EXPLORING METHODS TO COMBINE ULTRASOUND AND ENDOSCOPIC IMAGES FOR IMPROVED DIAGNOSTIC PRECISION

A PROJECT REPORT

PHASE II

Submitted by

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In partial fulfillment for the award of the degree
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BONAFIDE CERTIFICATE

Certified that this Report titled **"EXPLORING METHODS TO COMBINE ULTRASOUND AND ENDOSCOPIC IMAGES FOR IMPROVED DIAGNOSTIC PRECISION"** is the bonafide work of **DIVYA V [20IT011] GAYATHRI S [20IT012] SUSHMITHA S [20IT052]** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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DECLARATION

We affirm that the Project work titled **"EXPLORING METHODS TO COMBINE ULTRASOUND AND ENDOSCOPIC IMAGES FOR IMPROVED DIAGNOSTIC PRECISION"** being submitted in partial fulfillment for the award of **BACHELOR OF TECHNOLOGY [IT]** is the original work carried out by us. It is not the part of any other Project work submitted for award of any degree or diploma, either in this or any other university.

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ABSTRACT

Machine learning (ML) and deep learning (DL) and their applications are spreading very fast in various aspects such as medicine. Today the most important challenge of developing accurate algorithms for medical prediction, detection, diagnosis, treatment and prognosis is data. ERCPMP is an Endoscopic Image and Video Dataset for Recognition of Colorectal Polyps Morphology and Pathology. Early detection is essential to improve patient prognosis and survival rates. Despite advances in medical imaging techniques, pancreatic cancer remains a challenging disease to detect. Endoscopic ultrasound (EUS) (ERCPMP) is the most effective diagnostic tool for detecting pancreatic cancer. models fail to strike a good trade-off between model diagnosis performance, model complexity and parameters size, rendering them unsuitable for real- world application .Morphological data is included based on the latest international gastroenterology classification references such as Paris, and JNET classification. The first large-scale nasal endoscopy dataset, named 7-NasalEID, comprising 11,352 images that contain six common nasal diseases and normal samples. The Proposed ERCP is an Endoscopic Retrogerade Cholangio pancreatography. The polyps images and videos of 191 patients with colorectalpolyps are preprocessed using binarization, histogram equalization, median filtering and edge enhancement algorithms. The improved YoloV4 convolutional neural network (ML) algorithm is used to train the data set and perform high accuracy is detected in real time. Finally, the average accuracy of this algorithm has reached 91.59%. The algorithm proposed that can make up for the shortcomings of manual detection in the original image detection system, improve the efficiency of detection, and at the same time as an auxiliary system can reduce detection misjudgments, and promote the development of automated and intelligent detection in the medical field.

Keyword: ERCP, Image Processing, Data Mining, CNN

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LIST OF ABBREVIATIONS

ML	Machine Learning
CNN	Convolutional Neural Network
ERCP	Endoscopic retrograde cholangio-pancreatography
YOLO V3	You Only Look Once, Version 3
SFL	Spatial Feature Learning
DNNIDS	Deep Neural Networks based intrusion detection systems
CWI	Centrum Wiskunde & Informatica

CHAPTER 1

INTRODUCTION

1.1 MACHINE LEARNING

Machine learning(ML) is a subset of AI, which uses algorithms that learn from data to make predictions. These predictions can be generated through supervised learning, where algorithms learn patterns from existing data, or unsupervised learning, where they discover general patterns in data. The term machine learning was coined in 1959 by Arthur Samuel, an IBM employee and pioneer in the field of computer gaming and artificial intelligence. The synonym self-teaching computers was also used in this time period. Machine learning holds a significant advantage in identifying trends and patterns across various industries. With the exponential growth of data, machine learning algorithms have become even more powerful in analyzing vast and complex datasets.

