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SAPOG Edge Detection Technique GUI using MATLAB

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ABSTRACT: In image Segmentation Process Edge detection is most frequently used operation. If edges of an images could be recognized accurately then all of the objects can be located efficiently and performance can be measured easily [2][9]. This research papers provides comparison on existing methods such as Sobel operator, Prewitt operator, Robert operator, Canny Edge detector, Marr-Hildreth Edge Detector, Laplacian and Log technique, Robinson Edge detector and Kirsch Edge detector. It has been shown that the Gray Code algorithm on each red green and blue plane for edge detection performs better than all these operators under almost all scenarios. The software is developed Graphical User Interface using MATLAB 2012b.

KEYWORDS: Edge Detection Operators, Graphical User Interface (GUI), Gray Code, MATLAB.

I. INTRODUCTION

Image segmentation segments the object from the background to understand the image properly and identify the bits and pieces of the image carefully. In this perspective, edge detection operation is an elementary tool for image segmentation [11].Edge detection is a crucial step in object recognition [6]. It is a process of finding sharp discontinuities in an image where discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. It contains rich information, step property, shape etc, which is able to describe the target object. So, the objective of edge detection is to produce a line drawing of the input image [9] [10]. In this paper an attempt is made to study the performance and compare most commonly used edge detection techniques with our proposed SAPOG edge detector using gray code on each RGB planes for image segmentation as shown in fig. 1. The Gray code is a type of cyclical binary code patented for the first time in 1947, but not given the name Gray code until the early 1950s, in subsequent patent applications [7]. Specifically, the code is a reflected binary code, meaning that the last numbers in the string can be the same as the beginning numbers, but in reverse order, thus allowing for building on and expanding the usefulness of standard or natural binary code [8].

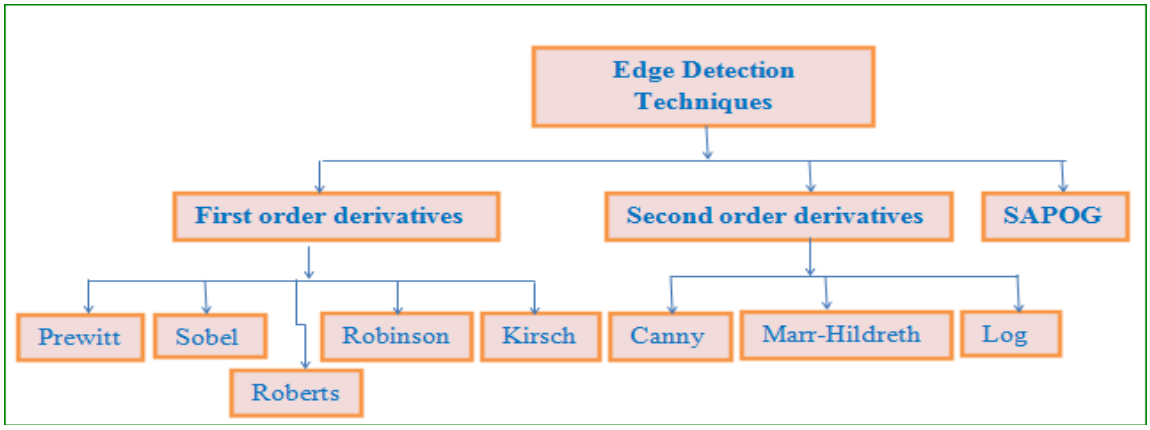

Fig. 1: Types of Edge Detection Technique

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II. MATERIAL AND METHODS

A. *GUI Tool Box*

GUIs (also called Graphical User Interfaces or UIs) provide point-and-click control of software applications, eliminating the need of learning a language or type of commands in order to run the application [3]. MATLAB software is 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. You can also create your own custom apps, including their corresponding UIs, for others to use. The principles of good GUI design are, for the most part, timeless and universal [3].
These Guide Tools include already mentioned Callback Editor, Property Editor, Alignment Tool, and the Menu Editor, etc [3]. The blank GUI using GUIDE is shown in figure 2.

