Code Documentation For Image Processing - Point Operations (Using JavaScript)

Contents

INTRODUCTION

The Point Operations Lab is a JavaScript version of the experiment originally written in PHP. It is used to modify images based on different functions (linear,non-linear,clipping,window) by changing the value of each pixel present in the image.

This is done by obtaining the pixel value and changing each of the r,g and b values according to the function.The output image is the enhanced image after the application of the point operation.This point operation is one of the basic methods used in image processing.

Languages Used:

- HTML
- CSS
- JavaScript

THEORY

The most popular application of image processing is to change the visual appearance of the image such as to improve the contrast, reduce the dynamic range of brightness, reverse the 'polarity' such as dark to white and vice versa. There are many image editing tools which enable one to do such alteration in the appearance of the image. Besides such everyday uses, these operations play an important role in many domains such as medical imaging, remote sensing, to overcome the inherent limitations in imaging acquisition process, adapting the image to different displays and so on.

In this experiment, we will study an effective, yet simple, technique that manipulates the pixel values in the given image using a mapping function. You will observe that the effects of processing, greatly depends on the nature of the chosen mapping function: linear or non-linear.

Point operations are simple image enhancement techniques. Here, the operations are directly performed on the pixel values. A given image $f(x,y)$ is transformed into an output image $g(x,y)$ using some transformation T. Let $f(x,y) = p$ and g(x,y) = q; p and q are also known as pixel values in the corresponding images at location (x,y). Thus,

$$q = T(p)$$

where, T is a transformation that maps p into q. The results of this transformation are mapped into the grey scale range as we are dealing here only with grey scale digital images. So, the results are mapped back into the range [0, 255].

There are four commonly used and basic types of functions (transformation) are described here:

1. Linear function
2. Non-linear function
3. Clipping
4. Window function

Linear function: The output pixel value is linearly related to the input pixel value. This can be described using a line equation as follows:

$q = s * p + o;$

where, s is the slope of the line and o is the offset from the origin. This type of transformation is particularly useful for enhancing white of gray details embedded in the dark regions of an image.

Non-linear function: The output pixel value is not linearly related to the input pixel value. Here, we consider example of log-transformation function to explain the process. In this function is:

$q = c * \log(1+p)$

where c is a constant variable. This function converts a narrow range of low gray-level values of p in to a wider range of q values or vice versa. This type of transformation is useful in expanding values of dark pixels while compressing the higher values.

Clipping: The value of output pixel is related to the input pixel value in piece-wise linear fashion. Though such functions are complex and require user input but useful in many practical situations. This function is defined as

$$q = \begin{cases} 0 & p < a \\ s * p + o & a \le p \le b \\ L & p > b \end{cases}$$

where, a and b are constant variables which define input pixel value range in which linear function with a slope s and offset o is applied. In gray level image, value of L is 255. In our experiment section, we kept value of offset fixed to zero.

Window: This function is similar to the clipper. In this, only a desired range of gray levels is preserved in the output image. It is defined as:

$$q = \left\{ \begin{matrix} 0 & p < a \\ s * p + o & a \le p \le b \\ 0 & p > b \end{matrix} \right\}$$

OVERALL DESCRIPTIONS

1. Image Grid
2. Run Button
3. Reset Button
4. Select function
    - Slope
    - Offset
    - Start (incase of clipping and window)
    - End(incase of clipping and window)
5. Graph

1. **Image Grid**

   It is used to select the image which will be displayed in the input box.It is this image that we are going to extract pixels from and modify them as a part of the experiment.It consists of nine <img> tags placed in a grid layout that shows upon clicking on the ‘select image’ button.

2. Run button

It is used to run the experiment to observe the result in the output box.It is supposed to be used only when all the fields are selected.

3. Reset button

It is used to reset all fields of the experiment to original conditions.

4.Linear Function

This function is used to modify each of the pixels in a linear fashion.

5.Non-Linear Function

This function is used to modify each of the pixels in a non-linear(logarithmic) manner.

6.Clipping Function

This function is used to modify each of the pixels according to the basic clipping formula.

7.Window Function

This function is used to modify each of the pixels according to the basic window formula.

WORKING DESCRIPTION

Here, we will be discussing about the functions written by the coder to perform point operations on the image.

1.Show grid function
This function helps to show the grid when the client wants to select the image.
This function has an innerfunction toggleGrid that helps in the appearance and the disappearance of the grid.This uses an addEventListener which listens for the click and then performs the function mentioned.

2. My function
This function is designed to take the id of the image as an attribute(as a reference for the element to be displayed in the input box) and consequently puts the user required image in the input box.Since the input destination is a canvas, we get the 2d context of it,store it in a variable,set the canvas attributes and load the image in the required place.

3. Function mynon,myclip,mylin and mywindow

Each of the above functions is written in the innerHTML of a div displaying it’s varying attributes.Eg:for linear,the client can vary the slope and offset.This is done by taking the innerHTML of the div by it’s id and inputs various values depending on the functions by using different class.

4.Function run

This function does the major part of the work in the program.There is a global variable in the program(z) that varies according to which function the client wants to use.Hence by using a switch case we will be able to change the pixel values in accordance to the desired function.In this we get the image data by using getImageData and store the data in the variable.Now,we traverse through each pixel in the image using a for loop and change it’s values(r,g and b values respectively).After all the pixels are modified according to the function,we putImageData in the output layer hence completing the operation of this button.

5.Function draw

The draw function is called inside the run function.The aim of the draw function is to plot the graph of the point operation function.This is also done using canvas.In this function we move our plot points to definite locations in the graph and further draw lines from the point according to the equation.This is done by using moveTo() and stroke() respectively.