JOURNAL OF KUFA−PHYSICS
www.uokufa.edu.iq/journals/index.php/jkp | ISSN: 2077−5830

Frontal Chest X-Ray Image Colorization Using Various Mathematical Experimental Equations

***Kawther H. Al-khafaji** **Layla Abd al Jaleel Al-Yasiri**

Kufa University/ Faculty of Education for Girls / Kufa/Iraq.

*Corresponding Author E-mail: Kutherh.kafajy@uokufa.edu.iq

ARTICLE INFO.:

Article history:
Received: 7 DEC, 2017
Accepted: 13 SEP, 2018
Available Online: 22 JNL, 2019

Keywords:

Colorization Process
Chest X-Ray Medical Images
Colour Image

ABSTRACT:

Chest x-ray medical images are widely used for diagnostic purposes for several reasons including it available, attainable and excellent imaging of hard tissues like bones, but there is difficulty in imaging of the soft tissues, moreover the saturated colour of the x-ray image causing intricacy to read it, therefore, turned attention to the colorization process which can be used to transform the grayscale medical images to the colour medical images.

In this paper, a new pseudo-coloring method proposed for colorizing the frontal chest x-ray medical images which are very important for disease detection and recognition. The key idea of this method is applying different and various experimental mathematical equations on the proposed medical sample image, which it belongs to the patient with Hydatid cyst parasite disease in the lung. The counterfeit coloring had intense contribute in enhancing of the visual attractiveness of medical images, the output colored images have a better visual description, it has a possibility to describe hidden information better than a conventional monochromatic image, this is an excellent indicator of the algorithm's suitability for the purpose for which it was formulated.

DIO.: http://dx.doi.org/10.31257/2018/JKP/2019/110112

تلوين صورة الأشعة السينية الصدرية الأمامية باستخدام معادلات رياضية تجريبية متنوعة

كوثر حسن صاحب الخفاجي ليلى عبد الجليل محسن

جامعة الكوفة / كلية التربة للبنات

الكلمات المفتاحية:

عملية التلوين
صور الأشعة السينية الصدرية
الصورة الملونة

الـــخُـــلاصــــة:

تستخدم صور الأشعة السينية الطبية الصدرية على نطاق واسع لإغراض التشخيص الطبي وهذا يعود لعدة أسباب منها كونها متاحة وسهولة الوصول إليها وأيضاً قابليتها الممتازة في تصوير أنسجة الجسم الصلبة كالعظام، ولكن هنالك صعوبة في تصوير الأنسجة الرخوة بهذه التقنية علاوة على ذلك إن الألوان المشبعة لصور الأشعة السينية تتسبب في تعقيد عملية قراءتها، لذلك تحول الانتباه إلى عملية التلوين والتي يمكن من خلالها تحويل الصور الطبية ذات التدرجات الرمادية إلى صور طبية ملونة.

في هذه الورقة البحثية تم اقتراح طريقة جديدة للتلوين الزائف لتلوين الصور الطبية الصدرية الأمامية الملتقطة بتقنية الأشعة السينية وهي مهمة جدا في عملية الكشف عن الأمراض وتميزها. إن الفكرة الرئيسية لهذا البحث هي تطبيق عدد من المعادلات الرياضية التجريبية على الصورة الطبية المقترحة والتي تعود لمريض مصاب بكيس مائي طفيلي في الرئة. في وقد ساهم التلوين المزيّف في تعزيز الجاذبية البصرية للصور الطبية، كما أن الصور الملونة الناتجة لها وصف مرئي أفضل ، ولديها إمكانية لتوصف المعلومات المخفية بشكل أفضل من الصور أحادية اللون التقليدية ، ويعد هذا مؤشر ممتاز على مدى ملائمة الخوارزمية المقترحة للغرض الذي وضعت لأجله.

1. INTRODUCTION

Medical images have a significant function in detecting and diagnosing diseases in the human body and living organisms in various medical fields, and they are able to examine complicated and sophisticated interior biological processes [1]. add to that it contains priceless anatomical information about clinical procedures[2].The most prominent types in the medical images are x-ray, ultrasound, magnetic resonance imaging(MRI) and computed tomography, magnetic resonance imaging(MRI), all those types usually come in grayscale which has only 256 gray shades variations, in other words, the color information has been overlooked in medical image analysis applications, this is because they are monochrome imaging models, and since colour is a powerful tool to increase the quality of information display [3][4], therefore, the researchers had to utilized the colorization technology[5].