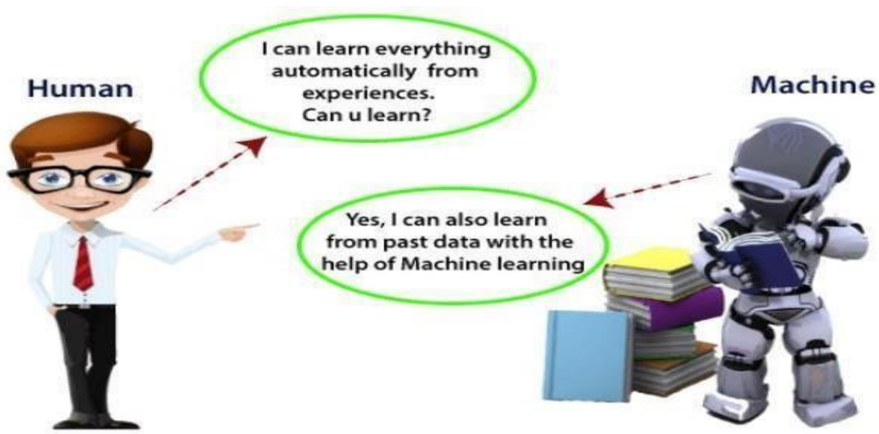

Figure-1.1.1 Interaction between User and Machine

TECHNIQUES OF ML

- **Machine Learning**

Machine Learning is an Application of Artificial Intelligence (AI) it gives devices the ability to learn from their experiences and improve their self without doing any coding.

- **Unsupervised Learning**

UL Detects hidden patterns or internal structures in unsupervised learning data. It is used to eliminate datasets containing input data without labeled responses. unsupervised machine learning models are given unlabeled data and allowed to discover patterns and insights without any explicit guidance or instruction.

- **Clustering**

Clustering is a common unsupervised learning technique. It is used for exploratory data analysis to find hidden patterns and clusters in the data. Applications for cluster analysis include gene sequence analysis, market research, and commodity identification. The process of grouping similar entities together is known as 'clustering' in unsupervised machine learning.

- **Supervised Learning**

Supervised machine learning, It is defined by its use of labeled datasets to train algorithms that to classify data or predict outcomes accurately. In supervised learning, the training data provided to the machines work as the supervisor that teaches the machines to predict the output correctly.

- **Classification**

  Classification is a supervised machine learning method where the model tries to predict the correct label of a given input data. In classification, the model is fully trained using the training data, and then it is evaluated on test data before being used to perform prediction on new unseen data.

- **Regression**

  Regression is a method for understanding the relationship between independent variables or features and a dependent variable or outcome. Outcomes can then be predicted once the relationship between independent and dependent variables has been estimated.

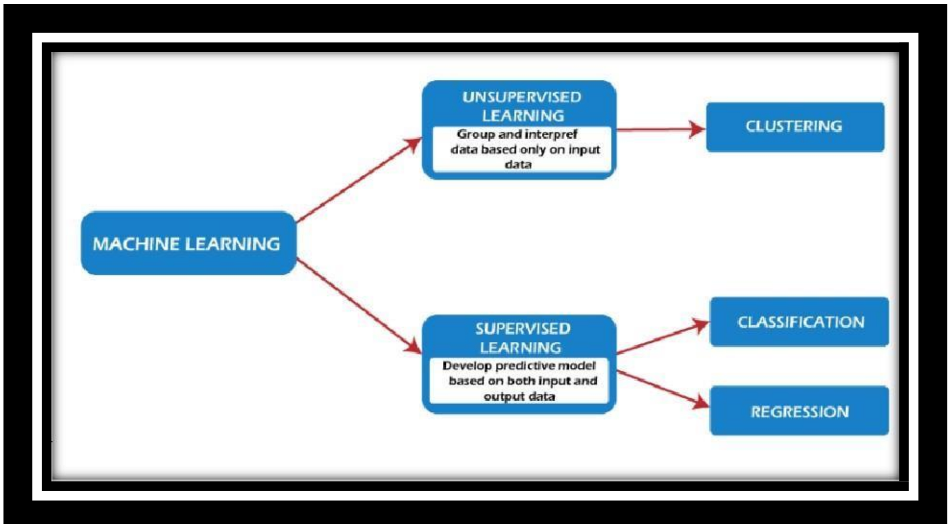

Figure-1.1.2 Techniques of ML

1.2 APPLICATIONS

One of the most notable machine learning applications is image recognition, which is a method for cataloging and detecting an object or feature in a digital image. In addition, this technique is used for further analysis, such as pattern recognition, face detection, and face recognition.

