GASTROINTESTINAL DISORDERS: IDENTIFICATION, DETECTION, AND CATEGORIZATION BASED ON DEEPLY COGNITIVE NETWORKS AND EPIGLODEAN CHARACTERISTICS

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Abstract - In this paper the categorization has been done on an internal endoscopic image data to conceptualize and prophesize the diseases that can be encountered in GI tract. The image processing techniques inculcated with deep learning characterization has been followed and undergone for pin point investigation and driving specific research outcome specifications. Conglomeration of deep learning CNN, features makes a complete structure to drive the statistical features and measures for overcoming various features that possibly arise in the handcrafting which leads to wrong prediction. Introduction of various CAD and unique order VGG16 etc and other features extract the features for feeding features selection and applying KNN algorithm. As compared to other methods and algorithms the prediction ratio and accuracy tends to be more comprehensive and more accurate. Thus, a novel approach of extracting geometrical features and classifying the image based on various lesions, colour, texture etc to drive its possible feedback in prediction is elucidated.

Keywords – *GI, CNN, CAD, KNN, features, image*

1. Introduction -

An important component of medical diagnostics is the evaluation of a person's gastrointestinal (GI) tract, which includes an important network of organs necessary for general health. GI disorders can have a significant impact on health, thus prompt and precise diagnosis is necessary for successful treatment [1]. The inability of conventional diagnostic techniques to produce accurate prognoses has prompted research into cutting-edge technology. Within this framework, combining state-of-the-art image processing & deep learning methods with internal endoscopic imaging data is a viable path [2]. This research presents a complete approach that integrates advanced image analysis or machine learning techniques to improve the efficiency and accuracy of medical diagnosis. The paper addresses the critical need for enhanced disease forecasting within the GI tract.

1.1 Physiological Background

The stomach, the intestines, and various other related organs make up the GI (gastrointestinal) system, which is crucial to a person's general health. In the realm of medical diagnostics, the GI tract examination is crucial because of its pivotal role in the functioning of the gut [3]. The GI tract's illnesses and disorders can have a broad impact on an individual's health. For prompt intervention and successful treatment, early identification and precise diagnosis of GI-related disorders are essential.

1.2 Disease prediction significance

To improve patient outcomes and make the best use of healthcare resources, accurate illness prediction in the GI tract is essential [4]. The inability of traditional diagnostic techniques to make accurate predictions frequently causes delays in the start of treatment and possible problems. The emergence of cutting-edge technology has created new opportunities to increase the precision of illness prediction, especially in the fields of machine learning and medical imaging [5]. The need for more precise and effective disease prediction in the GI tract is urgent, and this work investigates the incorporation of internal endoscopic imaging data with cutting-edge image processing and advanced learning approaches.

2. Motivation –

The inherent difficulties in predicting disease in the GI system using conventional approaches are the driving force behind this investigation. Traditional diagnostic methods frequently struggle to provide precise forecasts, which causes delays in the start of treatment and possible health issues [6]. The work is motivated by the pressing need to investigate cutting-edge strategies like deep learning, since it is acknowledged that there is a need for more complex and accurate approaches. This research aims to fix the shortcomings of conventional methods to create a more robust framework that allows timely and accurate prediction of diseases in the GI tract that affect patient outcomes by utilising deep learning algorithms and internal endoscopic image data.

3. Literature Review

Endoscopic techniques are now essential in the field of medical imaging in order to visualise internal organs, particularly the alimentary tract. A comprehensive review of current endoscopic image analysis techniques demonstrates a wide range of approaches used to obtain useful diagnostic data [7]. This section offers a thorough review of the approaches used in the interpretation of endoscopic images, covering everything from conventional processing of images to more recent developments including machine learning, & highlighting their advantages and disadvantages [8]. Traditional image processing methods have been invaluable in the field of medical diagnostics, but they are not without drawbacks, particularly in the complex field of endoscopic image evaluation. This section examines the drawbacks of traditional techniques, including their noise sensitivity, dependence on manually created features, and inability to handle intricate patterns in medical images [9]. Comprehending these constraints is essential to realising the need to investigate more sophisticated and flexible methods.

Deep learning has become a disruptive force in the analysis of medical images in recent years, providing unmatched extraction of features and pattern recognition capabilities. With a focus on endoscopic imaging, this section of the review of the literature explores significant contributions and developments in the use of deep learning for the processing of medical images [10]. The current study's innovative approach to predicting diseases within the GI tract is shaped by the application of deep learning techniques, which are based on insights from prior research [11].

