A Generalized Algorithm for Image Enhancement

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Abstract: Contrast and sharpness enhancement of images is required in majority of the applications. One of the important tools for sharpness enhancement is the unsharp masking. In this paper, a generalized unsharp masking algorithm is proposed which is designed mainly to address three issues: 1) Enhancing the sharpness and contrast of an image simultaneously 2) Minimizing the halo effect by the use of an edge-preserving filter, and 3) solving the problems by means of log-ratio and tangent operations. This paper also presents a study of the properties of the log-ratio operations and discloses a new connection between the Bregman divergence and linear systems in general. This connection opens a new pathway for system development. A new system called the tangent system based upon a specific Bregman divergence is presented here. Compared to recently published results, the proposed experimental results show that the proposed algorithm can significantly enhance the contrast as well as sharpness of an image. The user can adjust two parameters controlling the contrast and sharpness to achieve the expected results. This way, the proposed system becomes practically very useful.

Key words: Bregman divergence, exploratory data model, halo effect, log-ratio operations, unsharp masking.

I.INTRODUCTION

Contrast and sharpness enhancement of images is required in majority of the applications. Contrast is defined as the difference in luminance (or) color to distinguish an object. Usually contrast is determined by the difference in the color and brightness of the object and all other parameters within same view field. In general, the human visual system will be more sensitive to contrast than luminance, regardless of the huge changes in illumination over the day or from place to place. The maximum contrast of an image is called the contrast ratio or dynamic range.

The term "acutance" with regards to image sharpness describes perception of an image. Image acutance is related to the derivative of brightness amplitude with respect to space. Image with higher acutance appears to be sharper due to the nature of human visual system though acutance increase does not actually increase the resolution.

Hence enhancement of image is used to increase the visual effect and image clarity so that the original image is conducted in a better way for the computers to process.

The image enhancement is used to improve the visual effects and the clarity of image or to make the original image more conductive for computer to process.

II. LITERATURE REVIEW

This chapter reviews some references from previous projects, journals, articles and books. All these information were collection from different sources such as internet, products, manuals etc. The information gathered in this chapter is related to background study of this project.

C.S. Chan, H. Liu, and D. J. Brown[1], "Recognition of human motion from qualitative normalised templates" this paper proposes a Qualitative Normalised Templates (QNTs) framework for solving the human motion classification problem. In contrast to other human motion classification methods which usually include a human model, prior knowledge on human motion and a matching algorithm, we replace the matching algorithm (e.g. template matching) with the proposed QNTs. The human motion is modelled by the time-varying joint angles and link lengths of an articulated human model. The ability to manage the trade-offs between model complexity and computational cost plays a crucial role in the performance of human motion classification. The QNTs is developed to categorise complex human motion into sets of fuzzy qualitative angles and positions in quantity space. Classification of the human motion is done by comparing the QNTs to the parameters learned from numerical motion tracking. Experimental results have demonstrated the effectiveness of our proposed method when classifying simple human motions, e.g. running and walking.

N. Kubota and K. Nishida[2], “Perceptual control based on prediction for natural communication of a partner robot” this paper, a technique is proposed depending on a reliable human skin detection method that is adaptable to different human skin colors and illumination conditions is essential for better human skin segmentation. Even though different human skin-color detection solutions have been successfully applied, they are prone to false skin detection and are not able to cope with the variety of human skin colors across different ethnic. Moreover, existing methods require high computational cost. In this paper, we propose a novel human skin detection approach that combines a smoothed 2-D histogram and Gaussian model, for automatic human skin detection in color image(s). In our approach, an eye detector is used to refine the skin model for a specific person. The proposed approach reduces computational costs as no training is required, and it improves the accuracy of skin detection despite wide variation in ethnicity and illumination.To the best of our knowledge, this is the first method to employ fusion strategy for this purpose. Qualitative and quantitative results on three standard public datasets and a comparison with state-of-the-art methods have shown the effectiveness and robustness of the proposed approach.

D. Brown, I. Craw, and J. Lewthwaite[3], “A SOM based approach to skin detection with application in real time systems” this paper describes a large body of human image processing techniques use skin detection as a first primitive for subsequent feature extraction. Well established methods of colour modelling, such as histograms and Gaussian mixture models have enabled the construction of suitably accurate skin detectors. However such techniques are not ideal for use in adaptive real time environments. We describe methods of skin detection using a Self-Organising Map or SOM, and show performance comparable (94% accuracy on facial images) to conventional techniques. We also introduce the AXEON Learning Processor as the basis for a hardware skin detector, and outline the potential benefits of using this system in a demanding environment, such as filtering Internet traffic, to which conventional techniques are not best suited.