- *Design Process Steps:-*
  - **a.** Define the task
  - **b.** Draw the GUI
  - **c.** Test the Design
  - **d.** Write the Code (use Guide)
  - **e.** Test the Code

It falls naturally into two parts:

- **a.** GUI design or how to make something useful.
- **b.** GUI implementation or how to make something workable.

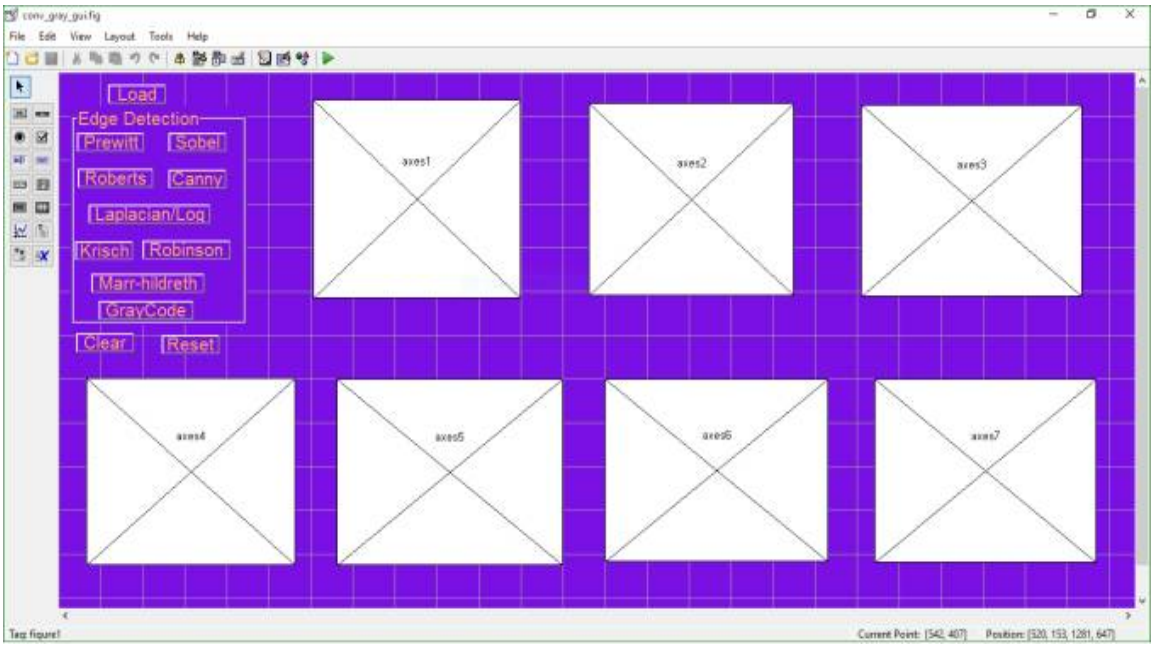

Fig. 2: GUI Editor

B. *Edge Detection Operators*

There are two main types: One is the first order derivative-based edge detection operator used to detect edges of an image by computing its gradient values, such as Robert operator, Sobel operator, Prewitt operator, Robinson operator, Kirsch operator and other is the second derivative-based edge detection operator, such as LOG operator, Marr-Hildreth operator, Canny operator.

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- *First Order Derivative of Edge Detection*

Gradient is a measure of the function changes [10] and also known as first order derivative of an image which corresponds to two-dimensional function. An image gradient is a directional change in the intensity or colour in an image and image gradients may use to extract information from images. An example of small image neighbourhood is shown:

$$\begin{bmatrix} Z_1 & Z_2 & Z_3 \\ Z_4 & Z_5 & Z_6 \\ Z_7 & Z_8 & Z_9 \end{bmatrix}$$

a. *Prewitt:* Prewitt has developed edge gradient detector which uses a different approach to approximate row and column edge gradients [5]. Prewitt operator edge detection masks are the one of the oldest and best understood methods of detecting edges in images The Prewitt edge detector use mask to approximate digitally the first derivatives Gx and Gy [5]. The following is a Prewitt mask which is used to compute the gradient in the x (vertical) and y (horizontal) directions.

