa.display.specshow(log_S_sample, sr=sample_rate, x_axis='time',␣
  ↪y_axis='mel')
plt.title('Mel power spectrogram')
plt.colorbar(format='%+2.0f dB')
plt.tight_layout()
plt.show()
```



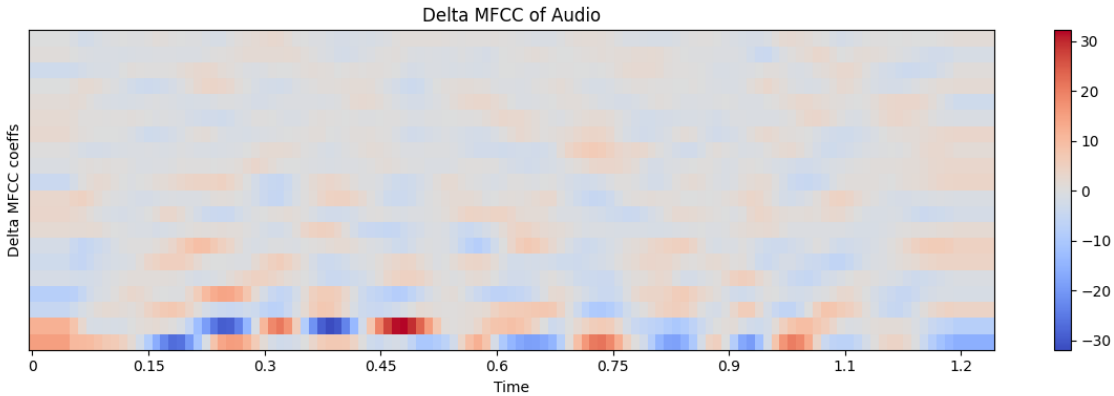
[34]:
```
# Compute MFCCs
mfccs = librosa.feature.mfcc(y=sample_weiner, sr=sample_rate)

plt.figure(figsize=(12, 4))
librosa.display.specshow(mfccs, sr=sample_rate, x_axis='time')
plt.ylabel('MFCC coefficients')
plt.xlabel('Time')
plt.title('MFCC of Audio')
plt.colorbar()
plt.tight_layout()
plt.show()
```



1.1.10 10. Delta MFCCS

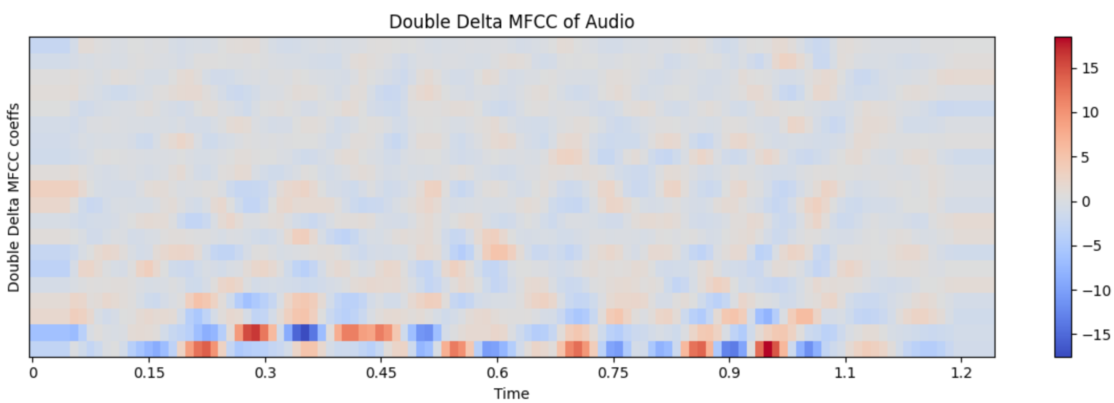
[35]:
```
plt.figure(figsize=(12, 4))
delta_MFCCS =  librosa.feature.delta(mfccs,order=1)
librosa.display.specshow(delta_MFCCS, sr=sample_rate, x_axis='time')
plt.ylabel('Delta MFCC coeffs')
```

```
plt.xlabel('Time')
plt.title('Delta MFCC of Audio')
plt.colorbar()
plt.tight_layout()
```



1.1.11 11. Delta Delta MFCCs

[36]:
```
plt.figure(figsize=(12, 4))
d_delta_MFCCS =  librosa.feature.delta(mfccs,order=2)
librosa.display.specshow(d_delta_MFCCS, sr=sample_rate, x_axis='time')
plt.ylabel('Double Delta MFCC coeffs')
plt.xlabel('Time')
plt.title('Double Delta MFCC of Audio')
plt.colorbar()
plt.tight_layout()
```



[37]:
```
hop_length = 512
```

```
chromagram = librosa.feature.chroma_stft(y=sample_weiner, sr=sample_rate, hop_length=hop_length)
plt.figure(figsize=(12, 4))
librosa.display.specshow(chromagram, x_axis='time', y_axis='chroma', hop_length=hop_length, cmap='coolwarm')
plt.ylabel('Pitch Class')
plt.xlabel('Time')
plt.title('Chroma Features of Audio')
plt.colorbar()
plt.tight_layout()
plt.show()
```