G. Pratl, D. Dietrich, G. P. Hancke, and W. T. Penzhorn[4], “A new model for autonomous, networked control systems”, existing communication utilities, such as the ISO/OSI model and the associated automation pyramid, have limitations regarding the increased complexity of modern automation systems. The introduction of profiles for fieldbus systems, or field-area networks (FANs), was an important innovation. However, in the foreseeable future the number of FAN nodes in building automation systems is expected to increase drastically. And here the authors see an opportunity to revolutionize the operation of intelligent, autonomous systems based on FANs. The paper introduces a system based on bionic principles to process the information obtained from a large number of diverse sensors. By means of multilevel symbolization, the amount of information to be processed is substantially reduced. A symbolic processing model is introduced that enables the processing of real world information, creates a world representation, and evaluates scenarios that occur in this representation. Two applications involving human actions in a building automation environment are briefly discussed. It is argued that the use of internal symbolization leads to greater flexibility in the case of a large number of sensors, providing the ability to adapt to changing sensor inputs in an intelligent way.

Y. Wang and B. Yuan[5], “A novel approach for human face detection from color images under complex background,”this paper proposes a novel fast approach to the detection, segmentation and localization of human faces in color images under complex background. First, a number of evolutionary agents are uniformly distributed in the 2-D image environment to detect the skin-like pixels and segment each face-like region by activating their evolutionary behaviors. Then wavelet decomposition is applied to each region to detect the possible facial features and a three-layer BP neural network is used to detect the eyes among the features. Experimental results show that the proposed approach is fast and has a high detection rate.

K. Sobottka and I. Pitas[6], “A novel method for automatic face segmentation, facial feature extraction and tracking”. The constructive need for robots to coexist with humans requires human–machine interaction. It is a challenge to operate these robots in such dynamic environments, which requires continuous decision-making and environment-attribute update in real-time. An autonomous robot guide is well suitable in places such as museums, libraries, schools, hospital, etc. This paper addresses a scenario where a robot tracks and follows a human. A neural network is utilized to learn the skin and non skin colors. The skin-color probability map is utilized for skin classification and morphology-based preprocessing. Heuristic rule is used for face-ratio analysis and Bayesian cost analysis for label classification. A face-detection module, based on a 2-D color model in the YC rCb and YUV color space, is selected over the traditional skin-color model in a 3-D color space. A modified

Continuously Adaptive Mean Shift tracking mechanism in a 1-D Hue, Saturation, and Value colors pace is developed and implemented onto the mobile robot. In addition to the visual cues, the tracking process considers 16 sonar scan and tactile sensor readings from the robot to generate a robust measure of the person's distance from the robot. The robot thus decides an appropriate action, namely, to follow the human subject and perform obstacle avoidance. The proposed approach is orientation invariant under varying lighting conditions and invariant to natural transformations such as translation, rotation, and scaling. Such a multimodal solution is effective for face detection and tracking.

P. Vadakkepat, P. Lim, L. De Silva, L. Jing, and L. L. Ling[7], "Multimodal approach to human-face detection and tracking". The present paper describes a novel method for the segmentation of faces, extraction of facial features and tracking of the face contour and features over time. Robust segmentation of faces out of complex scenes is done based on color and shape information. Additionally, face candidates are varied by searching for facial features in the interior of the face. As interesting facial features we employ eyebrows, eyes, nostrils, mouth and chin. We consider incomplete feature constellations as well. If a face and its features are detected once reliably, we track the face contour and the features over time. Face contour tracking is done by using deformable models like snakes. Facial feature tracking is performed by block matching. The success of our approach was varied by evaluating 38 different color image sequences, containing features as beard, glasses and changing facial expressions.

III. PROPOSED WORK

The main blocks and block diagram of the generalized unsharp masking algorithm is shown below:

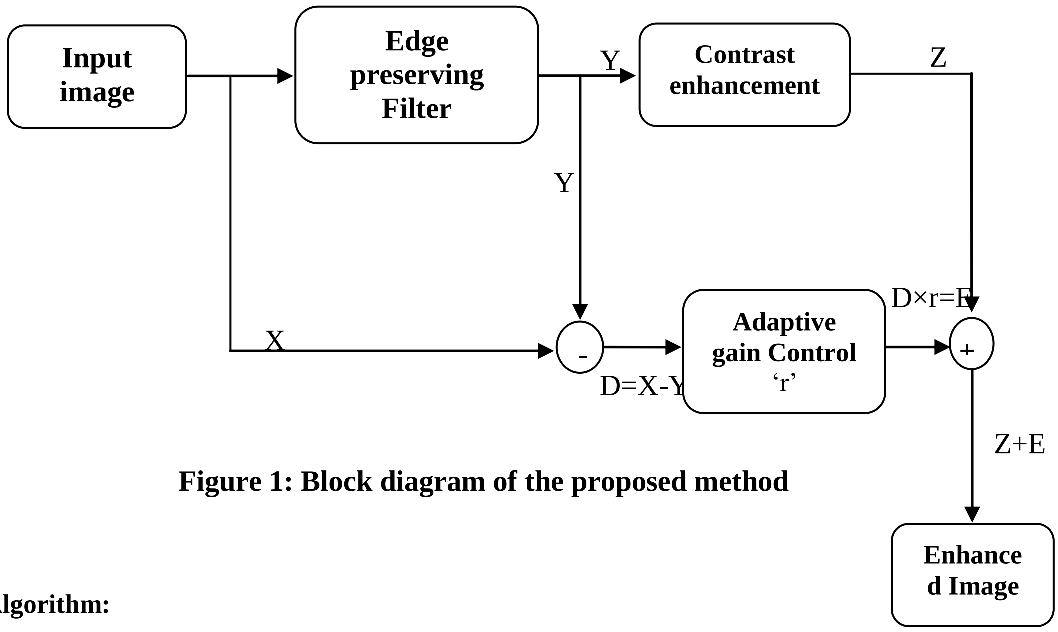

Figure 1: Block diagram of the proposed method

Algorithm:

The algorithm of the unsharp masking is as follows.

