NTU Journal of Pure Sciences
Double Blind Peer Review Journal
ISSN: 2789-1089 EISSN: 2789-1097
Available Online: https://journals.ntu.edu.iq/index.php/NTU-JPS
Volume 4, No. 4, 2025

Original Article

Cutting Digital Images Using Curvelet Transform Millimeter

Abdulwahhab F. Shreef [a, *], Ahmed H. Saleh [a], Mohammed F. Ibrahim [a]

[a] Scientific Affairs Department, Northern Technical University, Mosul 41001, Iraq.

*Corresponding: Abdulwahhab F. Shreef, Email: abdalsied2017@ntu.edu.iq

Received: 23 July 2024
Accepted: 16 April 2025
Published: 12 January 2026
DOI: https://doi.org/10.56286/3eeshw92
Article No: 1048

© 2025 The Author(s). Published by NTU Journal of Pure Sciences. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license: https://creativecommons.org/licenses/by/4.0/

ABSTRACT

Image fragmentation into non-overlapping areas where the boundaries contribute significantly in the utilization of the image in many areas of study like medical, imaging, and military technology. Curvelet transform method is used here due to its great possibilities and many advantages in preserving the borders of the image and its edges, in addition to its ability to capture information for these borders or soft edges in the image which helps draw the geography of territory and borders that contradict each other but within the limits of the overall picture. This research suggests the use of a normalized cut algorithm, which depends on fragmenting the selected image that was selected and converted using curvelet transform This provides a clear definition of the edges in the image and is cut into a number of sections required after calculating the eigenvalue and eigenvector by divide The image to several sections required, the section to be studied in detail after being partially deducted from the original image identified and distinguished by the proposed algorithm the image which can give high-quality discrimination and accuracy, which is intended to this conclusion.

Keywords: Curvelet Transform, Image Segmentation, Normalized Cut Algorithm, Edge Detection, Digital Image Processing

Introduction

The digital image is used in many fields of science for the purpose of clarification, approximation, and distinction. Digital image management in the computer is based on a two-dimensional array and is represented by (0 and 255). Each digital image consists of a number of points called (pixel) The smallest unit of the image. and since each image is based on a matrix that contains rows and columns. The more the number of points increases the clearer the image becomes the digital image can be divided into:

1. Binary Image: An image that contains only black and white colors and each pixel carries either a zero or one.
2. Grayscale image: It consists of black and white color with the gradient process of gray colors, and its intensity is represented by numbers from 0 to 255.
3. Color Images: digital images that support colors by assigning three boxes to each pixel to determine the intensity of the three primary colors (red, green and blue).

processing digital image focuses on understand, recognize and distinguish the features of the digital image that are useful in many fields to identify the shapes and patterns that help in many areas of life, especially medical, robot control, as well as military fields.

One of the most common ways to process digital images is to cut them into multiple parts that contradict one another within the limits of the overall image to study each part separately and understand the details it contains [1].

Gital photo cutting

Cutting the Image has become one of the important and widely used field of broad application in recent years. Segmentation of important information of the digital image into a number of non-overlapping areas that contradict one another within the limits of the overall image. Image segmentation is of great importance in many areas of digital image processing, signaling, and computer vision. Segmentation is the process of separating an image into homogeneous regions and defining them or finding its external features. There are three criteria to evaluate a particular fragmentation method [2]:

a. accuracy and reproducibility
b. Quality: consistent with the truth
c. Efficiency: The time required to complete the cutting process.

The fragmentation is based on dividing the image into areas that represent objects or areas of meaning in the image, which can be for example, people, cars, buildings or the sky. it has two goals:

1. The first goal is to cut the image into multiple parts so it will be possible to analyze the smallest detail.
2. The second objective is to represent it in a more efficient way.

The regions extracted from the fragmentation must be uniform with respect to some interchangeable characteristics such as color and density, and the regions adjacent to each other must be different with respect to these characteristics, that is, they differ from each other, but within the limits of the overall picture [3].

Research aim

This study is proposing to cut the image and discover its internal features and various details by adopting the curvelet transform field which gives a clear edge definition of the image higher than any other filter such as (Sobel, canny, Jacobi). And an eigenvector for the selected image, for which a curvelet transform was calculated, and the results extracted from the images were studied after the cut parts were dropped on the original image to enlarge it and view its details. for the fragmentation purpose, the nature cut algorithm has been used through the calculation the eigenvector and eigenvalue of the image that its curvelet transform was calculated.

