

Image Enhancement GUI using MATLAB

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ABSTRACT: In this paper, we present an overview of image enhancement processing techniques in spatial domain and developed its Graphical User Interface (GUI) in MATLAB. This paper describes the basic technological aspects of Digital Image Processing with reference to Enhancement in image processing. Image enhancement techniques help in improving the visibility of any portion or feature of the image, suppressing the information in other portions or features [1]. The enhancement procedures are applied to image data in order to effectively display the data for subsequent visual interpretation [2]. It involves techniques for increasing the visual distinction between features in a scene. There exists a wide variety of techniques for improving image quality. The contrast stretching, image negative, density slicing, edge enhancement, and spatial filtering are the more commonly used techniques. The existing techniques of image enhancement can be classified into two categories: Spatial Domain and Frequency domain.

KEYWORDS: Graphical User Interface, Histogram Processing, Image Enhancement, MATLAB, Point Processing, Spatial Domain Operations.

I. INTRODUCTION

A *digital image* is a representation of two-dimensional images as a finite set of digital values, called picture elements or pixels [1]. Digital Image Processing (DIP) involves the modification of digital data for improving the image qualities with the aid of computer. The processing helps in maximising clarity, sharpness and details of features of interest towards Information enhancement and further analysis [2].

Digital image processing is a broad subject and often involves procedures which can be mathematically complex, but central idea behind digital image processing is quite simple. These results form a new digital image that may be displayed or recorded in pictorial format or may it be further manipulated by additional computer programs [2]. The Stages of Digital Image Processing in Image Enhancement is described in the fig. 1.

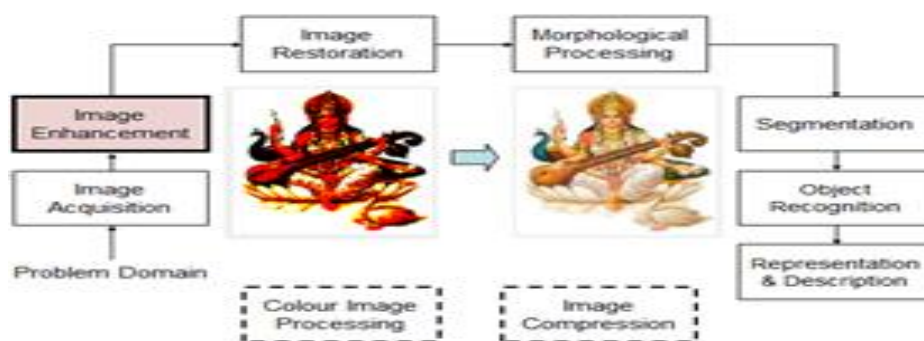


Fig1 Stages of Digital ImageProcessing: Image Enhancement

II. MATERIAL AND METHODS

A. GUI Tool Box

GUIs (also known as Graphical User Interfaces or UIs) provide point-and-click control of software applications, eliminating the need to learn a language or type commands in order to run the application. MATLAB apps are self-contained MATLAB programs with GUI front ends that automate a task or calculation. The GUI typically contains controls such as menus, toolbars, buttons, and sliders etc. You can also create your own custom apps, including their

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corresponding UIs, for other users [5]. The principles of good GUI design are, for the most part, timeless and universal. The Guide Tools include the already-mentioned Property Editor, the Call-back Editor, the Alignment Tool, and the Menu Editoretc. The fig. 2 shows the sample GUI using GUIDE in MATLAB.

1. Design Process Steps:-
 - Define the task
 - Draw the GUI
 - Test the Design
 - Write the Code (use Guide)
 - Test the Code
2. It falls naturally into two parts:
 - GUI design, or how to make something that's useful
 - GUI implementation, or how to make something that works