Step1: First we have to take an input image. Let's assume this as 'x'.

Step2: The input image is applied to the edge triggered filter which enhances the edges of the image. Let's assume the output of medium filter as 'y'.

Step3: we have to give 'x' and 'y' to subtractor and the o/p of subtractor is denotes as'd'.

Step4: The output of the medium filter is applied to the adaptive histogram equalizer for the contrast enhancement.

Step5: And the o/p of the subtractor is applied to the adaptive gain controller.

Step6: The two outputs of adaptive histogram equalizer and adaptive gain controller are applied to an adder.

Step7: The o/p of the adder is the enhanced image of the i/p image.

Image Enhancement:

The important aspect of image enhancement is processing a given image to make it more suitable for a specific application than the original image. Processing an image may include sharpening the image features like edges, boundaries and contrast etc to make the image more suitable for display and analysis. Enhancement doesn't actually increase the internal information of the data but it enhances the dynamic range of the selected features hence they can be detected clearly and easily.

Image Sharpening:

Images that have been scanned or digital images that have been reduced or manipulated in some way can often become soft or somewhat fuzzy looking. Sharpness of an image can be improved in many ways.

The most frequent and simplest method is the Photoshop filter Unsharp Mask. This is most suitable for majority images while used with a light hand. The problem with using this method is that the filter can change the image colors as it increases the contrast of the dark and light edges. In addition, any JPG artifacts present in the image can be enhanced or improved to the point of becoming a distraction to the eye.

Here are a few other methods to try when sharpening your image. Normally all sharpening should be applied once all image manipulation is over. This is especially true if the image will be reduced in size. Often reducing the size of an image usually softens the image.

Converting from RGB to HSV:

Usually an image can be processed using an RGB or HSV color space. In RGB color space, colors are described in terms of amounts of red, blue, green colors present whereas, in HSV color space, colors are described in terms of hue, saturation and value. In applications where description of color plays an important role, often HSV color model is preferred over RGB. The HSV color model presents colors in similar way as to how the human eye perceives a particular color. In RGB model, colors are described in terms of the three primary colors where as HSV color model describes colors by comparing parameters such as color, vibrance and brightness.

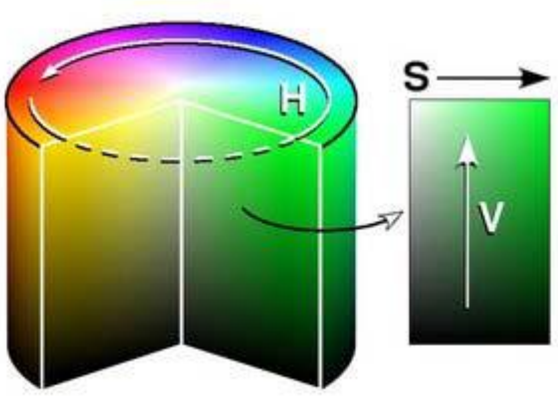

Figure 2: HSV Conversion

- Hue represents the color type which is described in terms of an angle on the above picture. Even though a circle normally contains full 360 degrees of rotation, the hue value is usually normalized to 0 to 255 range, 0 being red.
- Saturation represents the vibrancy of the color. Its value ranges from 0 to 255. If the saturation value is more then more gray is present in a color due to which the color appears to be faded.
- Value indicates the brightness characteristic of the color ranging from 0 to 255, with 0 indicating complete dark and 255 indicating complete bright.
- White color has a Hue Saturation Value of 0-255, 0-255, 255 ranges respectively. Black has a HSV value of 0-255, 0-255, 0 ranges respectively. The term distinguishing black and white is the value. When the value is at maximum or minimum intensity levels, hue and saturation levels do not make any

difference.

- For example a color camera on the robot. Once the camera reads these color values, they are converted to HSV. The HSV values are then determine the location of a particular object or color the robot is searching for. The pixels are then checked individually to match a predetermined color threshold.

Adaptive Gain Control (AGC):

The purpose of AGC is to provide controlled signal amplitude at its output, despite variations of the amplitude in the input signal. We cannot use universal gain for the whole image if we want to achieve good results, because in order to enhance small details relatively large gain is needed. However a large gain can lead to the saturation of the detailed signal whose values are larger than a curtained threshold. Saturation is not desirable as different amplitudes of the signal are mapped to either 0 or 1. This may cause loss of information.

