

Image Processing in MATLAB with GUI Design

INTRODUCTION

Digital Signal Processing or DSP is an idea of using computers to understand signals such as voltage generated by the brain and heart, images from remote space, seismic vibrations, and other applications. It is a manipulation of information signals that uses the mathematical method to modify and improve a signal. It is denoted by representing discrete frequency, discrete-time, and discrete domain signals by having a sequence of numbers and processing these signals.

Signals themselves can be represented in discrete time or discrete domains. Processing these signals is basically what signal processing means. In this project, the signals illustrated in an image are digitally processed by computation software; the data in this image can also be filtered. The filtering process of an image is divided into parts such as low pass filter, high pass filter, band pass filter, and band reject filter. The low pass filter filters out the high frequency to make the image smooth. While the high pass filter filters out the low frequency to make the image sharp, filtering both low and high frequencies will enhance the edges of the image and reduces the noise of the images, and this is called band pass filter. Lastly, combining both high and low frequencies while filtering the frequencies between them denoises the image; this is the band reject filter.

This project also shows image filtering for binary, intensity, indexed, multi-frame, red, green, and blue. Ordinary operations like adjustable contrast and brightness can be applied to the image. In the GUI, the photos can be uploaded to a save address and downloaded into a file address. In addition, the reset capabilities are applied, and rotation and flip operation can also be done in the image.

As mentioned, GUI is a MATLAB app designed with an integrated editor that allows users to program to do functionalities they want. It can be done manually layout the design GUI.

The following are the different types of image filtering:

1. Intensity Image – also called grayscale image where the image shows only colors in shades of grey.
2. Binary image – image pixels have two intensity values: Black and white.
3. Indexed Image – filtered images have limited colors (specified colormap). It cannot access the full specification of colors.
4. Multiframe image – the original image is replicated in n-frames.
5. RGB image – the filtered image contains only one color (red or blue or green)
6. Estimate Background – removes the image and retains the background.
7. Subtraction of the Background – removes the background and retains the image.

PROGRAM DESCRIPTION

The project of image processing or filtering was implemented with a graphical user interface (GUI) in MATLAB App Design. As a requirement for the project, the program must have three categories for filter characteristics wherein three output images will be available at the end. Each category or group of filter types can only display the filtered image in its corresponding display section, or in this case, axes located in the right panel.

As the user simulates the program, a selection button can choose the desired image for processing. The program will then process the selected image depending on the filter types or parameter changes the user will make. Applying the FIR filter to the image will sharpen, smoothen, denoise, or enhance it depending on the FIR filter type used. The cut-off frequencies are available for a specific range of frequencies, allowing a better visual display of how each FIR filter type affects the image. Aside from FIR filtering, image brightness adjustment and background removal are also available for the first group or category of filters. Unlike standard background removal functions, the program uses an input radius value to process the estimated background that will be removed from the original image. The second group or filter category includes RGB or truecolor, intensity or grayscale, binary or bilevel, and background estimation using morphological opening.

The image can be converted to an RGB, grayscale, or binary image type according to the pressed buttons. Like background removal, the background estimation uses varying input values to process the image; however, unlike background removal, it retains the estimated background of the picture. The last group or category of filter consists of another image type, the pseudocolor or index image together with multiframeing the image and adjusting the image contrast.

The program displays all output images after filtering or processing in the right panel. It consists of three axes, one for each category of filter. The first group outputs the filtered image in the top axes display while the second group is in the center and the third group in the bottom axes.

