

USING FUZZY LOGIC TO OBJECT RECOGNITION IN IMAGE

Shahla Hazim Ahmed Kharofa¹

¹Department of Dental Basic Sciences, College of Dentistry, University of Mosul, Mosul, Iraq

Email: shahlakharofa@uomosul.edu.iq, <https://orcid.org/0000-0002-9711-5992>

Ali Tariq Kalil Al-khayyat²

²Department of Dental Basic Sciences, College of Dentistry, University of Mosul, Mosul, Iraq

Email: ali.khalil987@uomosul.edu.iq, <https://orcid.org/0000-0003-0590-4001>

Abstract: At the peak of technological progress, we began to see in our daily lives many applications that depend on artificial intelligence, and in the medical field, artificial intelligence provides support and assistance to doctors and medical workers in making sound decisions that help the doctor and the person concerned in the process of discovering and identifying the disease.

Fuzzy logic is one of the modern techniques used to find a solution to many problems and recognize objects within the image, and in this research, fuzzy logic was used to extract features from the density values within the image, and by using different density values, rules are formed in fuzzy logic.

Four medical images (tumor images) were used and the proposed algorithm was implemented, which leads to clear recognition of the object (tumor) within the image, and using the Image J system, the tumor area was found.

Keywords: Artificial Intelligence, Computer Vision, Object Recognition, Fuzzy Logic, Rules in Fuzzy Logic.

1. Introduction

In today's technology and internet era, the study of intelligence techniques is growing developing demand. Computer vision aims to recognize objects (tumors) within an image [1].

Object recognition is a method for defining objects in images, the general structure of object recognition is represented by several points, the most important of which is acquiring and processing information, then extracting distinctive characteristics and finding common characteristics within the specific shape or pattern [2].

The main goal of the objects recognition in an image is to make the objects in the resulting image more appropriate than the original image, and it depends greatly on the issue to be applied. This process results in an increase in the amount of information that can be interpreted visually from the input data [3]. The process of distinguishing a digital image into several sectors has the primary goal of simplifying the image or changing the representation of an image to something that is more useful and easier to analyze. In other words, giving a label to each group of pixels that has certain characteristics. Object recognizing has many uses, especially in the medical field, if the input data is large, complex and is required to help diagnose a specific case disease [4]. Dealing with gray scale images is more convenient than true color images, so it is more flexible and using by the researchers [5]. In this research, the focus was on the intensity values present in

the image. The gray level images uses a pixel values ranging from 0 to 255 to represent the light intensity [6], it's for each pixel is a single value for a gray level image. Intensity value is the basic information stored inside pixels, and it is the most common and important feature used in object recognition [7]. In this research, fuzzy logic was used to objects recognition (tumor) from the intensity values inside the medical image.

Many studies have addressed this topic, including:

- Soobia Saeed et al. in 2019 introduced a new method to detect the brain tumors by using image processing [8]
- K. Vaishnavi et al. in 2023 proposed a new method to object detection using deep learning to recognize object in images [2]
- Narayana Challa in 2023 proposed a method to executed the artificial intelligence for object detection [3]
- Abdelraouf Ishtaiwi et al. in 2024 proposed a method to detection Brain Tumor by using different yolo versions models [9]

2. Methodology

In this research, artificial intelligence represented by fuzzy logic was used to find the tumor area in medical images

2.1 Artificial Intelligence

Artificial intelligence is the science that searches for effective methods to simulate human intelligence digitally and to find optimal methods to understand how the brain works, and how it responds to various circumstances and situations with great flexibility. It is also defined as the ability of a calculator to do things that require intelligence, and research's aims to the artificial intelligence increases the ability of computers to collect information, learn from it, understand it, and gain experience by carefully, in addition to using mathematical laws provided to the computer then building self-knowledge, so that in the end the machine is able to respond to the various variables with complete flexibility and with good timing and duration in various situations and surrounding circumstances [10].

