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Research Article

Enhancing Histopathological Image of Hashimoto's Thyroiditis Disease by Using Image Processing Techniques

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ABSTRACT

Image enhancement methods are among the most important and complex techniques in image processing technology. This research aims to use a number of methods and techniques to produce images that are more suitable for display and analysis, ensuring higher quality. This helps doctors and specialists improve disease diagnosis, provide early treatment, and enhance patients' quality of life through accurate diagnosis.

KEYWORDS: Image processing, image enhancement, histogram equalization, liner algebra, Hashimoto's Thyroiditis Disease

INTRODUCTION

The benefit of using image enhancement is to apply some transformation to the original image in order to obtain an image visually more clear and more detailed [1]. Information technology (IT) has become an essential part of modern life, and its excess effect on medicine and healthcare has become particularly clear in recent years. Is one of the most Crucial forms of Correspondence , images is well establish and it has a huge of essential information [2]. Digital images presents everywhere around us in today's digital world. They are basically visual representations of objects, people, or scenes captured and stored electronically.[3] Digital image Technically, can be comprehensible as a two-dimensional function, often referred to as f(x,y). This function represents a dropping of a three-dimensional display onto a two-dimensional plane. That is "In a digital image, x ، y denote the spatial coordinates of a pixel, that each coordinate pair stores specific intensity or chromatic information [3]. A digital image is 2D matrices that is a composed of a finite set of points, widely known as pixels, pels, or picture element, the represented for pixel is: For grayscale images, the single intensity value is (between 0 and 255), while color images use three values to represent the Red (R), Green(G), and Blue(B) components [3]. Many research have been discuss Image Processing such as 1"A review of Histogram Equalization in medical imaging was undertaken by Kyriakopoulou (2020). Within this study, the Execution of CLAHE on CT scans was Exhibited, comparing original HE with Adjustable (AHE) and Multi-scale Adaptive (MAHE) versions." [4]. In 2021 study titled 'Hiding Region of Interest in Image using Fuzzy Logic,' undertaken by Shahla Hazim Ahmed Kharofa and Ali Tariq Kalil Al-khayyat Introduced an algorithm designed to secure images during transmission. The method Precisely locates and conceals the face as a Pivotal Area (ROI). By Embedding fuzzy logic to evaluate these sensitive areas, the researchers significantly enhanced the robustness and effectiveness of the Encoding Procedure." [5]. In their 2022 study, Kim and Kim put forward an edge-preserving set against enhancement method particularly formulate for non-uniformly lit dark images. The essence of the method is an adjustable transformation function motivated by brightness-specific edge degrees. By handling the image throughout base and detail layer disintegration, the algorithm productively enhances range of vision without boosting noise. Factual evidence exhibits that this way achieves higher-quality performance evaluated against to ongoing state-of-the-art methods [6].

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LINEAR ALGEBRA

Linear algebra is a core branch of mathematics, deal with the study of vectors, vector spaces or linear spaces, linear mapping, and linear equations systems. The aims of this field were created by the study of Cartesian spaces with vectors in two- and three-dimensional [7].

Definition 1

Matrixes

A matrix is table of numbers put in shape of row and columns. Rows represent the horizontal lines parallel to the x- axis, And column represent the lines parallel to y- axis. The intersection of m rows and n columns form a an m×n matrix (“an m by n matrix”) is called matrix. For example, a32 means "the number in the third row and second column."

$$\begin{pmatrix} i_{11} & \cdots & i_{1*n} \\ \vdots & \ddots & \vdots \\ i_{m*1} & \cdots & i_{m*n} \end{pmatrix}$$

Examples of Matrices

1. Column Matrix (order 2×1): Matrix = [[3],[7]]
2. Row Matrix (order 1×2): Matrix = [[2, 5]]
3. Identity Matrix (order 2×2): Matrix = [[1, 0], [0, 1]]
4. Null Matrix (order 2×2): Matrix = [[0, 0], [0, 0]]
5. Square Matrix (order 2×2): Matrix = [[3, 2], [7, 7]]
6. Rectangular Matrix (order 2×3): Matrix = [[3, 4, 7], [7, 6, 10]]

