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Gastrointestinal Tract Disease Classification from Wireless Endoscopy Images Using Pre-trained Deep Learning Model

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Abstract: A biopsy is a important medical examination or procedure involved to take a small amount of body tissue taken for analyzing with microscope and the tissue can be taken from any part of the body like skin, organs or other structures of the body. The biopsy image analysis may provide that the cells are cancerous or not, the image analysis report can be a support system for the medical professionals about the origin of the cancer cells and more types of cancer information. The processed image may provide lucid information about aggressive level of the cancer are called cancer grade, of course lab test ,imaging scan test procedures are applied in the practice. Beyond all biopsy, the only complete solution to identify the real cancer in any part or organ of the body . A Computed Tomography (CT) offers clear and valuable information regarding solids and liquids shape and volume that suggests a possibility of cancerous but, only tissue imaging under microscope determines exactness of the diagnostics. A clinical biopsy can be employed to find various diseases, its origin and severances of the cancer cells ,but it is very difficult to share or identify patterns associated with histological features. When the wrong diagnostics is the result leads to inappropriate treatment is inevitable and makes the situation still worsen. The dynamic up gradation is needed in medical imaging to meet the challenging task in front of the medical professionals. An Artificial Intelligence (AI) with Deep Learning and computer aided vision system integrated with Convolutional Neural Network (CNN) can solve such complex issue. CNN can be employed primarily to distinguish image classification, identification and detecting the targeted issue if exist among the images. The results will be more convincible and beyond microscope many additional features can be extracted that are undistinguishable. The Proposed research emphasis the detection of various diseases in gastrointestinal biopsy Images using Deep Learning to cater the immediate need of the medical professionals.

Keywords: CNN - Convolutional Neural Network, CT - Computed Tomography, AI - Artificial Intelligence OC – Esophageal Cancer , GC – Gastric Cancer ,CRC colorectal Cancer

I. Introduction

There are three cancers are very pathetic in nature and creates huge mortality rate around 1.8 million per year in the world called Esophageal (OC), gastric (GC) and colorectal (CRC). Apart from the mortality rate these types of cancers creates issues to the organs of the victims escaped from death and this are called digestive track tumors because of the notable molecular heterogeneity. This makes more complex in detection of the exact disease, selection of therapy ,prognostication, follow ups and implementing safe and essential therapeutics. Nevertheless, important milestone have been invented to achieve ultra precision molecular based precision oncology with the help of dataset creation using Deep learning algorithms and other latest image based analysis. Apart from the Deep Learning solutions , Convolutional Neural Network (CNN) implementation may achieve exact and deep analysis of the image and provide solution to understand the real disease. A CNN model shown in the figure no 1 gives us the detailed representation of the working.

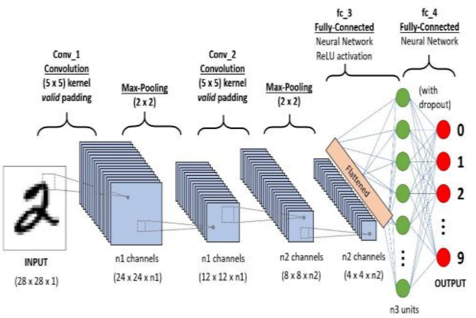

Figure 1 Layers of CNN working methodology.

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The block diagram Figure no 2 of CNN based image classification mentioned below and implemented in the proposed research

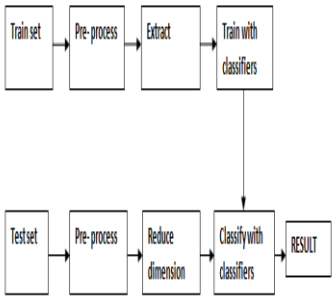

Figure 2 Block diagram of CNN used in this research.