The colorization is a novel image processing field [6], it's the process through which it can be added colour to black and white pictures. This process used to convert grayscale medical image into colour medical image, since the colour increase a visual appeal of images and it make the medical visualization more interesting. alterations in colour are more easily noticed than alterations in shades of gray, therefore, this procedure makes the explanation and understanding of the images much easier, and expectantly make the images more readable[7].In addition, the information content of some medical images can be perceptually enhanced with colour by exploiting variations in chromaticity as well as luminosity [6][8].

2. SYSTEM OVERVIEW

Colour perception is a specific psychophysiological process that occurs in the human's brain. The peculiarities of the human visual system tend to perceive the information's more easily in colour. In medical fields, color can be important because it increased detection ability, allows the radiologist to explain the images in more details, and diagnostic preciseness. Chest x-ray test consider as the most important prominent in diagnosis and detecting many lung diseases, the colors of x-ray images are white and black or shades of gray (monochrome image), the bone and metal will appear white because it blocks the most of x-ray particles, the structures how containing air will be black, but the muscle, fat, and fluid will appear as shades of gray. Therefore, the current trend is to adding colour to those type of images to enhance the visibility of details and reduce the complexity of read it, and enhancing the x-ray image in the same time, which is the aims of this work.

3. IMAGE ACQUISITION

This work is carried out in Matlab R2012b, and the test image is a chest x-ray medical image downloaded from source[9]. It belongs to the patient with Hydatid Cysts disease. The input image is a gray level image (monochrome image).

Figure.1 The original chest x-ray image

4. Mathematical Morphology

In any colour pattern, there must be three channels for the new colored pixel and accordingly, there must be three mathematical functions that transform the value of those channels. In each channel, the range of values it should be between 0 and 1. The three results are integrated together as a red, green and blue channel to produce a colored image. The resulted image color content is adjusted by the type of a transformation function, the general formula of the experimental coloring equation it was dealing with it previously in [10]:

$$I_c(x,y) = \begin{bmatrix} |2\pi\mathcal{F}I_z(x,y)| \\ |2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P| \\ |2\pi\mathcal{F}I_z(x,y) + P| \end{bmatrix} \dots\dots (1)$$

Where,

$I_c(x,y)$ the output colouring image.

$I_z(x,y)$ the initial processed image.

$\mathcal{F}$ the frequency coefficient.

P the phase coefficient.

$\mathbb{N}$ is the Optional empirical coefficient.

In this specific research, mathematical functions are utilized to perform the required transformation from grayscale to color. This includes representation the right parts of the equation.1 in terms of fundamental trigonometric functions were used as a transformation function, Sine and cosine functions are used in each channel where the gray value are transformed.

The idea underlying this approximation is to perform three individual transformation of a gray level of an input pixel, to achieve more acceptable results.

5.Proposed Methodology

In this section, the proposed algorithm of chest x-ray medical image coloring will be applied and discussed, the algorithm stages are:-

Step1: Image acquisition.

Step2: Intensity adjustment of images.

Step3:Convert the resulting image to double precision image.

Step4: Input three parameters .

Step5: Expression of the original image in terms of the parameters.

Step6:Expression the mathematical equations in terms of trigonometric functions.

Step7: Change the trigonometric functions or the mathematical operations or both.

Step8: Colouring chest x-ray image.