HISTORY OF DIGITAL IMAGE PROCESSING

The initial use of technology of the digital image manipulation is spotted in an industry such as newspaper industry in the 1920s. During that time, digital images were transferred electronically through London as well as New York. That make the time reduced when transported a picture move from the Atlantic to three hours [9]. In 1960s Digital Image processing were established, at Maryland University by using Bell Lab, Jet Propulsion Laboratory(NASA,s JPL), Massachusetts Institute (MIT) [10]. In 1964 by Ranger 7, the initial use sent of space Detector America Jet lunar photos was the very first successful application [10]. In 1970s then it changed as specialized hardware were accessible and digital image analyses expanded as cheaper computers [10]. In(1986), Bruce as well as Young demonstrate an elaborate model elucidating the intricacies of face recognition, dividing the process into multiple stages [11]. In 1999, Wang with his colleagues describe the Dual Sub Image Histogram Equalization (DSIHE) [12]. In 2010, by Ooi and Isa , the algorithm of a novel Quadrant Dynamic Histogram Equalization (QDHE) was provided [12]. In 2015, Lin et al implemented Average Histogram Equalization (AVHEQ) to enhance the juxtapose and maintain the luminance of image [12]. Between 2018 and 2025, progress accelerated with deep learning [13].

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METHOD

IMAGE ENHANCEMENT

Image enhancement is necessary to illustrate characteristic of image. Images that are collected in darkness consist of limited clarity and variation of the image is small. the quality of Image can be raised with using of multiple techniques [14]. Images establish one of the fundamental form of communication; it is used by society and include an information that described very important in a large amount. The human vision system(HVS) is normally has the potential to extract important naturally [15]. In 1964 Image processing has been focused on with the analyzing of the images of the lunar surface.

HISTOGRAM EQUALIZATION TECHNIQUE

A spatial reign technique that is used to produce an output image with a regular distribution of pixel intensities. In other words, it flattens and methodically spreads out the histogram of the image to enhance its contrast [15]. This method is commonly used in image enhancement due to its simplicity and its comparatively superior performance which is compared to other traditional techniques [15]. The technique of histogram equalization is a memorable method in the field of image enhancement. Its common vogue for contrast improvement stems from its notable simplicity and proven effectiveness [16]. Most digital images suffer from poor contrast because they are affected by inadequate lighting, bad weather, and the deficiencies of the acquiring device (such as a video camera) when capturing the image. Low contrast is a common problem of digital pictures because of bad lighting, bad weather and problems with the device that takes the picture like a video camera. This is because most of the digital pictures are not well contrasted due to bad lighting, bad weather or problems with the device (such as a video camera) that took the picture. Digital pictures often have low contrast due to wrong lighting, the environment is not good enough, or the imaging equipment (camera) used to take the picture has built-in limitations [17]. One particular feature enhancement in image enhancement is contrast enhancement. Histogram equalization (HE) is one of the most common ways to improve the image contrast. Contrast enhancement is one of the most important parts of image enhancement processing. Histogram equalization (HE) is one of the most widely used techniques for this [18]. The histogram technique has given much information for image parameters. This is why, histogram modeling with spatial image domain technique is so useful. It is important for digital image processing and assembly in various settings [19].

HASHIMOTO THYROIDITIS DISEASE

Chronic lymphocytic thyroiditis, can be also called as Hashimoto thyroiditis (HT) or autoimmune thyroiditis, in 1992 in Germany was the first defined the term Lymphomatous Struma [20]. In the US and around, Nowadays it is known as major common cause of hypothyroidism and goiter with sufficient iodine. the fundamental result of goiter in children and young adults, in addition to unknown cause idiopathic myxedema, which represents final stage of Hashimoto thyroiditis differentiate by complete damage of the gland [20]. Hashimoto's thyroiditis is an autoimmune disease described by antibody-mediated immune responses that lead to inflammation of the thyroid gland. It is also famous by several synonyms, including chronic lymphocytic thyroiditis, autoimmune thyroiditis, non-goitrous thyroiditis, and atrophic thyroiditis. The happening of Hashimoto's thyroiditis has been increasing in recent years, a direction associated with excessive iodine intake. It is evaluated to be 10–15 times more popular in females, especially during middle age (30–50 years) [21]. Autoimmune diseases are a set of conditions where immune system of the body's accidentally attacks its self, produce various health complexity. the autoimmune condition that precisely affects the thyroid gland is famous as Hashimoto's thyroiditis [22]. A ……patients from different age groups (Males and Females) were studied for Hashimoto thyroiditis. First step: after receiving the specimen (thyroid gland), then start to prepare the glass slides. Tissues are prepared in 4 steps.