$$G_x = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} G_y = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

b. *Sobel:* Sobel edge detector doubles the east, west, north and south pixels of the Prewitt operator. The Sobel edge detector computes gradient by using the discrete differences between rows and columns of a 3X3 neighbourhood [5]. The Sobel operator is based on convolving an image with a small, separable, and integer valued filter. Following is the Sobel edge detection mask which is used to compute the gradient in the x (vertical) and y (horizontal) directions [5].

$$G_x = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} G_y = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

c. *Robert:* Robert's model is yet susceptible to fluctuations in an image even though the edges can be properly positioned [5]. Robert operator performs a perfect edge positioning, but it is sensitive to the noise, so it is suitable for image segmentation when images have clear edges and less noise such as the binary image. To approximate digitally the first derivatives Gx and Gy Roberts edge detector uses masks which is [5].

$$G_x = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \quad G_y = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$$

d. *Kirsch Edge detection:* Kirsch edge detector is introduced in 1971 by kirsch. The masks of this Kirsch technique are defined by considering a single mask and rotating it to 8 main compass directions as North, Northwest, West, Southwest, South, Southeast, East and Northeast [11]. The convolution mask is as follows:

$$\begin{bmatrix} -3 & -3 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & 5 \end{bmatrix}$$

The edge magnitude is defined as the maximum value found by convolution of each mask with an image and the direction defined by mask produces the maximum magnitude.

e. *Robinson Edge detection:* The Robinson edge detector is similar to Kirsch but it is easy to implement because they rely only on 0, 1 and 2 coefficients. The masks are symmetrical about their directional axis, the axis with the zeros [11]. The convolution masks is as follows

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$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

- *Second Order Derivative Edge Detection*

Edge is detected if there is a significant spatial change in second derivative [10]. Different approaches using second order derivative on edge detection are given below:

a. *Canny:* In image processing tools the most commonly used edge detector is canny edge detector which detects edges in a very forceful manner [5]. Canny edge detector is broadly considered to be the standard edge detection method in the industry. Canny treats the edge detection problem as a signal processing optimization problem, so an objective function is developed to be optimized and the solution to this problem is rather difficult exponential function, but Canny found numerous ways to approximate as well as optimize the edge-searching problem [5].

$$G_x = \begin{bmatrix} -1 & 1 \\ -1 & 1 \end{bmatrix} \quad G_y = \begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix}$$

b. *Marr-Hildreth Edge Detection:* The Marr-Hildreth (1980) edge detector is used to detect edges in digital images which have continuous curves wherever there is well-built and rapid variations in image brightness [11]. Marr-Hildreth edge detector is easy and operates by convolving the image with the LoG function and due to its image shape the LoG method is referred to as the Mexican hat wavelet while turned up-side-down. Marr-Hildreth edge detector algorithm is as [11]:

- Smooth images using a Gaussian
- Apply 2-D Laplacian to the smoothed image (often the first two steps are combined into a single operation)
- Loop through the result and look for sign changes. If there is any change in sign plus the slope across the sign change is greater than some threshold then mark it as an edge.
- To get better results then run the result of the Laplacian through a hysteresis alike to canny's edge detection although this is different as how the edge detector was firstly implemented [11].

c. *LoG edge detection:* The Laplacian of Gaussian (LoG) technique proposed by Marr in 1982 [11]. The LoG of an image f(x,y) is a second order derivative which is defined as,

$$\nabla^2 f = \frac{\delta^2 f}{\delta x^2} + \frac{\delta^2 f}{\delta y^2}$$

LoG has two effects first it smoothes the image and other it computes the Laplacian, which yields a double edge image and locating edges consists of finding the zero crossings between the double edges [11]. Digital implementation of Laplacian function is made by convolution mask which is written below,

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

The Laplacian is normally used to find whether a pixel is on the dark or light side of an edge [11].