The program also enables resetting the filtered images without changing the sample image to proceed in the other filter types. A user at any time can choose another image again to be processed

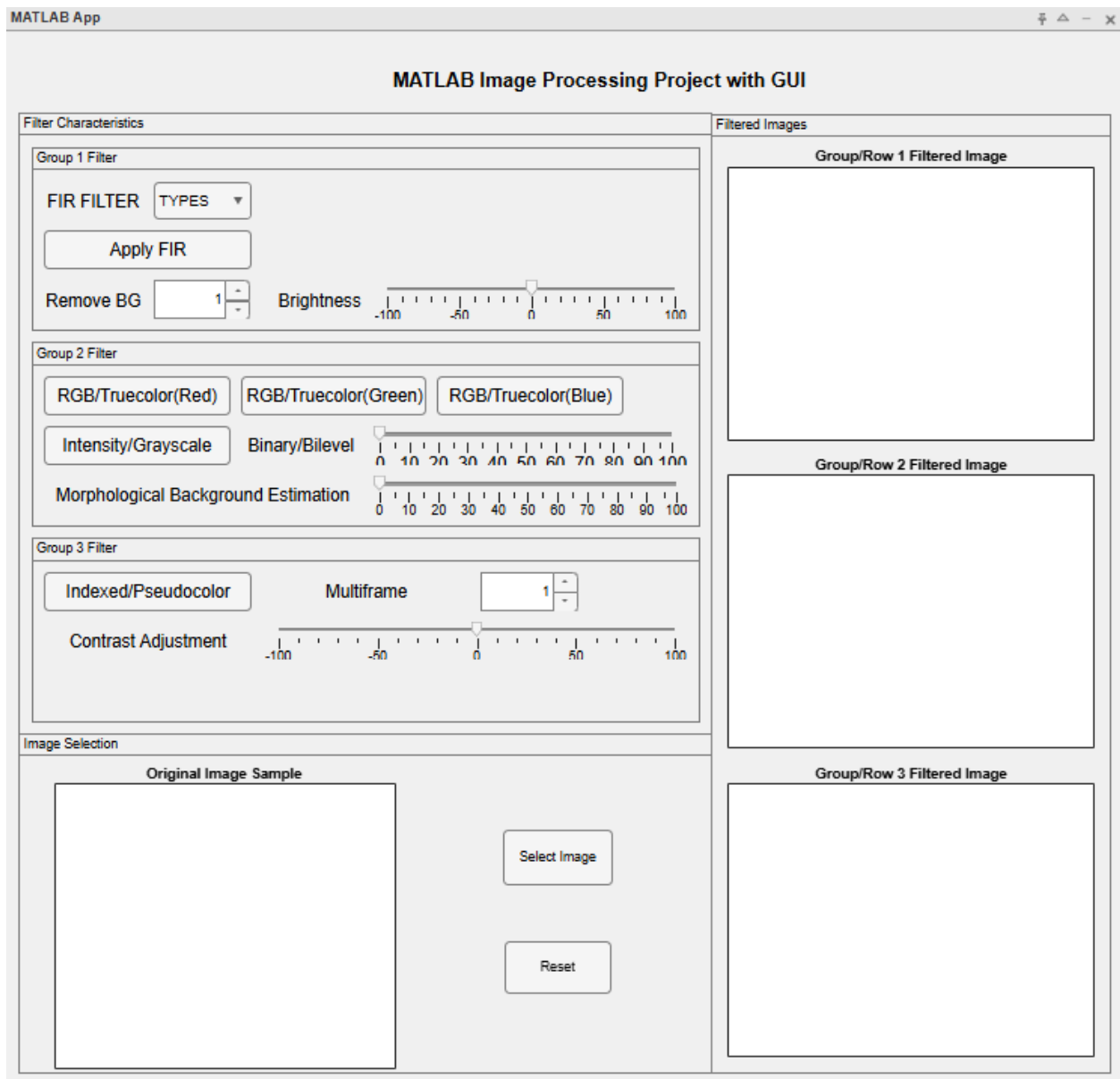
The program code can be learned, applied, and modified with the help of the Image Processing Toolbox available in MATLAB. This toolbox comes with defined functions to process images, such as the ones used in the program.

SCOPE AND LIMITATIONS

This project can import images from the local files of the user for image processing. Images can be converted to different images such as RGB or Truecolor image, Binary or Bilevel image, Intensity or Grayscale image, or Index or Pseudocolor image. It can also process the image according to the type of FIR filter, estimate and remove the background of the image, and adjust the brightness and contrast of the image.