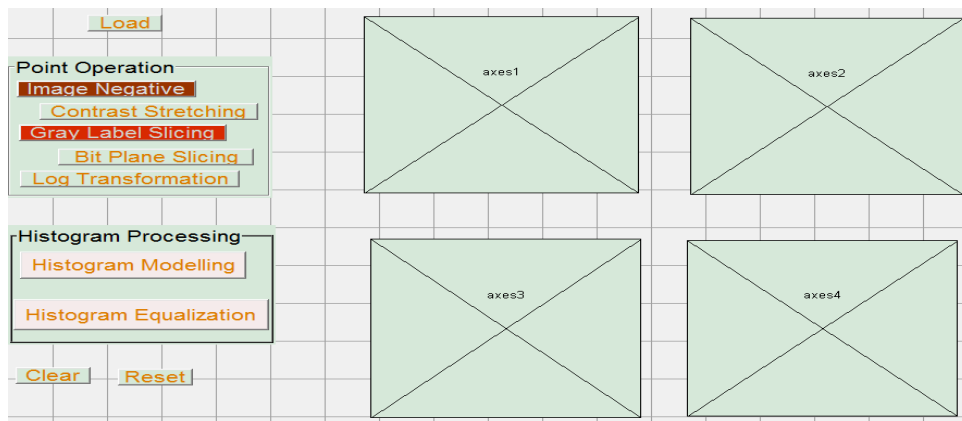


Fig2 GUI Editor

B. Spatial Domain Techniques

The term spatial domain refers to the aggregate of pixels composing an image. Spatial domain methods are procedures that operate directly on these pixels [2]. Spatial Domain processes will be denoted by the expression $g(x, y) = T[f(x, y)]$ Where $g(x, y)$ is an output image, $f(x, y)$ is an input image and T is an operator on f (or a set of input images), defined over neighbourhood of (x, y) [4]. The image enhancement in spatial domain described in the fig. 3.

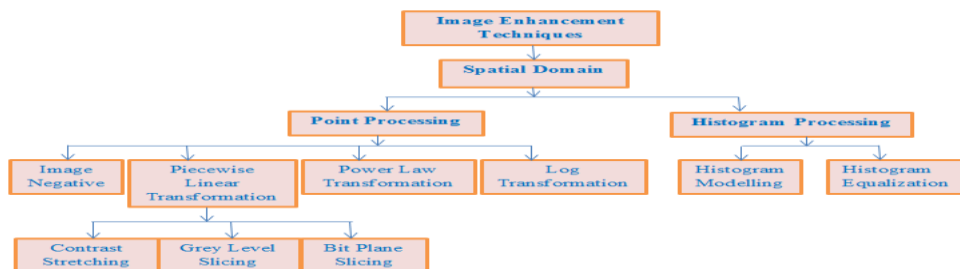


Fig3 Image Enhancement in spatial Domain

1. Point Processing

Point operations, or image processing operations are applied to individual pixels only. The point operation is represented by

$$g(m, n) = T[f(m, n)]$$

Where $f(m, n)$ is the input image, $g(m, n)$ is the processed image, and T is the operator defining the modification process which operates on one pixel. Some examples or techniques of point processing are as follows:

- Digital Image Negative

It is useful in a number of applications. eg. X-ray images. The term Negative means inverting the grey levels. The Negative of image transform result is shown in the fig. 4. Digital Negative can be obtained by: $s = 255 - r$ (Where, $r_{max} = 255$) when, $r = 0$; $s = 255$ & if $r = 255$; $s = 0$

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$s = (L - 1) - r$ Where, L – total number of grey levels[7].

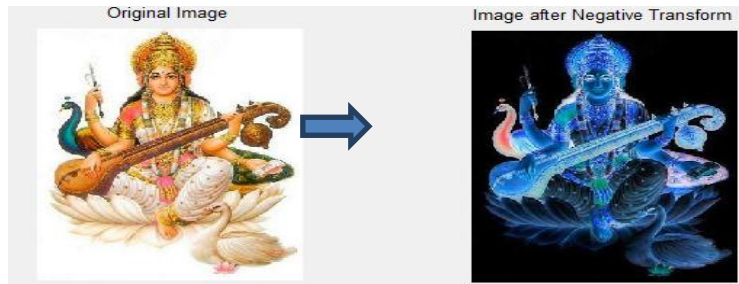


Fig4 Image Negative

- **Piecewise Linear Transformation**

The principal advantage of piecewise linear functions over the types of functions we have discussed thus far is that the form of piecewise functions can be arbitrarily complex. The principal disadvantage of piecewise functions is that their specification requires considerably more user input [8].

➤ **Contrast Stretching:** This is done when the captured image has poor illumination or lens aperture has been placed wrong. Idea behind contrast stretching is to make dark portion darker and bright portion brighter [8] as shown in fig. 5.

