International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING

ISSN:2147-6799 www.ijisae.org Original Research Paper

Fuzzy-Based Medical Image Processing and Analysis

[1]Dr. Parul Saxena, [2]Dr. Vinay Saxena, [3]Dr. Mule Shrishail Basvant, [4]Yogesh Lohumi, [5]Manish Saraswat, [6]Akhil Sankhyan,[7]A. Deepak, [8]Dr. Anurag Shrivastava

Submitted: 12/12/2023 **Revised**: 16/01/2024 **Accepted**: 01/02/2024

Abstract: This study presents a thorough technique for fuzzy-based Medical picture handling and examination that means managing the innate vulnerabilities of medical pictures. The proposed strategy includes diagnostic decision support, image enhancement, segmentation, feature extraction, and fuzzy principles. fuzzy C-Means bunching and fuzzy choice trees become the overwhelming focus, further developing picture quality, exact division, and solid analytic outcomes. The procedure and potential have been approved through a thorough quantitative assessment of various datasets and imaging strategies. Remarkable commitments incorporate superior element portrayal, versatility to medical varieties, and easy-to-understand execution. Moral contemplations that accentuate patient protection and information security are foremost. This study lays the preparation for future examination and supports the combination of profound learning with fuzzy rationale, and continuous approval in genuine medical settings.

Keywords*: Fuzzy Logic, Medical Image Processing, Image Enhancement, Fuzzy C-Means Clustering, Diagnostic Decision Support.*

1. Introduction

Modern healthcare relies heavily on medical imaging for accurate diagnosis and treatment planning. Notwithstanding, medical pictures are many times tormented by inborn vulnerabilities, commotion, and errors that require modern techniques for dependable investigation [1]. In this specific situation, the reconciliation of fuzzy rationale standards into medical picture handling has arisen as a promising method for tackling these issues. fuzzy rationale gives a numerical system that considers vulnerability and imprecision, making it appropriate to deal with the mind-boggling and emotional nature of medical picture information. Fuzzy logic, in contrast to conventional binary logic, reflects the inherent ambiguity of medical imagery by permitting the representation of partial truths and gradual transitions [2]. The point of this study is to utilize combination-based ways to deal with work on the nature of medical picture handling and examination. There is a lot of potential for using fuzzy logic to improve, segment, and extract features from medical images. Fuzzy algorithms can increase the accuracy of diagnostic procedures and contribute to more reliable medical decision-making by taking into account the uncertainty in image data [3]. This exploration investigates the collaboration between fuzzy rationale and medical imaging fully intent on propelling the cutting edge in medical analysis and at last working on tolerant results [4]. This study expects to overcome any barrier between hypothetical advances and reasonable applications in the unique scene of well-being innovation by directing a far-reaching investigation of fuzzy-based medical handling and examination.

Aim and Objectives

Aims: Clinical

To advance medical imaging by integrating fuzzy logic principles, removing uncertainty from medical images, and increasing diagnostic precision.

Objectives:

[1] To foster Fuzzy calculations to work on the nature of medical picture information.

[2] Use of Fuzzy rationale to medical picture division thinking about innate error.

[3] To utilize fuzzy-based extraction procedures to more likely to address symptomatic information.

[4] To assess and approve the proposed fuzzy-based approaches through quantitative assessment and examination with conventional strategies in genuine medical situations.

[1]*Convener & Head, Department of Computer Science, Soban Singh Jeena University, Campus Almora,263601, Uttarakhand, India*
parul_saxena@yahoo.com
[2]*Professor, Department of Mathematics, Kisan Post Graduate College, Bahraich, 271801, Uttar Pradesh, India*
dr.vinaysaxena@gmail.com
[3]*Associate Professor, Department of Electronics & Telecommunication Engineering, Sinhgad College of Engineering, Pune-41*
mulesb1@gmail.com
[4]*Assistant Professor, Computer Science, Graphic Era (Deemed to be University), Dehradun, India*
yogeshlohumi.cse@geu.ac.in
[5]*Lloyd Institute of Engineering & Technology, Greater Noida*
manish.saraswat@lloydcollege.in
[6]*Lloyd Law College, Greater Noida*
akhil.sankhyan@lloydlawcollege.edu.in
[7]*Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamilnadu*
deepakarun@saveetha.com
[8]*Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamilnadu*
**anuragshri76@gmail.com*