The limitation of the program is that it can only process a single image one at a time. Only four types of FIR filtering are available, which are the most common types: a lowpass filter, a highpass filter, a bandpass filter, and a bandstop filter. Some pictures or images cannot be filtered or processed due to their dimensions or image size. This is because some parts of the program code can only accept inputs of a square matrix where the row and column of the image must be equal. Images cannot be filtered continuously from multiple types of filtering, and the display only shows single filtering to the image. Also, the program is limited to run with some specifications to avoid system errors such as initial values for the bandpass and bandstop filters or the image size for processing the image.

SCREEN CAPTURE OF THE GUI

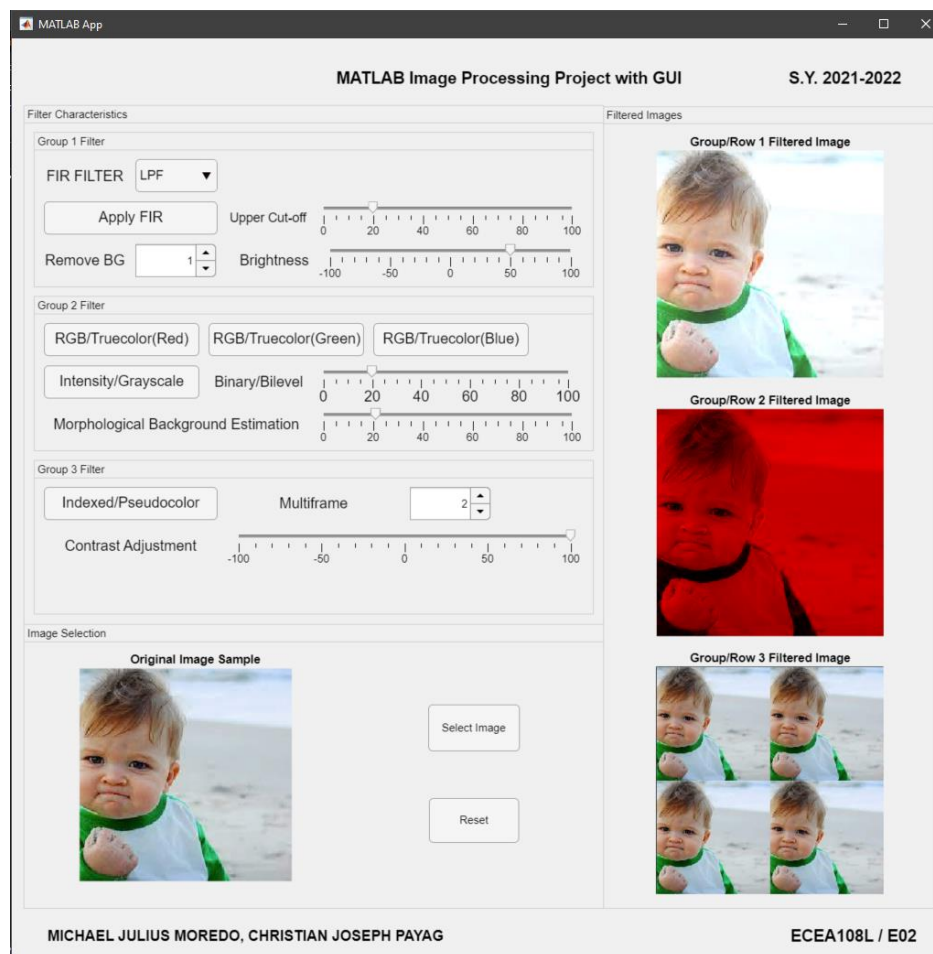


TWO SAMPLE OUTPUT

Source Images:



Output 1



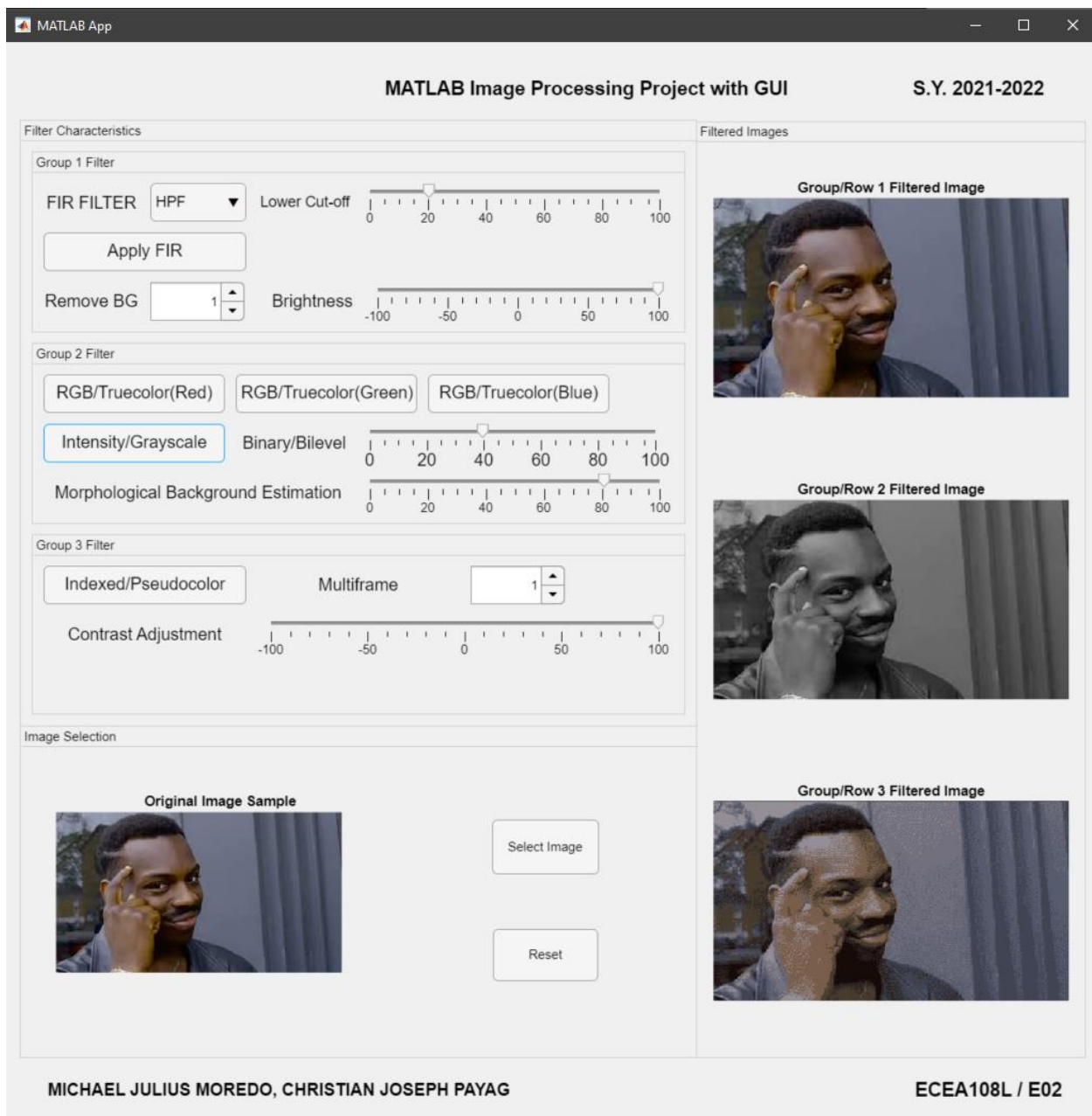
Output 1 (Source 1)

Filter 1: Brightness (50), LPF (20)

Filter 2: Red, Binary (20), Morphological (21)

Filter 3: Multiframe (2x2), Contrast (100)

Output 2



Output 2 (Source 2)

Filter 1: Brightness (100), HPF (20)

Filter 2: Grayscale, Binary (40), Morphological (81)

Filter 3: Multiframe (1x1), Contrast (100)