

Disease Diagnosis Using DI Models With XAI

Ayesha Mukhtar Shaikh ^{1*}, Mohd Amjad ², Dr. Kotari Sridevi ³, Dr. M Upendra Kumar ⁴

¹ M.Tech CSE Student, MJCET OU Hyderabad, Telangana, India

² Computer Programmer, Department of M.TECH CSE MJCET OU Hyderabad, Telangana, India

³ Associate Professor, Department of CSE, IFHE-FST Hyderabad, Telangana, India

⁴ Professor, Department of CSE, MJCET OU Hyderabad, Telangana, India

* Corresponding Author: **Ayesha Mukhtar Shaikh**

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Abstract

With the popularity of artificial intelligence, specifically in deep learning domain, there are a large host of neural models due to various learning techniques like supervised, transfer learning amongst various others techniques allow to automate diagnosis; thereby, reducing workload on healthcare professionals or lack of workforce availability and reducing the chances of mis-identification or diagnosis.

In order to ensure trust among both professionals working with the automated system and the patients that are being diagnosed are efficient, a need is there for employing interpretation of the model used, while performing its task.

The transformer model used to perform diagnosis of the gastrointestinal tract by multi-class classification of anomalies using wireless capsule endoscopy images from Kvasir dataset and a visualization technique as grad-cam which allows to determine the key regions (i.e eliminate the black box nature of neural network) within the GiT that the model uses to classify.

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Keywords: Disease Diagnosis, Deep Learning, Xai

1. Introduction

1.1 Objective

Using images derived from wireless capsule endoscopy technique to determine the various abnormalities that could lead and become as catastrophic if remain unchecked or mis-diagnosed.

- To be able to create a model using deep learning where the diagnosis can be programmed.
- To have the ability to trust the system built where model is deriving an outcome.
- To create a model which has the ability to avoid mis-classifying the predicted output, without external interference.
- Apply a model with better architectural advantage, so that system is built with adequate functionality to provide correct or right prediction.
- To perform visualization technique to address the reliability aspect of using xai

1.2 Purview of Proposal

The project is used to address the trust aspect of xai where a needs to be utilized with a single model along with grad-cam as visualization techniques after the primary model engages in multi-class classification task using the latest deep learning model which is an extension from the natural language processing in computer vision.

The system that is proposed needs to undergo through evaluation from practitioners from the healthcare industry where there are chances of deployable functionality exists in real world. In order to be reliable for the system to be in use, various methods need to be processed to be compliant with the ability of fault tolerance and ensure no deviations from an actual practitioners work and aid them in faster diagnosis.

The model that is created makes use of the concept of transfer learning, where the model was initially used for a different domain then extended for use with a different application space.