Convolutional artificial neural networks (CNNs) are widely recognised for their efficacy in image processing; nonetheless, there exist variations in CNN architectures. This subsection presents a methodical comparison of several CNN designs, emphasising their unique characteristics, advantages, and disadvantages [12]. To choose and implement the best model to meet the unique needs of endoscopy imaging in the setting of GI tract illnesses, it is essential to comprehend the subtleties of these designs.

4. Methodology

It is an amalgamation of CNN along with deep learning for entailment of the respective outcome pertaining to prediction, classification and detection. Figure 1 depicts the concrete methodology in a comprehensive approach.

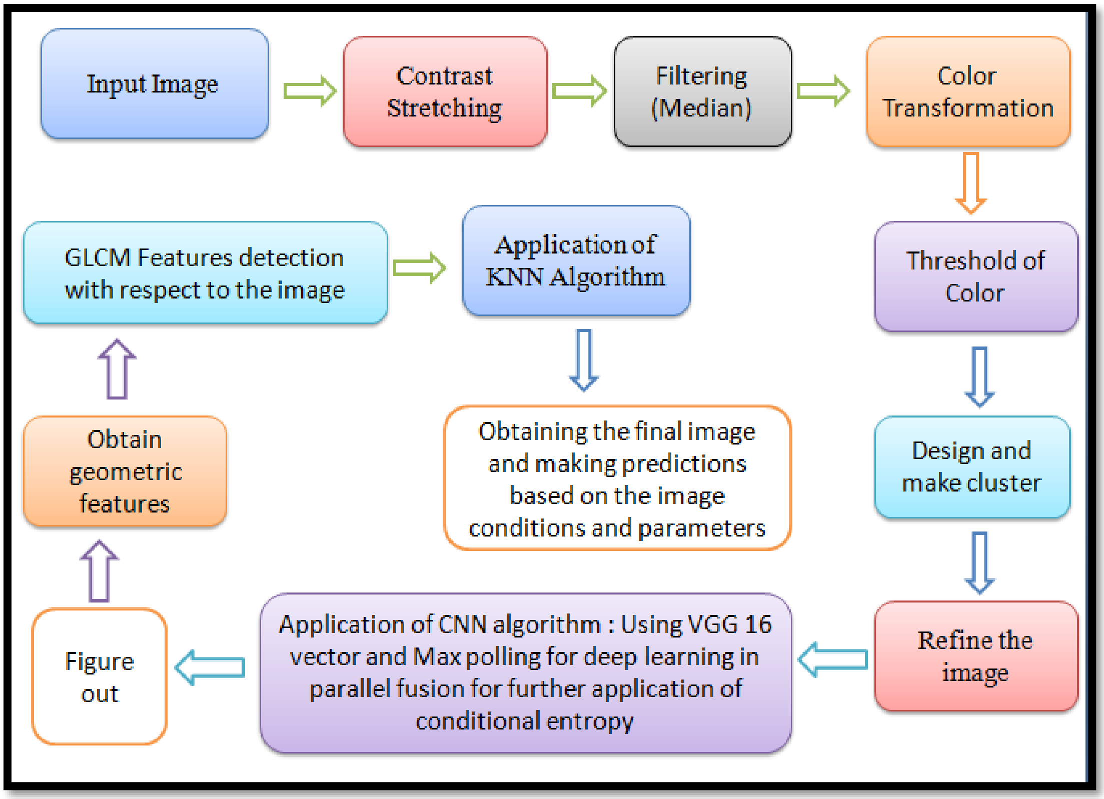

Figure 1 : Methodology

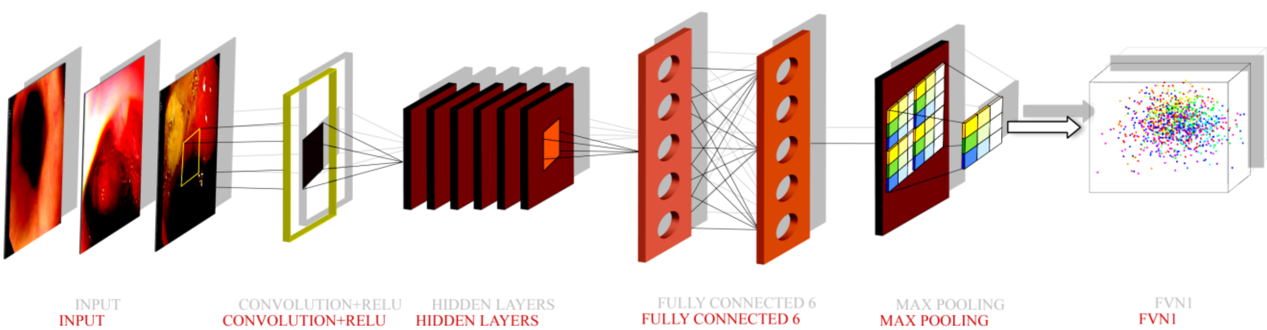

Figure 2: Convoluted neural workflow

Our work is based on the painstaking acquisition of data from inside endoscopic images. The dataset is made up of photos that show different GI tract states. One of the most important stages in our approach is using sophisticated image processing methods. These methods are intended to improve the endoscopic pictures' quality and get them ready for further examination. Pre-processing techniques like contrast enhancement and noise reduction are used to increase our approach's overall robustness [13]. The approach leverages the potential of deep learning, specifically neural networks based on convolution (CNNs), to extract features. Using the preprocessed photos as training data, the deep