Some common diseases in the gastrointestinal tract (Figure 3) are mentioned below can be identified using CNN based system ,few are explained in the context of biology and Imaging

- Celiac
- Irritable bowel syndrome
- Lactose intolerance
- Chronic diarrhea
- Constipation
- Gastroesophageal reflux disease
- Peptic ulcer disease
- Crohn's disease
- Ulcerative colitis
- Gallstones
- Acute and chronic pancreatitis
- Liver disease
- Diverticulitis

Normal -pylorus: The pylorus is defined as the area aroundthe opening from the stomach in to the first part of the small bowel (duodenum). The opening contains circumferential muscles that regulate the movement of food from the stomach. The identification of pylorus is necessary for endoscopic instrumentation to the duodenum, one of the challenging maneuvers within gastroscopy. A complete gastroscopy includes inspection on both sides of the pyloric opening to reveal findings like ulcerations, erosions or stenosis. The image to the left shows an endoscopic image of a normal pylorus viewed from inside the stomach. Here, the smooth, round opening is visible as a dark circle surrounded by homogeneous pink stomach mucosa.

Esophagitis: Esophagitis is an inflammation of the esophagus visible as a break in the esophageal mucosa in relation to the Z-line. The image to the left shows an example with red mucosal tongues project in gup in the white esophageal lining. The grade of inflammation is defined by length of the mucosal breaks and proportion of the circumference involved. This is most commonly caused by conditions where gastric acid flows back into the esophagus as gastro-esophageal reflux, vomiting or hernia. Clinically, detection is necessary for treatment initiation to relieve symptoms and prevent further development of possible complications. Computer detection would be of special value in assessing severity and for automatic reporting.

Normal cecum: The cecum the most proximal part of the large bowel. Reaching cecum is the proof for a complete colonoscopy and completion rate has shown to be a valid quality indicator for colonoscopy. Therefore, recognition and documentation of the cecum is important. One of the characteristics hallmarks of cecum is the appendiceal orifice. This combined with a typical configuration on the electromagnetic scope tracking system may be used as proof for cecum intubation when named or photo documented in the reports [7]. The image to the left shows an example of the appendiceal orifice visible as a crescent shaped slit, and the green picture in picture shows the scope configuration for cecal position

Dyed and Lifted Polyps: polyp lifted by injection of saline and indigo carmine. The light blue polyp margins are clearly visible against the darker normal mucosa. Additional valuable information related to automatic reporting may involve successfulness of the lifting and eventual presence of non lifted are as that might indicate malignancy.

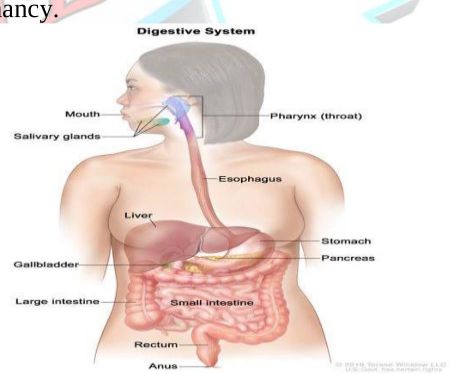

Figure 3 gastrointestinal tract

The most common diseases in the gastrointestinal tract are

Celiac
Irritable bowel syndrome
Lactose intolerance
Chronic diarrhea
Constipation
Gastroesophageal reflux disease
Peptic ulcer disease
Crohn's disease

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Ulcerative colitis
Gallstones
Acute and chronic pancreatitis
Liver disease
Diverticulitis

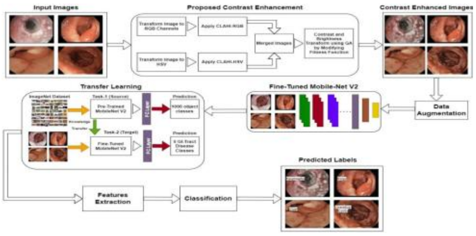

Figure 4 Block diagram of CNN with all tools

Dyed -lifted-polyps: The resection margins are important in order to evaluate whether the polyp is completely removed or not. Residual polyp tissue may lead to continued grow that in worst case malignancy development. Illustrates the resection site after removal of a polyp . Automatic recognition of the site of polyp removals are of value for automatic reporting systems and for computer aided assessment on completeness of the polyp removal

II. Data Set Description

The data set used in the studies is a GIT Figure 3 and Figure 4 images taken with endoscopic equipment at Norway's VV health trust. The training data is obtained from a large gastroenterology department at one of the hospitals in this trust. The further medical experts meticulously annotated the data set and named it Kvasir-V2. This dataset was made available in the fall of 2017 as part of the Mediaeval Medical Multimedia Challenge, a benchmarking project that assigns tasks to the research group Anatomical landmarks, pathological observations, and polyp removal the images in the dataset rangeinresolutionfrom720×576to1920×1072pixels.An anatomical landmark is a characteristic of the GIT that can be seen through an endoscope. It is necessary for navigation and as are ference point for describing the location of a given discovery. It is a so possible that the landmarks are specific areas for pathology, such as ulcers or inflammation.