1. Fixation makes the tissue stable and healthy. It prevents changes.

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2. When the tissue is embedded it solidifies and can be sectioned.

3. Sectioning, or "slicing," provides the very thin samples required for microscopy.

4. Staining makes things visible and can help locate certain parts of tissue.

It has been found that the slide quality was not optimum, so that we try to apply the …….to improve the quality of the H&E slides.

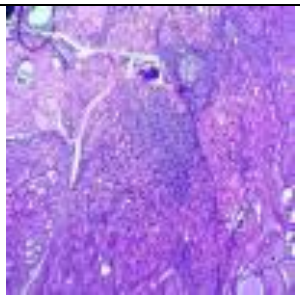
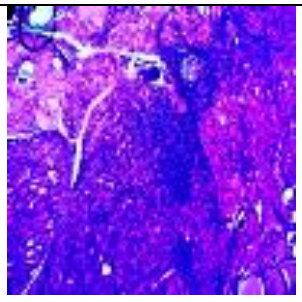
PROPOSED ALGORITHM

In this research, the following algorithm is proposed to improve Histopathological Image of Hashimoto's Thyroiditis Disease

1. Start
2. Input Hashimoto's Thyroiditis Histopathological Image.
3. Find size of Hashimoto's Thyroiditis Histopathological Image.
4. Generate the histogram for the Hashimoto's Thyroiditis Histopathological Image.
5. Find the count, min, max, mean, SD, Mode in original Hashimoto's Thyroiditis Histopathological Image.
6. Execute the histogram equalization process for Hashimoto's Thyroiditis Histopathological Image which include (step7 to step10).
7. Determine the values of the running sum of the histogram.
8. From step 7 Normalize the values through dividing with total number of pixels.
9. From step8 multiply the results with maximum value and round.
10. Map the values obtained in step 9, using a one-to one correspondence.
11. Print Hashimoto's Thyroiditis Histopathological Image.
12. Generate the histogram for the result Hashimoto's Thyroiditis Histopathological Image ,Find the count, min, max, mean, SD, Mode in the result Hashimoto's Thyroiditis Histopathological Image.
13. Find
14. End

RESULT AND DISCUSSION

In this research, nine Hashimoto's Thyroiditis Histopathological Image were dealt with, and the proposed algorithm was applied to each image, as shown in Figure 1. The smallest value, largest value, mean value, standard deviation, and most repeated value were calculated before and after optimization, as shown in Table 1.

	
Histopathological Image 1	Histopathological Image 1 after enhancement

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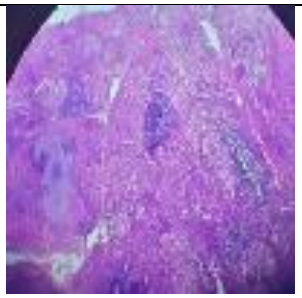
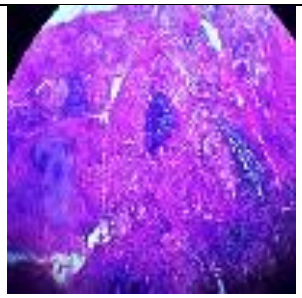
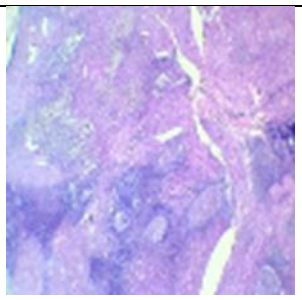
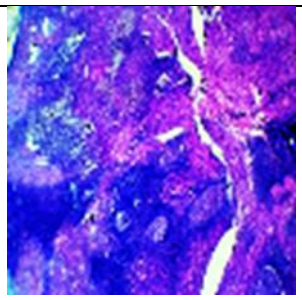
	
