IMPROVING GASTRIC ULCER DIAGNOSIS WITH CONVOLUTIONAL NEURAL NETWORK USING ENDOSCOPY IMAGES

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ABSTRACT :

Stomach ulcers, a common gastrointestinal disorder, can lead to severe complications if left undiagnosed or untreated. Early and accurate detection is critical to improving patient outcomes and reducing healthcare costs. This Project aims to develop an artificial intelligence (AI)-based system to detect and classify stomach ulcers using medical imaging techniques such as endoscopy. Leveraging deep learning algorithms, particularly convolutional neural networks (CNNs), the system analyzes endoscopic images to identify ulcerative lesions with high accuracy and efficiency. The proposed model integrates advanced image preprocessing techniques, such as segmentation and contrast enhancement, to isolate regions of interest and improve diagnostic precision. A comprehensive dataset of annotated images, collected in collaboration with medical professionals, is used for training and validation. The system is designed to provide real-time diagnostic support, assisting clinicians in identifying ulcers, assessing their severity, and distinguishing them from other Gastric conditions. This AI-based approach has the potential to reduce diagnostic errors, speed up clinical workflows, and make expert-level diagnostic capabilities accessible in resource-limited settings. By combining technological innovation with medical expertise, this project aims to advance healthcare delivery and improve the quality of life for patients suffering from gastric disorders.

Keywords: Stomach Ulcer, CNN, Endoscopy Images, AI ,Image detection

I. INTRODUCTION :

OVERVIEW:

Stomach ulcers, also known as peptic ulcers, are sores that develop on the lining of the stomach or the upper part of the small intestine. They are typically caused by Helicobacter pylori infection or prolonged use of nonsteroidal antiinflammatory drugs (NSAIDs). If left untreated, stomach ulcers can lead to severe complications such as internal bleeding, perforation, and even stomach cancer. Early diagnosis and treatment are crucial to prevent these adverse outcomes. Traditional methods of diagnosing stomach ulcers primarily rely on endoscopic examinations, where a clinician visually inspects the stomach lining for ulcerative lesions. While effective, this process is time-consuming, heavily dependent on the expertise of the endoscopes, and prone to human error. Additionally, the increasing demand for diagnostic services places a burden on healthcare systems, particularly in regions with limited access to skilled medical professionals. Advances in artificial intelligence (AI) and deep learning have opened new avenues for automating and enhancing medical diagnostics. Image analysis using AI, particularly convolutional neural networks (CNNs), has demonstrated remarkable success in identifying patterns and anomalies in medical imaging.

OBJECTIVES :

The primary objective of this project is to develop an artificial intelligencebased system for the accurate and efficient detection of stomach ulcers using medical imaging techniques, such as endoscopic images. This system aims to enhance the diagnostic process by reducing human error, improving accuracy, and providing real-time support to medical professionals.

1. Automated Detection: To design and implement a deep learning model capable of detecting stomach ulcers from endoscopic images with high precision and reliability.

2. Classification: To classify ulcers based on their severity, size, and type (e.g., gastric or duodenal ulcers), enabling detailed diagnostic insights.

3. Image Pre-processing: To employ advanced image processing techniques such as segmentation and enhancement to improve the quality of input data and isolate regions of interest.

4. Clinical Integration: To develop a system that can be integrated into clinical workflows, providing real-time diagnostic assistance to healthcare professionals during endoscopic examinations.

5. Scalability and Accessibility: To create a solution that is scalable and accessible, ensuring its applicability in

resource-limited settings and telemedicine platforms.

6. Validation and Accuracy Assessment: To evaluate the performance of the AI system against expert diagnoses using a comprehensive dataset and robust validation techniques.

EXISTING SYSTEM

Accurate patient disease classification and detection through deep-learning (DL) models are increasingly contributing to the area of biomedical imaging. The most frequent gastrointestinal (GI) tract ailments are peptic ulcers and stomach cancer. Conventional endoscopy is a painful and hectic procedure for the patient while Wireless Capsule Endoscopy (WCE) is a useful technology for diagnosing GI problems and doing painless gut imaging. However, there is still a challenge to investigate thousands of images captured during the WCE procedure accurately and efficiently because existing deep models are not scored with significant accuracy on WCE image analysis.