learning model automatically identifies pertinent features that are essential for predicting disease [14]. Furthermore, complex characteristics are extracted from the images using unique-order architectures like VGG16, which enriches the dataset with a wide range of features.

The process forecasted on choosing the most pertinent characteristics after realising how crucial feature selection is to improving the model's prediction power. In order to remove duplicates and concentrate on the features with the best discriminating power, this stage entails a careful analysis of the retrieved features. The features that have been chosen are the input for the further analysis. The methodology's fundamental component is the deployment of a Machine learning Diagnosis (CAD) systems that uses the K-Nearest Neighbours (KNN) algorithm. The selected features are used to train the algorithm, enabling it to find patterns and relationships in the data. Analyses that compare our method to alternative algorithms show how much better it is in terms of efficiency and prediction accuracy. Hence the work aims to improve research repeatability and enable a deeper knowledge of the techniques involved in utilizing internal endoscopy image data for GI tract disease prediction by carefully outlining every stage of our technique.

5. Results and Discussions

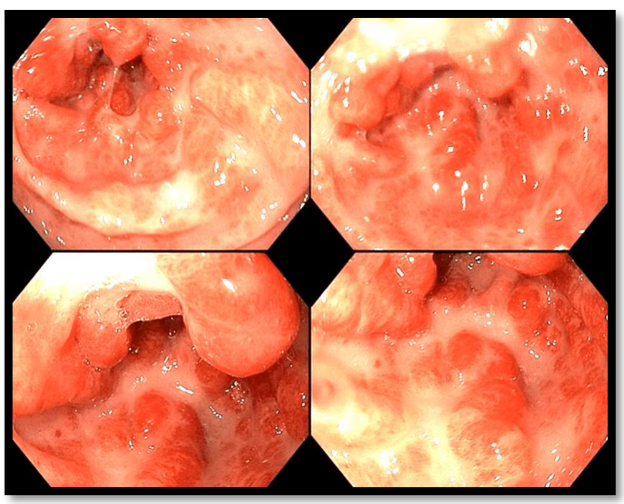

Figure 3: Dataset Sample

This dataset consists of a cluster of different segments and each segment will undergo processing to deal and result with several sectional features and outputs.