1.3 Existing system

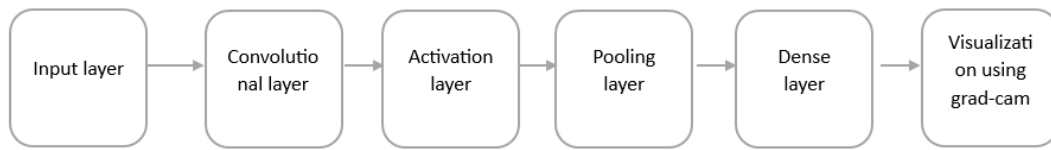


Fig 1: Existing system architecture

1.4 Dataset description

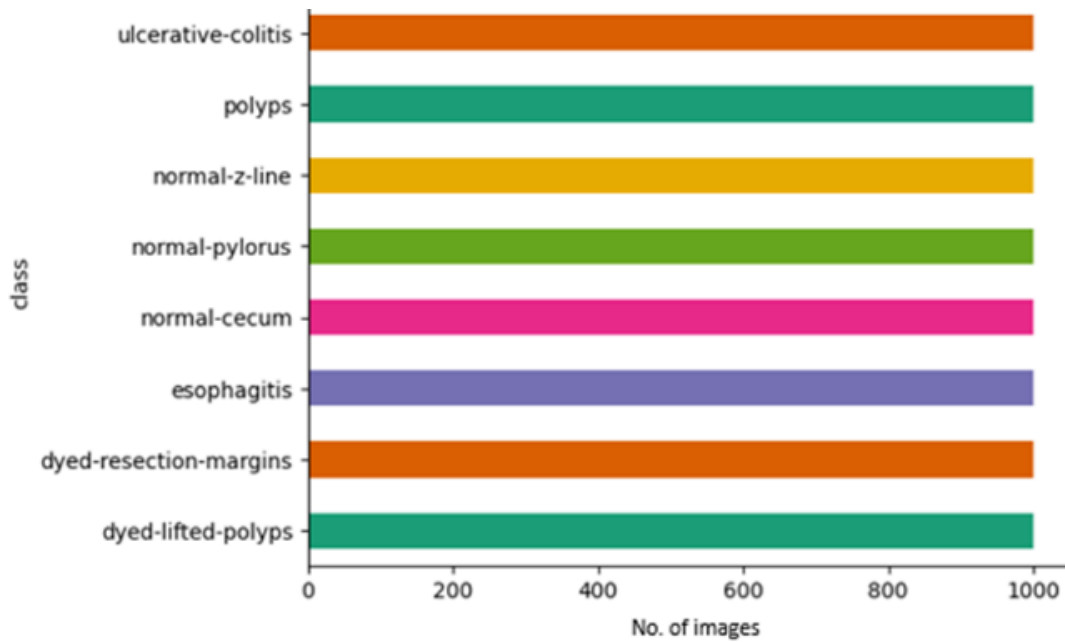


Fig 2: kvasir-v2 dataset consists of balanced classes

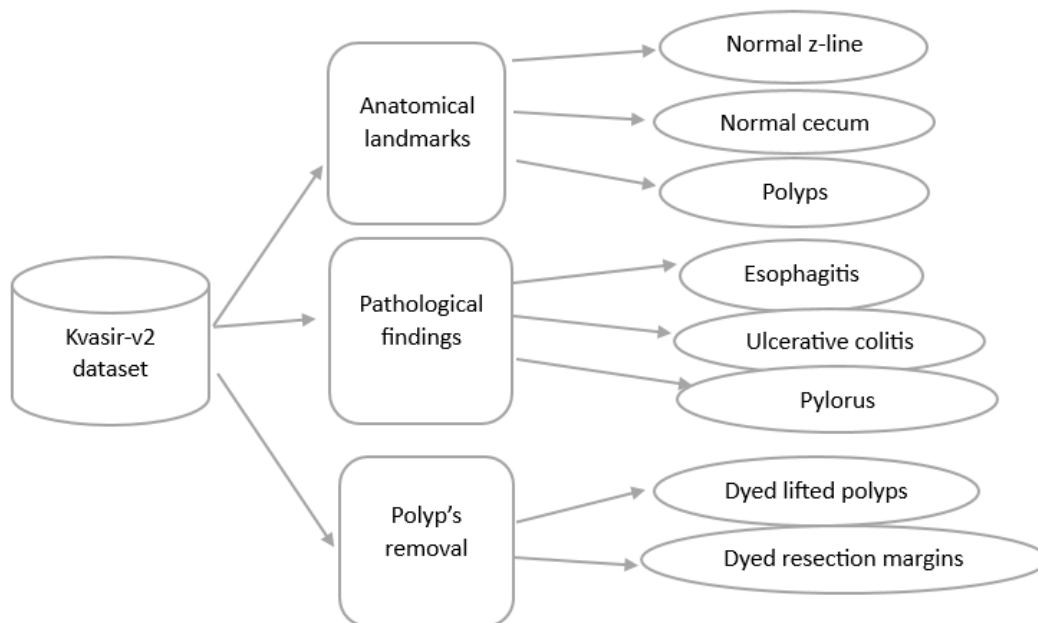


Fig 3: Dataset description of different classes for multi-class classification.