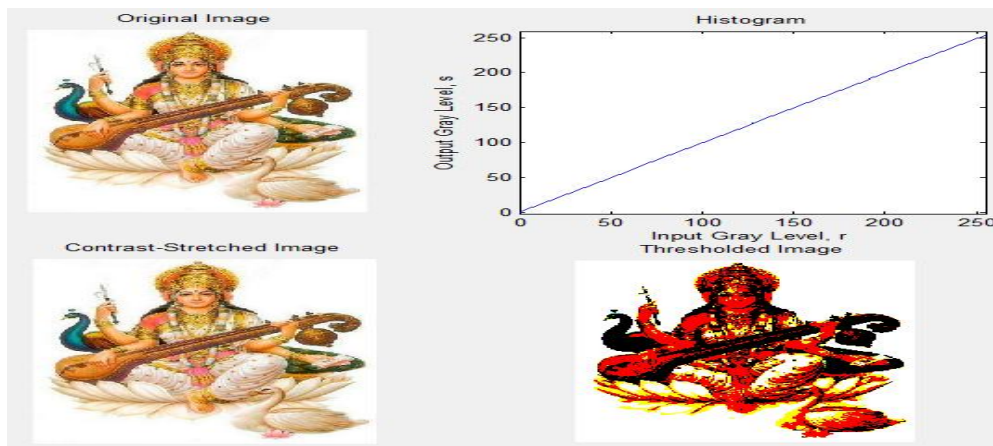


Fig5 Piecewise Linear Transformation

$$s = \begin{cases} L * r; & \text{for } 0 \leq r \leq a \\ m(r - a) + v; & \text{for } a \leq r \leq b \\ n(r - b) + w; & \text{for } b \leq r \leq L - 1 \end{cases}$$

Thresholding: Extreme Contrast Stretching yields Thresholding. If $r_1 = r_2, s_1 = 0$ & $s_2 = L-1$ Then we get Thresholding function. Expression becomes:

$$s = \begin{cases} 0; & \text{if } r \leq a \\ L - 1; & \text{if } r > a \end{cases}$$

Where, L is number of Grey levels[7]. Threshold images have maximum contrast as there are only BLACK & WHITE grey values as show in fig. 5.

➤ **Grey Level Slicing:** Thresholding splits the image in 2 parts [7]. But at the time we need to highlight a specific range of grey levels.eg. X-ray scan, CT scan. Grey level slicing looks similar to thresholding except that we select a band of grey levels in this technique. The result of grey level slicing is shown in fig. 6.

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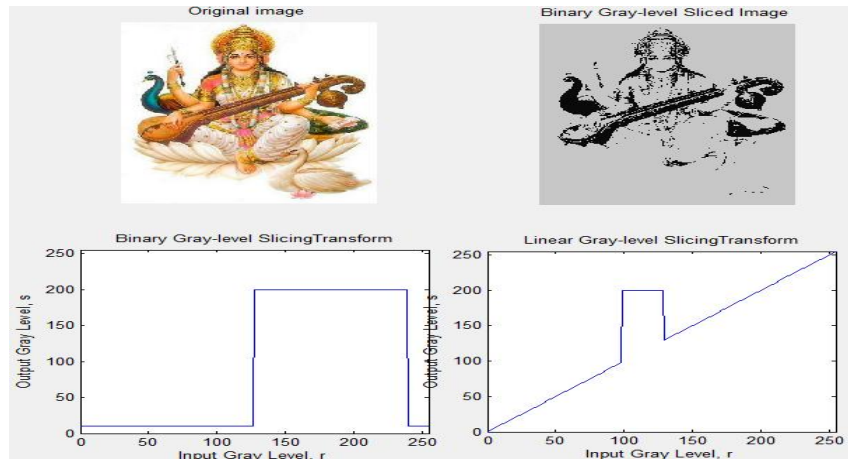


Fig6 GrayLevel Slicing

➤ *Bit Plane Slicing*: In bit plane slicing, each bit contributes to the formation of final image. Example of bit plane slicing is steganography.