II. PROPOSED SYSTEM :

The proposed system utilizes artificial intelligence to automate the detection and classification of stomach ulcers using endoscopic images. It begins with the collection and annotation of a comprehensive dataset, ensuring that images are labelled by medical experts for accuracy. Pre-processing techniques such as segmentation and contrast enhancement are applied to isolate relevant regions and improve image quality. A deep learning model, particularly a convolutional neural network (CNN), is developed to analyze these images, identifying ulcers and categorizing them based on severity, size, and type. The system supports real-time analysis, enabling integration with endoscopic equipment for on-the-spot diagnostic assistance. A user-friendly interface allows clinicians to upload images and view results, including detected ulcer regions visualized as heat maps for better interpretability. The performance of the model is validated against expert diagnoses, using metrics like accuracy, precision, and recall to ensure reliability. Designed for scalability, the system can be integrated into hospital management systems and telemedicine platforms, providing accessible and efficient diagnostic support even in resource-limited settings.

SYSTEM REQUIREMENT SPECIFICATION :

This chapter describes about the requirements. It specifies the hardware and software requirements that are required in order to run the application properly. The Software Requirement Specification (SRS) is explained in detail, which includes overview of dissertation as well as the functional and non-functional requirement of this dissertation.

A SRS document describes all data, functional and behavioural requirements of the software under production or development. SRS is a fundamental document, which forms the foundation of the software development process. It is the complete description of the behaviour of a system to be developed. Requirement Analysis discusses the conditions to be met for a new or altered product. Requirement Analysis is critical to the success to a development project. Requirement must be documented, measurable, testable, related to in identified business needs or opportunities, and defined to a level of detail sufficient for system design. The SRS functions as a blueprint for completing a project. The goal of preparing the SRS document is to:

- Facilitate communication between the customer, analyst, system developers, maintainers.
- To form a foundation for the design phase.
- Support system testing facilities.
- Controlling the evolution of the system.

- It is the sequential design that give permission to CNN to learn hierarchical attributes.
- In CNN, some of them followed by grouping layers and hidden layers are typically convolutional layers followed by activation layers.
- The pre-processing needed in a ConvNet is kindred to that of the related pattern of neurons in the human brain and was motivated by the organization of the Visual Cortex.

CONVOLUTED NEURAL NETWORK :

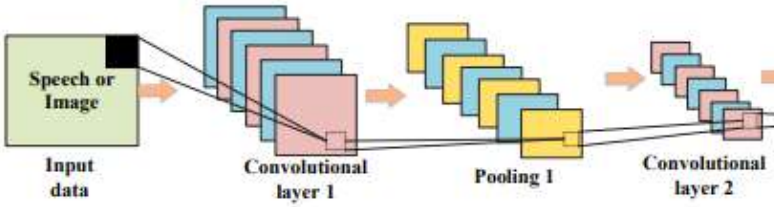

Fig. CNN

A Convolutional Neural Network (CNN) is a type of deep learning algorithm that is particularly well suited for image processing tasks. It is made up of multiple layers, including convolutional layers, pooling layers, and fully connected layers.The convolutional layers are the key component of a CNN, where filters are applied to the input image to extract features such as edges, textures, and shapes. The output of the convolutional layers is then passed through pooling layers, which are used to down-sample the feature maps, reducing the spatial dimensions while retaining the most important information. The output of the pooling layers is then passed through one or

more fully connected layers, which are used to make a prediction or classify the image.CNNs are trained using a large dataset of labelled images, where the network learns to recognize patterns and features that are associated with specific objects or classes. Once trained, a CNN can be used to classify new images, or extract features for use in other applications such as object detection or image segmentation.CNNs have achieved state-of-the-art performance on a wide range of image recognition tasks, including object classification, object detection, and image segmentation. They are widely used in computer vision, image processing, and other related fields, and have been applied to a wide range of applications, including self-driving cars, medical imaging, and security systems.

Convolutional Neural Network Design:

- The construction of a convolutional neural network is a multi-layered feed-forward neural network, made by assembling many unseen layers on top of each other in a particular order.