C. *Gray Code*

The term "Gray code" is sometimes used to refer to any *single-distance* code, that is, one in which adjacent code words (perhaps representing integers differing by 1) differ by 1 in one digit position only. Gray introduced what

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we would now call the *canonical* binary single-distance code, though the mentioned that other binary single-distance code could be obtained by permuting the columns and rotating the rows of the code table. The codes of Gray, and natural extensions to bases other than binary, are only a very small subset of all single-distance codes [7]. In this paper we use term "Gray code" to refer the code of Gray and "single-distance" to demote to the more general case; we are concerned with properties of the Gray code [7]. In practice, a "Gray code" refers to a binary-reflected Gray code (BRGC) [8]. However, mathematicians have discovered other kinds of Gray codes. Like BRGCs, each consists of word lists in which each word differs from the next by one digit (each word has a Hamming distance of 1 from the next word).

III. PROPOSED WORK

In this research paper we defined a new edge detector named as SAPOG (Sanjeev Poonam Gray) operator in which we used Gray code on each Red Green and Blue plane on medical images using MATLAB 2012b software. Many edge detection techniques have been compared with the proposed technique. The principal objective of SAPOG Edge Detection technique is used to detect edges more finely of an image and to make it more suitable for a given task and a specific observer. In this paper I discussed about Edge detection techniques in which I covered first order derivatives as, Prewitt, Sobel, Roberts, Robinson and Kirsch and second order derivatives like Log (Laplacian of Gradient) operator, Marr-Hildreth operator and Canny operator.

IV. EXPERIMENTAL RESULT

This section presents the Comparison of various edge detection techniques such as Robert, Sobel, Prewitt, Kirsch, Robinson, Marr- Hildreth, LoG and Canny Edge Detectors with the proposed SAPOG Edge Detector. All the edge detection techniques were implemented using MATLAB 2012b, and tested with MRI images. The objective is to produce a clean edge map by extracting the edge features of images. The original image and the image obtained by using different edge detection techniques are given in figure 3&4.