2. Literature Review

Table 1: Summary of literature

S. no	Title of the paper	Technique	Models used	Analysis
1	Endoscopic Image Classification Based on Explainable Deep Learning by Doniyorjon Mukhtorov <i>et al</i> , 2023	Transfer learning with five cnn models.	1.resnet18 2.resnet152 with grad-cam 3.mobilenetv2 4.densenet201 5.vgg16	Use a different architectural model.
2	GIT-Net: An Ensemble Deep Learning-Based GI Tract Classification of Endoscopic Images by Hemalatha Gunasekaran <i>et al</i> , 2023	Ensemble method with three cnn models.	1.inceptionv3 2.resnet50 3.densenet201	Use interpretability on models.
3	A Comprehensive Analysis of Deep Learning-Based Approaches for the Prediction of Gastrointestinal Diseases Using Multi-class Endoscopy Images by Priya Bhardwaj <i>et al</i> , 2023	Transfer learning with five different models.	1.densenet201 2.inceptionresnetv2 3.resnet152v2 4.efficientnetb4 5.xception	Use different model with interpretability.
4	A Deep-Learning Approach for Identifying and Classifying Digestive Diseases by J. V. Thomas Abraham <i>et al</i> , 2023	Transfer learning with five cnn models.	1.custom-cnn 2.inceptionv3 3.densenet121 4.resnet50 5.efficientb0	Use visualization for the DL models.
5	Deep learning-based prediction model for diagnosing gastrointestinal diseases using endoscopy images by Anju Sharma <i>et al</i> , 2023	Transfer learning with four class classification.	1.vgg16 2.inceptionv3 3.resnet50	Perform multi-class classification.

Table 2: Summary of literature

S.no	Title of the paper	Technique	Models used	Analysis
6	Classification of Anomalies in Gastrointestinal Tract Using Deep Learning by Ibtesam M. Dheir <i>et al</i> , 2022	Transfer learning with five cnn models.	1.vgg16 2.Xception 3.Resnet 4.Mobilenet 5.inceptionv3	Use a different architectural model with visualization.
7	Deep learning-enabled classification of gastric ulcers from wireless capsule endoscopic images by Deepak Bajhaiya <i>et al</i> , 2022	Single cnn model with binary classification.	1.densenet121	Perform multi-class classification.
8	Gastrointestinal image classification based on VGG16 and transfer learning by Benkessirat Amina <i>et al</i> , 2022	Single cnn model with multi-class classification.	1.Vgg16	Use visualization and different architectural model.
9	Automatic intestinal content classification using transfer learning architectures by Palak Handa <i>et al</i> , 2022	Different dataset with five cnn models.	1.resnet50 2.resnet101 3.mobilenetv2 4.Xception 5.inceptionv3	Use visualization on cnn models.
10	Gastrointestinal Disorder Detection with a Transformer Based Approach by A.K.M Salman Hosain, 2022	Four class classification with comparison between transformer and cnn model.	1.Transformer 2.densenet201	Employ interpretability on the Neural network models.

3. System Anaysis and Design

3.1 Architecure

The transformer model performs the task of classification by performing various functions at different layers.

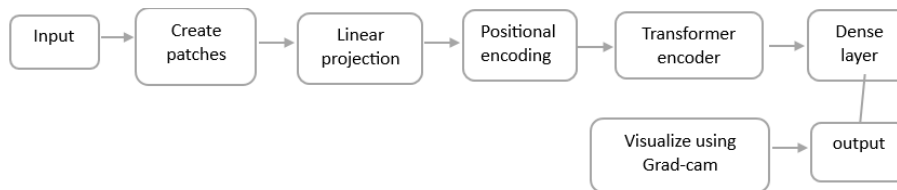


Fig 3: Implementation strategy for multi class classification for gastro-intestinal tract disease diagnosis

3.2 Proposed Algorithm

Input: Image dataset.

Output: Classification and visualization of the images.

Step 1: Load the dataset.

- Step 2: Visualize dataset.
- Step 3: Preprocess the dataset (by scaling).
- Step 4: Augmentation on the resized dataset.
- Step 5: Split dataset as train, validate and test datasets.
- Step 6: Perform patch and position embedding on the dataset.
- Step 7: Build and load the transformer model.
- Step 8: Predict the accuracy on test dataset.
- Step 9: Perform experimental analysis on the performance of the model.
- Step 10: visualize the outcome.