6. The Flow Chart of X-Ray Coloring Algorithm

Figure(1) shows The basic algorithm stages:-

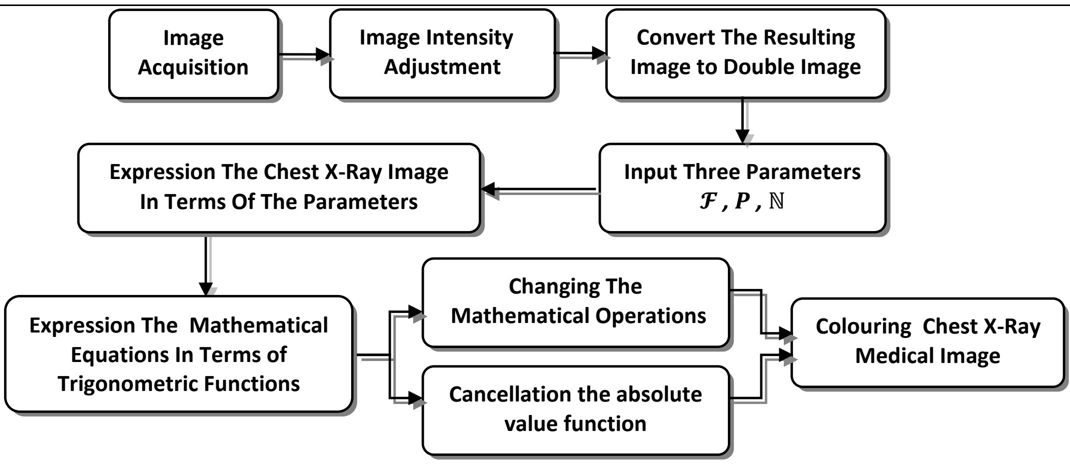


Figure.2 The Flowchart of Coloring Algorithm

7. The Framework and Experimental Results

In this work, implementation of every stage of the algorithm listed in section.5 to provide the x-ray images with artificial colors specific colour or mixture of colors using sub equations composite from equation(1) by changing both trigonometric functions and mathematical operations. This sort of change has a wide impact on the output images. The change comprises changing trigonometric functions and mathematical operations or both alteration in each one of the previous equations, In all experimental attempts to coloring the medical images the coloring experimental equation coefficients were assigned to take the following values :- (□ = 0.9, P =0.2, and □ =0.5). The coefficients values have been selected by trial(exploratory).

8. Sine and Cosine Transformation:-

8.1.A. Previously an effective algorithm for image colour enhancement was introduced and the coloring images was a sub-product of the algorithm[6]. The right parts in all set of the triple equations in the main coloring experimental equation(1) will be represented through trigonometric functions (sin, cosine) as transformation functions, the output colour image is shown in Figure3(a, c):-

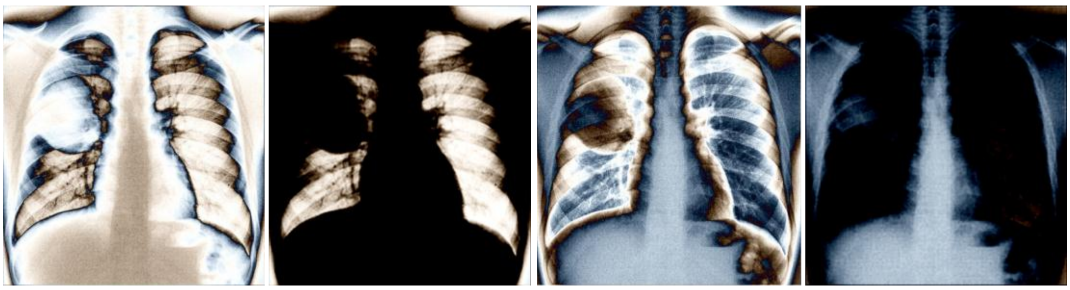
$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \dots (2)$$

$$I_c(x,y) = \begin{bmatrix} |\cos(2\pi\mathcal{F}I_z(x,y))| \\ |\cos(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ |\cos(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \dots (3)$$

8.1.B. Canceling absolute value functions of the right parts in all set of a triple equation, and perform this procedure in all of a previous equations(2,3). The newly equations and the output images are shown in Figure3(b, d):-

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}I_z(x,y)) \\ \sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P) \\ \sin(2\pi\mathcal{F}I_z(x,y) + P) \end{bmatrix} \dots (4)$$

$$I_c(x,y) = \begin{bmatrix} \cos(2\pi\mathcal{F}I_z(x,y)) \\ \cos(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P) \\ \cos(2\pi\mathcal{F}I_z(x,y) + P) \end{bmatrix} \dots (5)$$



-a- -b- -c- -d-

Figure.3 (a) colored image by apply equation.2 (b) The colored image after cancelling the absolute value functions in the equation.2,(c) colored image by an apply equation.3,(d) The colored image after cancelling the absolute value functions in equation.3

8.1.C. Cancellation of the absolute value functions in one or two set of equation(2,3) produces new equations, the output images are shown in Figure (4):-

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}I_z(x,y)) \\ |\sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \dots (6)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ \sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P) \\ |\sin(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \dots (7)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ \sin(2\pi\mathcal{F}I_z(x,y) + P) \end{bmatrix} \ldots (8)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}I_z(x,y)) \\ \sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P) \\ |\sin(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \ldots (9)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ \sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P) \\ \sin(2\pi\mathcal{F}I_z(x,y) + P) \end{bmatrix} \ldots (10)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}I_z(x,y)) \\ |\sin(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ \sin(2\pi\mathcal{F}I_z(x,y) + P) \end{bmatrix} \ldots (11)$$