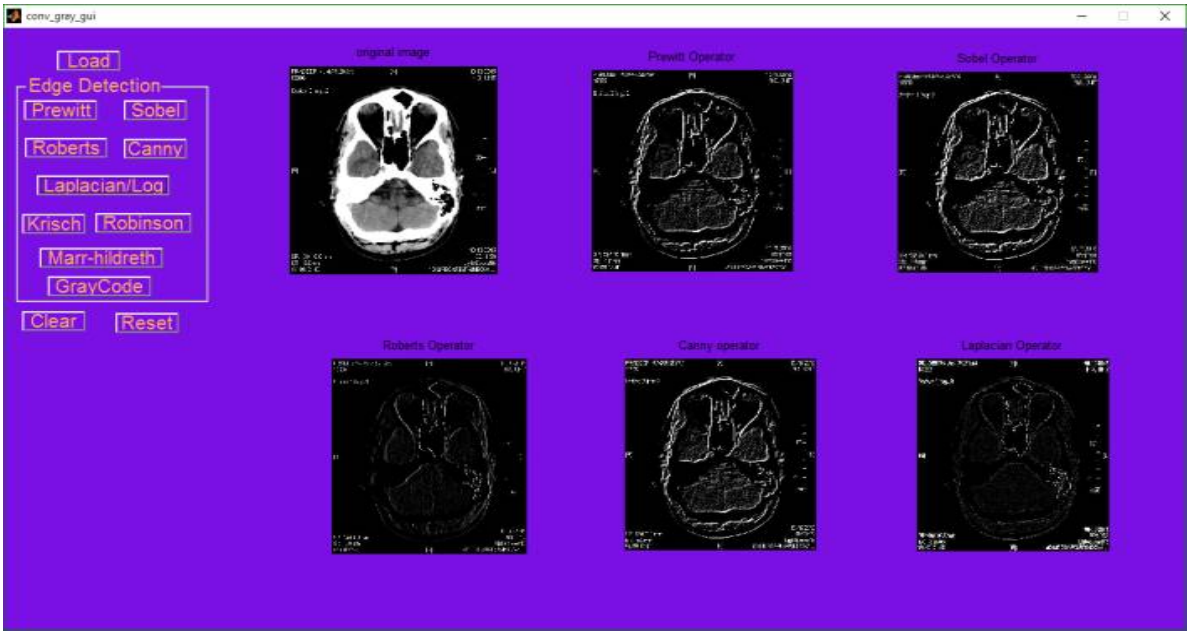

Fig. 3: Result of edge detection techniques.

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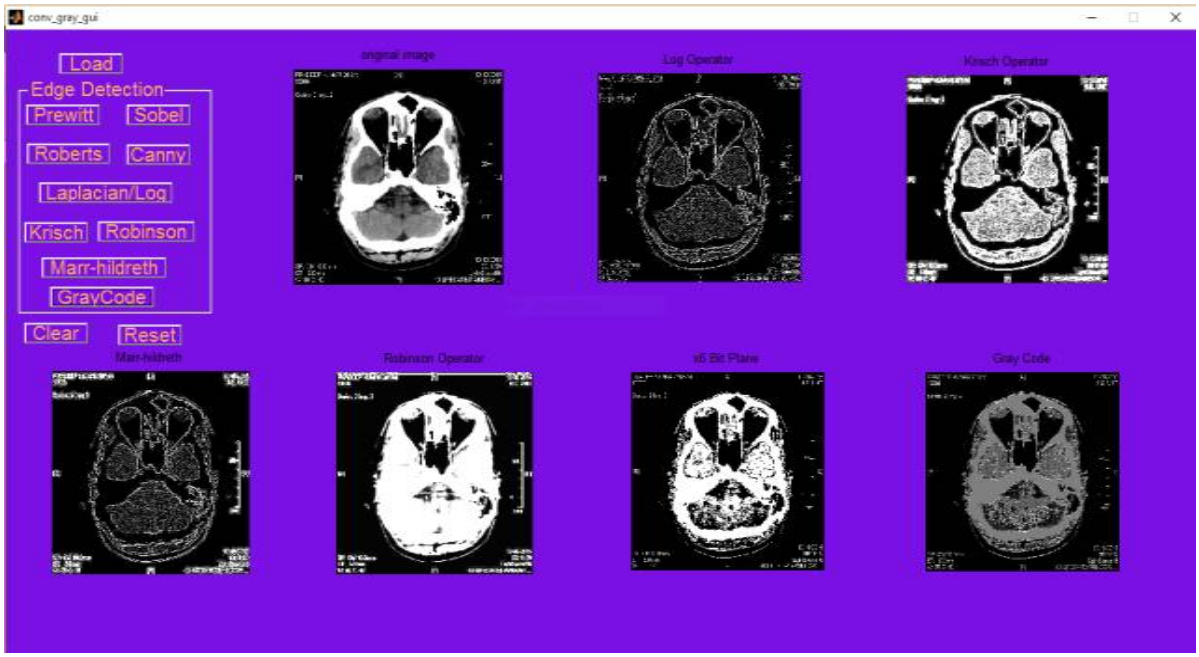

Fig. 4: Result of proposed edge detector

Prewitt, Sobel and Roberts results deviated from the others while Canny, LoG and Marr-Hildreth, generate almost same edge map whereas Kirsch and Robinson almost same edge maps so, it is observed from the figure 3&4 that SAPOG result is superior by far than other results.

V. CONCLUSION

In this research paper we have studied and compare different edge detection techniques and we have seen that SAPOG edge detector gives better results as compared to all other techniques.

In this research, processing is done on MRI image database using different edge detection algorithms in which each image is converted into grayscale image. These images are compared to determine the best edge detection algorithm. The software was implemented GUI using MATLAB.

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BIOGRAPHY

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