More accurate classifiers are given more weight. A classifier with 50% accuracy is given a weight of zero, and a classifier with less than 50% accuracy (kind of a funny concept) is given negative weight.

III. PYTHON

Python is a widely used high-level, general-purpose, interpreted, dynamic programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C++ or Java. The language provides constructs intended to enable clear programs on both a small and large scale. Python supports multiple programming paradigms, including object-oriented, imperative and functional programming or procedural styles. It features a dynamic type system and automatic memory management and has a large and comprehensive standard library. Python interpreters are available for installation on many operating systems, allowing Python code execution on a wide variety of systems.

Python Popular Frameworks and Libraries:

Python has wide range of libraries and frameworks widely used in various fields such as machine learning, artificial intelligence, web applications, etc. We define some popular frameworks and libraries of Python as follows.

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- **Web development (Server-side)** - Django Flask, Pyramid, CherryPy
- **GUIs based applications** - Tk, PyGTK, PyQt, PyJs, etc.
- **Machine Learning** - TensorFlow, PyTorch, **Scikit-learn**, Matplotlib, Scipy, etc.
- **Mathematics** - Numpy, Pandas, etc.
- **BeautifulSoup:** a library for web scraping and parsing HTML and XML
- **Requests:** a library for making HTTP requests
- **SQLAlchemy:** a library for working with SQL databases
- **Kivy:** a framework for building multi-touch applications
- **Pygame:** a library for game development
- **Pytest:** a testing framework for Python
- **Django REST framework:** a toolkit for building RESTful APIs
- **FastAPI:** a modern, fast web framework for building APIs
- **Streamlit:** a library for building interactive web apps for machine learning and data science
- **NLTK:** a library for natural language processing

Scripting Language

A scripting or script language is a programming language that supports scripts, programs written for a special run-time environment that automate the execution of tasks that could alternatively be executed one-

by-one by a human operator. Scripting languages are often interpreted (rather than compiled). Primitives are usually the elementary tasks or API calls, and the language allows them to be combined into more complex programs. Environments that can be automated through scripting include software applications, web pages within a web browser, the shells of operating systems (OS), embedded systems, as well as numerous games. A scripting language can be viewed as a domain-specific language for a particular environment; in the case of scripting an application, this is also known as an extension language. Scripting languages are also sometimes referred to as very high-level programming languages, as they operate at a high level of abstraction, or as control languages.

Object Oriented Programming Language

on the concept of "objects", which may contain data, in the form of fields, often known as attributes; and code, in the form of procedures, often known as methods. A distinguishing feature of objects is that an object's procedures can access and often modify the data fields of the object with which they are associated (objects have a notion of "this" or "self"). In OO programming, computer programs are designed by making them out of objects that interact with one another. There is significant diversity in objectoriented programming, but most popular languages are class-based, meaning that objects are instances of classes, which typically also determines their type.

Data PreProcessing

bounding box required for Yolo training were calculated considering the coordinates of the smallest rectangle containing the segmented lesion. Instead, the ROI coordinates for the proprietary dataset were computed from the square region that inscribes the circle containing the ROI. The CBIS-DDSM dataset has an acceptable size for deep learning architectu training. For this reason, only for the CBIS-DDSM dataset, the contrast limited adaptive histogram equalization (CLAHE) was applied for image enhancement, with the following setting: 1 as contrast limit, 2×2 as grid size, followed by a 3×3 Gaussian filter. For all data-sets, the gray levels were scaled in the range 0–255, and the images were resized to 640 ×640 using the Lanczos filter. The CBIS-DDSM dataset was spitted randomly considering 70% training, 15% validation, and 15% test set. Conversely, the INbreast and the proprietary datasets were split into training (80%) and test set (20%), respectively. Considering the small size of the two datasets and the unbalanced issue, the next “Data Augmentation” discusses data augmentation for class balancing and

generation of the validation set "Techniques for Class Balancing Before the Training Phase", as well as the procedure to improve the training "Techniques Used During the Training Phase".