Histopathological Image 2	Histopathological Image 2 after enhancement
	
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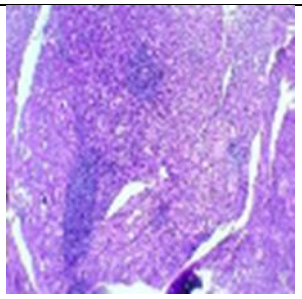	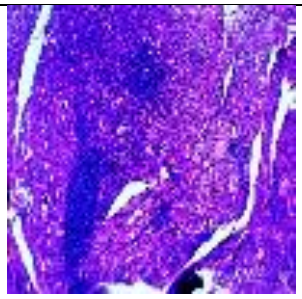
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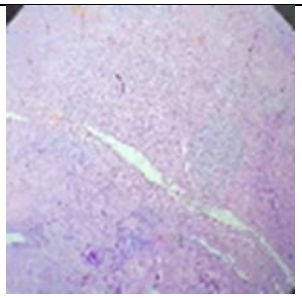	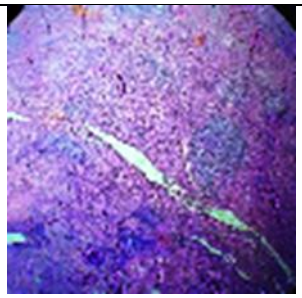
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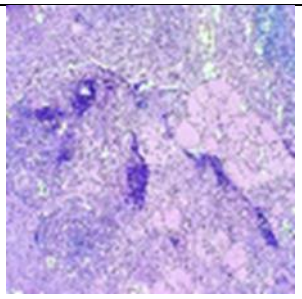	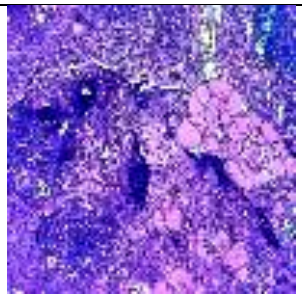
Histopathological Image 6	Histopathological Image 6 after enhancement

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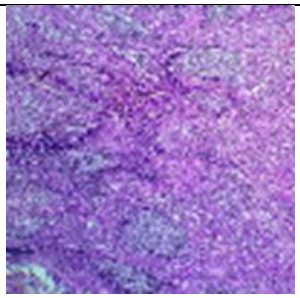	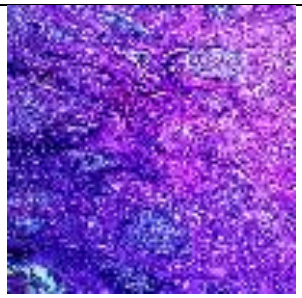
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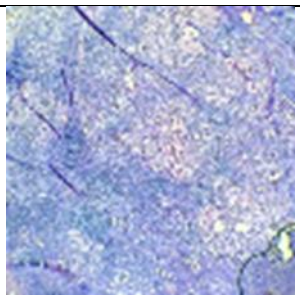
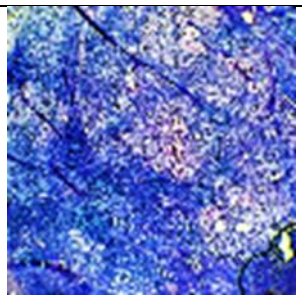
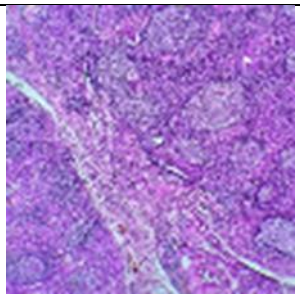
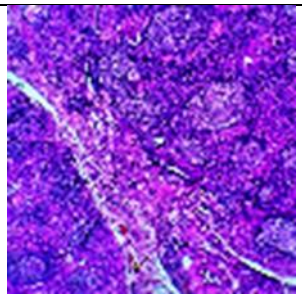
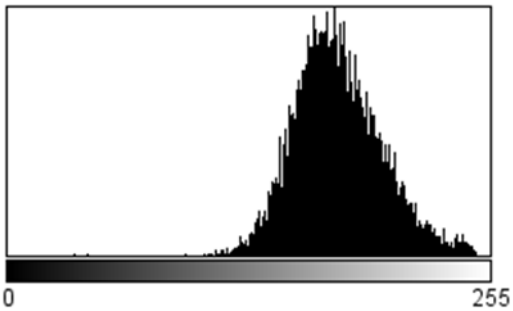
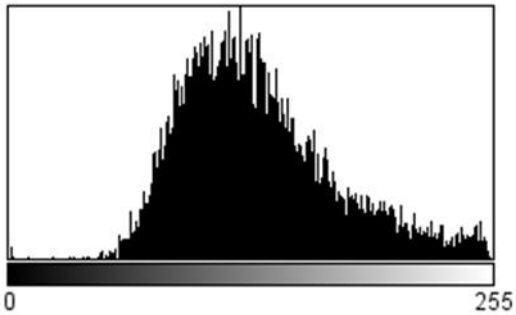
	