III. Literature Review

Mariumkhan, SAsad Ali,Sean R.Moore, Beatrice C. Amadi, Paul Kelly (2019) [11], Deep learning for detecting diseases in gastrointestinal biopsy images, Machine learning and computer vision have found applications in medical science and, recently, pathology. In particular, deep learning methods for medical diagnostic imaging can reduce delays in diagnosis and give improved accuracy rates over other analysis techniques. This paper focuses on methods with applicability to automated diagnosis of images obtained from gastrointestinal biopsies. These deep learning techniques for biopsy images may help detect distinguishing features in tissues affected by enteropathies.

Melaku bitew haile, Ayodeji Olalekan salau, belay Enyew & Abebech jenber belay (2022) [12], *Detection and classification of gastrointestinal disease using convolutional neural network and SVM***.** Gastrointestinal tract is a series of hollow organs connected in a long tube twisting from the mouth to the anus. Recovery of gastrointestinal disease patients depends on the early diagnosis of the disease and proper treatment. In recent years, the diagnosis of gastrointestinal tract diseases using endoscopic image classification has become an active area of research in the biomedical domain. However, previous studies show that there is a need for improvement as some classes are more difficult to identify than others. In this study, we propose a concatenated neural network model by concatenating the extracted features of VGG Net and Inception Net networks to develop a gastrointestinal disease diagnosis model.

J. Yogapriya, Venkatesan Chandran, M. G. Sumithra, P. Anitha, P. Jenopaul & C. Suresh Gnana Dhas (2021) [13]. *Gastrointestinal Tract Disease Classification from Wireless Endoscopy Images Using Pre-trained Deep Learning Model,* wireless capsule endoscopy is a noninvasive wireless imaging technology that becomes increasingly popular in recent years. One of the major drawbacks of this technology is that it generates a large number of photos that must be analyzed by medical personnel, which takes time.

2. Hanna borgli (2020) [14], *Hyperkvasir, a comprehensive multi-class image and video dataset for gastrointestinal endoscopy.* Artificial intelligence is currently a hot topic in medicine. However, medical data is often sparse and hard to obtain due to legal restrictions and lack of medical personnel for the cumbersome and tedious process to manually label training data. These constraints make it difficult to develop systems for automatic analysis, like detecting disease or other lesions. In this respect, this article presents HyperKvasir, the largest image and video dataset of the gastro intestinal tract available today.

XinziSun,dechunWang(2021)[15],*Colorectalp olyp detection in real-world scenario.* Colorectal polyps are abnormal tissues growing on the intima of the colon or rectum with a high risk of developing into colorectal cancer, the third leading cause of cancer death worldwide. Early detection and removal of colon polyps via

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colonoscopy have proved to be an effective approach to prevent colorectal cancer. Recently, various CNN-based computer-aided systems have been developed to help physicians detect polyps. However, these systems do not perform well in real- world colonoscopy operations due to the significant difference between images in a real colonoscopy and those in the public datasets.

IV. Methodology And Implementation

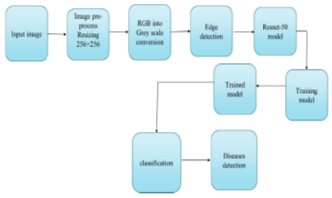

Figure 5 Block diagram of the proposed system

In this paper we use input as gastrointestinal endoscopy images we take at in the hyperkvasir and to solve the issue of small data sizes, transfer learning was used to fine-tune they are ResNet-50, on the training images of the kvasir dataset.