Data Augmentation Techniques for Class Balancing Before the Training Phase. Due to the excessive imbalance classes for the INbreast and proprietary dataset, the minority class images (benign) of the training set were augmented. Although the main purpose of the work is to evaluate the detection performance on the proprietary dataset (regardless of lesion class), the following data augmentation procedure was applied to the proprietary dataset before the training phase. Figure□2 sum-marizes the transformation considered. In particular, 180◦ rotation and 180◦ rotation + flip upper-down (UD) were applied for benign images. The other transformations were applied during the training of Yolo, as discussed in the next subsection "Techniques Used during the Training Phase".

In addition, according to, the remaining test dataset was augmented to obtain the validation set. In fact, flip UD, 180◦ rotation + flip UD, flip left-right (LR) and 180◦ rotation were applied on benign images, and Flip LR for malignant images. Considering the smaller difference between the classes, on INbreast, also, 180◦ rotations for malignant masses was considered [9].This procedure resulted in the generation of a balanced validation set. In addition, the discussed procedure for INbreast and the proprietary datasets was repeated considering 5 different splitting of training and test sets (5-fold cross-validation).

DEEP LEARNING

Deep learning is a method in artificial intelligence (AI) that teaches computers to process data in a way that is inspired by the human brain. Deep learning models can recognize complex patterns in pictures, text, sounds, and other data to produce accurate insights and predictions. You can use deep learning methods to automate tasks that typically require human intelligence, such as describing images or transcribing a sound file into text.

IV. USES OF DEEP LEARNING

Artificial intelligence (AI) attempts to train computers to think and learn as humans do. Deep learning technology drives many AI applications used in everyday products, such as the following:

- Digital assistants
- Voice-activated television remotes
- Fraud detection
- Automatic facial recognition

It is also a critical component of emerging

technologies such as self-driving cars, virtual reality, and more.

Deep learning models are computer files that data scientists have trained to perform tasks using an algorithm or a predefined set of steps. Businesses use deep learning models to analyse data and make predictions in various applications.

Deep learning has several use cases in automotive, aerospace, manufacturing, electronics, medical research, and other fields. These are some examples of deep learning:

- Self-driving cars use deep learning models to automatically detect road signs and pedestrians.
- Defence systems use deep learning to automatically flag areas of interest in satellite images.
- Medical image analysis uses deep learning to automatically detect cancer cells for medical diagnosis.
- Factories use deep learning applications to automatically detect when people or objects are within an unsafe distance of machines. You can group these various use cases of deep learning into four broad categories—computer vision, speech recognition, natural language processing (NLP), and recommendation engines.

Deep learning work

Deep learning algorithms are neural networks that are modelled after the human brain. For example, a human brain contains millions of interconnected neurons that work together to learn and process information. Similarly, deep learning neural networks, or artificial neural networks, are made of many layers of artificial neurons that work together inside the computer.

Artificial neurons are software modules called nodes, which use mathematical calculations to process data. Artificial neural networks are deep learning algorithms that use these nodes to solve complex problems