Histopathological Image 8	Histopathological Image 8 after enhancement
	
Histopathological Image 9	Histopathological Image 9 after enhancement

Figure 1. Represent the original Histopathological images and Histopathological images after enhancement

	
Histogram of Histopathological Image 1	Histogram of Histopathological image 1 after Enhancement

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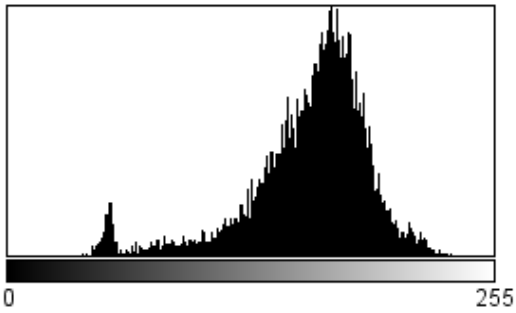
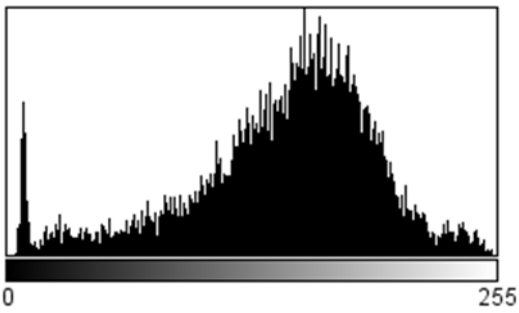
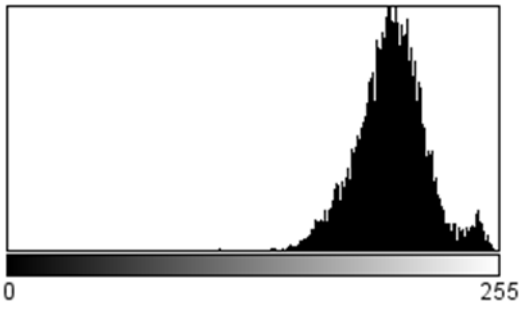
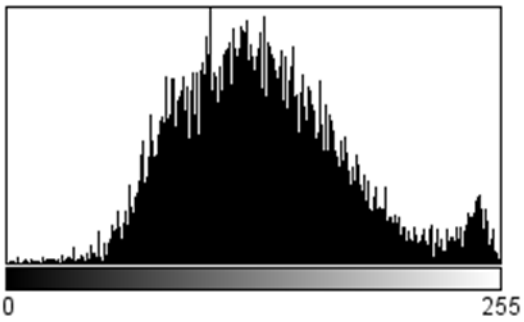
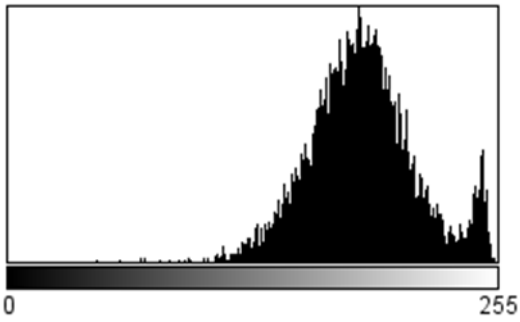
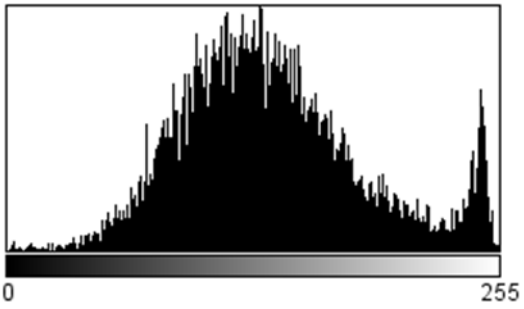
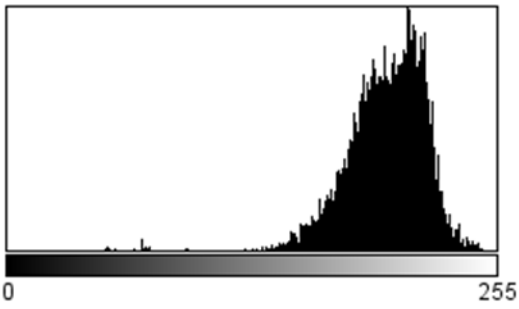
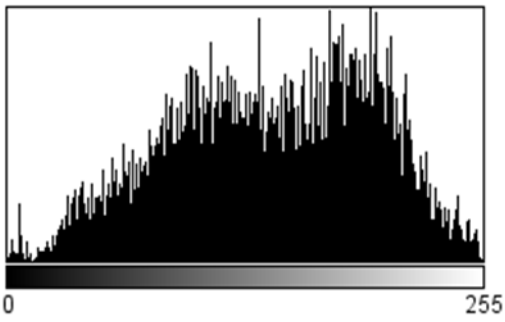
	