The images are of various dimensions and need to be resized or scaling operation needs to be performed as:

To visualize the step 3 the entire dataset undergoes resizing due to various dimensions present. For a single image as, in case of polyps class:

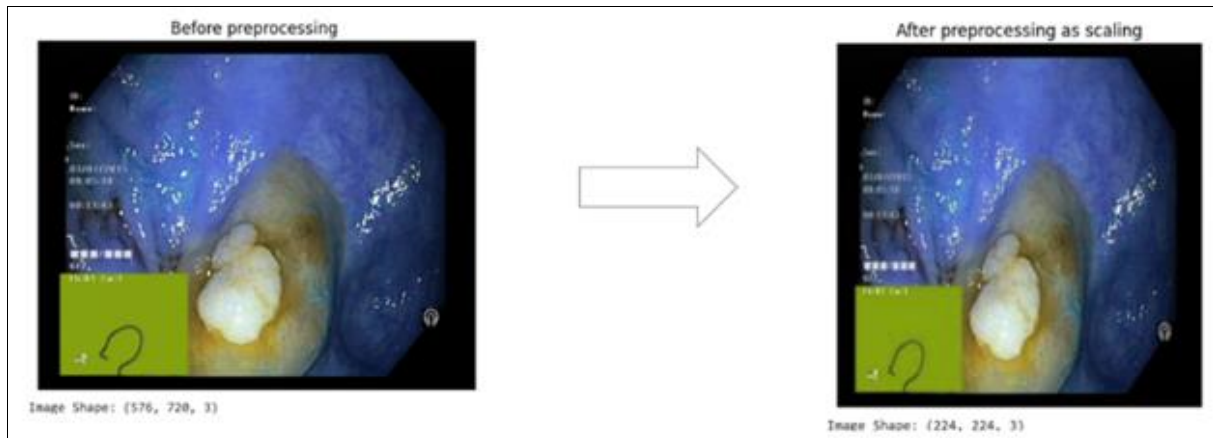


Fig 4: For a single image of class as polyps, showing rescaling with before and after dimensions.

Step 4: The entire dataset undergoes augmentation as zoom, rotation, brightness and shift in height and width. To demonstrate data augmentation performed on a single image can be depicted as:

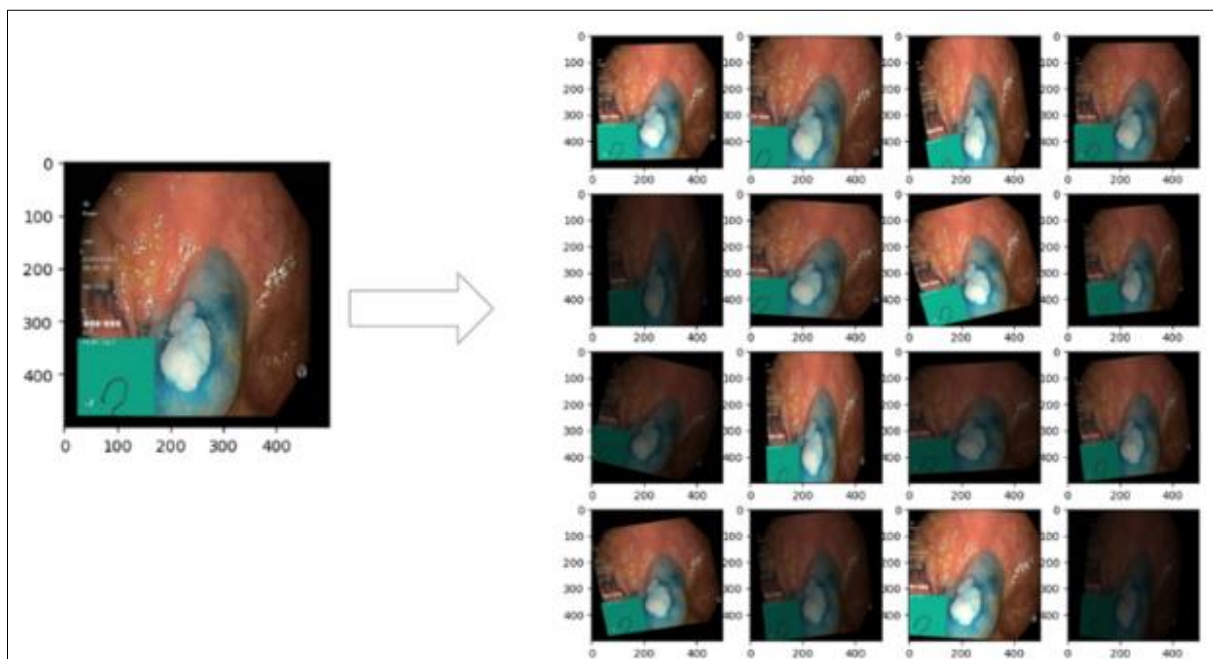


Fig 5: For a single image of class as polyp, depicting the augmentation performed on the it.



Fig 6: Depicting the actual change in architectural aspect of the neural network

4. Results and Discussion

	precision	recall	f1-score	support
0	0.65	0.69	0.67	200
1	0.68	0.63	0.65	200
2	0.68	0.85	0.75	200
3	0.85	0.86	0.86	200
4	0.94	0.98	0.96	200
5	0.82	0.57	0.67	200
6	0.54	0.84	0.66	200
7	0.81	0.34	0.47	200
accuracy			0.72	1600
macro avg	0.74	0.72	0.71	1600
weighted avg	0.74	0.72	0.71	1600

Fig 7: Report on confusion matrix

4.1 Graphical representation

The graph infereces the accuracy of the model per epoch when employing validation set while training for multi-class classification using better architectural structure of the network in deep learning. The maximum accuracy achieved is 75%.