Therefore the gain must be adaptively controlled. For gain control, we must first perform a linear mapping of detail signal with a new signal c.

$$c=2d-1$$

The dynamic range of c is(-1, -1). Simple idea to set the gain as a function of the signal c and to gradually decrease the gain from its maximum value g_{max} when $|c|<T$ to its minimum value g_{min} when $|c|=1$. We propose adaptive gain control function.

$$g(c) = \alpha + \beta \exp(-|c|^{\eta})$$

Where η is a parameter that controls the rate of decreasing. The two parameters α and β are obtained by solving the equations:

$$g(0) = g_{max} \text{ and}$$

$$g(1) = g_{min}.$$

For a fixed η, we can easily determine the two parameters as follows:

$$\beta = (g_{max} - g_{min}) / (1-e^{-1}) \text{ and}$$

$$\alpha = g_{max} - \beta$$

Although both g_{max} and g_{min} could be chosen based upon each individual image processing task, in general it is reasonable to $g_{min=1}$.

This setting follows the intuition that when the amplitude of the detailed signal is large enough, it does not need further amplification.
As such, the scalar multiplication has little effect.

Contrast Enhancement of the Root Signal:

Contrast enhancement is done using adaptive histogram equalization using MATLAB function in the image processing toolbox. The function using which result can be obtained visually pleasing from the MATLAB functions is "adapthisteq". In the proposed simulation, default values for other parameters of the function are used.

Histogram Equalization (HE):

Histogram equalization is most widely used technique for contrast enhancement in a wide variety of applications due to its simplicity and effectiveness. It works by gratifying the histogram and extend the dynamic range of the gray levels using the image cumulative density function.

One problem with histogram equalization is that after histogram equalization, the brightness of an image is altered; hence it is not suitable for consumer electronic products for which original brightness preserving and enhancing the contrast are crucial for avoiding annoying artifacts.

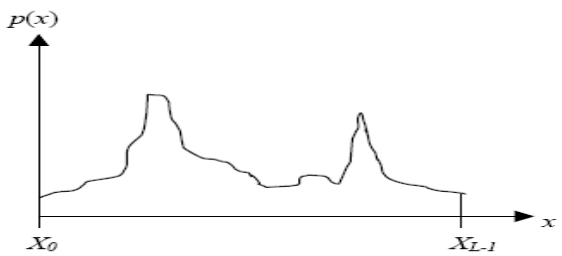

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Figure 3: X0 – XL-1 Levels

0 to 255 Gray levels

P(x) Number of pixels

Above figure shows the histogram equalization used for mapping the input image into complete dynamic range, (Xo, XL-1) using the cumulative density function. Histogram equalization has an effect of stretching the dynamic range of a given image since it flattens the density distribution of the image.

Examples of Histogram:

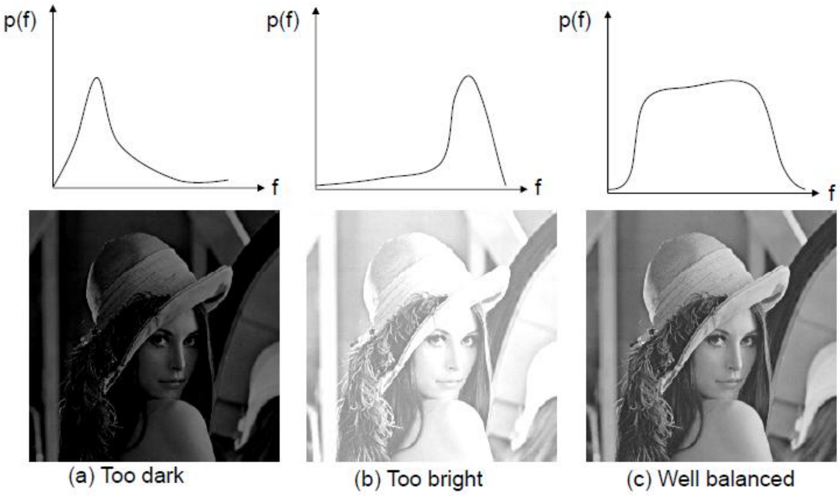

Figure 4: Histogram examples

Dealing with Color Images:

First image is converted from RGB color space to HSV. The chrominance components such as the Hue and Saturation are not processed. Once luminance component is processed, an inverse operation is performed. By doing so an enhanced representation in RGB color space is obtained. The reason for processing only the luminance component is to avoid problem of altering the image's white balance while processing the RGB components individually.

GUI:

GUI refers to graphical user interface (GUI) which is a user interface built by graphical objects, like buttons, text fields, sliders menus etc. In general, these objects are already familiar to most computer users. For instance, when a slider is moved, value changes; when OK button is pressed, settings are applied and the dialog box is disappeared. To leverage this built-in familiarity, use of various GUI-building components is essential.

GUI Development Environment:

GUI implementation involves two basic tasks:

- Laying out the GUI components

- Programming the GUI components

GUIDE primarily is a set of layout tools. GUIDE also generates an M-file that consists of code to take care of the initialization and launching of the GUI. This M-file gives a framework for the implementing callbacks - the functions which are executed GUI components are activated by the users.

Implementation of GUI:

Using an M-file containing necessary commands a GUI can be implemented. However, it is convenient to use GUIDE for laying the components interactively and generating the two files which save and launch a GUI:

A fig-file

Contains description of GUI figure and all of its constituents and values of all object related properties.