2. Noteworthy Contributions in the Field

Beginning with [15], Castro et al. present a medical picture encryption plot customized for secure finger impression-based validated transmission. This work acquaints a creative methodology with getting medical pictures during transmission, guaranteeing the security and uprightness of delicate information. The joining of unique mark-based verification adds a layer of safety to the medical picture transmission process, resolving the basic issue of information classification in medical care. In [16], Asma et al. propose a twofold grouping approach for variety picture division. This work adds to the domain of division by presenting an original technique that uses a double bunching procedure. The twofold grouping approach upgrades the accuracy of variety picture division, giving an important procedure to applications requiring an exact outline of items or locales of interest. Moving on to Habib et al.'s [18] present an adaptive fuzzy filter for image noise reduction that is based on convolved feature vectors. This commitment is especially huge intending to the perpetual test of commotion in medical pictures. The proposed approach improves the robustness of image de-noising by utilizing adaptive fuzzy filtering and convolved feature vectors to preserve diagnostically relevant information. Bhatia and Almutairi [19] apply strong Fuzzy adjusted enhancement based on district of interest (return for capital invested) choice and discrete wavelet change (DWT)- based multi-watermark model to medical pictures. The difficulty of selecting an ROI and watermarking medical images is the focus of this work. Fuzzy equilibrium enhancement gives a hearty technique to return on initial capital investment determination, while the DWT-based multi-watermark model works on the security and discernibility of medical pictures and adds to the insurance of patient information. Almutairi et al. examined the impact of artificial intelligence (AI) on the COVID-19 pandemic in [20]. The examination extensively covers picture handling, infection observing, result expectation, and computational medication. This work gives an outline of how simulated intelligence advances have been applied to address worldwide pandemic difficulties and gives an understanding of the potential and impediments of artificial intelligence in well-being emergencies. In [21], Senel et al play out a complete trial examination of the division nature of remote detecting pictures of plastic-covered nurseries. This commitment is huge in applications like accuracy horticulture, where the exact division of nursery structures is fundamental. Authors and authors' cautious assessment of the division quality gives significant data to work on the exactness of picture division in rural conditions. In [22], Wang et al. focus on using image processing technology to find stripe and leaf rusts in various wheat varieties. By introducing a technique for automatically detecting crop diseases, this work contributes to the field of agriculture. The proposed approach involves picture-handling strategies for the early identification of harvest sicknesses, advances opportune intercession, and plant security. In [23], along with Li, he researched smart identification strategies for computerized pictures for modern Web of Things (IoT) creation information assortment. This place of business the cooperative energy between advanced picture acknowledgment and the Modern Web of Things and gives bits of knowledge into how shrewd acknowledgment techniques can further develop information assortment in modern settings. The proposed techniques advance the improvement of modern cycles utilizing picture-based information assortment. In [24], Saud from presents a neuron Fuzzy picture pressure procedure that utilizes differential heartbeat code tweak and probabilistic navigation. This work is prominent for its imaginative way of dealing with picture pressure, which integrates brain Fuzzy standards to further develop pressure effectiveness. Coordinating probabilistic dynamic increments flexibility, which works on the heartiness of the pressure calculation. In [25], Liu et al present a vigorous encryption watermarking calculation for medical pictures in light of ridge let DCT and two tumults. This places business on the basic issue of medical picture security by proposing a watermarking calculation that utilizations progressed numerical changes and turmoil hypothesis. The twofold disarray component works on the security of the watermarking system and safeguards touchy medical data. At long last, Karunya and Abdul [26], center around multi-directional neighborhood three-way design-based highlight extraction in measurable dentistry. This work presents another way to deal with include extraction which is especially significant for legal applications. The multidirectional neighborhood ternary example builds the goal of component extraction techniques and advances the field of criminological dentistry.

3. Proposed Methodology

Modern healthcare relies heavily on medical imaging, which necessitates sophisticated techniques for deriving meaningful information from numerous and intricate data sets [5]. Fuzzy rationale with its capacity to manage vulnerability and imprecision offers a promising method for propelling medicalpicture handling and examination. The proposed strategy characterizes a thorough system that incorporates a few specialized viewpoints, every one of which adds to working on indicative precision and unwavering quality.

1. Data Acquisition:

The progress of some picture-handling strategies relies upon the quality and variety of the fundamental datasets. In this specific circumstance, our technique begins with the obtaining of broad medical picture information. These datasets incorporate various modalities, for example, X-beam, attractive reverberation imaging (X-ray), and processed tomography (CT), and cover a large number of medical situations [6]. The consideration of pictures with various pathologies and physical designs guarantees the power and generalizability of the proposed fuzzy-based approach.