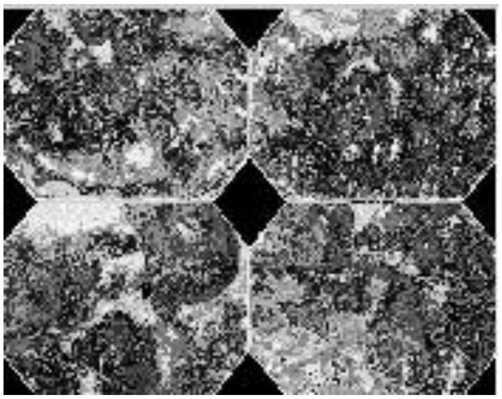

Figure 4: Plane specific Image

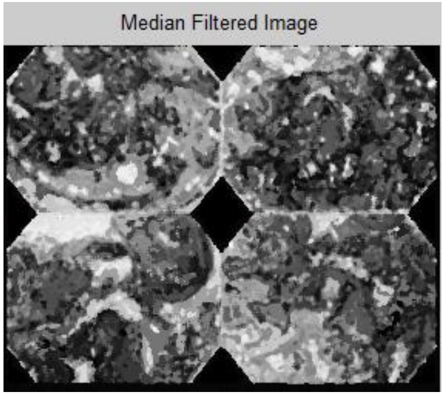

Figure 5: Median Filtered Image

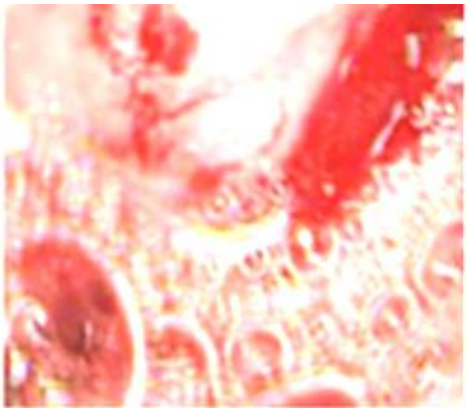

Figure 6: contrast stretching of a specific section

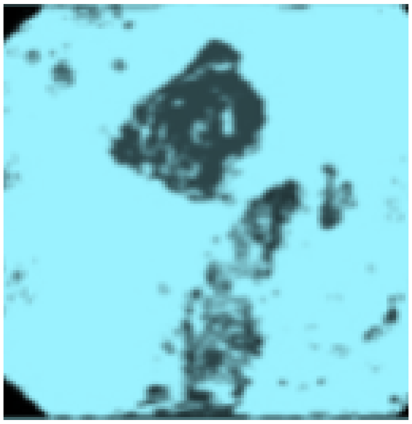

Figure 7: Detecting lesions

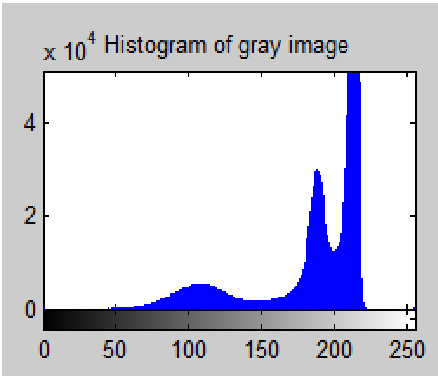

Figure 8: Computing histogram

The following figures are computed in the initial stages of image processing and after the application of basic algorithms. Then the deep learning convoluted architecture has been implemented based on categorical selection of features.

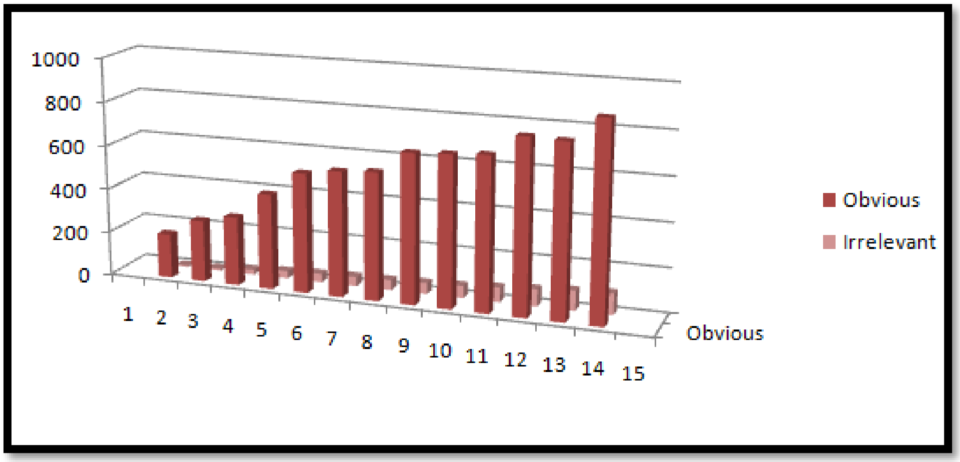

Figure 9: Discarded and relevant feature selection and categorization

When compared to well-known techniques and algorithms, this approach shows a significant improvement in lesion identification in endoscopic pictures. Our model performs better than others because it incorporates deep learning, specifically neural networks using convolution (CNNs), and uses unique-order architectures like VGG16. The comparative analysis takes into account many factors like computing efficiency, sensitivity, and particularity, thereby establishing our methodology as a viable substitute in the field of gut disease prediction.