V. GastrointestinaltractdiseaseclassifIcation UsingResNet-50

ResNet-50 is a convolutional neural network that is 50 layers deep Figure 6. You can load a pre-trained version of the neural network trained on more than a million images from the ImageNet database. The pre-trained neural network can classify images into 1000 object categories, Such as 5 classes. As a result, the neural network has learned rich feature representations for a wide range of images. The neural network has an image input size of 224-by-224. For more pre-trained neural networks in MATLAB

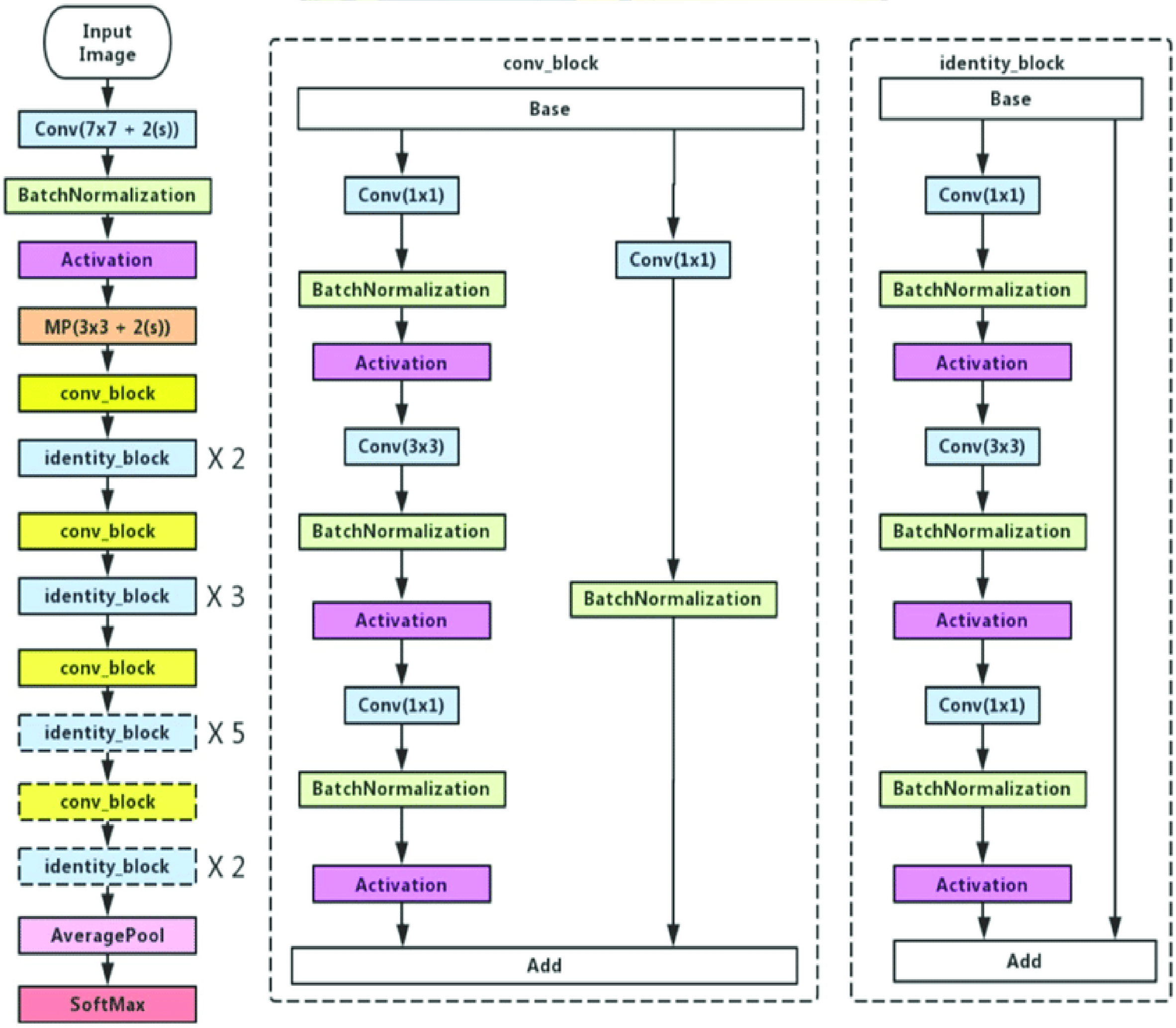

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Figure 6.ResNet-50Architecture

Image pre-processing is the term for operations on images at the lowest level of abstraction. These operations do not increase image information content but they decrease it if entropy is an information measure. The aim of the pre- processing is an improvement of the images data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task.