Artificial intelligence has created a qualitative breakthrough in all areas of life over the past few. Almost no field is devoid of employing applications of artificial intelligence, especially its multiple uses in the medical field, as it has been used to diagnose diseases better and faster than humans and perform simple and complex surgical operations [11]. It helps people with hearing and visual disabilities and the elderly in multiple ways, due to its ability to perform complex tasks thanks to its ability to analyze large data and extract and distinguish patterns. It benefits from the data and information available to it and learns from it. It possesses intelligent algorithms that can extract patterns and make independent inferential decisions. It also relies on training new models using known data to solve problems and improve performance. Artificial intelligence has become the most important foundations on which the technology industry is based by building machine that can be perception and rational and logical thinking so that computer think like humans.

Today, it is also considered a valuable partner for researchers, doctors, and innovators in achieving new innovations and expanding the boundaries of knowledge [12].

2.1.1 Fuzzy Logic

Fuzzy logic is the most intelligent technologies that have a high ability to find appropriate solutions for many different applications, which are subject to recognized scientific frameworks and rules. Through it, clear conclusions can be obtained [13]. This is done by simulating human capabilities in making appropriate decisions as well as the process of logical reasoning, which relies on rules built from available facts through certain conditions on which the entered data on based to obtain the required results [14-16].

Fuzzy logic is used in many medical, industrial, computer science applications and fields that require decision making on a specific issue. Its can find a method to formulate models to solve very complex and ambiguous issues that cannot be analyzed using traditional methods [17-19]. It has the ability to estimate and guess without relying on mathematical and statistical models, thus enabling the data analyst and users to make the appropriate decision in solving complex issues through continuous experiments [20, 21].

2.2 Brain tumors

The brain is the main control center over other parts of the body. There are several types of brain tumors. Some of them are benign. This means that any excess cell growth forms a mass. But the others are malignant. This means that the mass is made up of abnormal cells that continue to spread and attack other tissues [8, 22].

The main causes of brain tumors are usually unknown, but genetic and hereditary factors may play a major role [9, 23]. It may also be caused by exposure to dangerous chemicals or exposure to radiation for long periods [24]. The disease is diagnosed through a medical examination in addition to a computed tomography or magnetic resonance imaging [25]. This is done by taking a biopsy, and medical images can help the doctor and specialist diagnose the patient's condition and the patient's response to treatment. It also depends on the area and size of the tumor and the time period for its detection [22, 26].

2.3 Proposed Algorithm

In this research, the following algorithm was proposed for tumor recognition in medical images by using fuzzy logic:

1. Read gray level image A (tumor image)
2. The size of tumor image (100, 100)
3. Show the tumor image
4. Normalized tumor image by divide each pixel in to 255
5. Executing Rules of Fuzzy Logic

For $i=1:100$

For $j=1:100$

Rule1: If $(A(i,j) == 0)$ Then $R(i,j) = 0$: $k1=k1+1$: Print(" Black")

Rule2: If $(A(i,j) > 0$ and $A(i,j) \leq 0.2)$ Then $R(i,j) = 0.2$: $k2=k2+1$: Print(" Very Dark")

Rule3: If $(A(i,j) > 0.2$ and $A(i,j) \leq 0.4)$ Then $R(i,j) = 0.4$: $k3=k3+1$: Print("Dark")

Rule4: If $(A(i,j) > 0.4$ and $A(i,j) \leq 0.6)$ Then $R(i,j) = 0.6$: $k4=k4+1$: Print("Gray")

Rule5: If $(A(i,j) > 0.6$ and $A(i,j) \leq 0.8)$ Then $R(i,j) = 0.8$: $k5=k5+1$: Print("Brightness")

Rule6: If $(A(i,j) > 0.8 \text{ and } A(i,j) \leq 0.996)$ Then $R(i,j) = 0.996$: $k6=k6+1$: Print(“Very Brightness”)

Rule7: If $(A(i,j) == 1)$ Then $R(i,j) = 1$: $k7=k7+1$: Print(“White”)