An M-file:

An M-File consists of functions which launch and control the GUI and are defined as sub functions. In this document, the M-file is referred as application M-file.

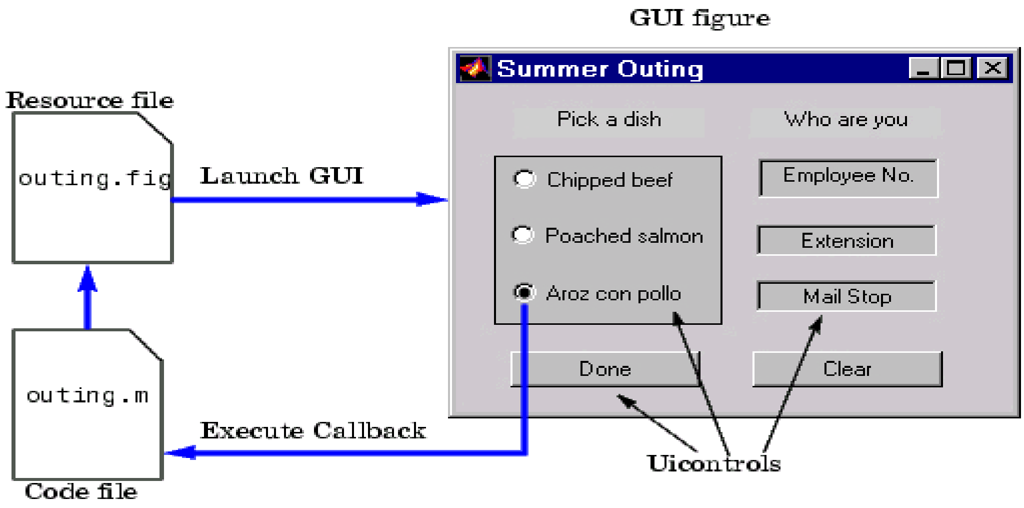

Figure 5: Parts of GUI

Features of the Guide generated application M-file:

Creation of GUI application can be simplified by GUIDE by generating an M-file framework automatically from the layout directly. This framework can then be used to code application M-file. There are many advantages of this approach:

M-file contains code to implement more number of useful features. The M-file adopts an effective approach to managing Object Handle Structure for more information). The M-files provides a way to manage global data (see Managing GUI Data for more information).Through commands such as find obj, set, and get.

GUIs are also created in figure windows. Generally, GUI figures need not be available as targets for graphics output as issuing a plotting command may direct the o/p to GUI figure, causing the graph to appear in the middle of the GUI.

In contrast, if you create a GUI that contains axes and you want commands entered in the command window to display in these axes, you should enable command-line access.

User Interface Controls:

The various user interface controls are:

- Push Buttons
- Sliders

- Toggle Buttons
- Frames
- Radio Buttons
- List boxes
- Checkboxes
- Popup Menus
- Edit Text
- Axes
- Static Text
- Figures

Figure 6: Proposed method output

IV: SIMULATION RESULTS

- Select the low contrast image by clicking the *input image* button.

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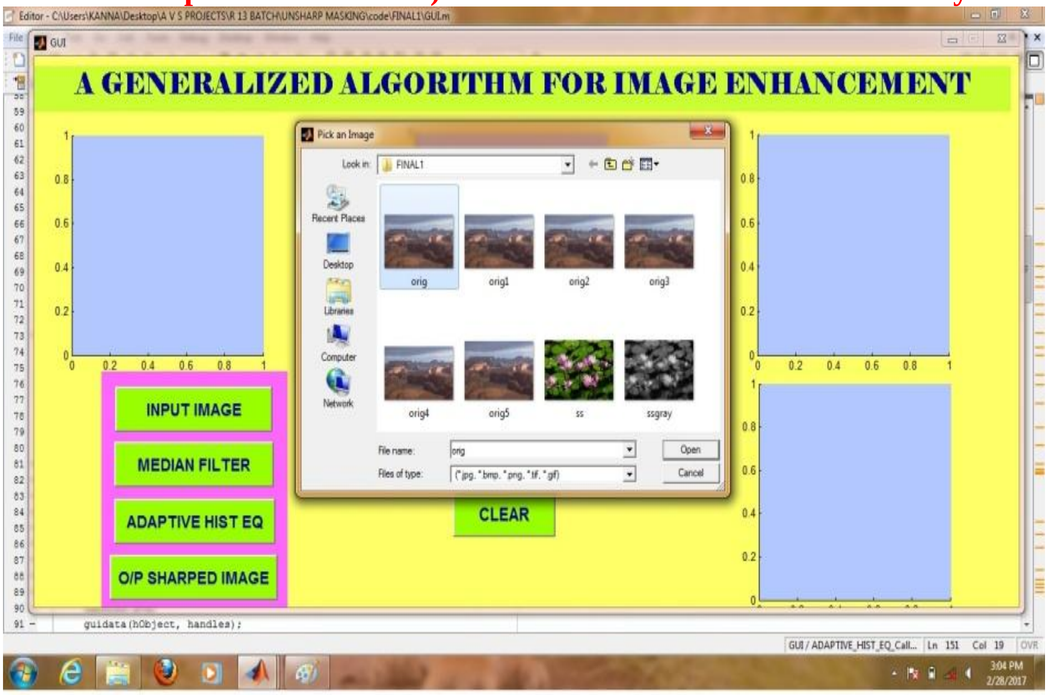

Figure 7: Selecting the input image.