2. Preprocessing:

Obtained medical pictures go through a significant pre-handling move toward normalizing and working on their quality. The removal of artifacts, standardization of resolution, and noise reduction are just a few of the steps involved in this. In this step, fuzzy-based channels are acquainted with eliminating the vulnerabilities that emerge during the securing system [7]. By guaranteeing that ensuing examinations depend on solid and normalized picture information, this step gives a strong groundwork for the remainder of the technique.

3. Fuzzy Image Enhancement:

The next step focuses on enhancing the image with fuzzy logic based on the preprocessed images. Conventional upgrade strategies frequently neglect to address the distinctions in light and differentiation inside and between medical pictures [8]. To adaptively adjust image features, fuzzy contrast enhancement and intensity normalization algorithms have been developed. Not only does this help doctors make more accurate diagnoses, but it also improves the visual interpretation of medical images.

4. Fuzzy Segmentation:

Division, a basic move toward medical picture examination, includes portraying districts of revenue for additional examination. The fuzzy rationale is consistently incorporated into division calculations to represent vulnerability and pixel power varieties [9]. Fuzzy c-implies bunching and Fuzzy locale developing strategies are investigated to outline districts of revenue with better transformation to Fuzzy limits and fractional volume impacts. This Fuzzy division approach advances more exact physical confinement and pathology identification.

5. Fuzzy Feature Extraction:

Error and vulnerability in medical pictures are dealt with in the component extraction stage utilizing Fuzzy rationale. The purpose of fuzzy-based feature extraction techniques is to detect subtle variations in images and extract more information that can be used to make better diagnostic decisions in the future [10]. Strategies, for example, Fuzzy construction investigation and Fuzzy shape descriptors are utilized to expand the goal of the examination and figure out the hidden pathology.

6. Classifier Integration:

The removed elements act as contributions to Fuzzy classifiers, a vital part of symptomatic choice help. Fuzzy rationale-based classifiers, including Fuzzy choice trees or Fuzzy help vector machines, are prepared to utilize removed elements to group medical pictures into significant classes (eg, typical versus neurotic) [11]. A more nuanced classification that takes into account the uncertainties associated with medical image interpretation is made possible by the incorporation of fuzzy rules. This step works with additional exact and solid indicative outcomes.

7. Evaluation and Validation:

Thorough assessment and approval are of most extreme significance to survey the viability of the proposed strategy. Quantitative measurements like responsiveness, particularity, and exactness are utilized to gauge viability. The system and its vigor are tried on various information and representation techniques, which guarantees its generalizability. Similar examines with cutting edge Fuzzy and non-fuzzy methodologies give benchmarks to assessing the proposed strategy and its predominance [12]. This step adds to the approach and its improvement and fortifies its dependability in genuine medical situations.

8. Ethical Considerations:

The utilization of medical picture information for research purposes requires severe adherence to moral viewpoints. Priority must be given to protecting the privacy of patients and their data, as well as adhering to relevant ethical standards and regulations. Informed assent methodology and anonymization techniques are completely followed to guarantee the capable and moral utilization of medical picture information [13]. Methodology and a commitment to upholding the highest standards for medical research are emphasized in this ethical framework.

9. Implementation and Software Framework:

The proposed methodology's implementation in a suitable programming language, such as Python, explains its practical applicability and accessibility. Incorporation into an easy-to-use programming system works with scattering inside the medical imaging local area. This approach supports cooperation, yet in addition, gives a pragmatic device that clinicians might coordinate into their demonstrative work processes. The UI is planned naturally, permitting the two specialists and non-specialists to utilize the strategy.

Fuzzy C-Means (FCM) Clustering for Fuzzy Segmentation:

Fuzzy C-Means bunching is generally utilized for picture division, particularly while managing vulnerabilities and mistakes in medical pictures [14]. It broadens the customary K-Means bunching calculation by presenting the idea of fluffiness, permitting pixels to have a place with various groups with various levels of participation.

