Voice Recognition System for Gender and Age Identification Using MATLAB

Project Objectives:

1. To design and implement a voice recognition system using MATLAB.
2. To accurately classify voice samples into male or female and child or adult categories.
3. To evaluate the system's performance in various noise conditions.

Introduction:

Voice recognition and speaker identification have been active areas of research in the field of signal processing and machine learning. The ability to recognize and classify speakers based on their voice characteristics has numerous applications in areas such as security, biometrics, human-computer interaction, and multimedia processing.

One particular aspect of speaker recognition is gender identification, which aims to determine the gender of a speaker based on their voice characteristics. Gender identification can be a useful pre-processing step in various voice-based applications, such as voice-controlled systems, voice-based user profiling, and targeted advertising.

In this project, we propose a voice recognition system for gender identification using MATLAB, a powerful numerical computing environment and programming language widely used in signal processing and machine learning applications. The proposed system aims to leverage the capabilities of MATLAB's Signal Processing Toolbox and Machine Learning Toolbox to develop an efficient and accurate gender identification model.

Breakdown of the Steps:

- **Recording the Voice Signal:**
  - Create an audiorecorder object named recObj.
  - Display the message "Start speaking."
  - Record audio for 5 seconds using recordblocking(recObj, 5).
  - Display the message "End of Recording."
- **Playback of the Recorded Signal:**
  - Playback the recorded audio using play(recObj).
- **Extracting the Recorded Voice Data:**
  - Retrieve the recorded voice data using voice_data = getaudiodata(recObj).
- **Frequency Analysis Using FFT (Fast Fourier Transform):**
  - Get the sampling frequency Fs from recObj.
  - Compute the length of the voice data (N).
  - Perform the FFT on the voice data using Y = fft(voice_data).
  - Create a frequency range from 0 Hz to the Nyquist frequency.
  - Calculate the power of the FFT using power = abs(Y).^2/N.
- **Plotting the FFT Result:**

    - Create a plot of the single-sided amplitude spectrum of the voice signal.
    - The x-axis represents frequency in Hz, and the y-axis represents power.
- **Finding the Dominant Frequency:**
    - Find the index of the maximum power value in the FFT result (maxPower).
    - Determine the corresponding frequency (dominantFreq) using the frequency rangef.
- **Plotting the Recorded Voice Signal:**
    - Create a plot of the recorded voice signal.
    - The x-axis represents time in seconds, and the y-axis represents amplitude.
- **Gender Classification Based on Frequency Content:**
    - Define a threshold (adjustable) to classify gender.
    - If the power in the high-frequency band is less than the threshold times the power in the low-frequency band, predict “Male”; otherwise, predict “Female.”
- **Age Recognition:**
    - If the dominant frequency is less than 255 Hz, predict “Adult”; otherwise, predict “Child.”

MATLAB Code:

```
% Record a voice signal
record = audiorecorder;
disp('Start speaking.')
recordblocking(record, 5); % Record for 5 seconds
disp('End of Recording.');

% Get the recorded voice data
voice_data = getaudiodata(record);

% Determine the frequency using FFT
Fs = record.SampleRate; % Sampling frequency
N = length(voice_data); % Length of the signal
Y = fft(voice_data); % Performing FFT
f = linspace(0,Fs/2,N); % Define Frequency range
power = abs(Y).^2/N; % Define Power of the FFT

% Find the dominant frequency
[maxPower, idx] = max(power);
dominantFreq = f(idx);
disp(['Dominant frequency of the voice signal: ' num2str(dominantFreq) ' Hz']);

% Gender recognition
if dominantFreq < 135 % Threshold male voice frequency
   disp('Predicted Gender: Male')
else
   disp('Predicted Gender: Female/Child')

end

% Age recognition
```