➢ Displaying the selected image

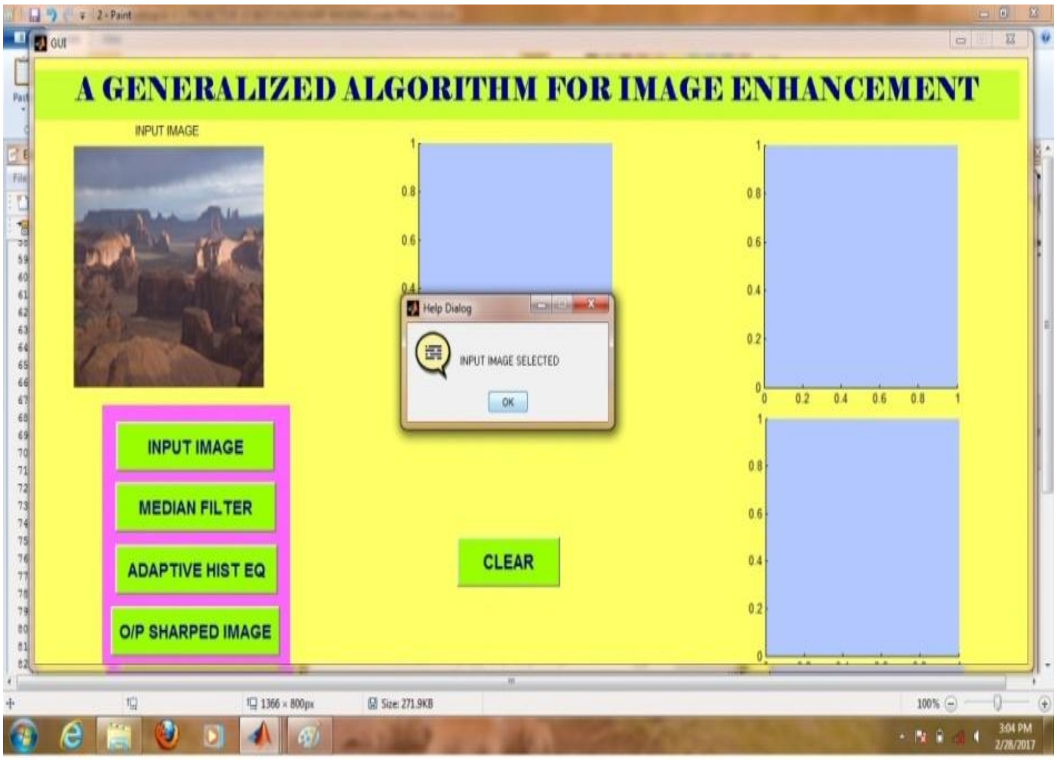

Figure 8: Displaying the selected input image

➢ Apply the selected image to the median filter whose output is a sharped image

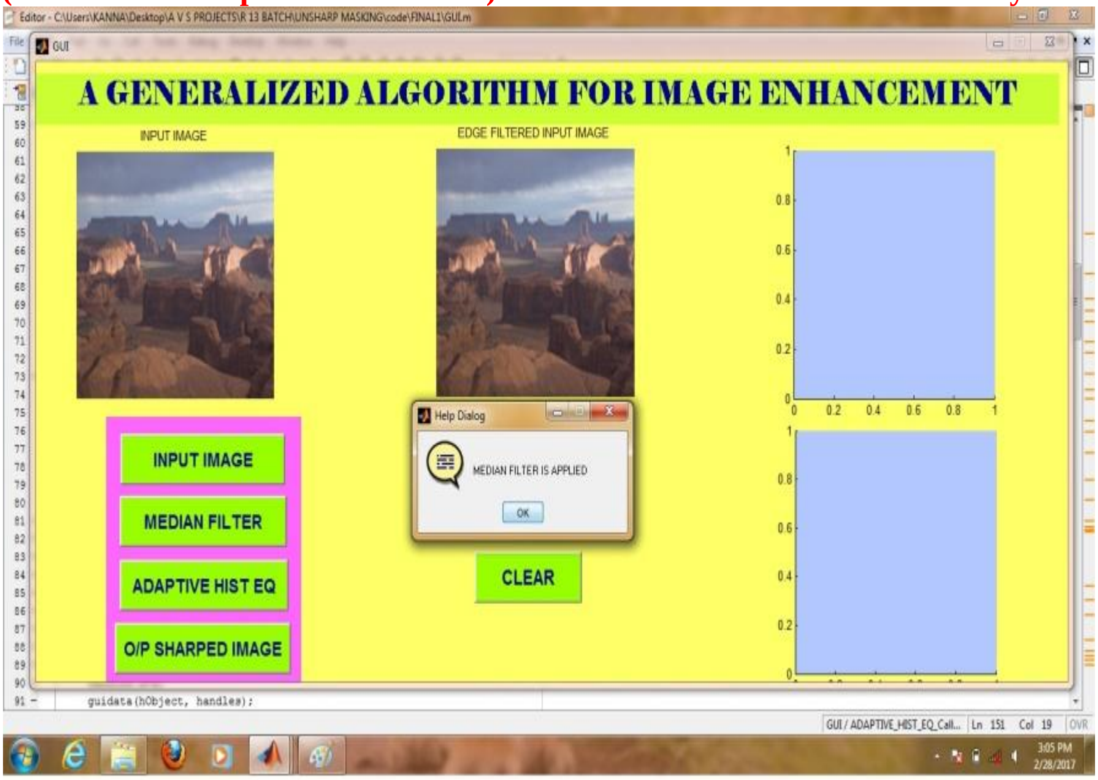

Figure 9: Median filter output

➢ Enhancing the contrast by Histogram Equalization