ML in Healthcare

- In healthcare, machine learning (ML) is revolutionizing the industry by leveraging advanced algorithms to extract meaningful insights from vast amounts of data. From improving diagnostic accuracy through the analysis of medical imaging to enhancing personalized treatment plans based on genetic information.
- ML plays a pivotal role in transforming patient care. Predictive analytics powered by ML assists in identifying patients at risk, enabling proactive interventions and better chronic disease management.

ML in Retail

In retail, machine learning (ML) is like a helpful guide for stores to understand customers better and make shopping more enjoyable. Think of it as a smart friend that suggests products you might like based on what you've bought before. ML helps stores keep the right amount of products in stock so they don't run out or have too much.

ML in Media

In media, machine learning is like a wizard behind the scenes making everything more exciting. It helps recommend movies or shows you might enjoy based on what you've watched before. When you see news articles or social media posts that interest you, that's machine learning paying attention to what you like.

ML in Finance

- Machine learning is like a super-smart assistant for handling money matters. It helps banks decide if you're eligible for a loan by looking at your financial history. When you use your credit card, machine learning is there to catch anything fishy and keep your transactions safe.
- It's also the reason you might see ads for things you're interested in, as machine learning learns about your preferences. So, the next time you shop online or check your bank balance, remember that machine learning is like your financial sidekick, making things smoother and more secure.

ML in travel

Machine learning is like a friendly travel companion, making your journey more personalized and hassle-free. It helps you find the best deals on flights and hotels by understanding your preferences. When you get suggestions for exciting destinations or activities, that's machine learning making your travel plans more tailored to your interests.

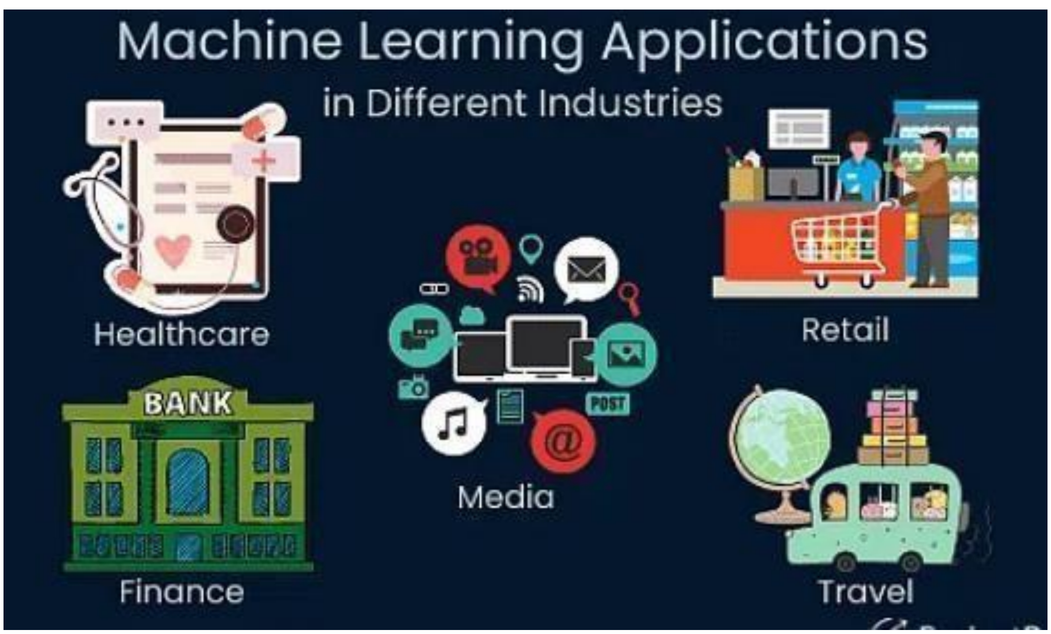

Figure-1.2.1 ML in Various Applications

ML in Marketing

Machine learning is a type of artificial intelligence that uses algorithms to make predictions and decisions based on data. It's used in many different areas of modern life, from healthcare to finance to advertising, and it can be applied directly to marketing activities like lead scoring email marketing and Social Media Advertising.