Curvelet transform

It is a technique that represents images with a number of edges and curves better than other wavelet transformations.

As the length and width of the Curvelet can be obtained through the equation (1). [5].

Width = (length) 2……1

As the curvelet transformation divides the image frequencies into dyadic coronae which are divided into sub-sections as show in Figure 1 [4].

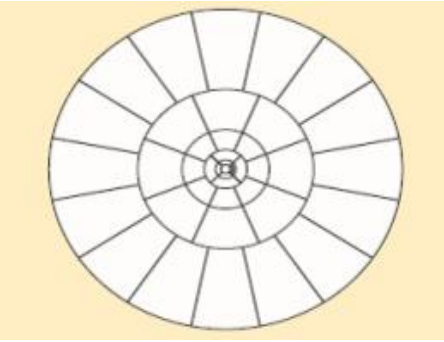


Figure 1. dyadic coronae

Since the discrete curvelet transform is implemented using the wrapping algorithm, where the k curvelet transform parameters are defined for each scale and angle in the Fourier transform the field by the formula (2) [4]:

$$Ck\ (r,\theta) = 2\text{-}3k/4\ R(2\text{-}k\ r)\ A(2\ (k/2)\ 2\ \prod .\theta) \ldots .\ 2$$

When Ck is the number of images produced depending on the radius (radial(R) and the angle A.

Related business

Image segmentation is defined as dividing images into disjointed groups with similar features that depend on density, homogeneity, or image features. Image cropping [8].

Currently, the image Fragmentation based on the graph (grah cuts). It is considered one of the effective tools for dividing the image under the assumption of homogeneity between the pixels and the adjacent pixels. The image is converted into undirected graphs based on the weights of the edge between the points of the image. The aim of this process is to divide while preserving some of the spatial structure of the image itself [10][9].

Ralized cut algorithm

The following are the steps of the natural fragmentation algorithm adopted in the research Figure (2) [2]:

1. Enter the image input from the Curvelet transformation and then calculate the weight graph of the plot G(V,E) using equation (3):

$$W_{i,j} = e^{\frac{-\|F(i)-F(j)\|_2^2}{I^{\sigma 2}}} * \begin{cases} e^{\frac{-\|X(i)-X(j)\|_2^2}{X^{\sigma 2}}} & if\ \|X(i)-X(j)\|_2^2 < r \quad .....3 \\ 0\ other\ wise \end{cases}$$

It may extend

X(i) is the spatial position of the point i, r which is equal to the largest possible distance between i and j in the segment.

F(i) represents the property vector and is defined as:

F(i)=1 the point of intersection of the sums.

F(i)=I(i) Density value of the intersection of the gray image.

where F(i) = [|I * f1|, ..., |I * fn|] represents the DOOG filters in different directions.

The weights were shown on the edges by tying each two knots, depending on the similarity between them.

2. Calculating the eigenvalue, the following formula was adopted:

$$|X - IN| = 0$$

Where

X: square matrix

I:Egien value

N : Identity matrix

3. Use the second smallest value of the eigen to split the diagram into two parts.
4. Determine whether the current part is divided into other parts or remains as it is.
5. The proposed algorithm in the research

The steps involved in the study for digital image fragmentation:

- Input the digital image after it is converted to gray form.
- Input the required number of clips S to cut the image into.
- Calculate the edges of the image using a curvelet transformation.
- Apply the naturalize cut algorithm after calculating the eigenvalue and eigenvector of the image.
- Configure the required clips in which the number of clips is determined by entering it in advance (S).
- Choosing the desired clip if it is done by entering it manually after watching the clips and selecting the required clip from them.
- Drop the selected clip on the original image for the purpose of enlarging the required clip.
- View the resulting image.

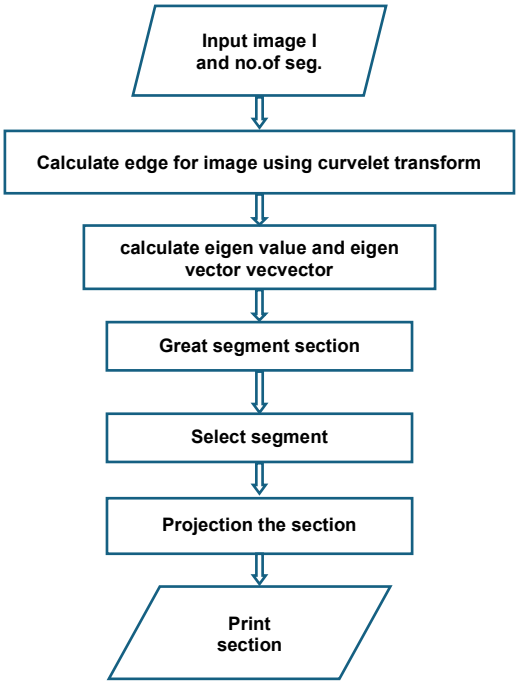


Figure 2. The proposed algorithms

An applied example of the proposed algorithm

In this research, the curvelet transformation was applied to the selected image to calculate its edges after it was converted to gray as in Figure (3).