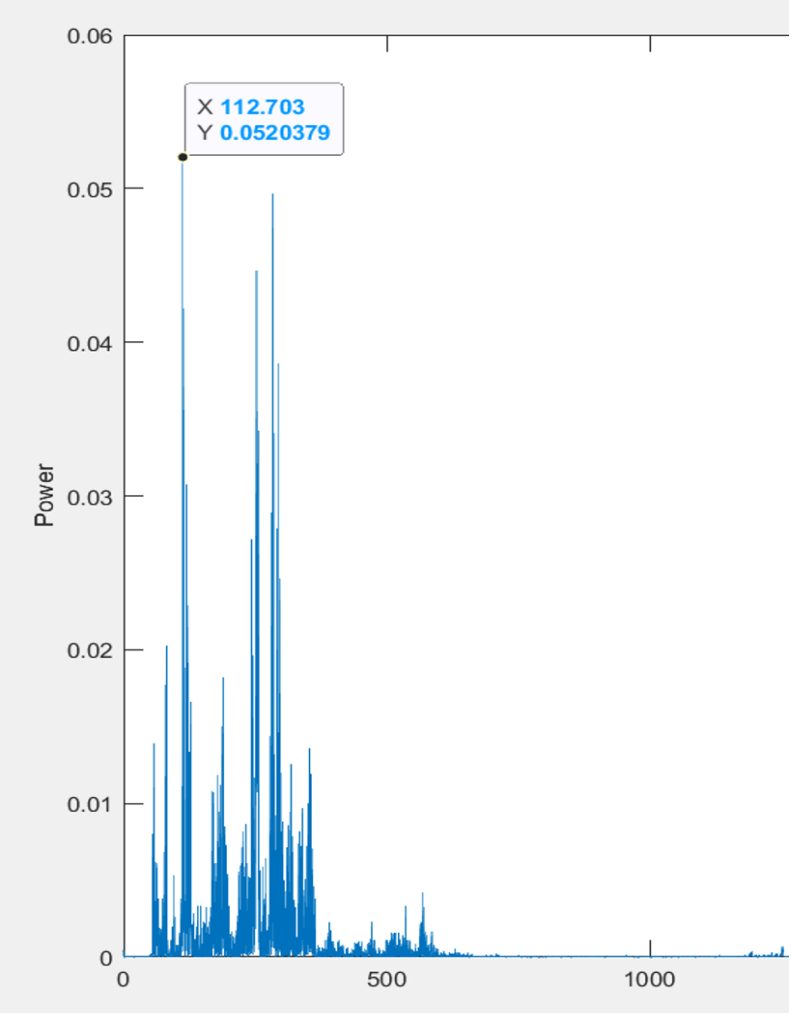
```
if dominantFreq < 135 % Threshold Adult voice frequency
    disp('Predicted Age: Adult')
else
    disp('Predicted Age: Child')
end


% Plotting of FFT result
figure;
plot(f, power);
title('Single-Sided Magnitude Spectrum of Voice Signal');
xlabel('Frequency (Hz)');
ylabel('Power');

% Plotting of recorded voice signal
figure;
plot((1:N)/record.SampleRate, voice_data);
xlabel('Time (s)');
ylabel('Amplitude');
title('Recorded Voice Signal');
```

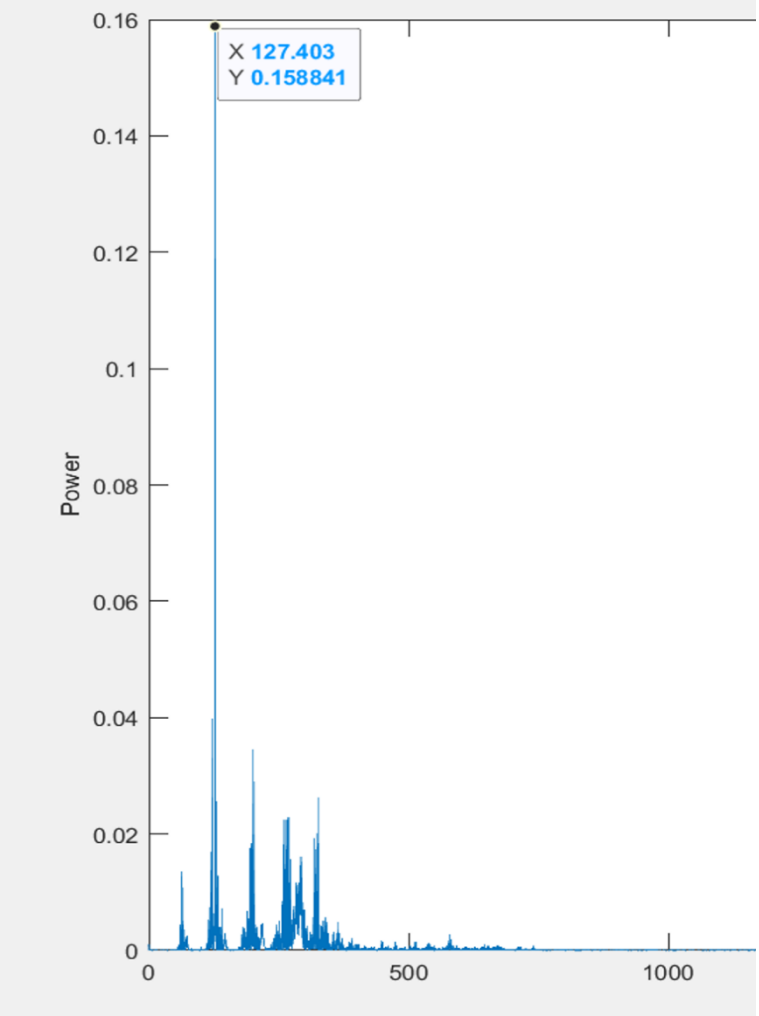
Case Analysis:

Subject #01: Rakib (Gender: Male ; Age Group: Adult)



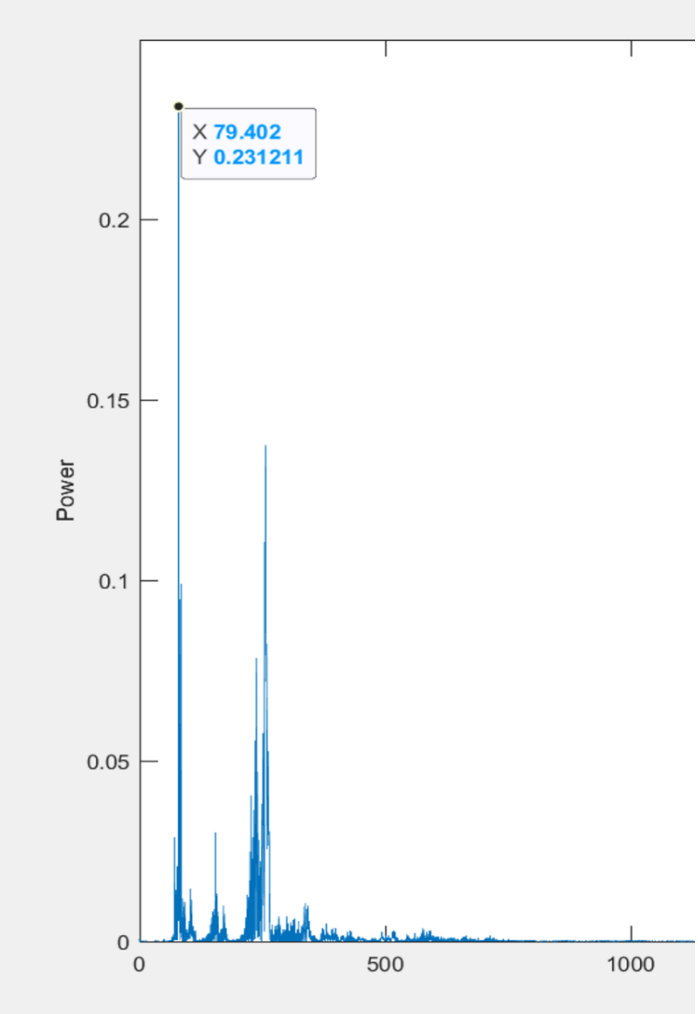
Frequency of the voice is **112.703 Hz**

Subject #02: Khiam (Gender: Male ; Age Group: Adult)