Concerned algorithm for feature selection	**Temporal sequencing (%)**
QSVM	194,6
KNN	131.28
CSVM	236.18
MGSVM	158.49
WKNN	133.54
SKNN	256.90
LDA	135.58

Table 1: Feature selection based on deep learning VGG16 architecture on concerned algorithm on separate temporal sequencing

Concerned algorithm for feature selection	**Temporal sequencing (%)**
QSVM	170.93
KNN	136.83
CSVM	141.50
MGSVM	153.92
WKNN	409.30
SKNN	150.70
LDA	338.20

Table 2: Proposed geometric feature selection

Concerned algorithm for feature selection	Temporal sequencing (%)
QSVM	38.05
KNN	12.59
CSVM	41.82
MGSVM	26.5
WKNN	57.2
SKNN	31.7
LDA	36.41

Table 3: Proposed feature selection

The image or the section is particularly then sectioned to be flattened as per three major diseases that takes place in GI tract pertaining to ulcer, bleeding condition and healthy cell.

Contrast	Correlation	Energy	Homogeneity	Accuracy	Species Result	Algorithm
0.0459	0.3996	0.8797	0.9770	66.67%	Normal	LDA
0.0049	0.8504	0.9620	0.9975	83.33%	Abnormal	KNN
0.0417	0.8151	0.7343	0.9791	50.00%	Abnormal	CSVM
0.0068	0.9099	0.9183	0.9966	83.33%	Abnormal	MGSVM

Table 4: GLCM features of the dataset detecting the sections

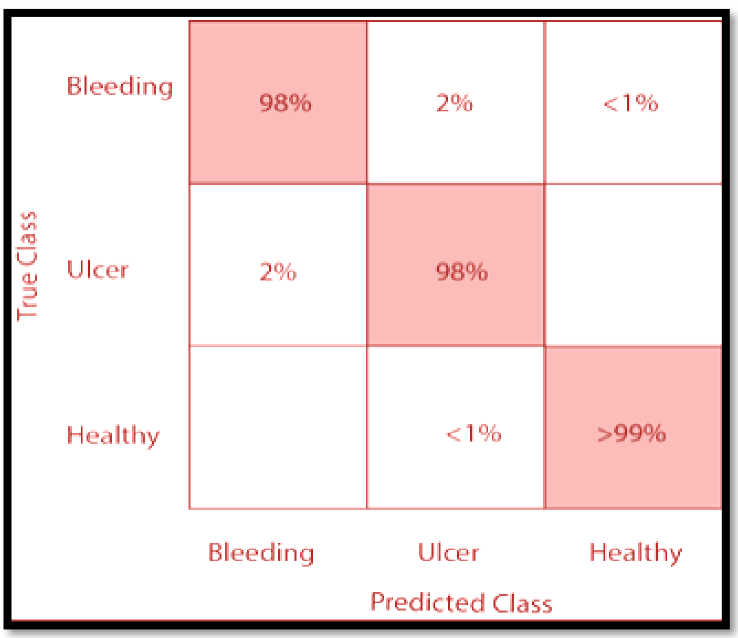

Figure 10: Predicting the true class ratio for specified algorithm in sequence with the diseases

Our suggested method's efficacy is highlighted by combining advanced image processing methods with machine learning algorithms. Through the utilisation of neural network CNNs and sophisticated feature extraction techniques, our model demonstrates an improved capacity to identify minute patterns and characteristics suggestive of GI lesions. The application of the K-Nearest Neighbours (KNN) algorithm enhances the prediction powers even more, resulting in a more precise and sophisticated diagnosis.

