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Medical Image Improvement Using a Proposed Algorithm

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Abstract

The clarity of medical images is crucial nowadays, as it forms the basis for diagnosing the patient's situation, determining the phase of the disease, and prescribing appropriate treatment. The objective of the present study is to enhance the clarity of colored medical images by increasing the thickness to eliminate soft edges and areas that may not be visible when determining the edges. The process involves converting the image from RGB to HSV, displaying the resulting image in the HSV color space, setting the edges in this space, and then incorporating them back into the image. Finally, the resulting image is converted from the HSV color space back to RGB. This algorithm can be implemented using Matlab2020a to optimize images. The proposed method is versatile and can be applied to all types of medical images, including (MRI, Ultrasound, X-ray, etc.), whether colored or grayscale, and regardless of size or the specific part of the human body. The results show a significant increase in the resolution of the resulting images, indicating improved consistency.

1. Introduction

The massive evolution of information technology has led to an increase in the use of digital images and the need for the development of multiple digital processing methods [1]. The tremendous growth of computer technology and significant advances in the digital recording of images have helped the emergence of appliances that allow the acquisition of images without chemical processing. Some of the advantages offered by digital imaging, such as image quality stability (regardless of the length of storage), the number of copies, and the possibility of computer processing, have provoked the interest of numerous medical workers, attracting them to digital imaging [2]. The image cannot usually be received from its original with exemplary accuracy for many causes, including the system's limitations and ineffectiveness, it is due to unavoidable defects in imaging systems as well as external effects from atmospheric conditions, body movement, or imaging systems during photography. These imperfections all reduce image quality (IQ) resulting from imaging systems. So those distortions tend to be addressed to obtain good images that can be analyzed and utilized. It has developed many distortion removal techniques and has been used in many filtration techniques to remove the noise accompanying digital images and reduce their impact. However, most processing processes are not completely excellent but sometimes improve the places and deformation of other sites, so in this research, many criteria for image quality inspection have been suggested [3].

2. Theoretical Part

2.1. The digital image is represented in four types:

A- Binary Image

The binary image is one of the simplest types of images represented by two values: white (1) or black (0), i.e., they only accept a single binary number for each fragment (Pixel of the elements of the image and an example of this type is written prints [4].

B- Gray Level Image

Monochrome images contain only glitter levels and do not include color gradients, and the value of each element in the image specifies the grey gradient between (0-255) and each element is represented by (8bits/pixel). In certain applications such as medical imaging is often represented by (12 bits/pixel) or (16 bit/pixel) and this increase in intensity levels is useful only when its small logic in the image has a high intensity. In this case, details that may be difficult to see can be distinguished without such an increase in severity levels [5].

C- Colored Image

These images represent a model of three bundles of monochrome data, each of which goes back to the glitter in each of the basic colors (Red, Green, and Blue), and by using (8 bits per item in each color package the color image is represented by (24bits). The total number of real blooms in the picture is limited (16 million match (28)3 [6].

D- Multi-Spectral Image

Multispectral images hold information exceeding the limits of graphical perception, containing data collected in several packets on the infrared, ultraviolet, or X-ray method and of all kinds of satellite images. Its information is collected in several packets ranging from (7-2) Spectral packets, from one to three of these packets fall within the visual spectrum duration, and other packets are located in hidden areas [7].

2.2. Digital Image Processing Stages

Image processing is considered one of computer science and informatics branches, which is interested in conducting operations on the image to improve it according to specific criteria, or extract some information from it. The traditional image processing system consists of six consecutive phases and is in order [8]:

1- Image acquisition is obtained by a photosensitive sensor such as Cameras, or a laser sensor.
2- Primary processing such as de-noise filtering.
3- Segmentation of image segmentation to separate important information from the background.
4- Features extraction.
5- Classification features and linking them to the pattern they are returning to and identifying patterns.
6- Image understanding

2.3. Digital Image Edges Detection:

Edge detection is known as the process of identifying spatial characteristics that are difficult to distinguish, Often directly from raw images to extract formative compositions, the edge detection process is a fundamental step in image understanding and analysis, and the edge detection process often involves identifying and isolating the edges of a digital image using digital image processing algorithms and methods [9]. Processes applied to an image to identify rims, several operations are required to delineate the edges of an image:

A. Smoothing

Smoothing on the spatial information of the image is achieved by specifying a particular point and several bordering on this point and then involving a smoothing process. Many jamming processing techniques rely on the digital filter application to mitigate the adverse impact of interference. The selection of processing methods is contingent upon the level of interference introduced into the image [10].