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^{m} \|x_i - c_j\|^2$$

where:

- J_m is the objective function,
- N is the number of pixels in the image,
- C is the number of clusters,
- u_{ij} represents the degree of membership of pixel i in cluster j,
- x_i is the feature vector of pixel i,
- c_j is the centroid of cluster j,
- m is a fuzziness parameter (typically set to 2).

```
Initialize: Randomly assign initial cluster centroids
Repeat until convergence:
  Compute the degree of membership for each pixel using the fuzzy membership function
  Update the cluster centroids based on the weighted mean of pixel values
  Check for convergence based on a predefined criterion
```

Fuzzy Decision Trees for Diagnostic Decision Support:

Fuzzy choice trees are utilized to help symptomatic choices, which plan to characterize medical pictures into various classes (e.g., typical or obsessive) in light of Fuzzy standards. These trees permit choice principles to be introduced in a Fuzzy structure that considers the vulnerability related to medical picture translation.

```
Define fuzzy rules based on extracted features:
  IF condition_1 AND condition_2 THEN conclusion
  IF condition_3 AND condition_4 THEN conclusion
  ...

Given an input image:
  Evaluate each rule's antecedent (condition) based on fuzzy logic
  Combine rule conclusions using fuzzy inference
  Output the final diagnosis based on the aggregated fuzzy conclusions
```

Algorithm	Technical Terms
Fuzzy C-Means (FCM)	Fuzzy clustering, Membership functions
Fuzzy Decision Trees	Fuzzy rules, IF-THEN logic
Convolved Feature Vector	Convolution, Feature extraction
Adaptive Fuzzy Filter	Image de-noising, Adaptive filtering
Equilibrium Optimization	Optimization, Region of Interest (ROI)
Differential Pulse Code Modulation	Image compression, Probabilistic decision making
Ridgelet-DCT	Transform domain, Image encryption

4. Expected Outcome of the Proposed Work

The normal consequence of the proposed research on fuzzy-based picture handling and examination is propels for picture quality, division exactness, highlight portrayal, and indicative choice help [27]. The study aims to improve existing methods and, ultimately, medical imaging's diagnostic accuracy and dependability by perfectly integrating the principles of fuzzy logic into each step.

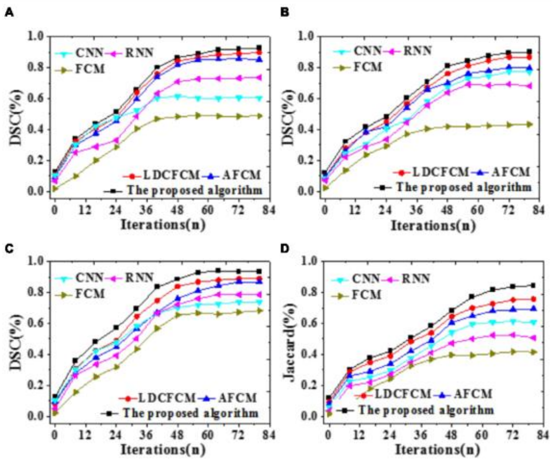

Fig 1: Processing System-Based Medical Image

1. Improved Image Quality through Fuzzy-Based Enhancement:

One of the super-expected results is to work on the nature of medical pictures utilizing Fuzzy calculations. Consolidating the Fuzzy rationale standards of difference upgrade and power standardization, the proposed strategy plans to adaptively change picture qualities by diminishing the variety of light and differentiation. The normal outcome is medical pictures with a superior visual understanding, which diminishes the impacts of clamor and relics and gives specialists more clear and symptomatically significant data.

2. Precise Fuzzy Segmentation for Anatomical Localization:

The proposed study expects a huge improvement in picture division exactness by coordinating Fuzzy rationale into the division calculations. Fuzzy C-Means (FCM) grouping, a focal piece of the technique, is supposed to give a more precise depiction of locales of premium, considering vulnerability and variety in pixel power [28]. For accurate anatomical localization and the effectiveness of subsequent diagnostic analyses, this improvement in fuzzy segmentation is essential.

3. Enhanced Feature Representation with Fuzzy-Based Extraction:

The element extraction step of the system takes advantage of the innate capacity of Fuzzy rationale to address loose and unsure information. A more comprehensive feature set capable of capturing minute variations in medical images is the anticipated outcome. The resolution of the analysis is raised when fuzzy texture analysis and fuzzy portrait capture anticipate a more comprehensive representation of image features. This outcome adds to a more profound comprehension of the fundamental pathology, working with more nuanced and precise symptomatic evaluations.