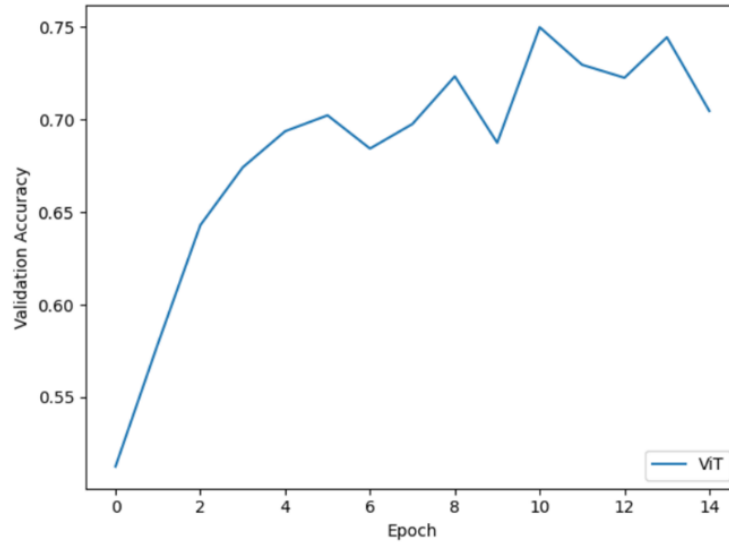


Fig 8: Graph demonstrating validation accuracy

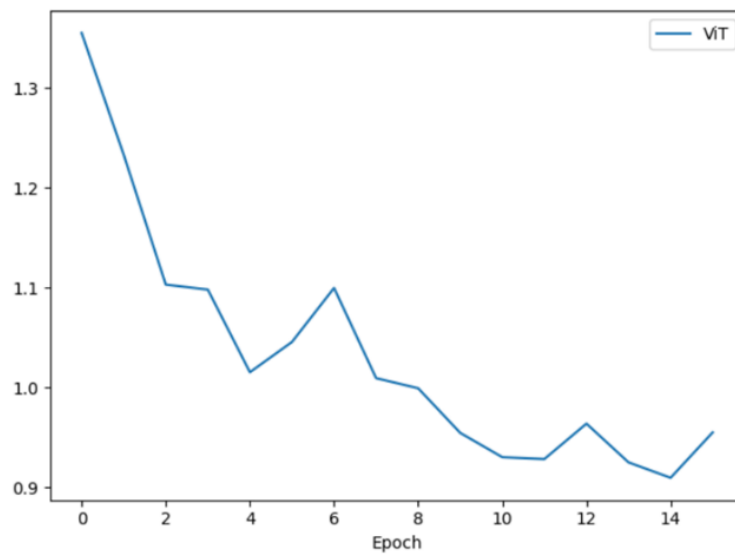


Fig 9: Graph demonstrating validation loss

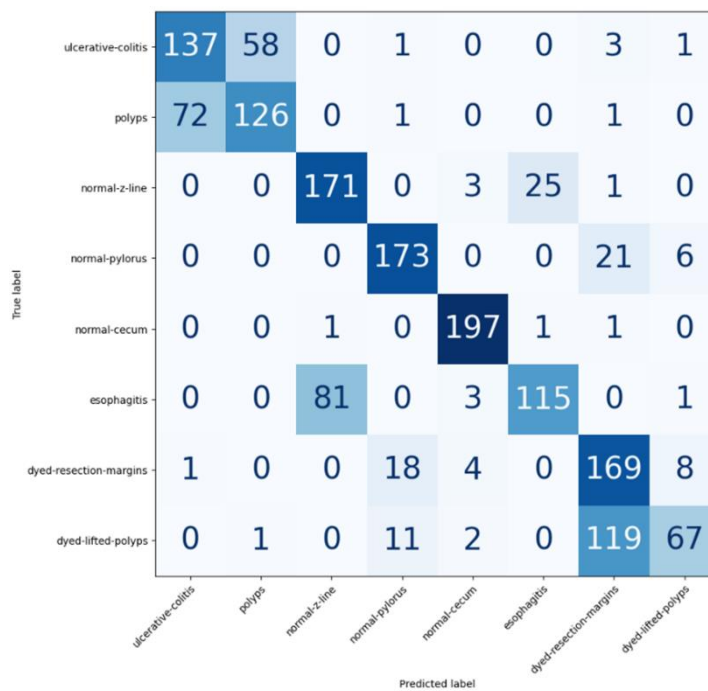


Fig 10: Confusion matrix for transforme

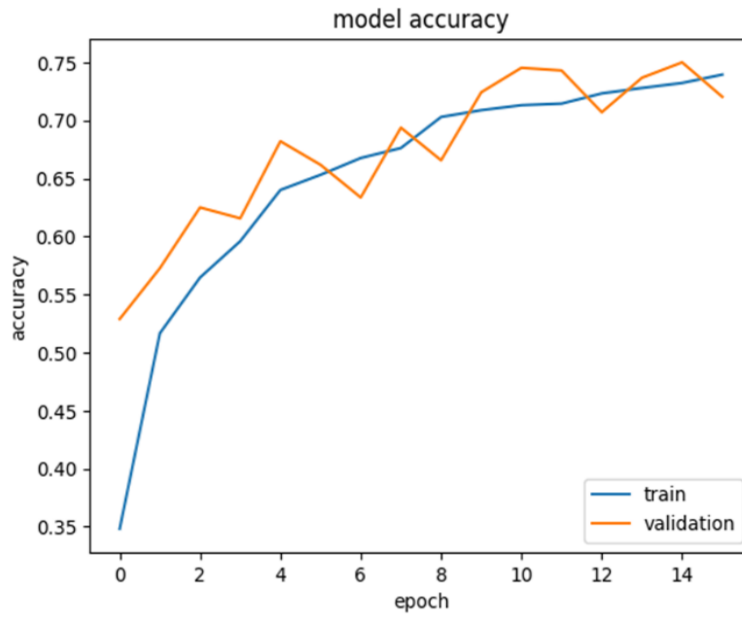


Fig 11: Model accuracy as vision transformer used for classification.