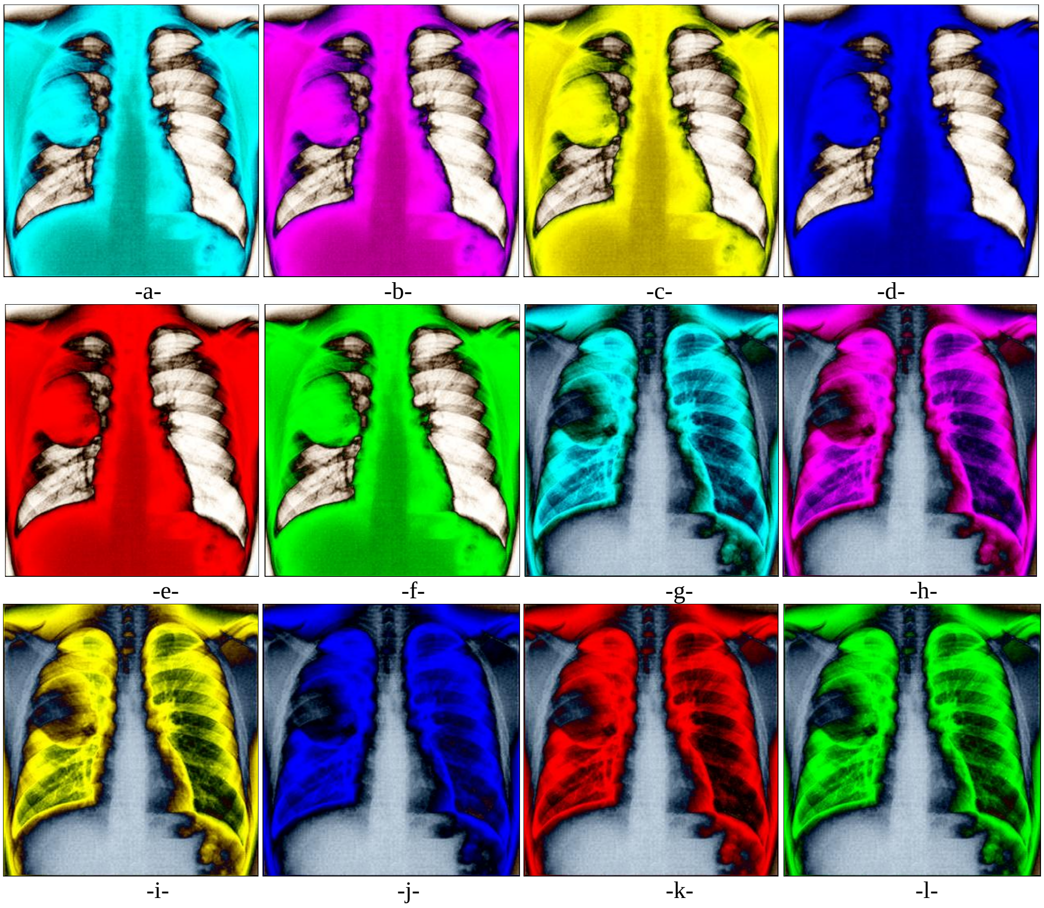


Figure.4 The colored output images (a) colored output image by applying equation (6),(b) colored output image by applying equation (7) ,(c) colored output image by applying equation (8), (d) colored output image by applying equation (9), (e) colored output image by applying equation(10),(f) colored output image by applying equation (11), (g) colored output image by applying equation (12), (h) colored output image by applying equation (13), (i) colored output image by applying equation (14) , (j) colored output image by applying equation (15), (k) colored output image by applying equation (16), (l) colored output image by applying equation (17).

$$I_c(x,y) = \begin{bmatrix} \cos(2\pi\mathcal{F}I_z(x,y)) \\ |\cos(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ |\cos(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \ldots (12)$$

$$I_c(x,y) = \begin{bmatrix} |\cos(2\pi\mathcal{F}I_z(x,y))| \\ \cos(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P) \\ |\cos(2\pi\mathcal{F}I_z(x,y) + P)| \end{bmatrix} \ldots (13)$$

$$I_c(x,y) = \begin{bmatrix} |\cos(2\pi\mathcal{F}I_z(x,y))| \\ |\cos(2\pi\mathcal{F}I_z(x,y) + \mathbb{N}P)| \\ \cos(2\pi\mathcal{F}I_z(x,y) + P) \end{bmatrix} \ldots (14)$$

$$I_c(x,y) = \begin{bmatrix} \cos(2\pi\mathcal{F}I_z(x,y)) \\ \cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P) \\ |\cos(2\pi\mathcal{F}I_z(x,y)+P)| \end{bmatrix} \ldots(15)$$

$$I_c(x,y) = \begin{bmatrix} |\cos(2\pi\mathcal{F}I_z(x,y))| \\ \cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P) \\ \cos(2\pi\mathcal{F}I_z(x,y)+P) \end{bmatrix} \ldots(16)$$

$$I_c(x,y) = \begin{bmatrix} \cos(2\pi\mathcal{F}I_z(x,y)) \\ |\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)| \\ \cos(2\pi\mathcal{F}I_z(x,y)+P) \end{bmatrix} \ldots(17)$$