B. Differentiation

One of the fundamental methods used is to catch the edges and find the amount of variability in the chromatic power value of the image data and the direction of variability as well [11]. The value of variation between the location point (i, j) and its adjacent points is calculated in both orientations (horizontal and vertical) as shown in the formula (1) and (2) respectively:

$$\boldsymbol{V \times G\ (i,j)\ =\ G(i,j)\ -\ G(i\ -\ 1,j)} \quad \textbf{(1)}$$

$$\boldsymbol{VyG\ (i.j)\ =\ G(i,j)\ -\ G(i\ ,j-1)} \quad \textbf{(2)}$$

The resulting value may be positive or negative depending on the direction of variance in the negative direction or in the positive direction (the operation's output can always be made positive using absolute value ([12].

To estimate the value of the variance in both orientations, finding the direction of the variance might be calculated as explained in formulas (3) and (4) and in order [12].

$$\mathbf{G\ (i,j) = \sqrt{\nabla \boldsymbol{x}^2 + \nabla y^2}} \quad \textbf{(3)}$$

$$\boldsymbol{\theta = \tan^{-1}\frac{\nabla y}{\nabla x}} \quad \textbf{(4)}$$

2.4. Canny edge detector

This influencer is one of the effective algorithms for edge detection because it depends on three criteria in estimating the efficiency of estimating the efficiency of the algorithm. The second adopted by the algorithm is the accuracy in defining the edge, which means achieving the least distance between the location of the selected edge and its real location in the image. As for the third criterion, the algorithm made one response to one edge, as this criterion is complementary to the first and second criteria, because edge repetition means adding false edges (shadow edges) and thus difficulty in determining the exact location of the edge [13]. To define these criteria, the following tasks are defined:

1-to calculate the value of fx and fy

$$\boldsymbol{f_x = \frac{\partial}{\partial x}(f * g) = f * \frac{\partial}{\partial x} g = f * g_x} \quad \textbf{(5)}$$

$$\boldsymbol{f_y = \frac{\partial}{\partial y}(f * g) = f * \frac{\partial}{\partial y} g = f * g_y} \quad \textbf{(6)}$$

Derivative of $g_x(x,y)$ dependent on :x

$$\boldsymbol{g_x(x,y) = \frac{-x}{\sigma^2} g(x,y)} \quad \textbf{(7)}$$

Derivative of $g_y(x,y)$ dependent on :y

$$\boldsymbol{g_y(x,y) = \frac{-y}{\sigma^2} g(x,y)} \quad \textbf{(8)}$$

2-Regression calculation:

$$\boldsymbol{Edge\ Magnitude = \sqrt{p_1^2 + p_2^2}} \quad \textbf{(9)}$$

2.5. Basic Color Space:

The primary color space (RGB) is often used in various processing methods, because color cameras, scanners, and most projectors use this color space in their main work input or output signals [14]. Figure (1) shows the space as a color cube where color is designated as a point in a three-dimensional space with Red R, Green G, and Blue B.

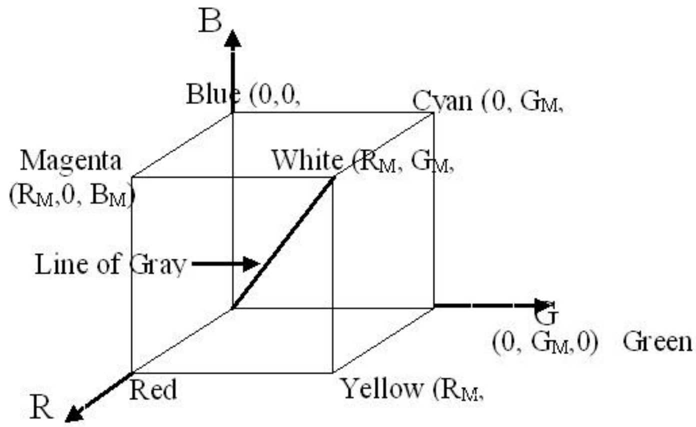


Figure 1: Original Color Space

In this space gray levels are set in the diameter of the cube confined between the point (0.0.0) which defines black and the point (M, M, M) White light identifies and M represents the highest value of any of the three R, G or B compounds and is equal to (1) in calibration (Normalization) Otherwise, the value is (255), while the angles of the other cube determine the colors (red, yellow (Yellow), green, dark blue (Cyan), blue and purple (Magenta)), as shown in figure (2). This space operates collectively and is used primarily for conversion to other systems because of the disadvantages of this space, including [15]:

1- The high correlation between its vehicles makes this space inappropriate for many applications in the field of color image processing.
2- It does not fit the nature of the sensory perception of human eyes.
3- It is irregular which means the difference between colors cannot be determined when felt based on the difference in measurement steps along coordinate axes when representing colors in this space.