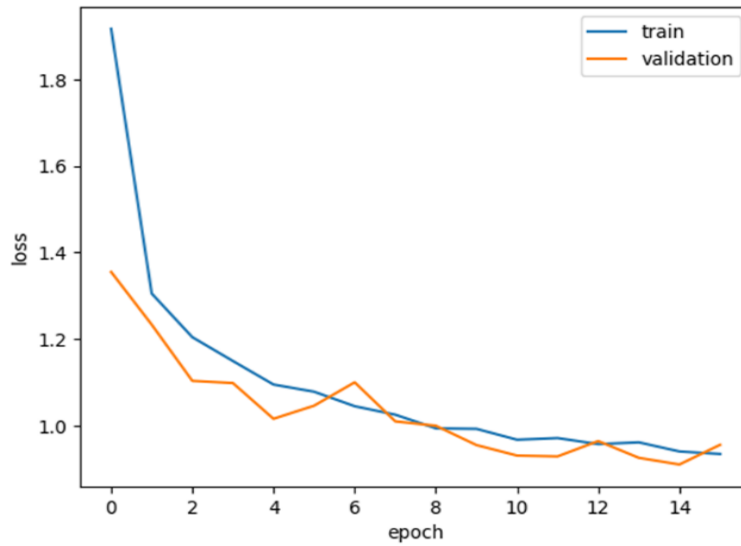


Fig 12: Loss calculation on validation and train datasets.

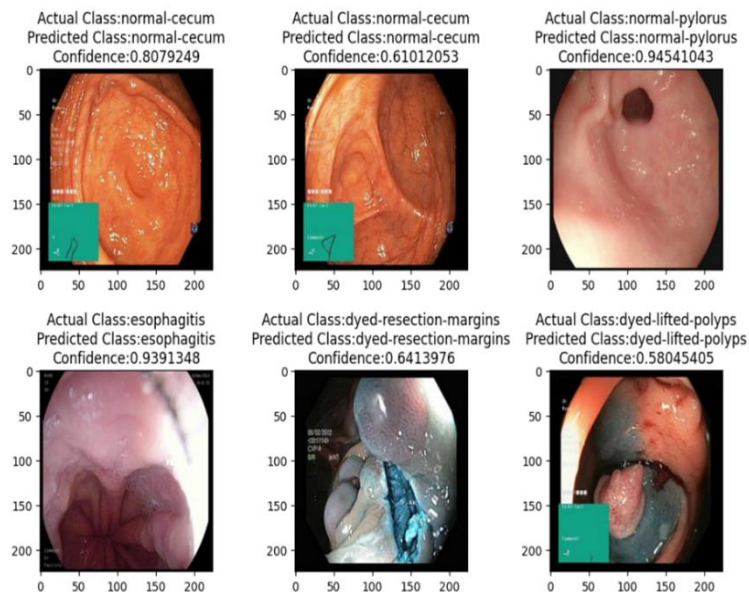


Fig 13: The prediction of model during correct classification for various classes which are labels as actual vs predicted.

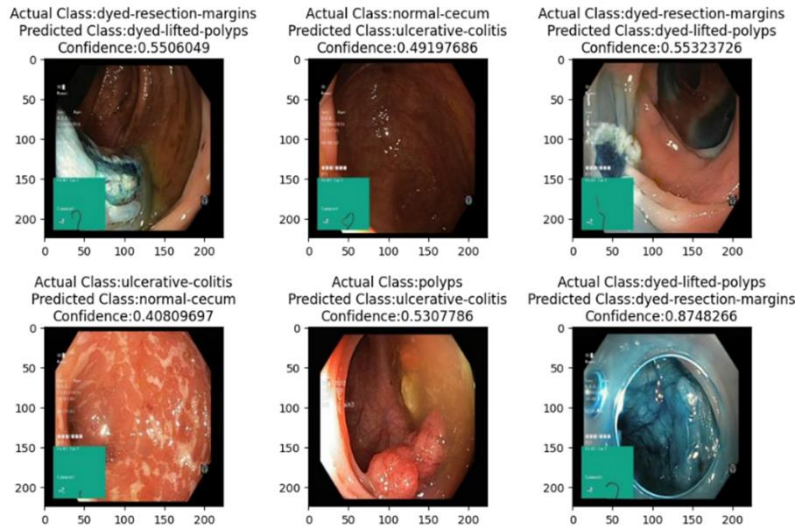


Fig 14: The prediction of model during incorrect classification for various classes which are labels as actual vs predicted.