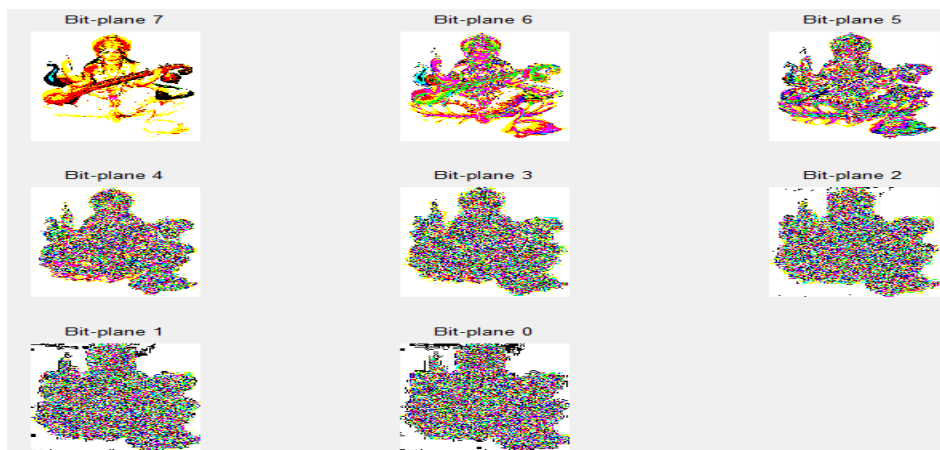


Fig7 Bit Plane Slicing

Let us consider a 256x256 image with 256 grey levels. For eg- Black is represented as 00000000 and White as 11111111. Consider LSB value of each pixel & plot image. Continue till MSB is reached. All 8 images will be binary. The higher order bits contain majority of the visually significant data, while the lower order bits contain less details of image [7] as shown in fig. 7.

- *Power Law Transformation*

Power-law transformations have the basic forms $s = c \cdot r^\gamma$ where c and γ are positive constants. Sometimes is written as $s = c(r + e)^\gamma$ high to account for an offset(that is, a measurable output when the input is zero)[2][4]. However, offsets typically are an issue of display calibration and as a result they are normally ignored. Power Law Transform can be used to increase dynamic range of image.

- *Log Transformations*

Log transformation is one of the elementary image enhancement techniques of the spatial domain that can be effectively used for contrast enhancements of dark images. The log transform is essentially a grey level transform which means that the grey levels of image pixels are altered. This transformation maps a narrow range of low grey

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level values in the input image to a wider range of output levels as shown in fig. 8. The general form of the log transformation can be mathematically represented as[6]

$$s = c \log(1 + r)$$

Where, s is the output grey level, r is the input grey level and c is a constant. It is assumed that $r \geq 0$.

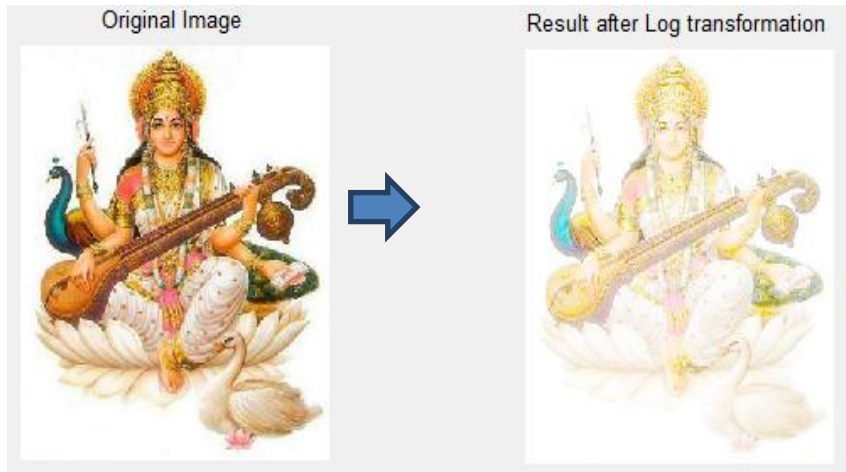


Fig8 Log Transformation

2. Histogram Processing

The histogram of a digital image with grey levels in the range $[0, L-1]$ is a discrete function

$$h r_k = n_k$$

Where r_k is the k^{th} grey level and n_k is the number of pixels in the image having gray level r_k [2]. It is common practice to normalize a histogram by dividing each of its values by the total number of pixels in the image, denoted by n . Thus, a normalized histogram is given by

$$p(r_k) = \frac{n_k}{n} \text{ for } k = 0, 1, p, L - 1$$

- **Histogram Modelling**

It is a technique used to increase the dynamic range of an image. In this method, we do not change the basic shape of the original histogram, but we spread it to the entire dynamic range. We achieve this by using a straight line equation as shown[8].