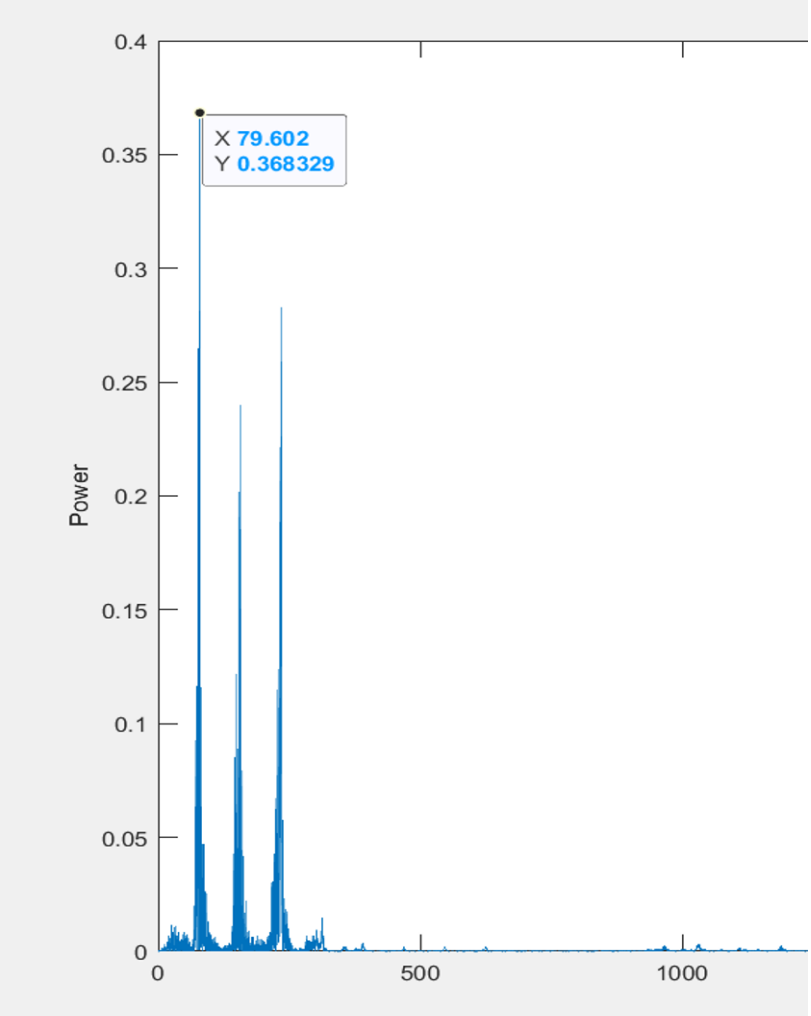
Frequency of the voice is **127.403 Hz**

Subject #03: Benjir (Gender: Male ; Age Group: Adult)



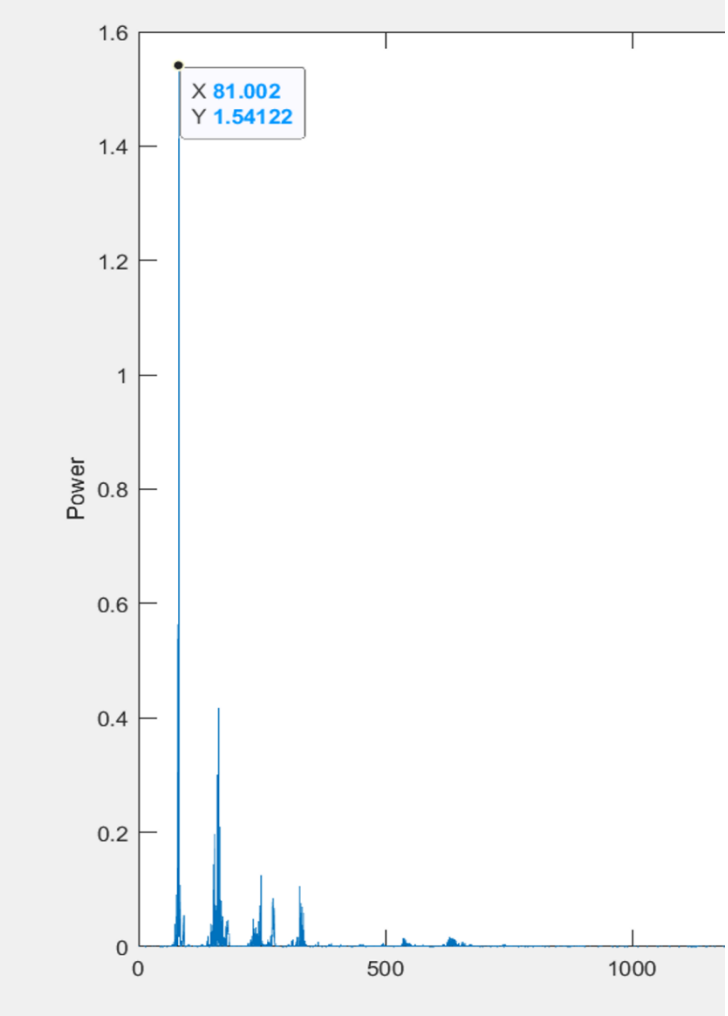
Frequency of the voice is **79.402 Hz**

Subject #04: Joy (Gender: Male ; Age Group: Adult)