2.6. Perceptive None Uniform Color Spaces

It is a set of spaces that depends on the generation of light, color gradient, and satisfaction i.e. Generalized Lightness, Hue, and Saturation (GLHS) can be divided into three basic types [[1]]:

a. Color gradient space, satisfaction, and triangular lighting. (HSL Triangle)

b. Color gradient space, satisfaction, and hexagonal value (HSV Hexone).

c. Color gradient space, satisfaction, and double hexagonal lighting. (HLS Double)

- These spaces are suited to the nature of human sensory perception.
- The possibility of separating color values from non-color values.
- The utilization of the RGBTODE platform represents a substantial alteration in the fundamental color properties, as opposed to the treatment of these color spaces, which is limited to adjustments solely in the luminance or the effective color channel while preserving the color attributes.

In HSV hexagonal space is determined by the relation

$$(\boldsymbol{c}) = \boldsymbol{V}(\boldsymbol{c}) = \boldsymbol{max}(\boldsymbol{r}, \boldsymbol{g}, \boldsymbol{b}) \quad \textbf{(10)}$$

V (c) represents value and max (r, g, b) is the greatest of the three values of r, g, and b that determine color in the primary color space, and Figure (2) shows HSV space.

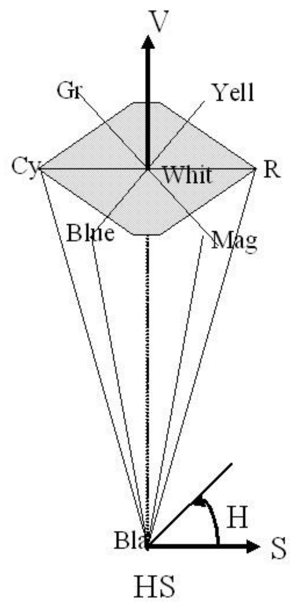


Figure 2: Shows HSV Space

Converting RGB to HSV

The HSV color space is a non-linear transform of the RGB color space .The color components of HSV is(Hue, Saturation, Lightness Value or intensity) [16]. There are main steps involved in applying the converting Process:

.

Given three numbers R, G, and B (each between 0 and 255), "we can first define m and M with the
Relations:
M = max{R, G, B}"
m ="min{R, G, B}
And then V and S are defined by the equations: V = M/255,
S = 1 - m/M, if M > 0 and S = 0 if M = 0.
As in the HSI and HSL color schemes, the hue H is defined by the equations
$H=\cos^{-1}[(R-\frac{1}{2}G-\frac{1}{2}B)/\sqrt{R^2+G^2+B^2-RG-RB-GB}]$ if $G \geq B$
or $H=360-\cos^{-1}[(R-\frac{1}{2}G-\frac{1}{2}B)/\sqrt{R^2+G^2+B^2-RG-RB-GB}]$ if $B>G$