End

End

6. Renormalized tumor image by multiply each pixel to 255 and round result
7. Print $k1, k2, k3, k4, k5, k6, k7$
8. Find the Rate of each group ($k1, k2, k3, k4, k5, k6, k7$) by divide each group to the summation of all groups
9. Print result image R
10. Execute some operation to illustrated the tumor Image
11. Convert tumor image R to the binary image
12. Remove unnecessary information from tumor image
13. Using Image J system to find the Area of the tumor
14. Print tumor Image
15. End

3. Results and Discussions

The proposed algorithm was executed on four medical images of brain tumor disease, as shown in Figure 1. Seven rules were built using fuzzy logic and based on the intensity values present in the original image. The number of pixels and the rate of all intensity values that fall within a specific range were found according to the rules of fuzzy logic, as shown in Table 1.

The size of image were processed is equal 100 rows and 100 column, and the sum of the ratio of all intensity values was equal to 1.

The Histogram was drawn, and this helped in recognize the tumor area better, as shown in Figure 2. Clarification of the resulting image was performed and it was converted to the binary system and removing unnecessary information. By using Image J system the tumor area was determined and find its area as shown in Table 2.

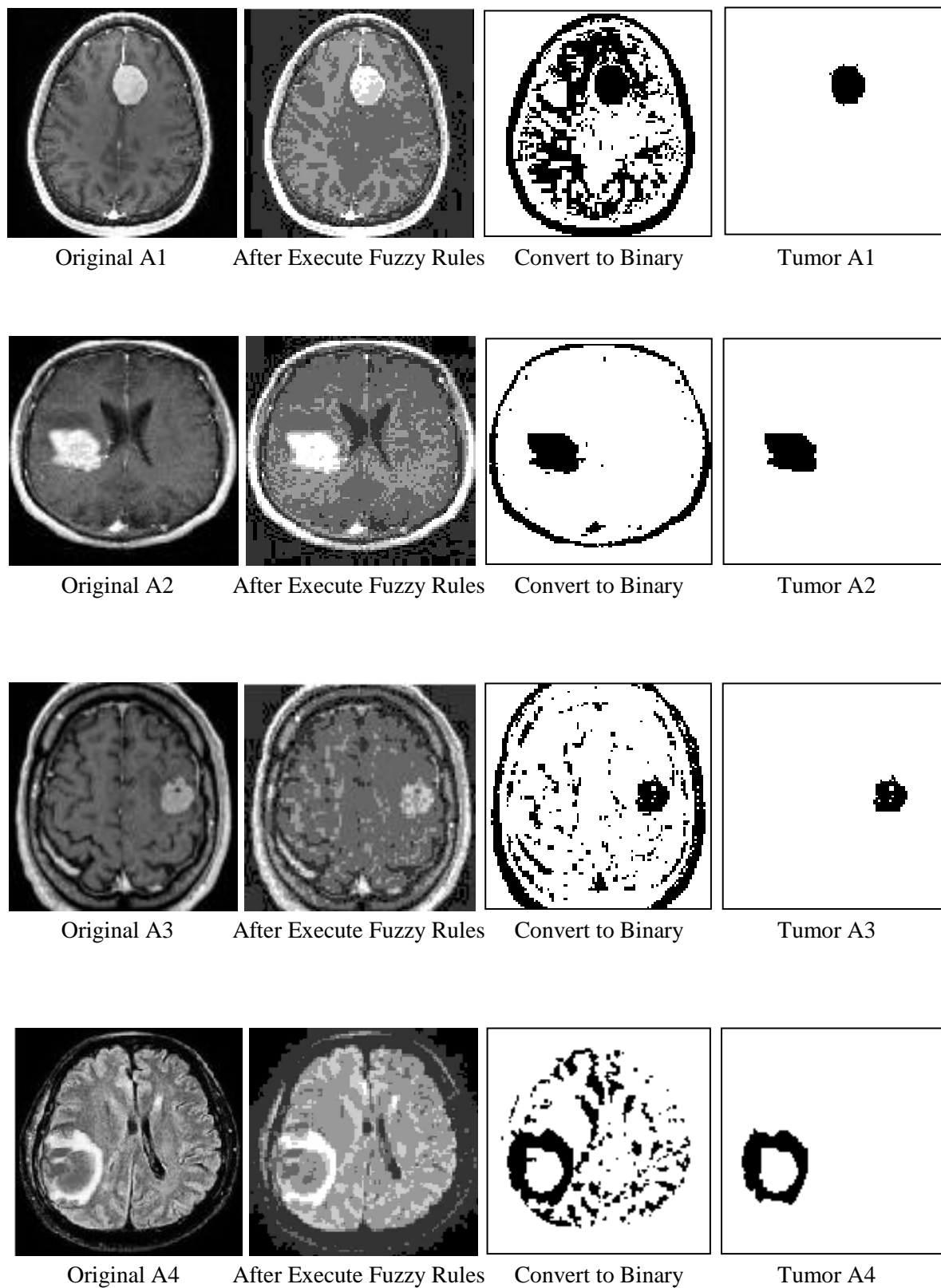


Figure 1: Represent the application of the proposed algorithm on four brain tumor images