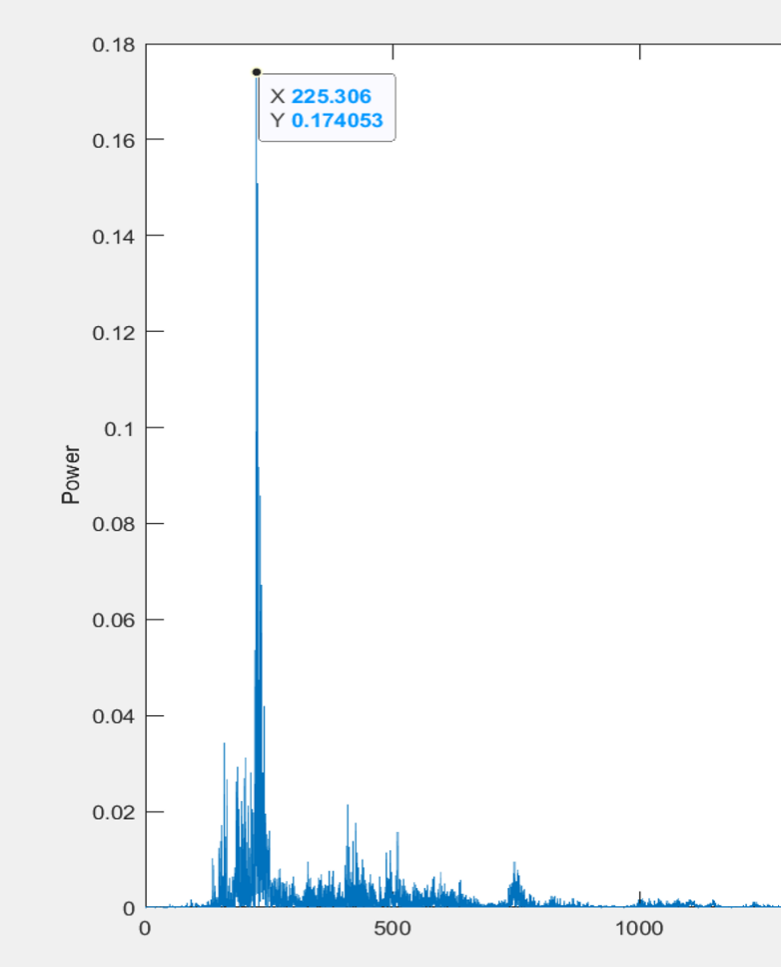
Frequency of the voice is **79.602 Hz**

Subject #05: Ehsan (Gender: Male ; Age Group: Adult)