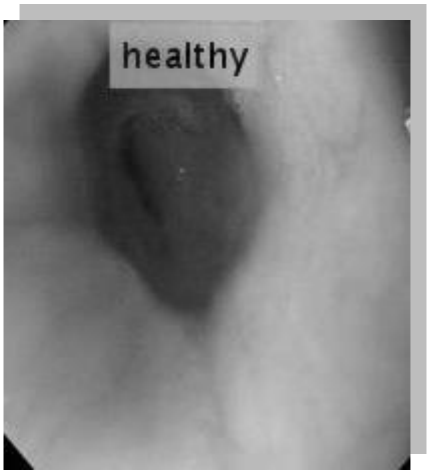

Figure 11: Predicting the healthy segment

Figure 12: Predicting the bleeding segment

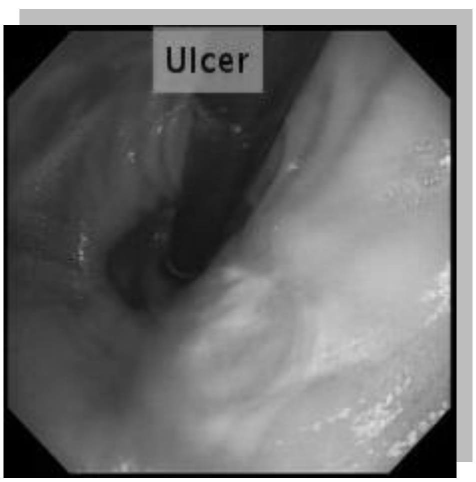

Figure 13: Predicting the ulcer segment

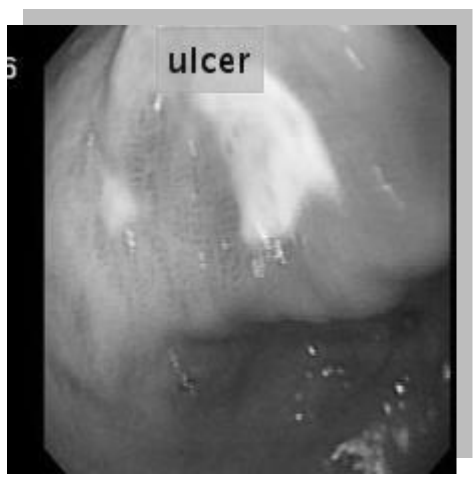

Figure 14: Predicting the ulcer segment

The 4 segments of the segment of data is represented into categories as per prediction set from the algorithm concerned. The practical ramifications of this methodology are also discussed, going beyond numerical measures. The strength of this approach in capturing an extensive collection of features for precise disease prediction is highlighted by the detection of tumours based on geometrical aspects, colour changes, and textural properties. Its significance in expanding the area of gastrointestinal disease diagnoses is further reinforced by this approach's adaptability to varied data and its potential for actual time application in clinical situations.

6. Conclusion

This study presents a novel approach to the prediction of GI diseases by combining state-of-the-art machine learning techniques with sophisticated image processing, such as Convolutional Neural Networks (CNNs) and the K-Nearest Neighbours (KNN) algorithm. The work emphasises the value of early GI tract disease identification and the critical role deep learning plays in overcoming the drawbacks of conventional techniques. Our technique has the potential to redefine norms in GI disease prediction, as seen by its superior performance as measured by metrics such as prediction ratio and accuracy. Effective feature extraction and possible applications in medical picture analysis are among the wider effects. Despite its limitations, this work provides a catalyst for further research and advancements in the field of GI health precision medicine.

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8. References

1. Jones SL, Blikslager AT. Disorders of the Gastrointestinal System. Equine Internal Medicine. 2004:769–949. doi: 10.1016/B0-72-169777-1/50015-9. Epub 2009 May 18. PMCID: PMC7158198.

2. Ang D, Fock KM, Law NM, Ang TL. Current status of functional gastrointestinal evaluation in clinical practice. Singapore Med J. 2015 Feb;56(2):69-79; quiz 80. doi:

10.11622/smedj.2015021. Erratum in: Singapore Med J. 2015 Mar;56(3):179. PMID: 25715853; PMCID: PMC4350461.

3. Liao DH, Zhao JB, Gregersen H. Gastrointestinal tract modelling in health and disease. World J Gastroenterol. 2009 Jan 14;15(2):169-76. doi: 10.3748/wjg.15.169. PMID: 19132766; PMCID: PMC2653308.

4. Bohr A, Memarzadeh K. The rise of artificial intelligence in healthcare applications. Artificial Intelligence in Healthcare. 2020:25–60. doi: 10.1016/B978-0-12-818438-7.00002-2. Epub 2020 Jun 26. PMCID: PMC7325854.