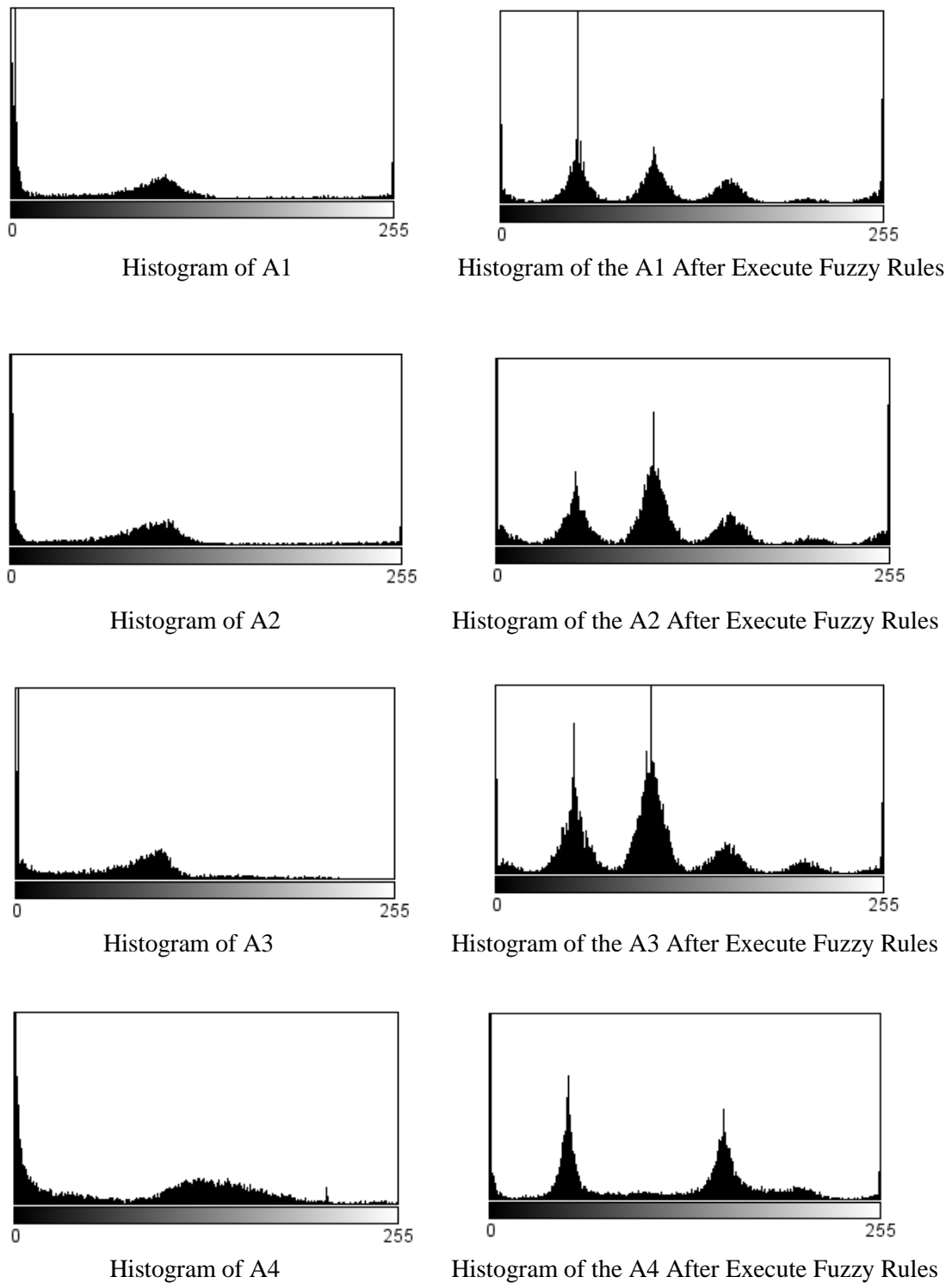


Figure 2: Represent the Histogram of original image and Histogram after execute fuzzy rules of four images

Table 1: Represent The Results of Execution proposed algorithm four images

Image Name	Execute Rules in Fuzzy Logic	Status	No. of Pixels	Rate
Image 1 (A1)	Rule1	Black	757	0.0757
	Rule2	Very Dark	3487	0.3487
	Rule3	Dark	2846	0.2846
	Rule4	Gray	1785	0.1785
	Rule5	Brightness	355	0.0355
	Rule6	Very Brightness	566	0.0566
	Rule7	White	204	0.0204
Image 2 (A2)	Rule1	Black	1017	0.1017
	Rule2	Very Dark	2413	0.2413
	Rule3	Dark	3816	0.3816
	Rule4	Gray	1651	0.1651
	Rule5	Brightness	399	0.0399
	Rule6	Very Brightness	608	0.0608
	Rule7	White	96	0.0096
Image 3 (A3)	Rule1	Black	541	0.0541
	Rule2	Very Dark	3066	0.3066
	Rule3	Dark	4333	0.4333
	Rule4	Gray	1285	0.1285
	Rule5	Brightness	575	0.0575
	Rule6	Very Brightness	194	0.0194
	Rule7	White	6	0.0006
Image 4 (A4)	Rule1	Black	1053	0.1053
	Rule2	Very Dark	3372	0.3372
	Rule3	Dark	850	0.0850
	Rule4	Gray	3270	0.3270
	Rule5	Brightness	1215	0.1215
	Rule6	Very Brightness	240	0.0240
	Rule7	White	0	0

Table 2: represent the area of tumor of four brain tumor images

Image Name	A1	A2	A3	A4
Area of Tumor	219	329	161	669

4. Conclusions:

The research concluded the following important points:

- The use of artificial intelligence, especially fuzzy logic, has a major role in the medical field because of its great importance in helping doctors and specialists diagnose the patient's condition.
- Detecting the tumor in the early stages has a major role in responding to treatment. The proposed algorithm can be applied to the patient several times to determine his health condition. It is applied after receiving the necessary treatment in order to know the extent of the patient's response to treatment. The importance of this stage lies in finding information about the tumor, represented by the area of the tumor.

- The research helped to find an intelligent method that makes it easier for researchers, doctors, and specialists to distinguish and recognize tumors by building rules in fuzzy logic based on the intensity values present in medical images, as the original image is entered, depend on the rules that were built in fuzzy logic, object (tumor) is recognize. Within the image, the resulting image is then converted to the binary system and unnecessary information is removed from the image. The tumor then determined and its area is found using the Image J system.

5. Acknowledgments

The authors thank the University of Mosul college of Dentistry for the help provided to get better the quality of the research.

