

**FACULTY OF ENGINEERING**

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**USING MATLAB GUI FOR SIGNAL ANALYSIS REPORT**

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1. **OBJECTIVE OF THE STUDY**

The objective of this study is to develop a MATLAB-based graphical user interface (GUI) that allows users to generate, manipulate, and analyze sinusoidal signals by adjusting various parameters. The main functionalities and goals of the study are as follows:

1. **Signal Generation**:
   * Users can create two independent sinusoidal signals by specifying parameters such as amplitude, frequency, and sampling frequency.
   * The application allows the selection of signal type (Sine or Cosine) to observe different waveform behaviors.
2. **Exploring Sampling Frequency Effects**:
   * The GUI enables users to adjust the sampling frequency and observe the effects on signal representation, including aliasing if the sampling rate falls below the Nyquist rate.
3. **Signal Analysis**:
   * The application includes tools to perform operations like summation, dot product, convolution, and Fast Fourier Transform (FFT) on the generated signals.
   * These features help users understand how signals interact, how they can be analyzed in the frequency domain, and how convolution demonstrates system responses.
4. **Noise Addition and Analysis**:
   * Users can add Gaussian noise to the signals by specifying mean and standard deviation, simulating real-world signal conditions.
   * The impact of noise on the signal and its frequency components can be analyzed by observing the noisy signal and its FFT.

Overall, the GUI aims to provide an interactive learning environment for understanding key signal processing concepts, offering hands-on experience with essential techniques and the effects of different signal parameters.

**2. ACTIVITES PERFORMED**

The development process was carried out in several steps, starting with the design of the visual interface, followed by the implementation of various signal generation and analysis features. Below is a detailed explanation of each activity, complemented by visual screenshots from the implemented application.

1. **Design of the Visual Interface**:  
   The GUI was designed using MATLAB App Designer, where different interactive elements were laid out for user input and signal visualization. The following components were included:
   * Numeric edit fields for specifying amplitude, frequency, and sampling rates for two sinusoidal signals.
   * Drop-down menus to select the type of signal (Sine or Cosine).
   * Buttons for generating signals, calculating sums, dot products, and performing FFT and convolution.
   * Dedicated plotting areas to visualize the signals and their analysis results.

metin, ekran görüntüsü, diyagram, sayı, numara içeren bir resim

Açıklama otomatik olarak oluşturuldu

1. **Signal Generation**:  
   Users can input parameters such as amplitude, frequency, and sampling frequency to generate two different sinusoidal signals. The GUI allows the user to select the type of signal (Sine or Cosine) for each of the two signals. The signals are plotted on separate axes to help users easily compare them.

metin, ekran görüntüsü, diyagram, yazılım içeren bir resim

Açıklama otomatik olarak oluşturuldu

1. **Signal Analysis**:
   * **Sum of Signals**: Once the signals are generated, users can click a button to calculate and display the sum of the two signals.
   * **Dot Product**: The dot product of the two signals is calculated and displayed on the interface.
   * **Fast Fourier Transform (FFT)**: The FFTs of both signals are computed to display their frequency domain representations, demonstrating how signal frequencies contribute to their overall structure.
   * **Convolution**: Users can calculate and view the convolution of the two signals, which is essential in signal processing for analyzing system responses.

metin, ekran görüntüsü, diyagram, tasarım içeren bir resim

Açıklama otomatik olarak oluşturuldu

1. **Noise Addition and Analysis**:
   * Users can add Gaussian noise to the generated signals by specifying parameters such as mean and standard deviation.
   * The noise is visualized along with its FFT, and users can also see how the noisy signal behaves in the frequency domain.

metin, ekran görüntüsü, diyagram, yazı tipi içeren bir resim

Açıklama otomatik olarak oluşturuldu

**3. Results and Evaluation**

**Results**:

* The MATLAB GUI was successfully developed, enabling users to create and analyze two different sinusoidal signals.
* Users could visualize the signals, their sum, dot product, convolution, and FFT, providing a comprehensive analysis tool.
* Gaussian noise addition and its effect on signals were demonstrated effectively, helping users understand real-world scenarios where signals are affected by noise.
* The GUI also allowed users to observe aliasing effects when the sampling frequency was set below the Nyquist rate, emphasizing important principles of signal processing.

**Evaluation**:

* **Positive Aspects**:
  + The GUI is user-friendly and provides a hands-on approach to learning signal processing.
  + Various signal operations are integrated seamlessly, and the visual outputs help users understand complex concepts intuitively.
  + The ability to adjust noise parameters and observe their effects in real time was particularly useful in showcasing the importance of noise handling in practical applications.
* **Negative Aspects**:
  + The current implementation does not support more advanced signal types (e.g., square waves, triangular waves) which could enhance the educational aspect of the tool.
  + The application performance might slow down when handling larger signals due to the high computational cost of operations like convolution.
  + Further improvements could include a feature to export plots and data, which would be useful for users who want to document their observations.

**Conclusion**: Overall, the developed MATLAB GUI serves as an effective tool for generating and analyzing sinusoidal signals, offering a visual and interactive method for understanding basic signal processing concepts. Future iterations of this project could include additional signal types, improved performance for larger datasets, and more advanced analysis options to broaden its educational and research applications.