Email Marketing

Email marketing is a powerful tool for digital marketers, and machine learning can be used to create personalized email campaigns based on customer behavior. This can be done by analyzing data from various sources, such as purchase history and browsing behavior, to create targeted email campaigns more likely to resonate with customers.
It also helps in marketing automation by allowing us to schedule emails beforehand.

Social Media Advertising

Social media advertising is an effective way to reach a large audience. Machine learning algorithms can be used to analyze social media data to identify patterns and insights that can be used to create more effective social media advertising campaigns. This can be done by analyzing data from various sources, such as social media engagement and website analytics.

Chatbots

Chatbots are becoming increasingly popular in digital marketing, and machine learning can be used to create intelligent chatbots that can provide customers with personalized recommendations and assistance. This can be done by analyzing customer data and using this data to develop customized chatbot interactions.

Figure-1.2.2 Digital Marketing

1.3 CHARACTERISTICS

- **Machine Learning**

Machine learning is a subset of AI, which uses algorithms that learn from data to make predictions. Machine learning technique that teaches computers to do what comes naturally to humans.

- **Chatbots**

Chatbots are software to provide a window for solving customer problems through either audio or textual input

- **Cloud Computing**

ML capabilities are working within the business cloud computing environment to make organizations more efficient, strategic, and insight- driven.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE SURVEY

2.1.1 Application Of Narrow Band Imaging In Early Screening Of Colorectal Cancer

AUTHORS: Qianyi Liu1* , Weishan Ruan1, Zhishang Liu1, Jiefeng Li1, Jiayan Li1

ABSTRACT

To explore the clinical application value of narrow band imaging (NBI) in the early screening of colorectal cancer. 200 patients were selected as the research objects, and were divided into test group and control group by the randomization method, within 100 cases in each group. The patients in the test group were examined by NBI, while the patients in the control group were examined by ordinary endoscopy, and then the lesion detection rate, image definition and pathological examination results of the two groups were compared. After the patients in the test group received NBI examination, the lesion detection rate, image definition and lesion detection coincidence rate were significantly higher than those of the control group, and the comparative difference between the two groups was statistically significant ($P < 0.05$). NBI examination of colorectal mucosa can clearly show the pit pattern and the morphological structure of capillaries of the early colorectal cancer and its precancerous lesions, thus effectively improving the diagnosis rate of early colorectal cancer and its precancerous lesions, playing a good clinical application value in the early screening of colorectal cancer, and guiding the later treatment, so it is suitable for clinical promotion.

Limitation

- Processing time is high
- Takes more time

2.1.2 Colorectal Cancer: Epidemiological, Clinical And Histopathological Aspects In Burundi

AUTHORS: Rénovat Ntagirabiri1*, Richard Karayuba2, Gabriel Ndayisaba2, Sylvain Niyonkuru2,Moebeni Amani1

ABSTRACT

Colorectal cancer is a major cause of morbidity and mortality throughout the world. There is no study about colorectal cancer in our country. The aim of the study was to assess epidemiological, clinical, therapeutic and histological aspects of colorectal cancer over a 10-year period (1999- 2008) in Kamenge university hospital, Bujumbura, Burundi, by a descriptive retrospective study. A total of 37 cases of colorectal cancer, 22 males (59.5%) and 15 females (40.5%), mean age 50.8 years, were retrieved over the period of the study. The colorectal cancer was revealed by a rectal bleeding in 21 patients (56.8%) and an occlusive syndrome in 5 patients (13.5%). All patients underwent surgery. According to Dukes' stages: 27% were A, 27% B, 19% C and 27% stage D. Histopathologically, 18 cases (46.7%) were differentiated adenocarcinoma, 14 cases (37.8%) undifferentiated adenocarcinoma, 2 cases of lymphoma and 2 cases of leiomyosarcoma. All patients underwent surgery. The hospitalization stay was a mean of 27 days. The prognosis was poor with a mortality rate of 13.5% in the hospital. In conclusion, colorectal cancer deserves awareness as a public health problem in our country.