6. References:

1. W. Victor and T. Lucas, (2018). Computer Vision and Image Processing: A Paper Review, *International Journal of Artificial Intelligence Research*, vol. 2, no. 1, pp. 28-36, <https://doi.org/10.29099/ijair.v2i1.42>
2. V. K., G. P. Reddy, T. B. Reddy, N. C. S. Iyengar and S. Shaik, (2023). Real-time Object Detection Using Deep Learning, *Journal of Advances in Mathematics and Computer Science*, vol. 38, no. 8, pp. 24-32, <https://doi.org/10.9734/jamcs/2023/v38i81787>
3. C. Narayana, (2023). Artificial Intelligence for Object Detection and its Metadata”, *International Journal of Artificial Intelligence & Machine Learning (IJAIML)*, vol. 2, no. 1, pp. 121-133, <https://doi.org/10.17605/OSF.IO/FG3SQ>
4. Y. Younis and K. I. Alsaif, (2021). Embedded Descriptor Generation in Faster R-CNN for Multi-Object Trackin, *Raf. J. of Comp. & Math's.*, vol. 15, no. 2, pp. 91-102, <https://doi.org/10.33899/csmj.2021.170013>
5. M. M. Syukri, A. Jumaat and R. Embong, (2024). Partitioning intensity inhomogeneity colour images via Saliencybased active contour, *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 14, no. 1, pp. 337-346, <https://doi.org/10.11591/ijece.v14i1.pp337-346>
6. A. G. M. T. Kasim, A. A. Abdulmajeed and H. E. Solayman, (2021). Significance of Enhancement Technique In Segmentation of Image and Signal: A Review of the literature, *Journal of Education and Science*, Vol. 30, No. 4, pp. 15-27, [doi: 10.33899/edusj.2021.129161.1134](https://doi.org/10.33899/edusj.2021.129161.1134)
7. A. S. Hussein and M. M. M. Maadi, (2023). Approach to Grayscale Image Enhancement by Noise Reduction, *Journal of Al-Qadisiyah for Computer Science and Mathematics*, vol.15, no. 4, pp. 20–27, <https://doi.org/10.29304/jqscsm.2023.15.41347>
8. S. Soobia, A. Abdullah and N. Jhanjhi, (2019). Investigation of a Brain Cancer with Interfacing of 3-Dimensional Image Processing, *Indian Journal of Science and Technology*, vol. 12, no. 34, pp. 1-6, <https://doi.org/10.17485/ijst/2019/v12i34/146150>
9. I. Abdelraouf, A. Ali, A. Al-Qerem and Yazan Alsmadi, (2024). Impact of Data-Augmentation on Brain Tumor Detection Using Different YOLO Versions Models , *The International Arab Journal of Information Technology*, vol. 21, no. 3, pp. 466-482, <https://doi.org/10.34028/iajit/21/3/10>
10. W. Pei, (2019). On Defining Artificial Intelligence”, *Journal of Artificial General Intelligence*, vol. 10, no. 2, pp. 1-37, <https://doi.org/10.2478/jagi-2019-0002>
11. G. N. Y. and J. S. M. Alneamy, (2023). Diagnosing Soft Tissue Tumors using Machine Learning Techniques: A Survey, *Journal of Education and Science*, vol. 32, no. 3, pp. 23-30, <https://doi.org/10.33899/edusj.2023.137706.1316>