VI. CONVOLUTION LAYER

CNN generally consist of three main layers for example Convolution layer, pooling layer, and fully connected layer. Convolution layer gives the dot product of the filter with the image patch which results in newer volume of size of the

Input image. Kernel or filter will be convoluted along with the source pixel to obtain a new pixel value. Number of convolution layer can be decided by the method of training the sets and then by learning from them.

POOLING LAYER

Pooling layers is often used to reduce the size of the pixel, max pooling is a pooling operation that calculates the maximum value for patches of a feature map, and uses it to create a down sampled feature map, and uses it to create a down sampled feature map-low level features. In is mostly used when the image has a light background since min pooling will select darker pixels. An average pooling is a pooling operation that calculates the average value for patches of a feature map, and uses it to create a down sampled feature map.

FULLY CONNECTED LAYERS

A fully connected layer refers to a neural network in which each neuron applies a linear transformation to the input vector through a weight matrix. As a result, all possible connections layers to layers are present, meaning every input of the input vector influences every input of the input vector influences every output of the output vector. It converts multi layers to one dimension.

DATASET DESCRIPTION

The dataset used in these studies is a GIT images taken with endoscopic equipment at Norway's VV health trust. The training data is obtained from a large gastro enterology department at one of the hospitals in this trust. The further medical experts meticulously annotated the dataset and named it Kvasir-V2. This dataset was made available in the fall of 2017 as part of the Mediaeval Medical Multimedia Challenge, a benchmarking project that assigns tasks to the research group Anatomical landmarks, pathological observations, and polyp removal the images in the dataset range in resolution from 720×576to1920×1072 pixels. An anatomical landmark is a characteristic of the GIT that can be seen through an endoscope. It is necessary for navigation and as a reference point for describing the location of a given discovery. It is also possible that the landmarks are specific areas for pathology, such as ulcers or inflammation.

VII.PROPOSED METHOD

To detect the gastro intestinal diseases using the deep learning techniques. In major diseases diagnosed using the ulcers, bleeding, malignancy, and polyps in the gastro intestinal tract Segmentation, classification, detection, and localization are techniques used to solve problem to diagnosing disease Figure 7. The advancement of CNNs as automated detection of diseases in various organ of the human body CNNs model has the advantage of extracting features hierarchically from low to high level. A computer-assisted diagnostic system is being proposed to classify GIT diseases in too many categories, including anatomical landmarks, pathological observations, and polyp removal The ResNet- 50, CNN architecture classify GIT tract diseases from the endoscopic images by slightly modifying the architecture.