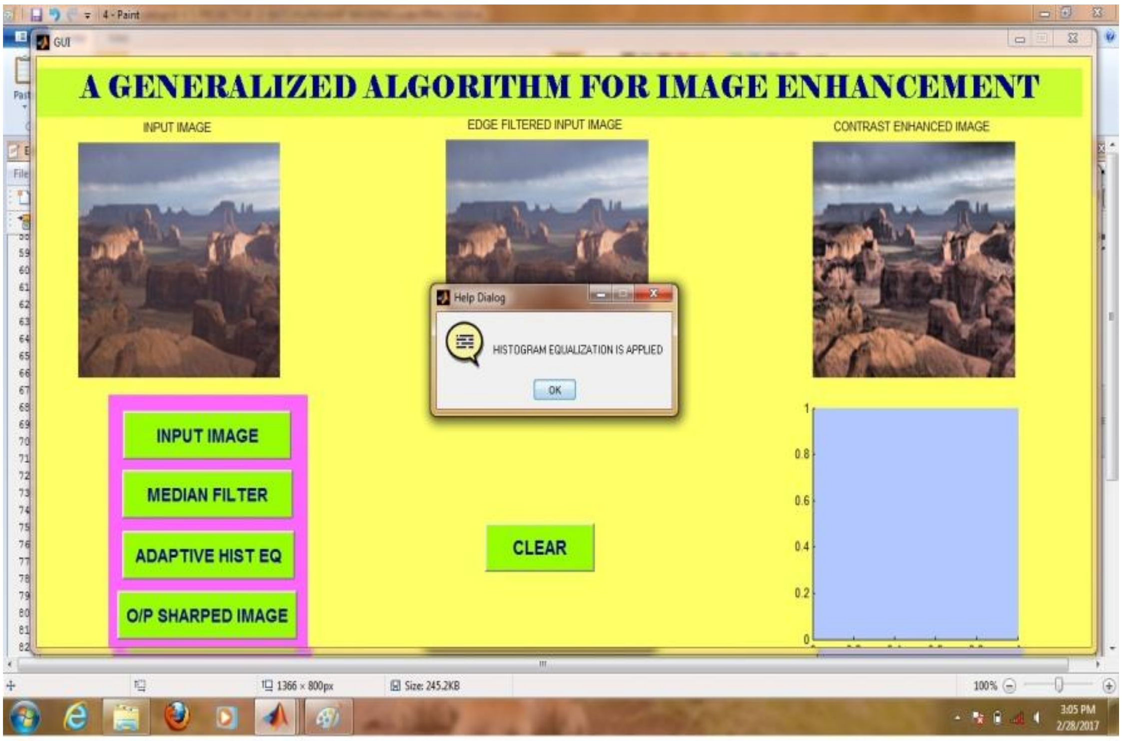

Figure 10: Adaptive histogram equalization

- The pixel values of the difference image (i. e input image-edge filtered input image) is increased by using adaptive gain control and the resultant image is added with the contrast enhanced image to obtain the sharp image with contrast enhanced image.