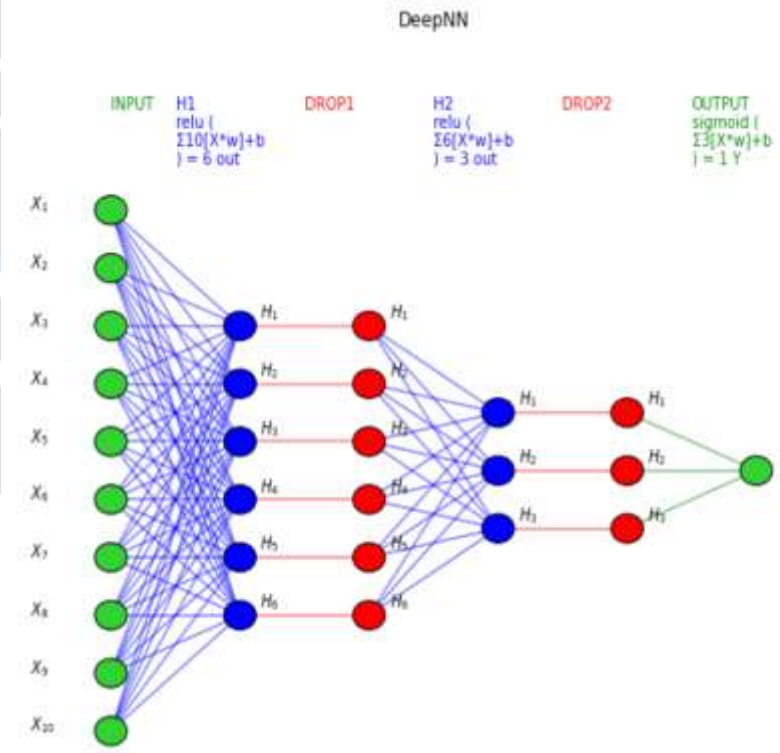

Fig. Deep learning Network

COMPONENTS OF DEEP LEARNING

The components of a deep neural network are the following.

Input layer

An artificial neural network has several nodes that input data into it. These nodes make up the input layer of the system.

Hidden layer

The input layer processes and passes the data to layers further in the neural network. These hidden layers process information at different levels, adapting their behavior as they receive new information. Deep learning networks have hundreds of hidden layers that they can use to analyze a problem from several different angles.

For example, if you were given an image of an unknown animal that you had to classify, you would compare it with animals you already know. For example, you would look at the shape of its eyes and ears, its size, the number of legs, and its fur pattern. You would try to identify patterns, such as the following:

- The animal has hooves, so it could be a cow or deer.
- The animal has cat eyes, so it could be some type of wild cat.

The hidden layers in deep neural networks work in the same way. If a deep learning algorithm is trying to classify an animal image, each of its hidden layers processes a different feature of the animal and tries to accurately categorize it.

Output layer

The output layer consists of the nodes that output the data. Deep learning models that output "yes" or "no" answers have only two nodes in the output layer. On the other hand, those that output a wider range of answers have more nodes.

V. CHALLENGES

As deep learning is a relatively new technology, certain challenges come with its practical implementation.

Large quantities of high-quality data

Deep learning algorithms give better results when you train them on large amounts of high-quality data. Outliers or mistakes in your input dataset can significantly affect the deep learning process. For instance, in our animal image example, the deep learning model might classify an airplane as a turtle if non-animal images were accidentally introduced in the dataset.

To avoid such inaccuracies, you must clean and process large amounts of data before you can train deep learning models. The input data pre-processing requires large amounts of data

storage capacity.

Large processing power

Deep learning algorithms are compute-intensive and require infrastructure with sufficient compute capacity to properly function. Otherwise, they take a long time to process results.

VI. STOMACH ULCER

A stomach or gastric ulcer is a break in the tissue lining of the stomach.

The term 'peptic ulcer' refers to those that occur in either the stomach or the first part of the small intestine that leads out of the stomach, called the duodenum.it was once commonly thought that **stress**, **smoking** and **diet** were the principal causes of stomach ulcers. However, the *Helicobacter pylori* (*H. pylori*) bacterium is now known to be responsible for most duodenal ulcers and 60% of stomach ulcers. The *H. pylori* bacterium also prompts many symptoms of indigestion (dyspepsia).

Treatment for stomach ulcers includes the use of antibiotics to kill the infection, and acid-suppressing drugs.

Symptoms of stomach ulcers

Some stomach ulcers don't produce any symptoms. If present, the symptoms can include:

- **abdominal pain** just below the ribcage
- **indigestion**

a variety of factors, including:

- **Helicobacter pylori** – bacteria is thought to be responsible for around 60% of stomach ulcers and at least 90% of duodenal ulcers.
- **Certain medications** – which include aspirin or clopidogrel, taken regularly to help prevent **heart attack** or **stroke**, and drugs for **arthritis**. Anti-inflammatory medications (NSAIDS) are thought to cause around two fifths of stomach ulcers.
- **Cancer** – **stomach cancer** can present as an ulcer, particularly in older people.

DISESASES

- **Esophagitis**
- **POLYPS**

A. Esophagitis

- Esophagitis is inflammation in your esophagus, the swallowing tube that runs from your throat down to your stomach. It may feel sore, swollen, raw or burning. Inflammation in your tissues occurs when your immune system has been activated to destroy an infection or allergen or to repair tissue damage. Erosive substances, such as stomach acid and certain medications, can injure your esophagus tissues.nausea
- loss of appetite
- vomiting
- weight loss
- bright or altered blood present in vomit or **bowel motions**
- symptoms of **anaemia**, such as light-headedness
- **shock** due to blood loss – a medical emergency.