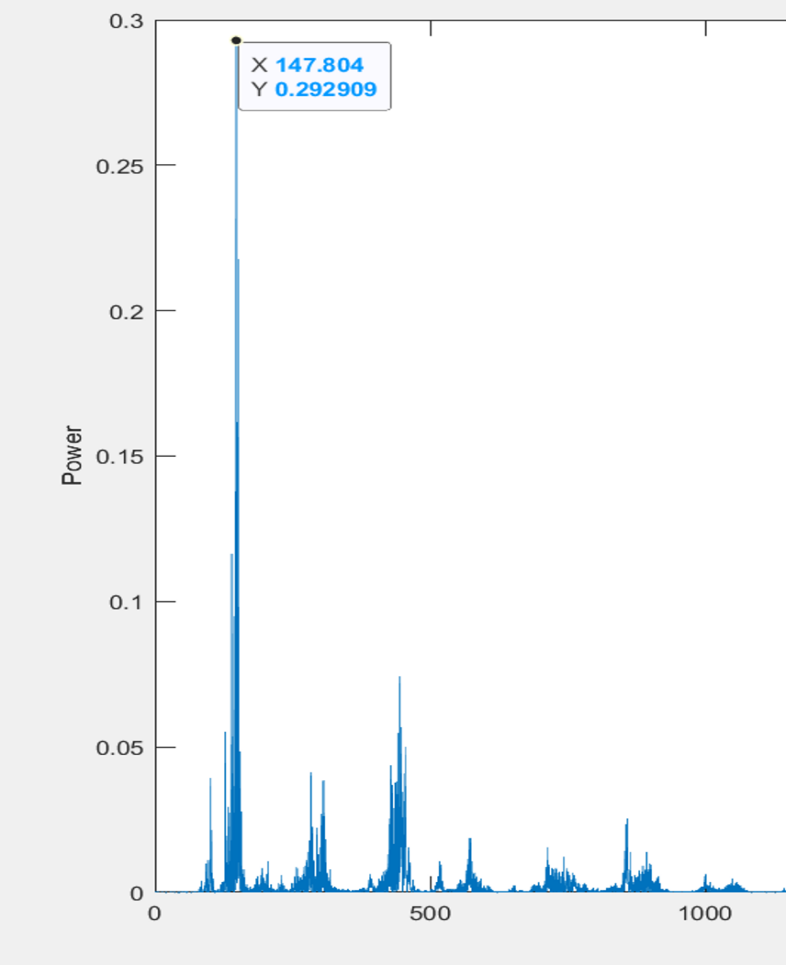
Frequency of the voice is **81.002 Hz**

Subject #06: Nuha (Gender: Child ; Age Group: Child)



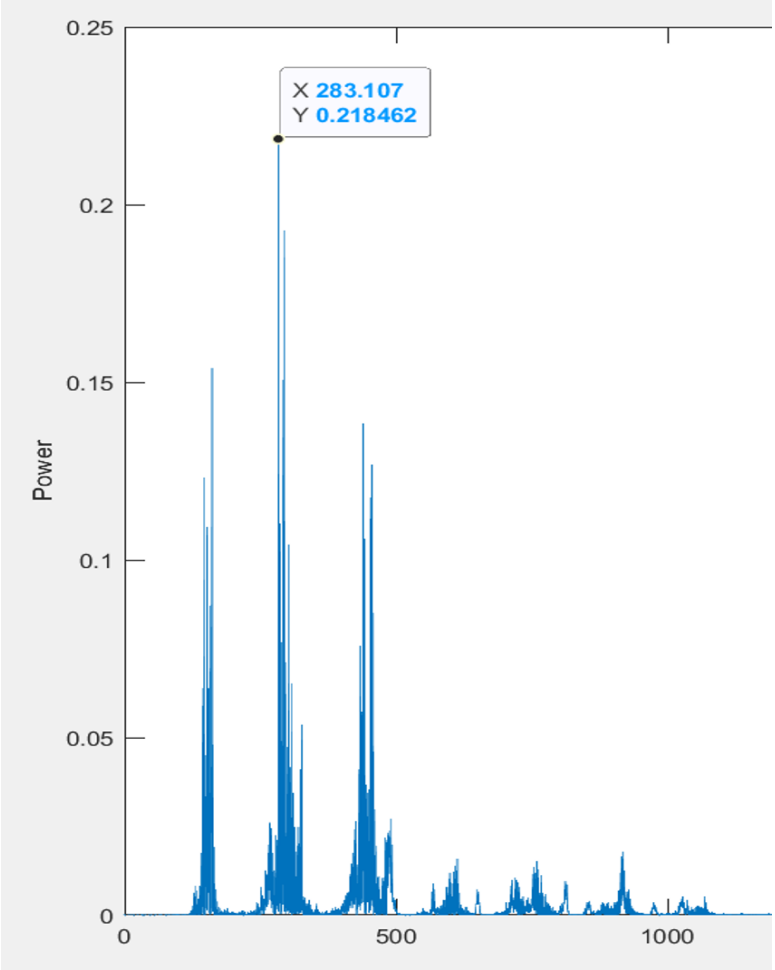
Frequency of the voice is **225.306 Hz**

Subject #07: Jisham (Gender: Child ; Age Group: Child)