3. Practical side:

3.1. Practical Algorithm

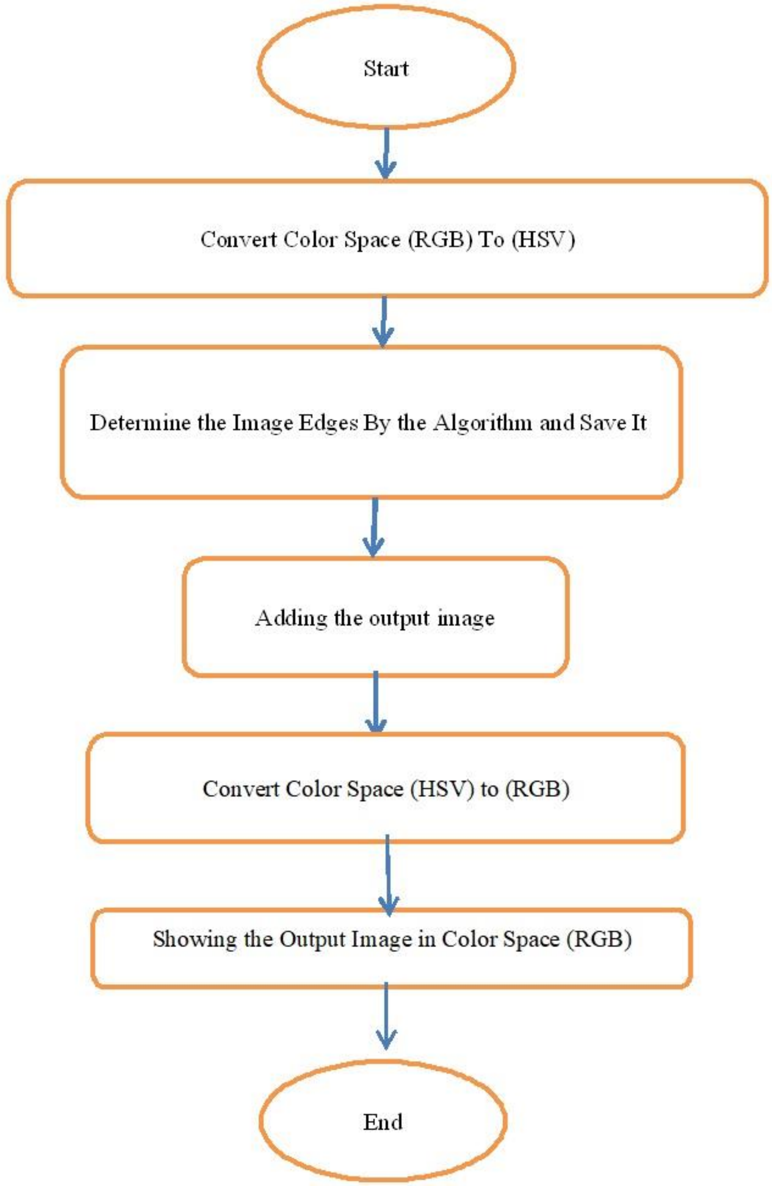


Figure 3: Flowchart Showing Current Study Algorithm

4. Results and discussion:

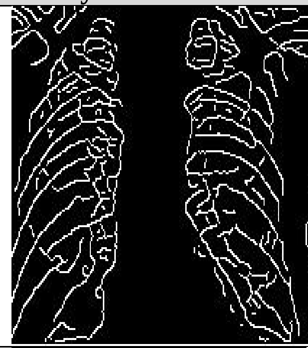
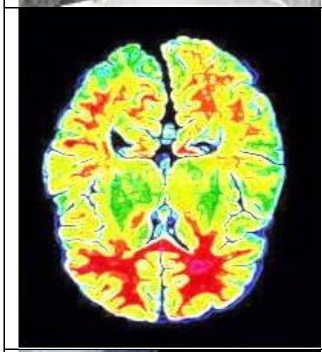
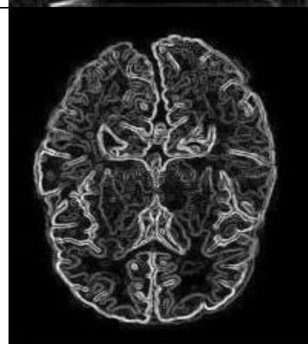
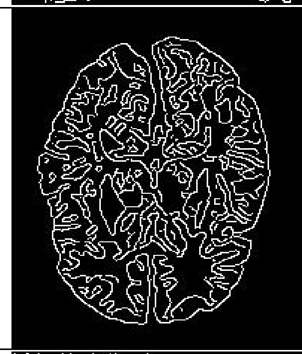
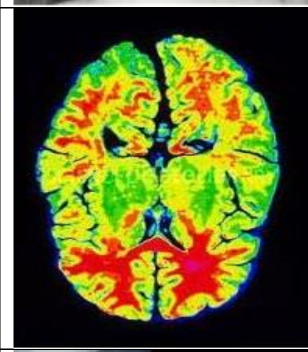
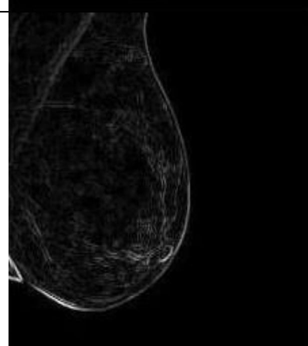
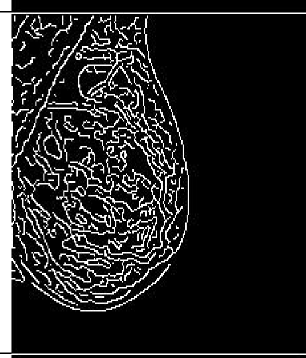
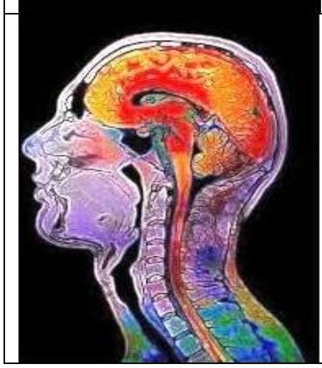
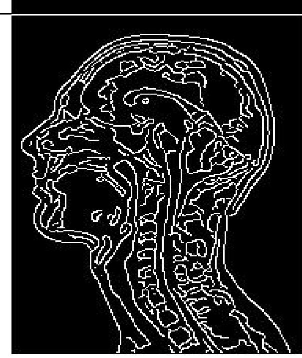
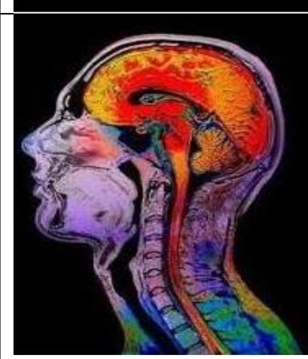
Stage 1: Determining the edges of images by algorithm.