Histogram of Histopathological Image 2	Histogram of Histopathological image 2 after Enhancement
	
Histogram of Histopathological Image 3	Histogram of Histopathological image 3 after Enhancement
	
Histogram of Histopathological Image 4	Histogram of Histopathological image 4 after Enhancement
	
Histogram of Histopathological Image 5	Histogram of Histopathological image 5 after Enhancement

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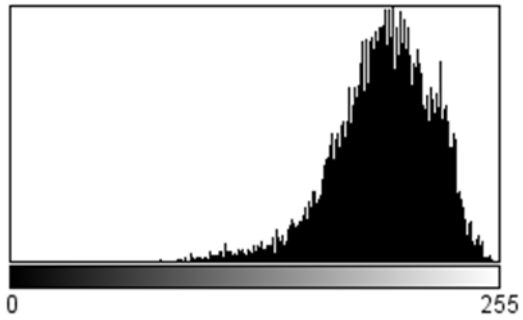	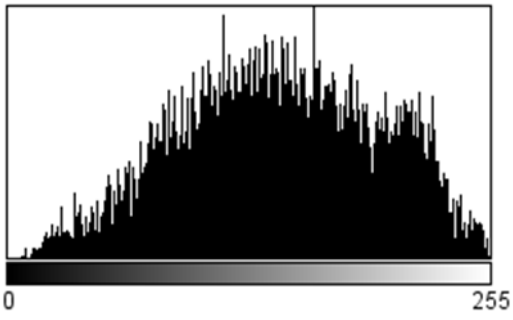
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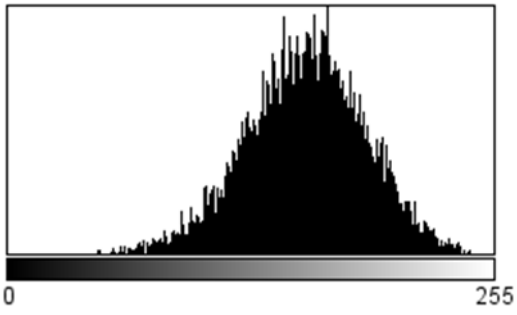	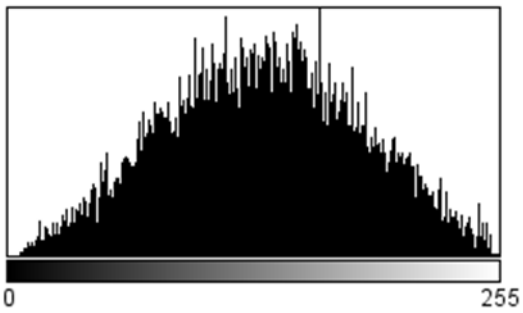
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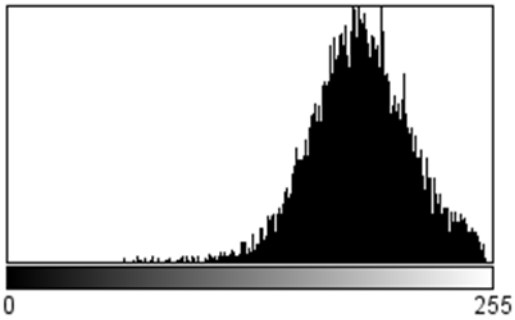
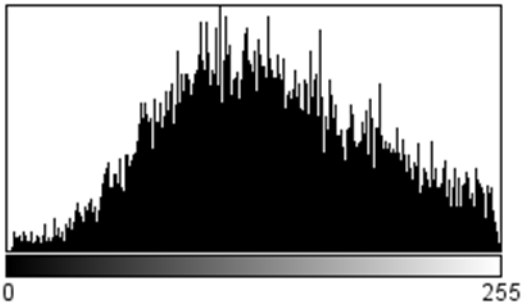
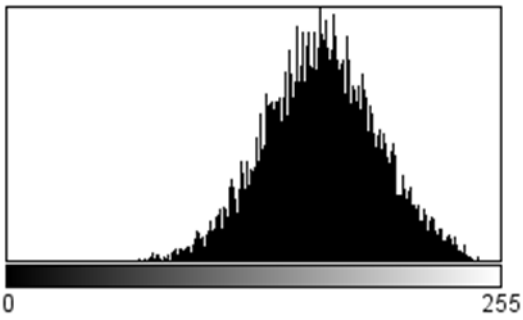
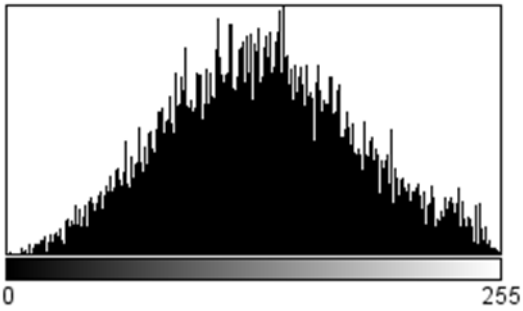
	
