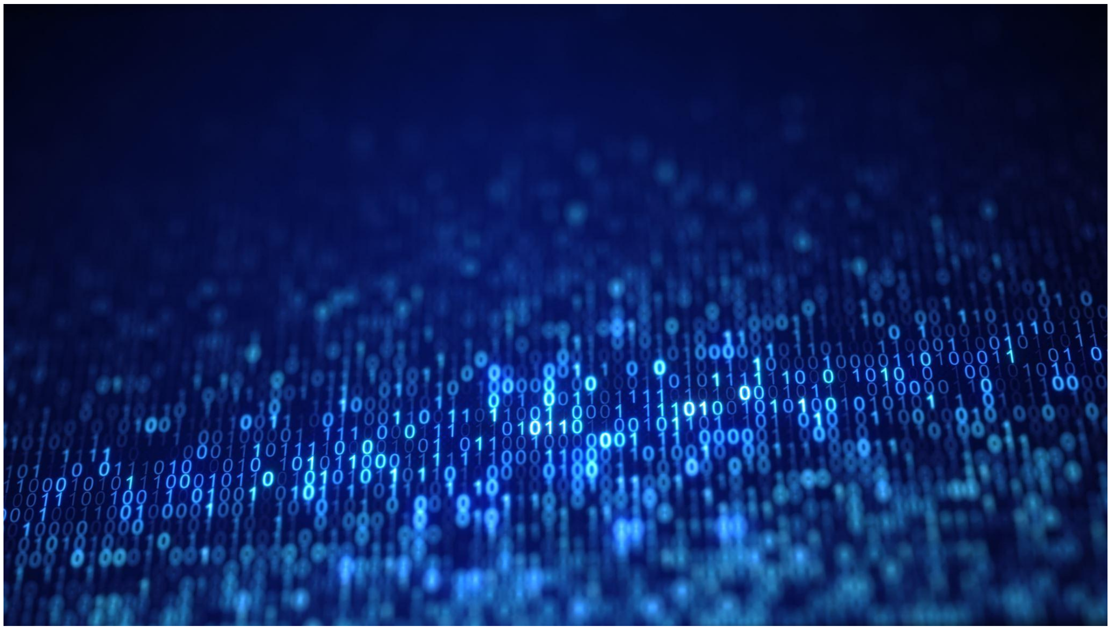
LBYEC4A – EK2

Signals, Spectra and Signal Processing Laboratory



Final Project Proposal

Creation of Laboratory Manual on Image Convolution Kernel

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PROJECT DESCRIPTION

An image kernel is a small matrix used to apply effects on images to smoothen, sharpen, intensify, or enhance some parts of the image that the user would like to highlight [1]. Your choice of kernel affects the output imge. Different sizes can be used for a kernels, however, 3x3 is commonly used. Also, one of its restrictions is that the convolution matrix is only comprised of integers.

Convolution works by determining the value of a central pixel, and then adding the weighted values of all its neighbors together [2]. Equation 1.1 displays the convolution formula.

$$V = \left| \frac{\sum_{i=1}^{q} \left(\sum_{j=1}^{q} f_{ij} d_{ij} \right)}{F} \right|$$

Where: fij = coefficient of a convolution kernel at i, j

dij = data value of the pixel that corresponds to fij

q = dimension of the kernel assuming a square kernel

F = sum of coefficients of the kernel

V = output

Equation 1.1. Convolution Formula.

There are some misconceptions between the terms kernel and filter. To differentiate, a kernel matrix is a 2D matrix, whereas a filter is a concatenation of multiple kernels [3].

Despite introducing the fundamentals of signal processing, there are still some subject areas that the current course syllabus can improve on, especially in terms of elevating the complexity of the applications of these processes. One can also argue that students can opt to utilize online courses instead; however, there are still some advantages if this topic is properly introduced as part of the course. This project aims to introduce a laboratory activity that the current course syllabus does not cover. The primary topic to be covered would be a more in-depth discussion on image convolution.

The authors aim to create an extension of the lessons in LBYEC4A on convolution kernels. The following objectives are set:

- To understand how convolution kernels work
- To explore different convolution kernels utilized in Image Processing in MATLAB
- To differentiate the various convolution kernels and make general observations on convolution kernels

METHODOLOGY

The project consists of two main parts: the creation of a laboratory manual or the lecture proper, and the creation of the exercise proper and solution manual for teachers.