Figure 3. The original image

Through Figure (4), which shows the images resulting from the application of the curvelet transformation algorithm to the selected image from the curvelet transformation, it represents three levels of the image resulting from the transformation.

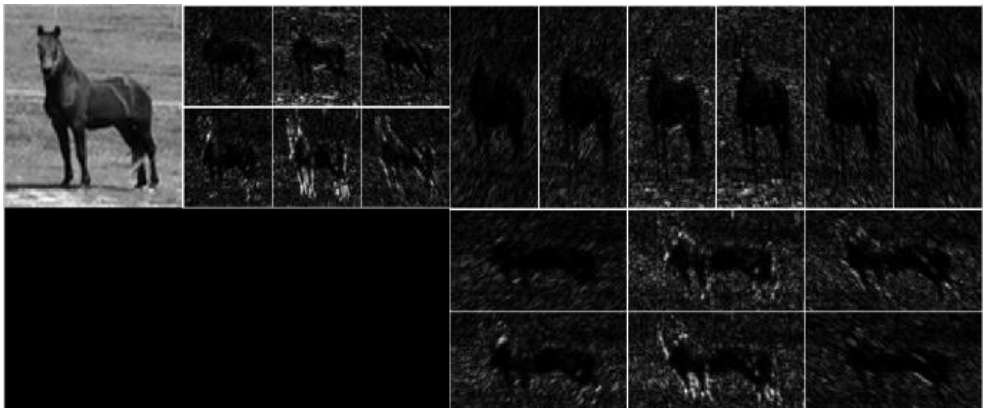
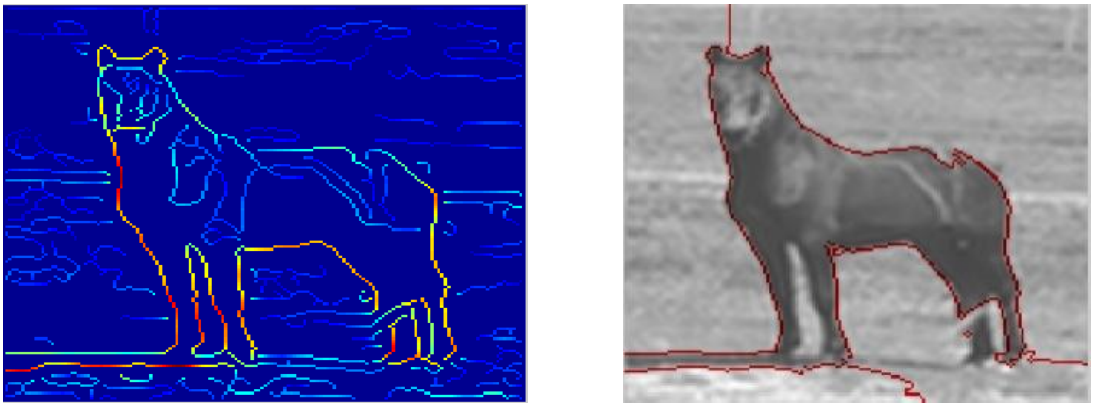


Figure 4. Applied curvelet transform

And through figure (5, a) which shows the eigen value and figure (5, b) which represents the number of sections of the selected image, in which the image was cut into five selected segments in detail.



a b

Figure 5. a. eigen value, b. iamge segment

Figure (6) represents the selection of the required clip and its projection onto the entered image for the purpose of enlarging it and studying its details more precisely, As all five clips were selected and dropped on the original image. Figure (6) Projecting the clips onto the original image.