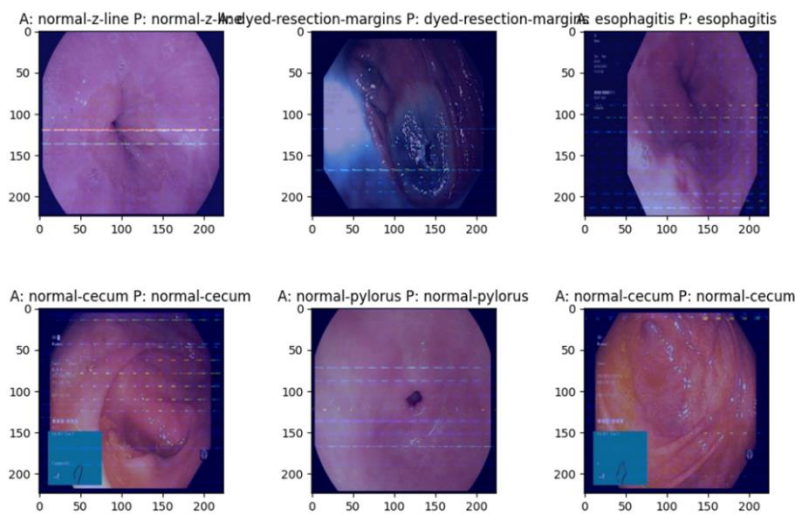


Fig 15: The interpretability of model during correct classification for various classes which are labels as actual vs predicted.

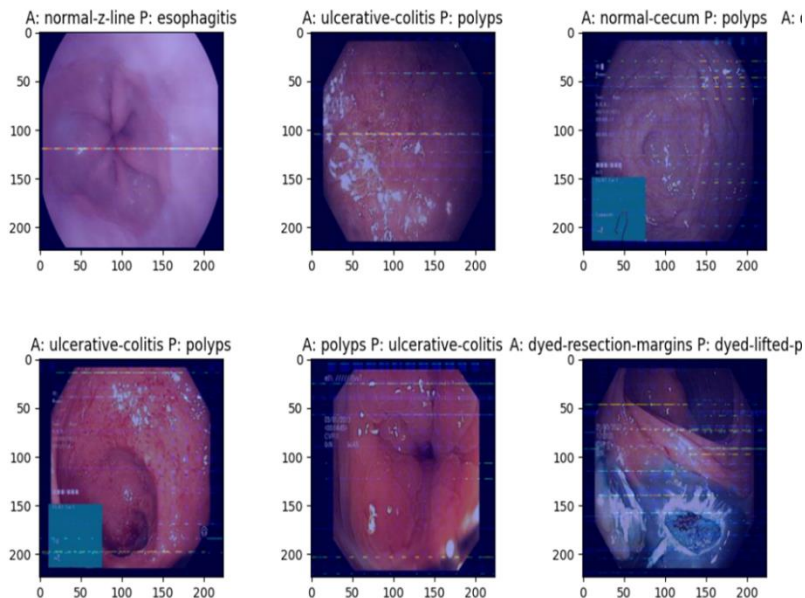


Fig 16: The interpretability of model during incorrect classification for various classes which are labels as actual vs predicted.

5. Conclusion and Future Enhancements

5.1 Conclusion

Deep Learning model like transformer have an advantage over cnn models due to architectural makeup of positional encoding and self-attention mechanism within the encoder block.

Using xai to perform the visualization using grad-cam with allows for the classification process to be transparent and trust to use the system.

5.2 Future Enhancements

A multi model system can be included where there are multiple types of input like text, image data amongst others. Various other areas of xai can be explored to ensure responsible, explainable, accountable and interpretable artificial intelligence can be employ into real world scenario, after consultation from the healthcare professionals.

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