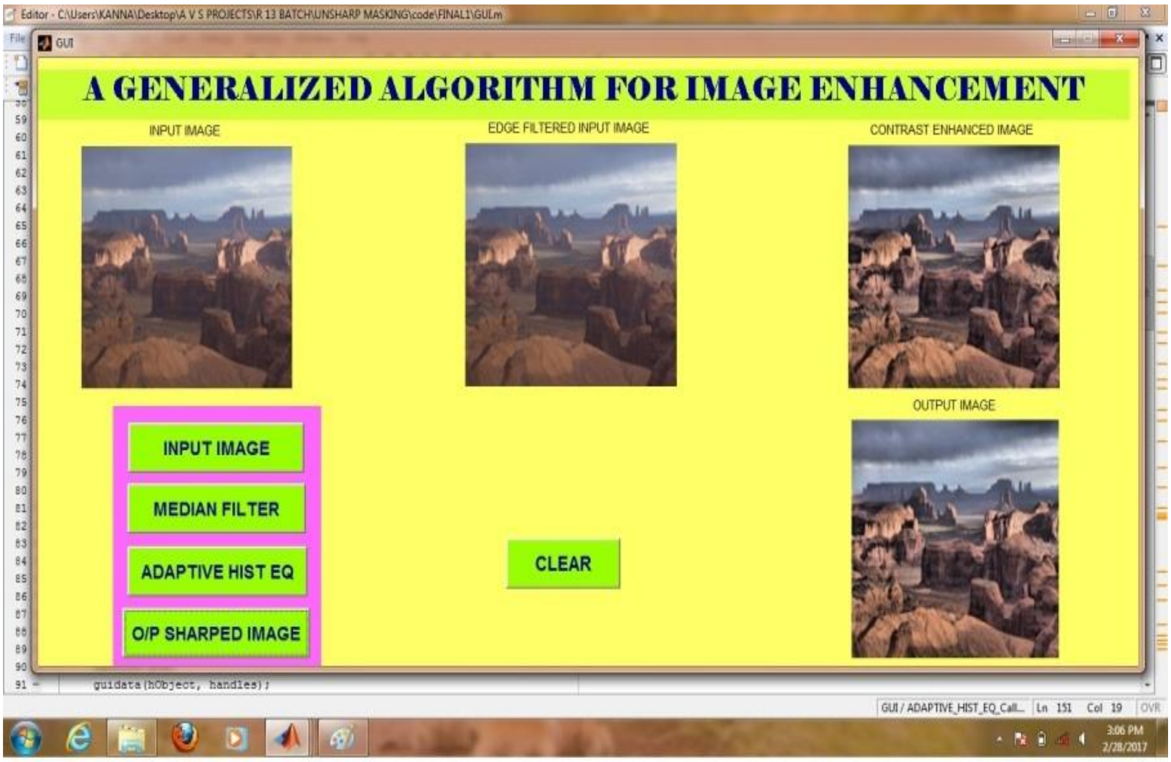

Figure 11: Sharpened image

- Finally the input unsharped image and the obtained sharped image are compared.

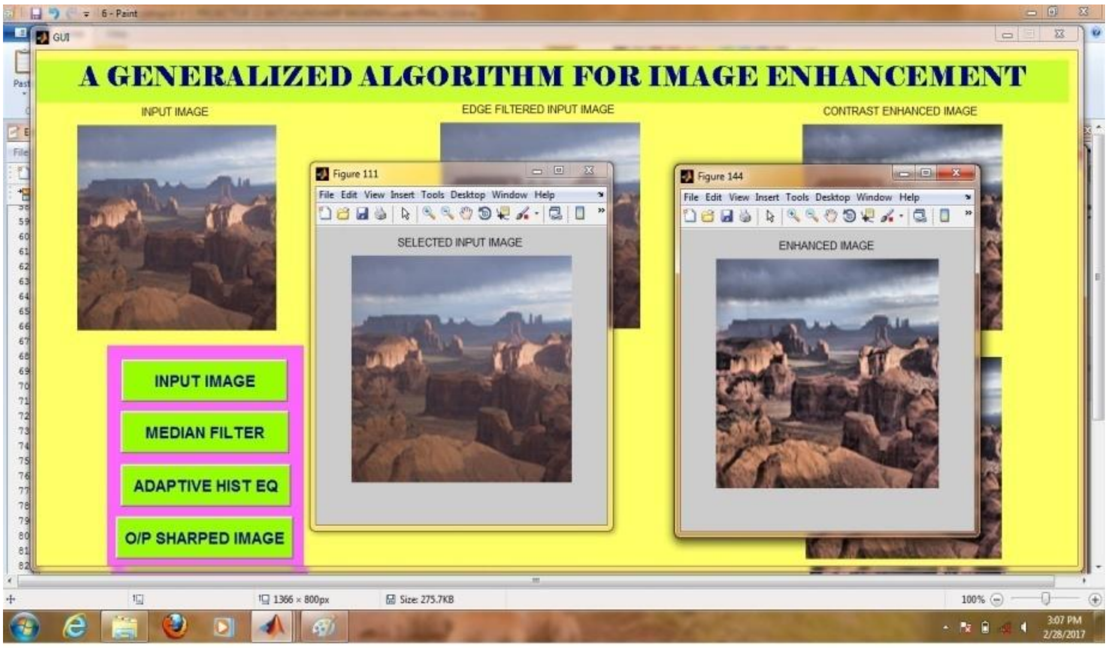

Figure 12: Comparing the images

V.CONCLUSION

In this paper, an exploratory data model is used as a unified framework to develop a generalized unsharp masking algorithm. Using this framework, a new algorithm is been proposed to address three major issues associated with images like enhancing the sharpness and contrast of an image simultaneously, minimizing the halo effect by the use of an edge-preserving filter and solving the problems by means of log-ratio and tangent operations.

The simulated results prove that the proposed algorithm is able to improve the contrast and sharpness of an image significantly by adjusting the two parameters controlling the sharpness and contrast of the image. This makes the proposed algorithm practically effective.

VI: REFERENCES

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