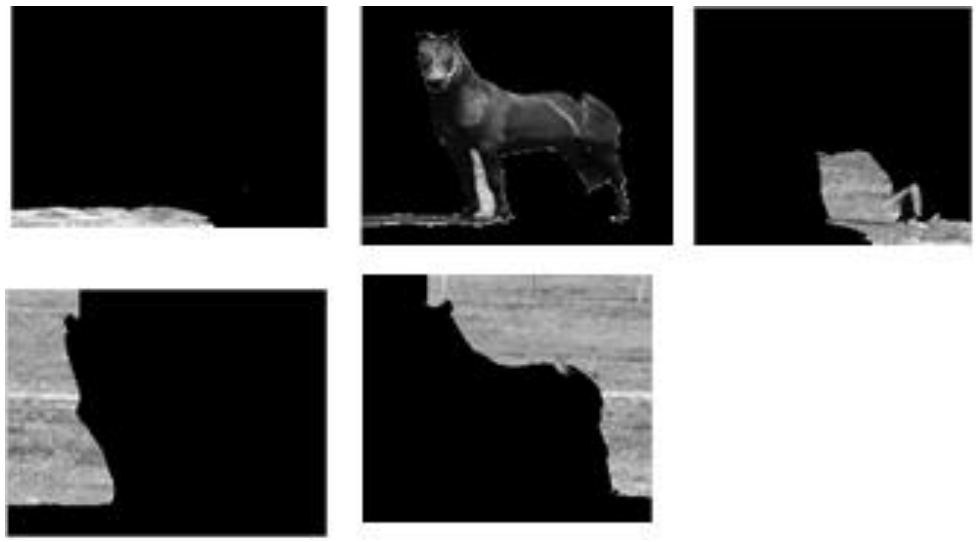


Figure 6. Projection the section in image

Through Figure (7), a group of various images of various shapes (BMP, JPg, png) with a size of 256 * 256 were cut. The images in Figure (7.a) represent the original BMP image and cut it into 10 pieces, while the image b. The Jpeg image is cut into 15 pieces, while the c is the PNG image is cut into 20 pieces.

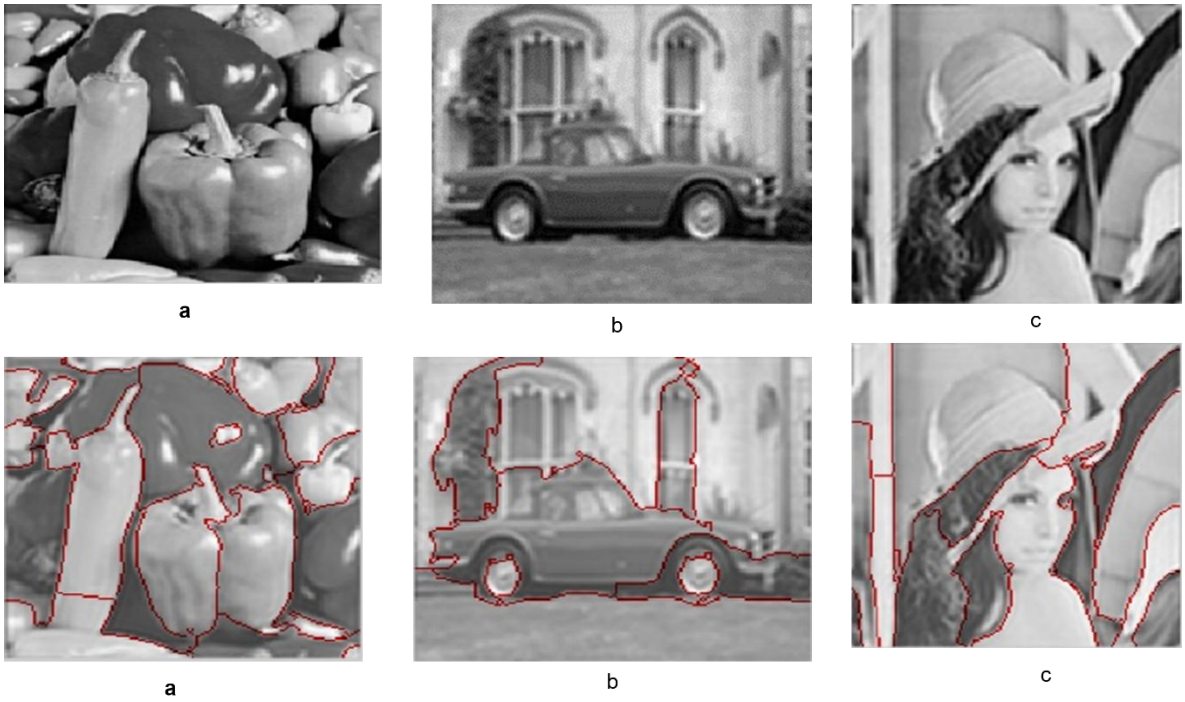


Figure 7. a image seg 10 pieces, b. image seg 15 pieces, c. image seg 20 pieces.