8.1.D. Changing mathematical operations i.e. the elementary arithmetic operations (+,-,×,÷) that connect the variables in equations(2,3), or exclusion one of the parameters produces new equations, the output images are shown in Figure (5) and Figure (6):-

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}+I_z(x,y))| \\ |\sin(2\pi\mathcal{F}+I_z(x,y)+\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}+I_z(x,y)+P)| \end{bmatrix} \ldots(18)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y)\div\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y)+P)| \end{bmatrix} \ldots(19)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}+I_z(x,y)) \\ \sin(2\pi\mathcal{F}+I_z(x,y)+\mathbb{N}P) \\ \sin(2\pi\mathcal{F}-I_z(x,y)+P) \end{bmatrix} \ldots(20)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}+I_z(x,y)) \\ \sin(2\pi\mathcal{F}+I_z(x,y)\div\mathbb{N}P) \\ \sin(2\pi\mathcal{F}I_z(x,y)\div P) \end{bmatrix} \ldots(21)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}-I_z(x,y)) \\ \sin(2\pi\mathcal{F}-I_z(x,y)\div\mathbb{N}P) \\ \sin(2\pi\mathcal{F}I_z(x,y)+P) \end{bmatrix} \ldots(22)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}-I_z(x,y))| \\ |\sin(2\pi\mathcal{F}-I_z(x,y)\div\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}-I_z(x,y)\div P)| \end{bmatrix} .(23)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(4\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y)+P)| \end{bmatrix} \ldots(24)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}+I_z(x,y)) \\ \sin(2\pi\mathcal{F}+I_z(x,y)+\mathbb{N}P) \\ \sin(2\pi\mathcal{F}+I_z(x,y)+P) \end{bmatrix} \ldots(25)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}+I_z(x,y)) \\ \sin(2\pi\mathcal{F}+I_z(x,y)+\mathbb{N}P) \\ \sin(2\pi\mathcal{F}I_z(x,y)+P) \end{bmatrix} \ldots(26)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y)\div\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y)\div P)| \end{bmatrix} \ldots(27)$$

$$I_c(x,y) = \begin{bmatrix} \sin(2\pi\mathcal{F}-I_z(x,y)) \\ \sin(2\pi\mathcal{F}-I_z(x,y)\div\mathbb{N}P) \\ \sin(2\pi\mathcal{F}-I_z(x,y)\div P) \end{bmatrix} \ldots(28)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y)\div P)| \end{bmatrix} \ldots(29)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)| \\ |\sin(2\pi\mathcal{F}I_z(x,y)+P)| \end{bmatrix} \ldots(30)$$

$$I_c(x,y) = \begin{bmatrix} |\sin(2\pi\mathcal{F}I_z(x,y))| \\ |\sin(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)| \\ |\sin(2\mathcal{F}I_z(x,y)+P)| \end{bmatrix} \ldots(31)$$

$$I_c(x,y)=\begin{bmatrix}|\sin(2\pi I_z(x,y))|\\|\sin(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\sin(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(32)$$

$$I_c(x,y)=\begin{bmatrix}|\sin(2\pi\mathcal{F}I_z(x,y))|\\|\sin(2\pi I_z(x,y)+\mathbb{N}P)|\\|\sin(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(33)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(4+\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(34)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(4\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(35)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(4\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(36)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2+\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(37)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2+\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(38)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(2+\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}(39)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}-I_z(x,y))|\\|\cos(2\pi\mathcal{F}-I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}-I_z(x,y)+P)|\end{bmatrix}(40)$$

$$I_c(x,y)=\begin{bmatrix}\cos(2\pi\mathcal{F}-I_z(x,y))\\\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)\\\cos(2\pi\mathcal{F}I_z(x,y)+P)\end{bmatrix}\ldots(41)$$

$$I_c(x,y)=\begin{bmatrix}\cos(2\pi\mathcal{F}-I_z(x,y))\\\cos(2\pi\mathcal{F}-I_z(x,y)+\mathbb{N}P)\\\cos(2\pi\mathcal{F}I_z(x,y)+P)\end{bmatrix}\ldots(42)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}-P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)-P)|\end{bmatrix}(43)$$

$$I_c(x,y)=\begin{bmatrix}\cos(2\pi\mathcal{F}-I_z(x,y))\\\cos(2\pi\mathcal{F}I_z(x,y)\div\mathbb{N}P)\\\cos(2\pi\mathcal{F}I_z(x,y)\div P)\end{bmatrix}\ldots(44)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)-\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(45)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(46)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(4\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(47)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi\mathcal{F}I_z(x,y)+P)|\end{bmatrix}\ldots(48)$$

$$I_c(x,y)=\begin{bmatrix}|\cos(2\pi\mathcal{F}I_z(x,y))|\\|\cos(2\pi\mathcal{F}I_z(x,y)+\mathbb{N}P)|\\|\cos(2\pi I_z(x,y)+P)|\end{bmatrix}\ldots(49)$$