$$s = T(r) = m * (r - r_{min}) + s_{min}$$

Where grey level of input image is

$$m = \frac{(s_{max} - s_{min})}{(r_{max} - r_{min})} \text{ where } \begin{cases} r_{max} = \text{maximum grey level of input image} \\ r_{min} = \text{minimum grey level of input image} \\ s_{max} = \text{maximum grey level of output image} \\ s_{min} = \text{minimum grey level of output image} \end{cases}$$

This transformation function shifts and stretches the grey level range of the input image to occupy the entire dynamic range (S_{min}, S_{max}) as shown in fig. 9.

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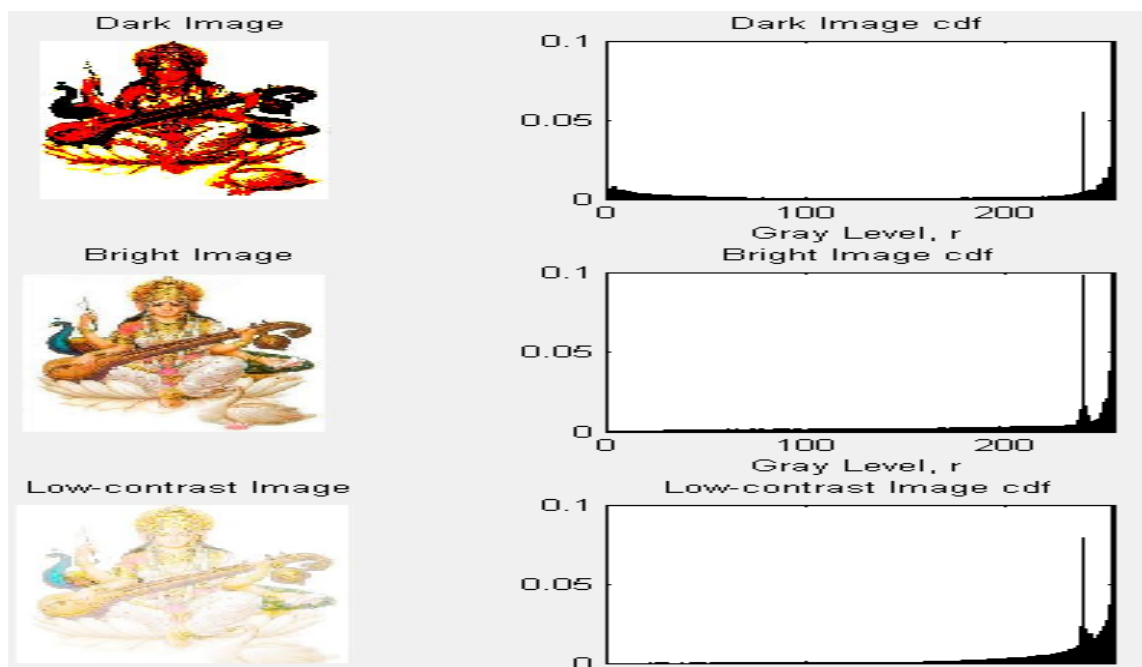


Fig9 Histogram Modelling

- Histogram Equalization**

Histogram equalization is the technique by which the dynamic range of the histogram of an image is increased[2]. It assigns the intensity values of pixels in the input image such that the output image as shown in fig. 10 contains a uniform distribution of intensities. It improves contrast and the goal of histogram equalization is to obtain a uniform histogram. This technique can be used on a whole image or just on a part of an image.

$$o_i = \left[\sum_{j=0}^i N_j \right] * \frac{\text{Max. Intensity Level}}{\text{No. of Pixel}}$$