Comparison between proposed algorithm and wavelet transform method

To show the feasibility of the proposed method in this research, a comparison was made between the results in the case of using the curvelet cutting algorithm and using the wavelet transform. The results showed the feasibility of using the curvelet transform method as in the figure (8), since the the Figure (8.a) is observed in the original image, and after applying the proposed algorithm in the figure (8.b 1,2,), we notice that it has been classified into five regions while preserving the interconnected regions that fall within the same object, while We notice from the figure (8.c 1,2) that some of the spokes were separated from each other, which were located in another object.

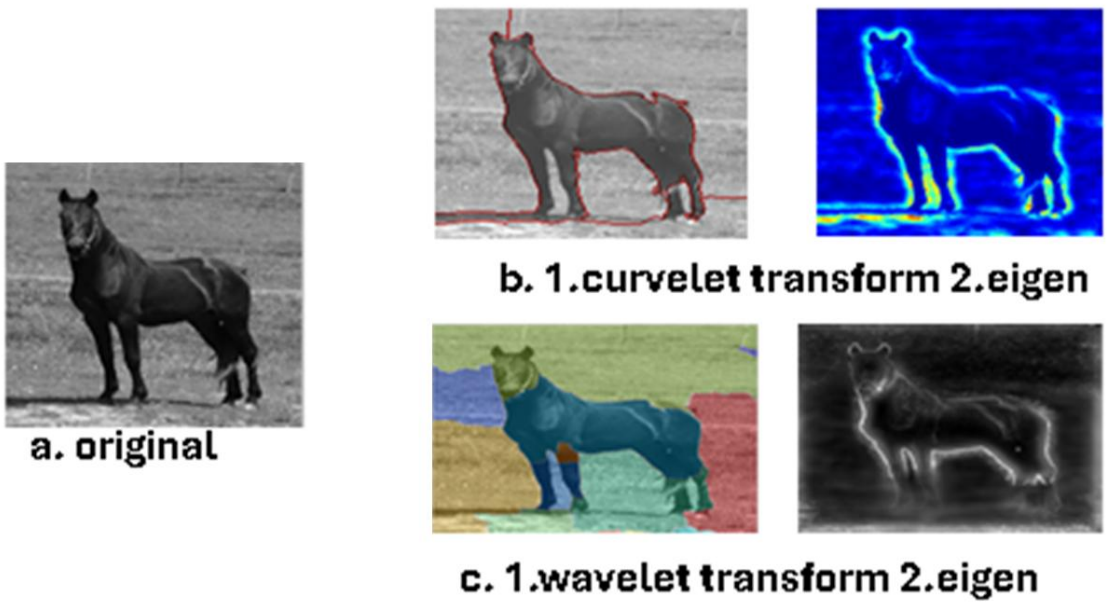


Figure 8. Compare the propose and wavelet transform value.

Conclusion

According to the results, it can be noted that adopting a curvelet transform to obtain the edges of the image, which gave a clear definition and high stability in preserving the edges of the image, is better than other filters (Sobel, canny, Jacobi) in particular its dealing with soft edges, as it was adopted by many researchers With medical photos, aerial photos, and military photos, The adoption of the selected image from this to change and its insertion on the naturalize cut algorithm provided stability for good fragmentation of the selected image into a number of selected segments this reduced the time required to cut the image which is set into a detailed study after selection whose details can be studied in detail after the segment required to be studied is selected.

Cut and fragment image processing into areas and borders that are not overlapping and intertwined with each other greatly contributes positively in many medical, photographic, and military fields. In the present paper, a method based on the curvelet transformation is proposed to be due to its great capabilities and advantages in preserving the borders and edges of the image. In addition to that this model has the ability to capture information for borders or smooth edges in the image in order to delineate the geography of a region and borders that differ from one another, but within the limits of the overall image. The research suggests using the normalized cut algorithm, which depends on cutting the selected image and transformed by adopting a curvelet transform, this gives a clear identification of the edges in the image and it is cut into a number of required segments after calculating the eigenvalue and eigenvector through which the segmentation is done into several required segments. The segment to be studied in detail after being partially deducted from the original image can be distinguished by the proposed algorithm that can provide high-quality and accurate distinctions.