Histogram of Histopathological Image 8	Histogram of Histopathological image 8 after Enhancement
	
Histogram of Histopathological Image 9	Histogram of Histopathological image 9 after Enhancement

Figure 2. Represent the histogram of original images and images after enhancement

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Table 1. Show the values (Min, Max, Mean, SD, Mode) of original images and images after enhancement

Image Name	Size(R, C)	Count	Min	Max	Mean	SD	Mode
Image 1	100, 100	10000	35	248	174.67	24.05	173
Image 1 after enhancement	100, 100	10000	1	254	131.67	41.66	122
Image 2	100, 100	10000	39	233	157.73	32.94	170
Image 2 after enhancement	100, 100	10000	4	253	143.18	50.12	155
Image 3	100, 100	10000	75	254	199.41	18.84	202
Image 3 after enhancement	100, 100	10000	1	255	132.09	44.46	105
Image 4	100, 100	10000	32	254	184.49	28.93	183
Image 4 after enhancement	100, 100	10000	1	255	136.77	48.26	131
Image 5	100, 100	10000	40	253	197.51	21.83	209
Image 5 after enhancement	100, 100	10000	0	255	141.47	55.20	195
Image 6	100, 100	10000	78	253	194.56	26.61	200
Image 6 after enhancement	100,100	10000	7	255	142.91	53.14	162
Image 7	100, 100	10000	40	248	156	31.88	168
Image 7 after enhancement	100, 100	10000	6	255	132.08	51.22	162
Image 8	100, 100	10000	44	252	185.34	27.5	182
Image 8 after enhancement	100, 100	10000	2	255	135.54	54.15	110
Image 9	100, 100	10000	50	251	162.43	29.6	162
Image 9 after enhancement	100, 100	10000	1	255	131.73	49.31	143

CONCLUSION

The research yielded the following results:

1. Image enhancement is a direct application of computational mathematics. Through computational mathematics, we can solve complex problems relatively quickly.
2. Medical image enhancement is an important image processing technique that helps specialists detect diseases and increase diagnostic accuracy.
3. Histogram equilibrium is widely used methods utilized in medical image for enhancement, as it clarifies and highlights unclear details, thus facilitating image analysis and disease diagnosis.
4. The most common organ-specific autoimmune conditions is autoimmune thyroid disease [23].

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