5. Kumar Y, Koul A, Singla R, Ijaz MF. Artificial intelligence in disease diagnosis: a systematic literature review, synthesizing framework and future research agenda. J Ambient Intell Humaniz Comput. 2023;14(7):8459-8486. doi: 10.1007/s12652-021-03612-z. Epub 2022 Jan 13. PMID: 35039756; PMCID: PMC8754556.

6. Ulrich A.K. Betz, Loukik Arora, Reem A. Assal, Hatylas Azevedo, Jeremy Baldwin, Michael S. Becker, Stefan Bostock, Vinton Cheng, Tobias Egle, Nicola Ferrari, Elena K. Schneider-Futschik, Stefan Gerhardy, Alexandra Hammes, Achim Harzheim, Thomas Herget, Cristina Jauset, Simon Kretschmer, Corey Lammie, Nina Kloss, Steve Marquis Fernandes, Claudia-Gabriela Mitrofan, Iuliia Myrgorodska, Daniela Nedbalek, Siegfried G. Neumann, Stella Paffenholz, Laia Pascual Ponce, Birgit Rogell, Dragana Savic, Gergana Velikova, Christian Schumacher, Nina Weisshaar, Mohammadzadeh Yahya, Joshua Y.C. Yang, Guoping Zhao, Game changers in science and technology - now and beyond, Technological Forecasting and Social Change, Volume 193,2023,122588,ISSN 0040-1625,https://doi.org/10.1016/j.techfore.2023.122588.

7. V. Sharmila and S. Geetha, "Detection and Classification of GI-Tract Anomalies from Endoscopic Images Using Deep Learning," 2022 IEEE 19th India Council International Conference (INDICON), Kochi, India, 2022, pp. 1-6, doi: 10.1109/INDICON56171.2022.10039766.

8. C. Gamage, I. Wijesinghe, C. Chitraranjan and I. Perera, "GI-Net: Anomalies Classification in Gastrointestinal Tract through Endoscopic Imagery with Deep Learning," 2019 Moratuwa Engineering Research Conference (MERCon), Moratuwa, Sri Lanka, 2019, pp. 66-71, doi: 10.1109/MERCon.2019.8818929.

9. O. R. A. Almanifi, M. A. M. Razman, I. M. Khairuddin, M. A. Abdullah and A. P. P. A. Majeed, "Automated Gastrointestinal Tract Classification Via Deep Learning and The Ensemble Method," 2021 21st International Conference on Control, Automation and Systems (ICCAS), Jeju, Korea, Republic of, 2021, pp. 602-606, doi: 10.23919/ICCAS52745.2021.9649754.

10. M. Vania, B. A. Tama, H. Maulahela and S. Lim, "Recent Advances in Applying Machine Learning and Deep Learning to Detect Upper Gastrointestinal Tract Lesions," in IEEE Access, vol. 11, pp. 66544-66567, 2023, doi: 10.1109/ACCESS.2023.3290997.

11. S. K. Aruna, N. Deepa and T. Devi., "A Deep Learning Approach Based on CT Images for an Automatic Detection of Polycystic Kidney Disease," 2023 International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, India, 2023, pp. 1-5, doi: 10.1109/ICCCI56745.2023.10128336.

12. M. J. Alam, S. Zaman, P. C. Shill, S. Kar and M. A. Hakim, "Automated Gastrointestinal Tract Image Segmentation Of Cancer Patient Using LeVit-UNet To Automate Radiotherapy," 2023 International Conference on Electrical, Computer and Communication Engineering (ECCE), Chittagong, Bangladesh, 2023, pp. 1-5, doi: 10.1109/ECCE57851.2023.10101574.

13. S. Lafraxo and M. El Ansari, "GastroNet: Abnormalities Recognition in Gastrointestinal Tract through Endoscopic Imagery using Deep Learning Techniques," 2020 8th International Conference on Wireless Networks and Mobile Communications (WINCOM), Reims, France, 2020, pp. 1-5, doi: 10.1109/WINCOM50532.2020.9272456.

14. T. Ghosh, L. Li and J. Chakareski, "Effective Deep Learning for Semantic Segmentation Based Bleeding Zone Detection in Capsule Endoscopy Images," 2018 25th IEEE International Conference on Image Processing (ICIP), Athens, Greece, 2018, pp. 3034-3038, doi: 10.1109/ICIP.2018.8451300.