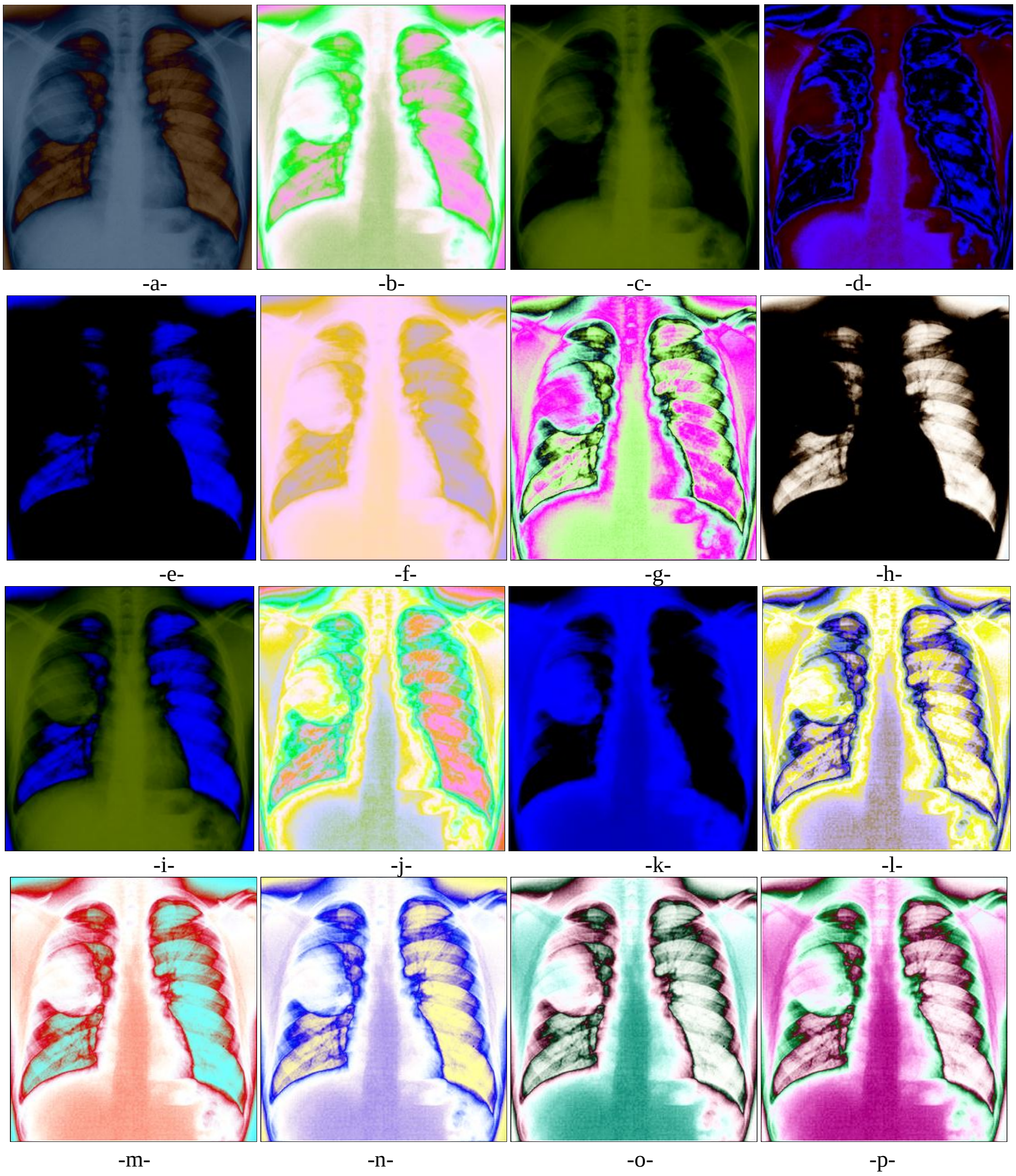


Figure.5 The colored output images (a) colored output image by applying equation (18),(b) colored output image by applying equation (19) ,(c) colored output image by applying equation (20), (d) colored output image by applying equation (21), (e) colored output image by applying equation(22),(f) colored output image by applying equation (23), (g) colored output image by applying equation (24), (h) colored output image by applying equation (25), (i) colored output image by applying equation (26) , (j) colored output image by applying equation (27), (k) colored output image by applying equation (28), (l) colored output image by applying equation (29),(m) colored output image by applying equation (30) ,(n) colored output image by applying equation (31) ,(o) colored output image by applying equation (32) ,(p) colored output image by applying equation (33).