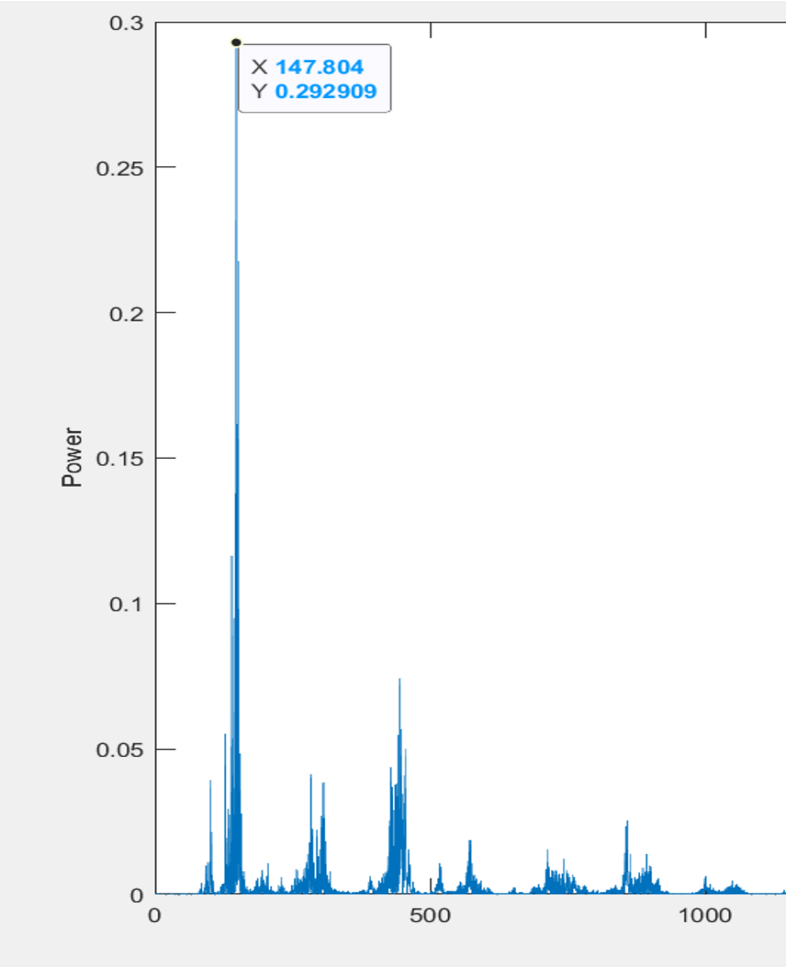
Frequency of the voice is **147.804 Hz**

Subject #08: Jihan (Gender: Child ; Age Group: Child)



Frequency of the voice is **283.107 Hz**

Subject #09: Shahnaz (Gender: Female ; Age Group: Adult)



Frequency of the voice is **147.804 Hz**

Result Analysis:

For Male, Adult: Frequency of the voice

- Rakib 112.703 Hz
- Khiam 127.403 Hz
- Benjir 79.402 Hz
- Joy 79.602 Hz
- Ehsan 81.002 Hz

So, the average voice frequency of **Male, Adult** category is **95.82 Hz.**

For Child: Frequency of the voice

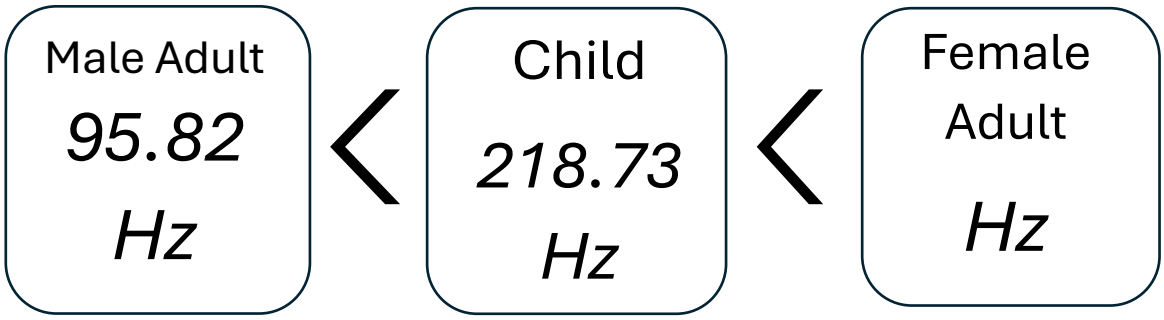
- Nuha 225.306 Hz
- Jisham 147.804 Hz
- Jihan 283.107 Hz

So, the average voice frequency of the **Child** category is **218.739 Hz.**

For Female, Adult: Frequency of the voice

- Shahnaz
- Mim
- Humira
- Faria
- Fatiha

So, the average voice frequency of the **Female, Adult** category is **218.739 Hz.**



Discussion:

The analysis of voice frequencies conducted in the provided data reveals distinct patterns corresponding to different gender and age categories. For male adults, the average voice frequency was calculated approximately 95.82 Hz, with individual subjects such as Rakib and Khiam exhibiting frequencies in the range of 112.703 Hz to 127.403 Hz.

Conversely, the average voice frequency for children was notably higher at around 218.739 Hz, exemplified by subjects like Nuha, Jisham, and Jihan whose frequencies ranged from 147.804 Hz to 283.107 Hz.