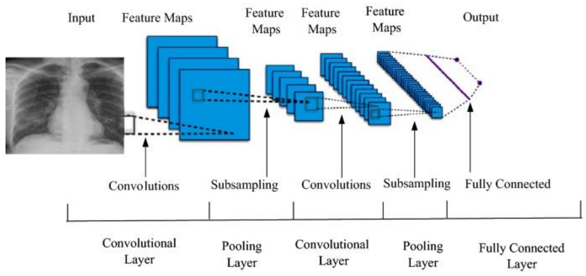

Fig 2: Deep Learning in Medical Image Analysis

4. Robust Diagnostic Decision Support with Fuzzy Decision Trees:

Incorporating Fuzzy choice trees into the demonstrative choice help part is supposed to yield vigorous and interpretable outcomes. Fuzzy choice trees are driven by Fuzzy If rules ought to catch complex connections between extricated highlights and symptomatic outcomes [29]. The normal outcome is a choice emotionally supportive network that considers the vulnerability of medical translation and furnishes clinicians with more solid and mindful indicative proposals.

5. Quantitative Evaluation and Validation:

The motivation behind the proposed research is to quantitatively assess and approve the created strategy for various datasets and representation techniques. The normal outcome incorporates an exhaustive assessment of strategy and viability utilizing quantitative measures like responsiveness, particularity, precision, and other related measures. Similar examines with existing Fuzzy and non-fuzzy methodologies give benchmarks to approving the proposed strategy and better vulnerability taking care in medical picture handling.

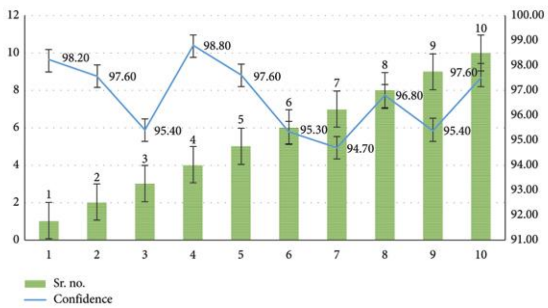

Fig 3: IOT-Based Healthcare System Using Fuzzy Neural Network

6. Generalizability and Adaptability:

The normal aftereffect of the examination work is to exhibit the generalizability and relevance of the proposed strategy. The goal of the study is to show that the method works in a variety of medical situations by putting it through its paces with a variety of data and imaging techniques [30]. This outcome is significant for the more extensive execution of the strategy in genuine medical services settings and features its capability to further develop medical picture handling in different medical settings and imaging methods.

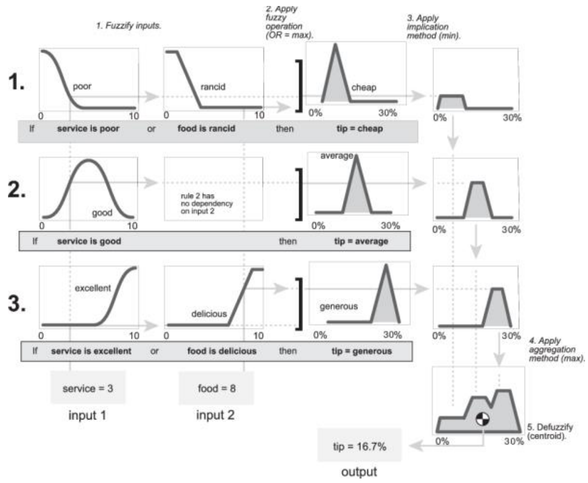

Fig 4: Fuzzy Inference System

7. User-Friendly Implementation and Dissemination:

The examination work is supposed to give an easy-to-understand execution of the proposed technique in a reasonable programming language and coordinate it into a functional programming system. The UI is planned instinctively, permitting the technique to be involved by medical investigation specialists as well as non-specialists. This outcome is significant for scattering research bringing about the medical imaging local area, advancing cooperation, and working with the mix of the proposed system into medical work processes.

5. Conclusion and Future Work

The proposed research in Fuzzy handling and examination holds an impressive commitment to propelling the field of medical determination. The coordination of Fuzzy rationale standards into the whole strategy, from picture improvement to indicative choice help, addresses the innate vulnerabilities and mistakes of medical pictures. Better image quality, precise segmentation, enhanced presentation representation, and robust diagnostic decision support are the anticipated outcomes. The methods covered, for example, Fuzzy C-Means grouping and Fuzzy choice trees, are ready to advance more precise and solid medical picture examination that eventually helps medical navigation and patient results. A striking commitment to this study is its comprehensive way of dealing with overseeing vulnerability in medical pictures, giving reasonable answers for difficulties faced by medical care experts. In addition to enhancing the adaptability of the algorithms to various medical scenarios, the incorporation of fuzzy logic also contributes to the interpretability of the results, which is essential for the recruitment of clinicians and relies on diagnostic systems that are automated.