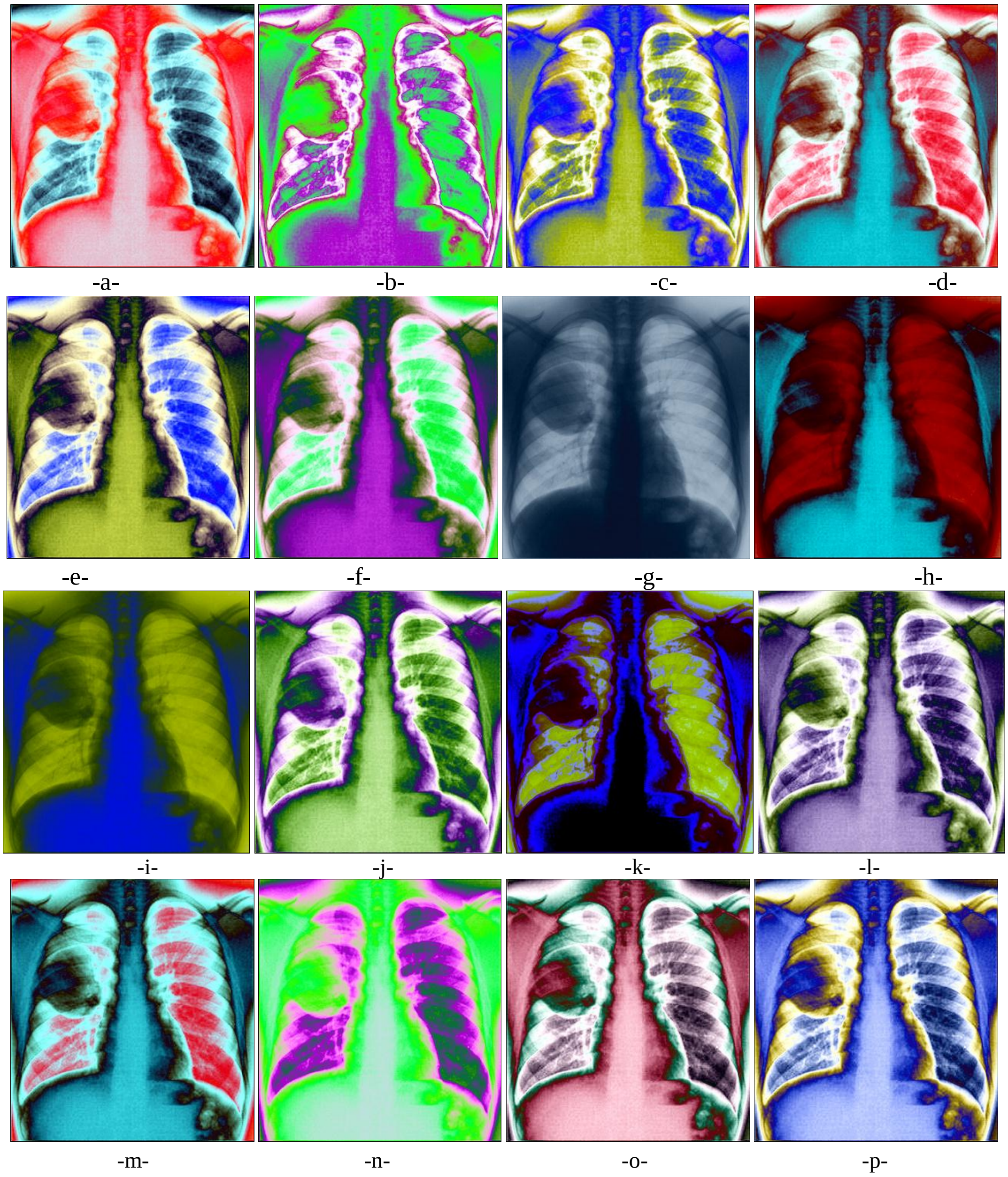


Figure.6 The colored output images (a) colored output image by applying equation (34),(b) colored output image by applying equation (35) ,(c) colored output image by applying equation (36), (d) colored output image by applying equation (37), (e) colored output image by applying equation(38),(f) colored output image by applying equation (39), (g) colored output image by applying equation (40), (h) colored output image by applying equation (41), (i) colored output image by applying equation (42) , (j) colored output image by applying equation (43), (k) colored output image by applying equation (44), (l) colored output image by applying equation (45),(m) colored output image by applying equation (46) ,(n) colored output image by applying equation (47) ,(o) colored output image by applying equation (48) ,(p) colored output image by applying equation (49).