The stomach

The stomach is an organ of the **digestive system**, located in the abdomen just below the ribs and on the left.

Swallowed food is squeezed down the oesophagus and pushed through a sphincter (small muscle ring) into the stomach, where it is mixed with powerful gastric juices

containing enzymes and hydrochloric acid. The stomach is a muscular bag, so it can churn the food and break it down mechanically as well as chemically.

Once the food is the consistency of smooth paste, it is squeezed through a second sphincter into the first part of the small intestine (duodenum). The lining of the stomach – the mucosa or gastric epithelium – is layered with multiple folds. Ulcers occur in this lining.

Causes of stomach ulcers

A stomach ulcer can be caused by

Fig. Esophagitis

B. POLYPS

Polyps stomach polyps are growths on the inside lining of your stomach. They're also called gastric polyps. Polyps are a type of tumor that grows out of the mucous lining inside your hollow organs, like the ones in your gastrointestinal tract. Stomach polyps are usually benign, but some can become cancerous. **Fundic gland polyps**. These are the most common stomach polyps, usually appearing sporadically through the upper part of your stomach (the fundus). They have little to no cancerous potential when they appear this way. However, they can sometimes occur in greater numbers with rare hereditary cancer syndromes, including familial adenomatous polyposis (FAP) and gastric adenocarcinoma and proximal polyposis of the stomach (GAPPS). In these cases, they're more likely to be precancerous.

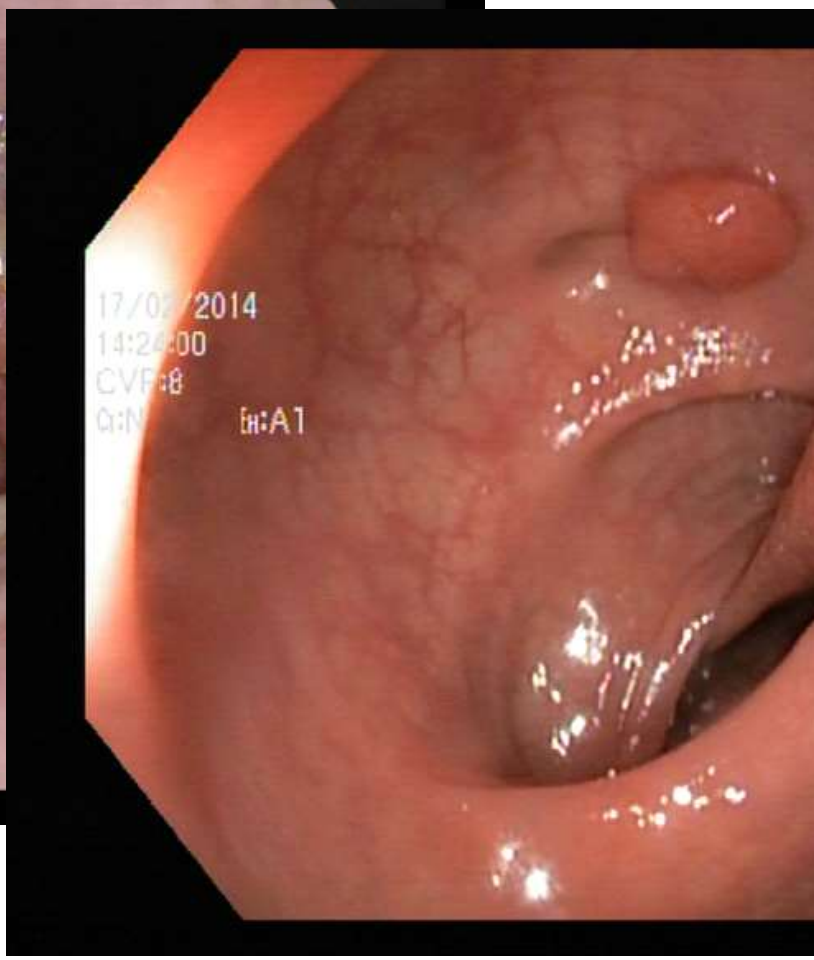

Fig . Polyps

C.ULCERATIVE COLITIS

. It also may bring about long-term remission.