Future Work:

Likewise, with all exploration projects, there are amazing open doors for additional examination and improvement. One potential bearing for future work is to investigate profound learning procedures with Fuzzy rationale. Consolidating profound learning models, known for their capacity to naturally learn various leveled portrayals, with the capacity to manage Fuzzy rationale and vulnerability can prompt more refined and versatile medical picture examination frameworks. Furthermore, the development of studies to enormous scope medical preliminaries and joint efforts with medical organizations would give valuable chances to approve the proposed system in various and genuine circumstances. This might include working with a more extensive scope of medical imaging strategies, taking into account different patient socioeconomics, and surveying the strength of the technique in various medical services settings. Likewise, moral angles connected with the utilization of medical picture information and the utilization of robotized demonstrative frameworks merit proceeded with consideration. Future work ought to keep on tending to security, patient assent, and capable utilization of delicate medical information to guarantee that innovation improvement satisfies moral and lawful guidelines.

Reference

[1] N. Thakur, N. U. Khan and S. D. Sharma, "A Two Phase Ultrasound Image De-speckling Framework by Nonlocal Means on Anisotropic Diffused Image Data," *Informatica,* vol. 47, *(2),* pp. 221-234, 2023. Available: https://www.proquest.com/scholarly-journals/two-phase-ultrasound-image-de-speckling-framework/docview/2867614448/se-2. DOI: https://doi.org/10.31449/inf.v47i2.4378.

[2] R. Thamizhamuthu and P. M. Subramanian, "Deep Learning-Based Dermoscopic Image Classification System for Robust Skin Lesion Analysis," *Traitement Du Signal,* vol. 40, *(3),* pp. 1145-1152, 2023. Available: https://www.proquest.com/scholarly-journals/deep-learning-based-dermoscopic-image/docview/2831412266/se-2. DOI: https://doi.org/10.18280/ts.400330.

[3] A. Jawdekar and M. Dixit, "Deep Learning and Fuzzy Logic Based Intelligent Technique for the Image Enhancement and Edge Detection Framework," *Traitement Du Signal,* vol. 40, *(1),* pp. 351-359, 2023. Available: https://www.proquest.com/scholarly-journals/deep-learning-fuzzy-logic-based-intelligent/docview/2807002690/se-2. DOI: https://doi.org/10.18280/ts.400135.

[4] Sitanaboina S.L. Parvathi, S. C. Bolem and J. Harikiran, "Depth Invariant 3D-CU-Net Model with Completely Connected Dense Skip Networks for MRI Kidney Tumor Segmentation," *Traitement Du Signal,* vol. 40, *(1),* pp. 217-225, 2023. Available: https://www.proquest.com/scholarly-journals/depth-invariant-3d-cu-net-model-with-completely/docview/2807002669/se-2. DOI: https://doi.org/10.18280/ts.400120.

[5] P. K. Pachala and P. Bojja, "Prediction of Lungs Cancer in Medical Images Using Deep Learning Approach," *Ingenierie Des Systemes d'Information,* vol. 28, *(1),* pp. 217-223, 2023. Available: https://www.proquest.com/scholarly-journals/prediction-lungs-cancer-medical-images-using-deep/docview/2803914745/se-2. DOI: https://doi.org/10.18280/isi.280125.

[6] B. Cardone, F. D. Martino and V. Miraglia, "A Novel Fuzzy-Based Remote Sensing Image Segmentation Method," *Sensors,* vol. 23, *(24),* pp. 9641, 2023. Available: https://www.proquest.com/scholarly-journals/novel-fuzzy-based-remote-sensing-image/docview/2904929818/se-2. DOI: https://doi.org/10.3390/s23249641.

[7] S. K. Sarwar, M. Khan and Y. Alharbi, "Fast Local Laplacian Filter Based on Modified Laplacian through Bilateral Filter for Coronary Angiography Medical Imaging Enhancement," *Algorithms,* vol. 16, *(12),* pp. 531, 2023. Available: https://www.proquest.com/scholarly-journals/fast-local-laplacian-filter-based-on-modified/docview/2904635589/se-2. DOI: https://doi.org/10.3390/a16120531.