9. Discussion

The output colored images produced by sine transformation are different than those produced by cosine transformation, in terms of the way the structure of the organs appears, this can be easily observed through the experimental results. In either way, the original chest x-ray images acquire false colors or so-called (pseudo-coloring). The pseudo-coloring gives non-real colors to the original grayscale images, this meaning it is not automatic colorization.

The proposed algorithm has resulted in a significant perception of images, where various parts such as (lung, ribs, rib cage, tissues, muscles, and spine)were visualized clearly. Throughout the process, the structure of images remains the same, and this indicates the intensity of the original grayscale images is constantly preserved, and it is made possible restoration of fine detail in x-ray images.

Cancellation the absolute value functions (section 8.1.C), In case of both sine and cosine transformation the images are coloring in almost identical colors, but not for the same organs, as it is clearly through the Figure.4. While in section 8.1.D, considered that the method of changing mathematical processes was random and not subject to a particular pattern, as a result, the output images were different in each case, as it is clearly through the Figure.5 and Figure.6.

10. Conclusions

Earlier, an efficient algorithm for image colour enhancement is introduced which enabled us to got the image colorization as a sub-result of the basic algorithm depending on changing the values of the main experimental equation coefficients.

In this paper, we have changed the previous algorithm to make it suitable for the intended purpose(image colouring), therefore, innovational colorization method has been presented based on applying sine transformation and cosine transformation, then change the general formula of the basic mathematical equations, the main purpose is making the disease detections and recognition process more easily and smoothly for medical radiologists and for specialists in this fields, In this work two medical applications it was obtained: colorization of medical gray scale images and distinguish the Cyst from the rest of the human chest organs conspicuously by giving them distinctive colour. The x-ray output colour images have gained more than three colours, in such a way that each organ of a particular intensity is colored differently than the other organs, where different parts like tissues, lung, ribs, and spine were visualized distinctly. The output images contained almost all of the following colour Categories: (cool colours, primary colours, basic colours, secondary colours, intermediate colours, complementary colours, analogous colours, neutral colours, saturated colours, cold colours, warm colours, dark colours). The experiment results indicate that the presented colorization algorithm produce innovative fascinating results, and it can be used in the visualization detection, and it also makes the medical visualization more interesting.

11. References

[1] Semary, Noura A. Aproposed Hsv-Based Pseudo-Coloring Scheme For Enhancing Medical Images. Computer Science & Information Technology, 2018.

[2] Khan, Muhammad Usman Ghani; Gotoh, Yoshihiko; Nida, Nudrat. Medical Image Colorization For Better Visualization And Segmentation. In: Annual Conference On Medical Image Understanding And Analysis. Springer, Cham, 2017. P. 571-580.

[3] Kase, Kannan. Effective Use Of Color In X-Ray Image Enhancement For Luggage Inspection. Master's Degree Thesis, 2002.

[4] Nida, Nudrat, Et Al. A Framework For Automatic Colorization Of Medical Imaging. Iioab J, 2016, 7: 202-209.

[5] Shah, Ami A.; Mikita, G.; Shah, Kalpesh M. Medical Image

Colorization Using Optimization Technique. 2013.

[6] Semary, Noura. Image Coloring Techniques And Applications. Grin Verlag, 2013.

[7] Lagodzinski, Przemyslaw; Smolka, Bogdan. Colorization Of Medical Images. In: Proceedings: Apsipa Asc 2009: Asia-Pacific Signal And Information Processing Association, 2009 Annual Summit And Conference. Asia-Pacific Signal And Information Processing Association, 2009 Annual Summit And Conference, International Organizing Committee, 2009. P. 769-772.

[8] Georgieva, Dessislava Valentinova; Gueorguiev, Vesselin Evgueniev. Computer-Assisted Pseudo-Coloring Method Of Lung X-Rays.2014.

[9] Http://Www.Elsevier.Es/Imatges/657/657v12n11/Grande/657v12n11-90188634fig2.Jpg

[10] Al-Khafaji, Kawther H. Intensification And Colour Enhancing For Chest X-Ray Medical Images By Matlab Program. Journal Of Kerbala University, 2017, 15.2: 259-273.