Ulcerative colitis is a type of inflammatory bowel disease (IBD) that causes inflammation and sores, called ulcers, in part of the digestive tract. Ulcerative colitis (UL-sur-uh-tiv koe-LIE-tis) affects the innermost lining of the large intestine, called the colon, and rectum. Symptoms usually develop over time, rather than coming on suddenly.

Ulcerative colitis can weaken the body and can sometimes lead to life-threatening complications. While it has no known cure, treatment can greatly reduce and relieve symptoms of the disease

Fig . Ulcerative colitis

DIAGNOSIS

Diagnosing a stomach ulcer is done using a range of methods, including:

- **Endoscopy** – a thin flexible tube is threaded down the oesophagus into the stomach under light anaesthesia. The endoscope is fitted with a video capture device and highly detailed images of the stomach lining can be obtained. If a gastric ulcer has been found, the endoscopy must be repeated after treatment to ensure healing and exclude the possibility of cancer.
- **Biopsy** – a small tissue sample is taken during an endoscopy and tested in a laboratory. This biopsy should always be done if a gastric ulcer is found.
- **C14 breath test** – checks for the presence of H. pylori. The bacteria convert urea into carbon dioxide. The test involves swallowing an amount of radioactive carbon (C14) and testing the air exhaled from the lungs. A non-radioactive test can be used for children and pregnant women.

RESULT

This chapter presents the analysis of CNN

models applied to gastric ulcer diagnosis based on the testing and training model, the project result & graphs shows below :

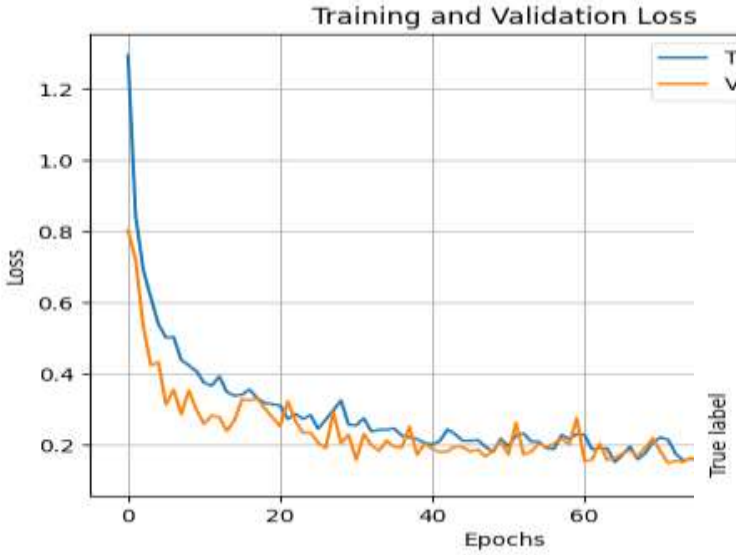

Fig . Training and Validation loss Graph

- The training and validation graph is the loss of the gastric ulcr prediction and the loss mention is error. Every row carry the 200 images , so the 0-20 is 200 images overall images 500 – 1000 set of images tested and trained. The loss high to decrese is showed on the figure 6.1