Stage II: Improving photo edges were added to the original image as the edges resulting from the first phase.

Sound medical images and infected medical samples were used and the results were as follows:

Table (1) represents the treated images of healthy samples for which the edges were identified and improved by the algorithm and compared with the edges of the image by Canny.

Table 1: Results of Canny on sound images, algorithm, and addition of edges to the original image.

Enhance Image Edges	Determine Edges by The Algorithm	Determine Edges by Canny	Original Image
			
			
			
			

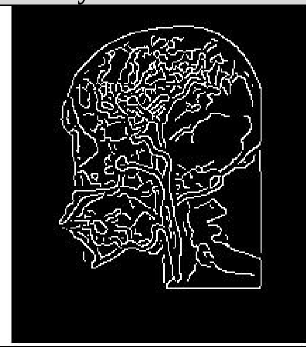
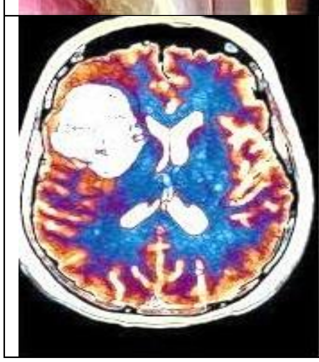
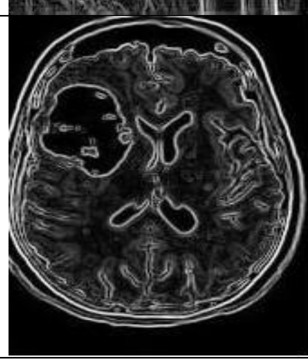
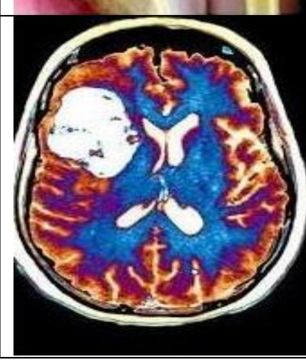
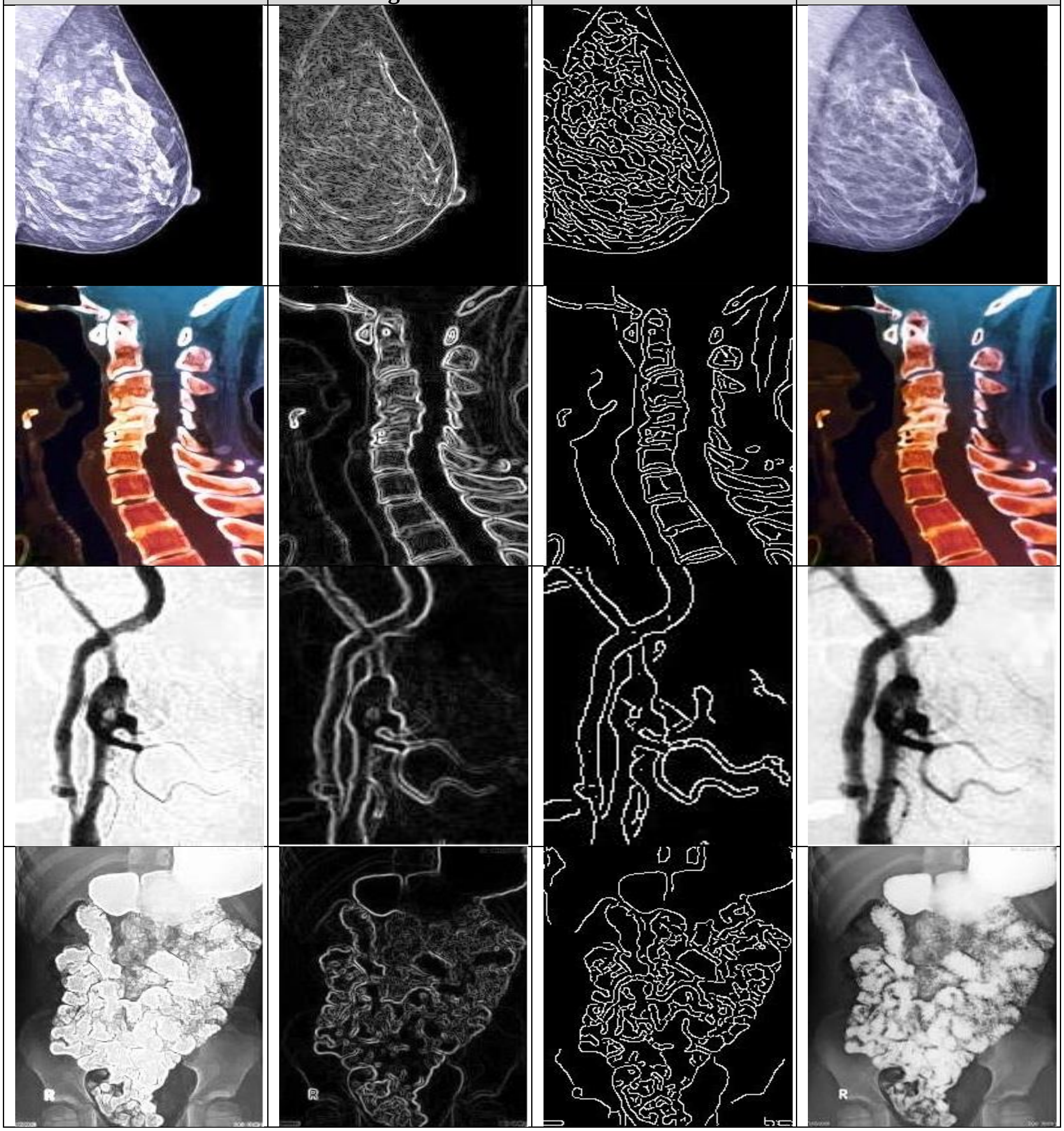
Enhance Image Edges	Determine Edges by The Algorithm	Determine Edges by Canny	Original Image
			
			

Table (2) represents the treated images of infected samples for which the edges were identified and improved by the algorithm and compared with the edges of the image by Canny.

Table 2: Results of Canny on infected images, algorithm, and addition of edges to the original image

Enhance Image Edges	Determine The Edges by The Algorithm	Determine the Edges by Canny	Original Image
			
			

Enhance Image Edges	Determine The Edges by The Algorithm	Determine the Edges by Canny	Original Image



5. **Conclusions**

The algorithm employed to determine the edges of the image has shown efficiency regardless of the type of image whether the image is grey or colorful, as the edges are determined after being converted from color space (RGB) to space (HSV). The algorithm is employed for edge detection and doesn't necessitate the conversion of colored images into grayscale, as is typically required in other methods such as Canny. The proposed method of "adding the image with its edges" works to improve and increase the thickness of the edges Color medical images (which need to be directly edged, such as grayscale images known as filters), This method helps specialist doctors to see clearly the edges of the resulting images of various types Medical images (MRI, CT, CAT, PAT, ...) are colorful and gray, of any size and any organ in the human body and diagnose the disease easily.

Recommendations and future work:

1- The study's applicability extends to other image types, including space images.

2- Develop the algorithm for identifying the edges of images and improve them after converting the image into other spaces.

Conflict of Interest: The authors declare that there are no conflicts of interest associated with this research project. We have no financial or personal relationships that could potentially bias our work or influence the interpretation of the results.

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