12. M. D. Douglas and E. W. Brown, (2018). Artificial Intelligence in Medical Practice: The Question to the Answer??. *The American Journal of Medicine*, vol. 131, no. 2, pp. 129-133, <https://doi.org/10.1016/j.amjmed.2017.10.035>
13. Y. X. Xia and S. Hadjiloucas, (2023). Digital Filtering Techniques Using Fuzzy-Rules Based Logic Control, *Journal of Imaging*, vol. 9, no. 208, pp. 1-28 , <https://doi.org/10.3390/jimaging9100208>
14. I. S. Zuhair and G. M. Dhaher, (2022). Combination of Fuzzy Logic and Kriging Technique Under Uncertainty for Spatial Data Prediction, *Journal of Education and Science*, Vol. 31, No. 03, pp. 123-135, [doi/10.33899/edusj.2022.134166.1249](https://doi.org/10.33899/edusj.2022.134166.1249)
15. A. M. Muthana, Q. I. Ibraheem, (2023). Implementing Runge-Kutta Method of Sixth-Order for Numerical Solution of Fuzzy Differential Equation, *Journal of Education and Science*, Vol. 32, No. 3, pp. 147-155, [doi: 10.33899/edusj.2023.139083.1347](https://doi.org/10.33899/edusj.2023.139083.1347)
16. D. G. Mahmood and S. A. A. Altamir, (2023). Performance of Spatial Distribution Quality by Ordinary Fuzzy Kriging for Soil Properties under Uncertainty, *Al-Rafidain Journal of Computer Sciences and Mathematics (RJCM)*, vol. 17, no. 1, pp. 63-69, <https://doi.org/10.33899/csmj.2023.179473>
17. N. Al-Akhir , A. N. Mozumder , M. R. Haque , F. H. Sifat , K. R. Mahmud , A. Al Azad and M. G. Kibria, (2023). A deep learning approach for brain tumor detection using magnetic resonance imaging, *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 13, no. 1, pp. 1039-1047, <https://doi.org/10.11591/ijece.v13i1>
18. T. H. Saad, B.I. Khaleel, (2021). Detection of citrus diseases using a fuzzy neural network, *Journal of Education and Science*, Vol. 30, No. 5, pp. 125-135, [doi: 10.33899/edusj.2021.130928.1179](https://doi.org/10.33899/edusj.2021.130928.1179)
19. R. Fawziya and M. N. Al-Hamdan, (2022). Intelligence System for Multi-Language Recognition, *Journal of Education and Science*, vol. 31, no. 1, pp. 93-110, <https://doi.org/10.33899/edusj.2022.132223.1200>
20. O. S. Hussien , S. W. Shneen , B. I. Jameel , O. H. Hassoon , M. A. Fayad , F. B. Ismail, (2025). Fuzzy Logic Technique Based on Classification Function Application in Quality Control, *Journal of Engineering and Sustainable Development*, vol. 29, no. 1, pp. 105-111, <https://doi.org/10.31272/jeasd.2326>
21. S. Hafizh, M.Fajri, (2025). Fuzzy Logic Approach for Prediction of Health Index of Feeder Cable Based on Partial Discharge Parameter, *Journal of Universal Studies*, vol.5, no. 1, pp. 611-627, [doi: 10.59188/eduvest.v5i1.50376](https://doi.org/10.59188/eduvest.v5i1.50376)
22. T. Juhong, H. Peng and J. Zhou, (2021). MRI Brain Tumor Segmentation Using 3D U-Net with Dense Encoder Blocks and Residual Decoder Blocks, *Computer Modeling in Engineering & Sciences*, vol. 128, no.2, pp. 427-445, <https://doi.org/10.32604/cmescs.2021.014107>
23. H. Tasneem and J. S. M. Alneamy, (2022). Medical Images Classification Using Artificial Intelligence: A survey, *Journal of Education and Science*, vol. 31, no. 3, pp. 110-122, [https://doi: 10.33899/edusj.2022.133358.1224](https://doi.org/10.33899/edusj.2022.133358.1224)
24. S. H. , V.N. M. Devi, K. S. Sreekanth and J. Vinoo, (2023). Predictive Biomarkers of Brain tumor Lesions through Correlation of Histopathological changes with Metabolites by Magnetic Resonance Spectroscopy, *International Journal of Radiation Research*, vol. 21, no. 4, 769-777, [doi: 10.52547/ijrr.21.4.24](https://doi.org/10.52547/ijrr.21.4.24)
25. P. Sravanthi, S. Maloji and K. Manepalli, (2021). Evolution in diagnosis and detection of brain tumor – review, *Journal of Physics*, vol. 2115, no. 012039 , pp. 1-20, [doi:10.1088/1742-6596/2115/1/012039](https://doi.org/10.1088/1742-6596/2115/1/012039)
26. D. Alberto and A. Moiraghi, (2024). Recent Advances in the Diagnosis and Treatment of Brain Tumors, *MDPI*, vol. 14 ,no. 224, pp. 1-5, <https://doi.org/10.3390/brainsci14030>