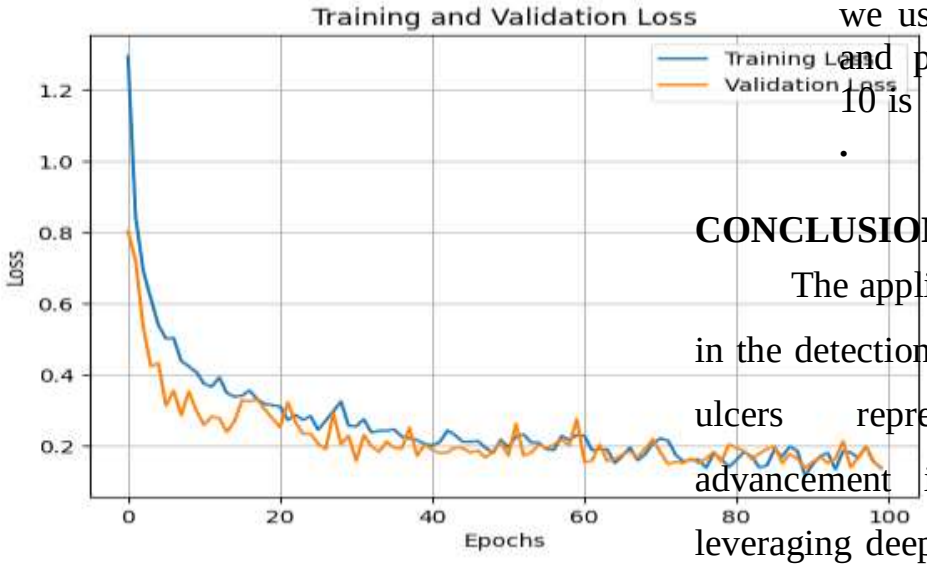

Fig. Training and Validation Accuracy Graph

- The training and validation accuracy graph is the accuracy of the gastric ulcr prediction and the low state to increasing the accuracy state in every training .
- The Every row carry the 200 images , so the 0-20 is 200 images overall images 500 – 1000 set of images tested and trained. After the low accuracy to increase high accuracy sequencely

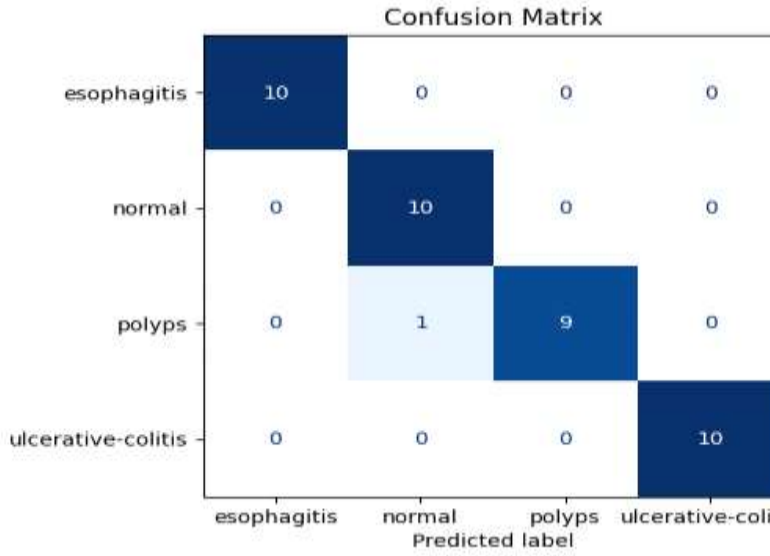

Fig. Confusion Matrix Disease Label

- Esophagitis, Polyps ,Ulcerative-Colitis & Normal Stomach these are the diseases we predicted and mentioned above. The matrix 0-10 we using the image quantity tested and predicted label accuratly. The 10 is 100% and 9 is 90% and above .

CONCLUSION

The application of artificial intelligence in the detection and classification of stomach ulcers represents a transformative advancement in medical diagnostics. By leveraging deep learning models, particularly convolutional neural networks (CNNs), this system demonstrates the potential to significantly enhance diagnostic accuracy, speed, and consistency. The use of large,

annotated datasets and advanced image preprocessing techniques ensures that the AI model can identify ulcerative lesions with precision, even in challenging clinical scenarios. This system not only reduces the reliance on manual interpretation, which can be prone to errors, but also provides real-time diagnostic support, making it highly beneficial for healthcare facilities with limited access to expert gastroenterologists. Additionally, the ability to classify ulcers based on severity and type can assist clinicians in formulating appropriate treatment plans, thereby improving patient outcomes.

While challenges such as data diversity, model generalizability, and ethical considerations remain, the integration of AI into endoscopic workflows has the potential to revolutionize gastrointestinal disease diagnosis. With further validation and development, this system could become a critical tool in both urban and rural healthcare settings, contributing to improved accessibility, efficiency, and equity in medical care.

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