Laboratory Manual

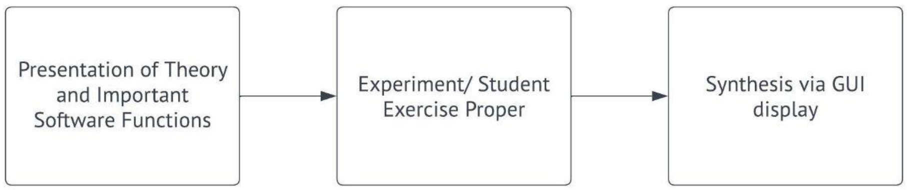

Figure 2.1. Laboratory Manual Flowchart.

The laboratory manual is sectioned into three parts: theory, experiment proper, and GUI display synthesis. The first contains important theory, background information, and essential software functions that are necessary for the exercise proper. After a brief review, the manual shall present exercises for the students to accomplish. More details for such is presented in the *Exercise Proper* of the current section. As an additional activity, the proponents of the experiment shall be given a simplified application/GUI that presents the original image, filtered image, and frequency domain representation. Features of the program shall include a drop down for easy change of convolution kernel.

Aside from the documentation, the Laboratory Manual also contains an interactive lesson proper wherein students get to see how different convolution kernels can affect their uploaded images.

Exercise Proper

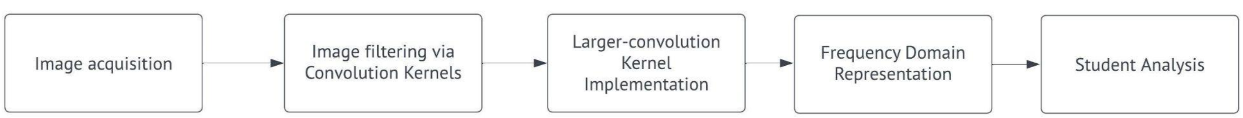

Figure 2.2. Exercise Proper Flowchart.

The exercise proper shall be designed in the flow shown in figure 2.2. Additionally, the design of the exercise shall consist of a given code for lines unnecessary for the learning of the proponent. Thus, the proponent shall fill the lines in between with the code that is required by the prompt.

In image filtering via convolution kernels, the proponent shall be given 3 x 3 matrices that represent an unknown convolution kernel. The purpose of presenting the convolution kernel to be unknown is for the student to identify the convolution kernel based on the description in the theory. The following are the convolution kernels to be utilized in the experiment:

- Blur
- Bottom Sobel
- Emboss
- Identity
- Left sobel
- Outline
- Right sobel
- Sharpen
- Top sobel

In large convolution kernel implementation, the proponents shall be given a 5 x 5 matrix version of the convolution kernel. Then, in frequency domain representation, the proponents shall be prompted to represent the original and filtered images in its frequency domain. Finally, the proponents should be able to analyze the filtered images based on the effects of the filter and the relevance of the values inside the matrix.

SCHEDULE OF ACTIVITIES

Task	Person-in-Charge	Deadline
Submission of Proposal	ALL	March 14, 2023
Gathering of Images	Alyssa Joie Tablada	March 20, 2023
Discussion of Theory and Background Information	Alyssa Joie Tablada	March 22, 2023
Creation of Student Tasks and Solution Set	John Ernesto Amadora Rafael Dominic Montaño	March 22, 2023
Debugging	ALL	March 24, 2023
Project Documentation	ALL	March 27, 2023
Demonstration	ALL	April 11, 2023

REFERENCES

[1] Powell, V. Image Kernels Explained Visually. [Online]. Available: https://setosa.io/ev/image-kernels/. [Accessed: March 14, 2023].

[2] Ludwig, J. Image Convolution. [PDF File]. Available: https://web.pdx.edu/~jduh/courses/Archive/geog481w07/Students/Ludwig_ImageConvolution.pdf. [Accessed: March 14, 2023].

[3] Ganesh, P. Types of Convolution Kernels: Simplified. [Online]. Available: https://towardsdatascience.com/types-of-convolution-kernels-simplified-f040cb307c37. [Accessed: March 14, 2023].