Conflict of Interest

The authors declare no competing interests.

References

[1] https://ar.wikipedia.org/wiki/digital image processing.

[2] خليل ابراهيم السيف ، كرم مؤيد عبدالله. (2011). تقطيع الصور الطبية بالاعتماد على التحويلات الكنتورية. مجلة الرافدين لعلوم الحاسبات والرياضيات المجلد (٨ العدد(2)٢٠١١ .)

[3] عز الدين محمود النعيمي. (2009). استخدام تقنيات الهندسة الكسورية في تحليل نسجات الصور الطبية. رسالة ماجستير ، كلية علوم الحاسبات والرياضيات ، جامعة الموصل.

[4] Ying L., Demanet L, and Candes E,2000. 3D Discrete Curvelet Transform Applied and Computational Mathematics, MC 217-50, Caltech, Pasadena, CA.

[5] Jean-Luc Starck, Fionn Murtagh, Emmanuel J. Candès, and David L. Donoho ,2003. Gray and Color Image Contrast Enhancement by the Curvelet Transform, IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 12, NO. 6, JUNE 2003. [1] Tedesco, P., Beraldo, P., Massimo, M., Fioravanti, M.L., Volpatti, D., Dirks, R. and Galuppi, R. (2020) Comparative therapeutic effects of natural compounds against *Saprolegnia* spp. (Oomycota) and *Amyloodinium ocellatum* (*Dinophyceae*). *Front. Vet. Sci*., 7(1) 83.

[6] Setarehdan, S. K. & Singh, S, 2012. Advanced algorithmic approaches to medical image segmentation: state-of-the-art applications in cardiology, neurology, mammography and pathology. Springer London.

[7] Batenburg, K J.; Sijbers, J. (June 2009). "Optimal Threshold Selection for Tomogram Segmentation by Projection Distance Minimization" (PDF). IEEE Transactions on Medical Imaging. 28 (5): 676–686. doi:10.1109/tmi.2008.2010437.

[8] R. Nock and F. Nielsen, Statistical Region Merging, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol 26, No 11, pp 1452-1458, 2004.

[9] Leo Grady (2006): "Random Walks for Image Segmentation", IEEE Transactions on Pattern Analysis and Machine Intelligence, pp. 1768–1783, Vol. 28, No. 11.

[10] Jianbo Shi and Jitendra Malik (2000): "Normalized Cuts and Image Segmentation", IEEE Transactions on Pattern Analysis and Machine Intelligence, pp 888-905, Vol. 22, No. 8

[11] Rafael Gonzalez, Richard Woods.“ Digital Image Processing“, Pearson Education Limited; 4th edition (November 2, 2017).

[12] Raju*, T. Sreenivasulu Reddy and M. Sivasubramanyam, 2016, "Denoising of Remotely Sensed Images via Curvelet Transform and its Relative Assessment", Sri Venkateswara University College of Engineering, S.V. University, Tirupati, A.P., India, Procedia Computer Science 89, 771 – 777.

[13] T. Ahmad, Li X., 2012, "An Efficient Curvelet Based Miso Image Super Resolution Algorithm Using Kurtosis As Input", Journal Of Computational Information Systems 8:22 , 9415-9423.

[14] Ren , J. Yang., 2012, "A Novel Color Microscope Image Enhancement Method Based On HSV Color Space And Curvelet Transform", IJCSI International Journal Of Computer Science Issues, Vol. 9, Issue 6, No 2, ISSN: 1694-0814.

[15] Abdullah, M. Ali, I. Al_Barazanchi, 2019, “Improving face recognition by elman neural network using curvelet transform and HSI color space”, Periodicals of Engineering and Natural Sciences, Vol.7, No.2, June 2019, pp.430-437, ISSN 2303-4521.

[16] Usama Sayed, M. A. Mofaddel, W. M. Abd-Elhafiez , M. M. Abdel-Gawad, " Image Object Extraction Based on Curvelet Transform", Applied Mathematics & Information Sciences An International Journal, Appl. Math. Inf. Sci. 7 No. 1, PP 133-138, 2013.

[17] N. Seo, “normalized cuts and image segmentation", http://note.sonots.com/SciSoftware/NcutImageSegmentation.html#matlab ,Oct., 2006.

[18] P. K. Parlewar , K. M. Bhurchandi ," A 4-quadrant Curvelet Transform for Denoising Digital Images”, International Journal of Automation and Computing, DOI: 10.1007/s11633-013-0715-z, 2013.