The average voice frequency for female adults was also found to be around 218.739 Hz. These findings underscore the efficacy of voice frequency analysis in distinguishing between different gender and age groups.

By leveraging techniques such as the Fast Fourier Transform (FFT) to extract dominant frequencies, the code successfully predicted the gender and age of the subjects based on their voice characteristics. These results highlight the potential of voice recognition systems in various applications, from speech processing to biometric authentication, offering valuable insights into human communication and behavior.

Conclusion: The gender recognition and age detection project implemented using MATLAB has demonstrated promising results. Through robust signal processing techniques accurate classification of gender and estimation of age have been achieved. MATLAB's comprehensive toolboxes for signal processing and audio processing have facilitated the development of a cohesive and efficient system. The flexibility of MATLAB has allowed for experimentation with various feature extraction methods and machine learning models, leading to optimized performance. Moving forward, further research and development can focus on enhancing the system's accuracy, scalability, and real-time processing capabilities. Additionally, efforts can be directed towards integrating the system into practical applications such as voice-controlled devices, security systems, and personalized user experiences. Overall, the gender recognition and age detection project in MATLAB lays a solid foundation for advancing the field and addressing real-world challenges in voice analysis and recognition.

Uses of Gender Recognition

Gender recognition technology, primarily based on machine learning algorithms trained on vast datasets of facial features, voice patterns, or other biometric data, has found applications across various sectors:

- ***Security and Law Enforcement:*** Facial recognition technology incorporating gender recognition is utilized in surveillance systems for identifying individuals in public spaces or tracking suspects. It can assist law enforcement agencies in identifying potential threats or suspects in real time.
- ***Retail and Marketing:*** Gender recognition technology is employed in retail settings to analyze customer demographics and tailor marketing strategies accordingly. It helps in understanding customer preferences, optimizing product placements, and enhancing the overall shopping experience.
- ***Healthcare:*** In healthcare, gender recognition technology can assist in patient identification and personalized care. It may aid in the diagnosis and treatment of certain conditions where gender-specific factors play a role, such as cardiovascular diseases or certain types of cancers.
- ***Education***: Educational institutions utilize gender recognition technology for attendance tracking, security purposes, and personalizing learning experiences. It can help educators identify and address the unique needs of students based on gender-specific learning patterns.
- ***HR and Recruitment:*** Gender recognition technology can be integrated into HR systems for unbiased recruitment processes. It helps in mitigating gender biases during resume screening, candidate selection, and performance evaluations.
- ***Entertainment and Gaming:*** Gender recognition technology enhances user experiences in entertainment and gaming by personalizing content based on gender preferences. It can customize recommendations for movies, music, or games, and even modify character appearances in gaming environments.
- ***Transportation and Travel:*** Gender recognition technology can improve safety and security measures in transportation hubs like airports and train stations. It assists in identifying passengers on watchlists and enhancing overall security protocols.
- ***Social media and Communication:*** Social media platforms utilize gender recognition technology for targeted advertising and content recommendations. It helps in delivering personalized content to users based on their gender preferences and interests.
- ***Fashion and Beauty:*** Gender recognition technology is integrated into virtual try-on tools for fashion and beauty products. It allows users to visualize how clothing items or cosmetics would look on them, considering their gender-specific features.
- ***Sports and Fitness:*** Gender recognition technology can be applied in sports analytics to analyze athletes' performance and tailor training programs based on gender-specific physiological differences. It also assists in monitoring fitness progress and providing personalized recommendations for users of fitness apps and wearables.
- While gender recognition technology offers numerous benefits across these sectors, it's crucial to address concerns regarding privacy, bias, and ethical implications associated with its use.

Ensuring transparency, accountability, and responsible deployment are essential for maximizing its potential while minimizing risks.

User manual:

1. At first turn on the device.

2. Turn on the microphone. (Which Should have noise cancellation technology)

3. Set the device in a quite place as much as possible.

4. Now take the data and get the overall output.

Reference:

- A. S. Malek, M. Saifuzzaman, M. R. Hassan, M. Z. Rashed, and R. S. Uddin, "Title of the paper (if available)," *Proceedings of [Conference Name, if mentioned]*, vol. [volume], no. [issue], pp. [page range], [month] [year]. Available: https://ieeexplore.ieee.org/abstract/document/9316053

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