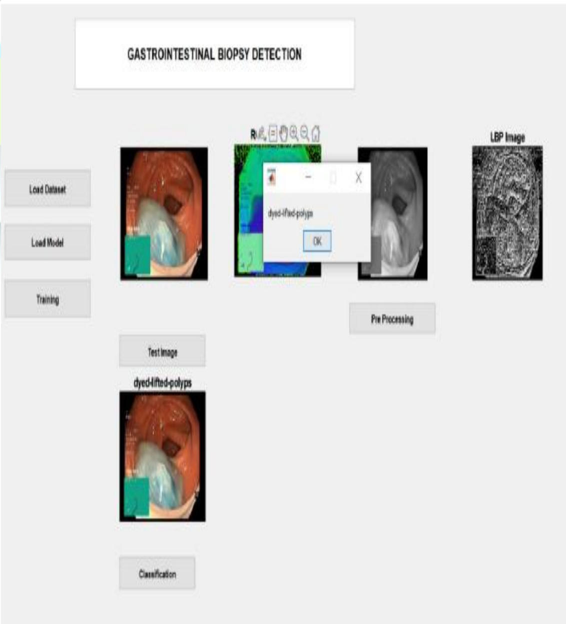

Figure 8 output of Detection of dyed-lifted-polyps

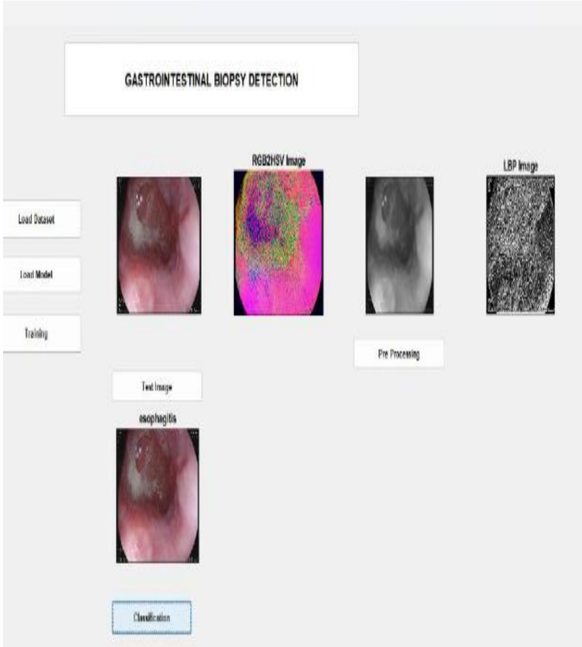

Figure 9 output of Esophagitis

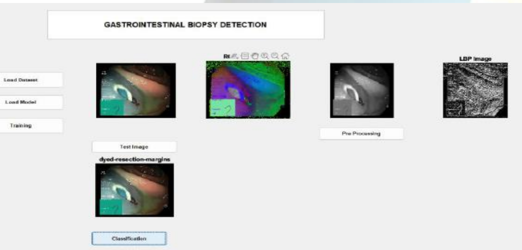

Figure 10 output of Dyed-Resection -Margins

In this proposed project research work, the kvasir dataset is used for the classification of GIT diseases, the entire dataset is divided into an 80% training and 20% validation set. Image with resolutions ranging from 720×576 to1920×1072 pixels were transformed to 256×256 pixels in collected dataset. in addition, the proposed system will likely be able to handle larger and more diverse datasets than the existing systems, allowing it to potentially detect a wider range of gastro intestinal diseases. The use of transfer learning and fine-tuning techniques will also make the proposed system adaptable to different clinical settings, improving its versatility and utility. It is important to note that the accuracy of the proposed system will depend on the quality and diversity of the training data, as well as the effectiveness of the deep learning algorithms used. Therefore, it will be necessary to collect a large and diverse dataset of gastrointestinal biopsy images and to carefully design and optimize the deep learning architecture to achieve the best possible results. Overall, the proposed system for detecting diseases in gastro intestinal biopsy images using deep learning has the potential to significantly improve the accuracy, efficiency, and scalability of disease diagnosis and to ultimately improve patient outcomes and quality of life.

VIII. CONCLUSION

In conclusion, detecting diseases in gastro intestinal biopsy images using deep learning techniques represents a promising approach to improving the accuracy and efficiency of disease diagnosis. The existing systems for disease detection have limitations in terms of accuracy, scalability, and transferability, which can be over come by using deep learning techniques such as CNNs. The proposed system for detecting diseases in gastrointestinal biopsy images using deep learning offers several advantages, including improved accuracy, scalability, transferability, automation, and reduce subjectivity. These advantages can potentially lead to faster and more accurate disease diagnosis, reduced healthcare costs, and improved patient outcomes. However, the effectiveness of the proposed system will depend on the quality and diversity of the training data, as well as the effectiveness of the deep learning algorithms used. Therefore, it will be important to collect a large and diverse dataset of gastro intestinal biopsy images and to carefully design and optimize the deep learning architecture to achieve the best possible results. Overall, the proposed system represents a significant advancement in the field of disease diagnosis and has the potential to significantly improve patient outcomes and quality of life. Further research and development in this area are necessary to fully realize the potential of deep learning techniques for detecting diseases in gastrointestinal biopsy images.

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