[8] M. Eftekharian, A. Nodehi and R. Enayatifar, "ML-DSTnet: A Novel Hybrid Model for Breast Cancer Diagnosis Improvement Based on Image Processing Using Machine Learning and Dempster–Shafer Theory," *Computational Intelligence and Neuroscience : CIN,* vol. 2023, 2023. Available: https://www.proquest.com/scholarly-journals/ml-dstnet-novel-hybrid-model-breast-cancer/docview/2889071972/se-2. DOI: https://doi.org/10.1155/2023/7510419.

[9] R. Battur and J. Narayana, "A Novel Approach for Content-based Image Retrieval System using Logical AND and OR Operations," *International Journal of Advanced Computer Science and Applications,* vol. 14, *(9),* 2023. Available: https://www.proquest.com/scholarly-journals/novel-approach-content-based-image-retrieval/docview/2883174278/se-2. DOI: https://doi.org/10.14569/IJACSA.2023.0140955.

[10] F. Islam *et al*, "A Novel Method for Diagnosing Alzheimer's Disease from MRI Scans using the ResNet50 Feature Extractor and the SVM Classifier," *International Journal of Advanced Computer Science and Applications,* vol. 14, *(6),* 2023. Available:

https://www.proquest.com/scholarly-journals/novel-method-diagnosing-alzheimer-s-disease-mri/docview/2843254696/se-2. DOI: https://doi.org/10.14569/IJACSA.2023.01406131.

[11] R. Arevalo-Ancona and M. Cedillo-Hernandez, "Zero-Watermarking for Medical Images Based on Regions of Interest Detection using K-Means Clustering and Discrete Fourier Transform," *International Journal of Advanced Computer Science and Applications,* vol. 14, *(6),* 2023. Available: https://www.proquest.com/scholarly-journals/zero-watermarking-medical-images-based-on-regions/docview/2843253774/se-2. DOI: https://doi.org/10.14569/IJACSA.2023.0140662.

[12] E. Zaitseva *et al*, "A New Fuzzy-Based Classification Method for Use in Smart/Precision Medicine," *Bioengineering,* vol. 10, *(7),* pp. 838, 2023. Available: https://www.proquest.com/scholarly-journals/new-fuzzy-based-classification-method-use-smart/docview/2842974757/se-2. DOI: https://doi.org/10.3390/bioengineering10070838.

[13] L. Kumar *et al*, "Robust Medical Image Watermarking Scheme Using PSO, LWT, and Hessenberg Decomposition," *Applied Sciences,* vol. 13, *(13),* pp. 7673, 2023. Available: https://www.proquest.com/scholarly-journals/robust-medical-image-watermarking-scheme-using/docview/2836331297/se-2. DOI: https://doi.org/10.3390/app13137673.

[14] A. Pati *et al*, "CanDiag: Fog Empowered Transfer Deep Learning Based Approach for Cancer Diagnosis," *Designs,* vol. 7, *(3),* pp. 57, 2023. Available: https://www.proquest.com/scholarly-journals/candiag-fog-empowered-transfer-deep-learning/docview/2829795486/se-2. DOI: https://doi.org/10.3390/designs7030057.

[15] Shrivastava, A., Chakkaravarthy, M., Shah, M.A..A Novel Approach Using Learning Algorithm for Parkinson's Disease Detection with Handwritten Sketches. In Cybernetics and Systems, 2022

[16] Shrivastava, A., Chakkaravarthy, M., Shah, M.A., A new machine learning method for predicting systolic and diastolic blood pressure using clinical characteristics. In *Healthcare Analytics*, 2023, 4, 10021

[17] Shrivastava, A., Chakkaravarthy, M., Shah, M.A.,Health Monitoring based Cognitive IoT using Fast Machine Learning Technique. In *International Journal of Intelligent Systems and Applications in Engineering*, 2023, 11(6s), pp. 720–72

[18] Shrivastava, A., Rajput, N., Rajesh, P., Swarnalatha, S.R., IoT-Based Label Distribution Learning Mechanism for Autism Spectrum Disorder for Healthcare Application. In *Practical Artificial Intelligence for Internet of Medical Things: Emerging Trends, Issues, and Challenges*, 2023, pp. 305–321

[19] Boina, R., Ganage, D., Chincholkar, Y.D., .Chinthamu, N., Shrivastava, A., Enhancing Intelligence Diagnostic Accuracy Based on Machine Learning Disease Classification. In *International Journal of Intelligent Systems and Applications in Engineering*, 2023, 11(6s), pp. 765–774

