

DSP projects (easy= 15 points, advanced= 17 points)

1. Design and implementation of a Digital Audio Equalizer (easy, Matlab, Python)

The goal of this project is to design, implement, and test a digital audio equalizer with at least 3 frequency bands: bass, midrange, and treble.

The equalizer will allow the user to modify the frequency response of an audio signal by boosting or attenuating specific frequency bands. This will be done by applying finite impulse response (FIR) filters to different frequency ranges of the audio signal.

2. Image enhancement and edge detection (easy, Matlab, Python)

The goal of this project is to apply DSP techniques for image enhancement and edge detection.

You will implement the following operations:

- **Histogram equalization:** used to enhance image contrast by redistributing the intensity values.
- **Edge detection:** implement and apply edge detection filters (e.g., Sobel operator) to detect edges in images.
- **Image filtering:** enhance image features and reduce noise by using smoothing and sharpening filters.

Compare the results of different enhancement and edge detection methods, and analyze their effectiveness.

3. Image Filtering and Noise Reduction (easy, Matlab, Python)

The goal of this project is to apply various DSP techniques to enhance and process digital images, focusing on noise reduction and image filtering. You will implement:

- **Gaussian Filter:** implement a Gaussian filter to blur the image. Discuss how the filter works and how the standard deviation affects the smoothing.

- **Averaging Filter:** implement a simple averaging filter (mean filter). Discuss its effects and limitations (e.g., blurring of edges).
- **Median Filter:** implement a median filter, which is effective in removing salt-and-pepper noise while preserving edges.
- **Bilateral Filter:** implement a bilateral filter, which smooths images while preserving edges.

Add Gaussian noise and salt-and-pepper noise to the original image to simulate real-world conditions and apply the filters you created. Comment on the effectiveness of such parameters.

4. Audio source separation (advanced, Python)

The goal of this project is to implement an audio source separation algorithm to isolate different sound sources from a mixed audio signal. You might focus on Independent Component Analysis (ICA), a widely-used DSP technique for separating mixed audio signals into their original source components (hint: use scikit-learn's FastICA or numpy to implement ICA on the mixed signal).

5. Speech enhancement (advanced, Python)

In this project, you will apply techniques to enhance the quality of a speech signal. The goal is to reduce background noise and improve the clarity of the speech. This is a fundamental problem in many audio processing applications, such as voice assistants, speech recognition, and telecommunications (hint: use three different approaches: spectral subtraction, Wiener filtering and adaptive filtering).