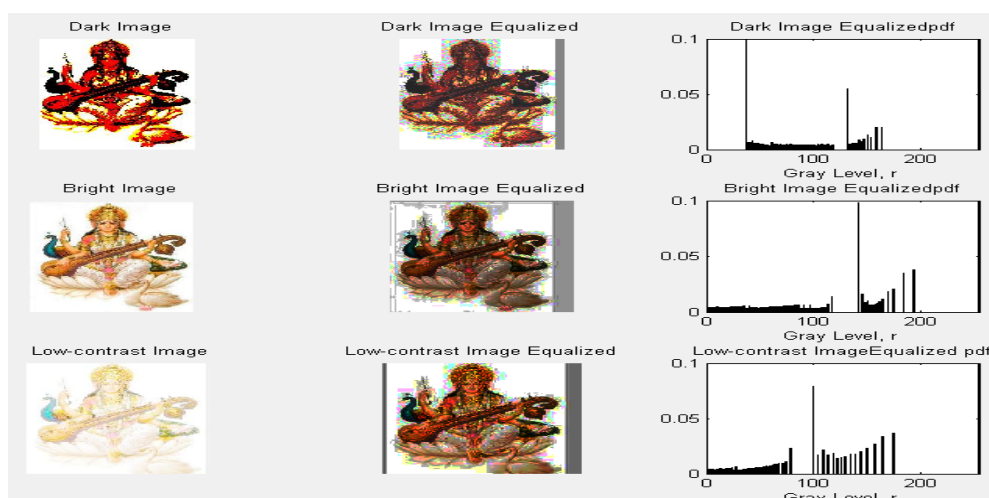


Fig10 Histogram Equalization

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III. PROPOSED WORK

Many image enhancement techniques have been proposed. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. During this process, one or more attributes of the image are modified. "It is important to keep in mind that enhancement is a very subjective area of image processing [3]. Improvement in quality of these degraded images can be achieved by using application of enhancement techniques [2]. Image enhancement approaches fall into two broad categories: spatial domain methods and frequency domain methods. The term *spatial domain* refers to the image plane itself, and approaches in this category are based on direct manipulation of pixels in an image. *Frequency domain* processing techniques are based on modifying the Fourier transform of an image [1]. In this paper I discussed about one of the techniques of Image Enhancement-Spatial domain in which I covered Point Processing, Histogram Processing Operations etc.

IV. CONCLUSION

The study of various Image enhancement techniques in spatial domain has been successfully accomplished using Graphical user interface (GUI) on one image of goddess 'SarswatiMaa' in this paper. In this paper, we focus on the existing techniques of image enhancement, which is spatial domain enhancement. The review of Image enhancement techniques in spatial domain is one of the most important and difficult component of digital image processing and the results for each method are also discussed here which describes the results of various techniques as shown in fig.11. We have also described recent development methods of image enhancement and point out promising directions on research for image enhancement in spatial domain and development of building GUI of the same for future research work.

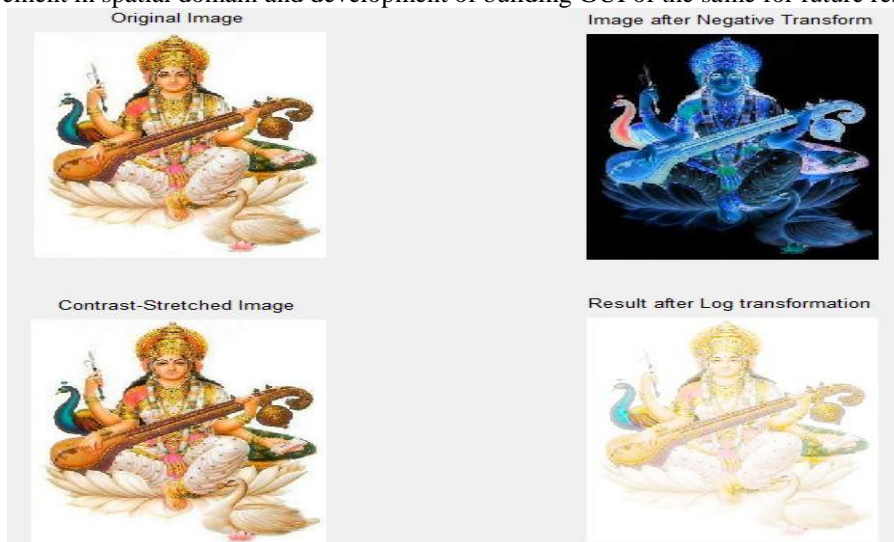


Fig 11 Sample Output of developed GUI

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