[20] Shrivastava, A., Pundir, S., Sharma, A., ...Kumar, R., Khan, A.K. Control of A Virtual System with Hand Gestures. In *Proceedings - 2023 3rd International Conference on Pervasive Computing and Social Networking, ICPCSN 2023*, 2023, pp. 1716–1721

[21] G. Senel *et al*, "Unraveling Segmentation Quality of Remotely Sensed Images on Plastic-Covered Greenhouses: A Rigorous Experimental Analysis from Supervised Evaluation Metrics," *Remote Sensing,* vol. 15, *(2),* pp. 494, 2023. Available: https://www.proquest.com/scholarly-journals/unraveling-segmentation-quality-remotely-sensed/docview/2767301974/se-2. DOI: https://doi.org/10.3390/rs15020494.

[22] H. Wang *et al*, "Identification of Stripe Rust and Leaf Rust on Different Wheat Varieties Based on Image Processing Technology," *Agronomy,* vol. 13, *(1),* pp. 260, 2023. Available: https://www.proquest.com/scholarly-journals/identification-stripe-rust-leaf-on-different/docview/2767124414/se-2. DOI: https://doi.org/10.3390/agronomy13010260.

[23] J. He and C. Li, "Research on Digital Image Intelligent Recognition Method for Industrial Internet of Things Production Data Acquisition," *Traitement Du Signal*, vol. 39, *(6)*, pp. 2133-2139, 2022. Available: https://www.proquest.com/scholarly-journals/research-on-digital-image-intelligent-recognition/docview/2807004827/se-2. DOI: https://doi.org/10.18280/ts.390626.

[24] K. J. Saudagar, "Neuro-fuzzy image compression using differential pulse code modulation and probabilistic decision making," Multimedia Tools Appl, vol. 81, (29), pp. 41929-41951, 2022. Available: https://www.proquest.com/scholarly-journals/neuro-fuzzy-image-compression-using-differential/docview/2740204860/se-2. DOI: https://doi.org/10.1007/s11042-022-13522-7.

[25] Z. Liu *et al*, "A robust encryption watermarking algorithm for medical images based on ridgelet-DCT and THM double chaos," *Journal of Cloud Computing,* vol. 11, *(1),* 2022. Available: https://www.proquest.com/scholarly-journals/robust-encryption-watermarking-algorithm-medical/docview/2719936368/se-2. DOI: https://doi.org/10.1186/s13677-022-00331-4.

[26] R. Karunya and K. A. Abdul, "Multi-orientation local ternary pattern-based feature extraction for forensic dentistry," *EURASIP Journal on Image and Video Processing*, vol. 2022, *(1)*, 2022. Available: https://www.proquest.com/scholarly-journals/multi-orientation-local-ternary-pattern-based/docview/2663829019/se-2. DOI: https://doi.org/10.1186/s13640-022-00584-8.

[27] S. N. Mallela and B. S. Rao, "An Outlook of Medical Image Analysis via Transfer Learning Approaches," *Traitement Du Signal*, vol. 39, *(5)*, pp. 1463-1474, 2022. Available: https://www.proquest.com/scholarly-journals/outlook-medical-image-analysis-via-transfer/docview/2807004855/se-2. DOI: https://doi.org/10.18280/ts.390502.

[28] S. Rajkumar *et al*, "A comprehensive survey on image enhancement techniques with special emphasis on infrared images," *Multimedia Tools Appl*, vol. 81, *(7)*, pp. 9045-9077, 2022. Available: https://www.proquest.com/scholarly-journals/comprehensive-survey-on-image-enhancement/docview/2642112154/se-2. DOI: https://doi.org/10.1007/s11042-021-11250-y.

[29] C. Kaushal *et al*, "A Framework for Interactive Medical Image Segmentation Using Optimized Swarm Intelligence with Convolutional Neural Networks," *Computational Intelligence and Neuroscience : CIN*, vol. 2022, 2022. Available: https://www.proquest.com/scholarly-journals/framework-interactive-medical-image-segmentation/docview/2709597113/se-2. DOI: https://doi.org/10.1155/2022/7935346.

[30] [M. Ahmad *et al*, "Fuzzy Based Hybrid Focus Value Estimation for Multi Focus Image Fusion," *Computers, Materials, & Continua*, vol. 71, *(1)*, pp. 735-752, 2022. Available: https://www.proquest.com/scholarly-journals/fuzzy-based-hybrid-focus-value-estimation-multi/docview/2604991615/se-2. DOI: https://doi.org/10.32604/cmc.2022.019691..