Limitation

- Low Detection of accuracy.

2.1.3 Endoscopic Diagnosis And Treatment Of Early Colorectal Cancer

AUTHORS: Seung Wook Hong, Jeong-Sik Byeon

ABSTRACT

Early colorectal cancer refers to cancer in the colorectum that is confined to the mucosa or submucosa and does not invade the muscularis propria, irrespective of lymph node or distant metastasis. As the number of persons undergoing screening colo- noscopy increases, the proportion of patients diagnosed with precancerous colorectal lesions and early colorectal cancer also increases. In the last decade, innovative optical technologies for endoscopic diagnosis have been introduced and endoscopic treatment techniques such as endoscopic submucosal dissection have provided major breakthroughs in the management of early colorectal cancer. With these remarkable developments, endoscopic treatment has established itself as an alternative to surgical resection in the treatment of early colorectal cancer. This review will discuss the endoscopic diagnosis and treatment of early colorectal cancer. Furthermore, the unmet needs in this field and the latest research addressing those issues will be summarized

Limitation

- Problematic capacity to dominate
- Does not read Accurately

2.1.4 Real-Time Automatic Polyp Detection In Colonoscopy Using Feature Enhancement Module And Spatiotemporal Similarity Correlation Unit

AUTHORS: Jianwei Xu A,† , Ran Zhao B,† , Yizhou Yu Zhizheng Ge C , Qingwei Zhang B,* B , And Dahong Qian , Xianzhang Bian A,*

ABSTRACT

Automatic detection of polyps is challenging because different polyps vary greatly, while the changes between polyps and their analogues are small. The state-of-the-art methods are based on convolutional neural networks (CNNs). However, they may fail due to lack of training data, resulting in high rates of missed detection and false positives (FPs). In order to solve these problems, our method combines the two-dimensional (2-D) CNN-based real-time object detector network with spatiotemporal information. Firstly, we use a 2-D detector network to detect static images and frames, and based on the detector network, we propose two feature enhancement modules-the FP Relearning Module(FPRM) to make the detector network learning more about the features of FPs for higher precision, and the Image Style Transfer Module (ISTM) to enhance the features of polyps for sensitivity improvement. In video detection, we integrate spatiotemporal information, which uses Structural Similarity(SSIM) to measure the similarity between video frames. Finally, we propose the Inter-frame Similarity Correlation Unit (ISCU)to combine the results obtained by the detector network and frame similarity to make the final decision. Experimental results show that these modules and units provide a performance improvement compared with the baseline method. Comparison with the state-of-the-art methods shows that the proposed method outperforms the existing ones which can meet real-time constraints. It's demonstrated that our method provides a performance improvement in sensitivity, precision and specificity, and has great potential to be applied in clinical colonoscopy

Limitation

- The task as a classification problem
- More Manual work needed

2.1.5 Real-Time Polyp Detection, Localization and Segmentation in Colonoscopy Using Deep Learning

AUTHORS: Debesh Jha*, Sharib Ali*, Nikhil Kumar Tomar, Håvard D.Johansen, Dag Johansen, Jens Rittscher, Michael A. Riegler, Pål Halvorsen

ABSTRACT

Computer-aided detection, localisation, and segmentation methods can help improve colonoscopy procedures. Even though many methods have been built to tackle automatic detection and segmentation of polyps, benchmarking of stateof-the-art methods still remains an open problem. This is due to the increasing number of researched computer vision methods that can be applied to polyp datasets. Benchmarking of novel methods can provide a direction to the development of automated polyp detection and segmentation tasks. Furthermore, it ensures that the produced results in the community are reproducible and provide a fair comparison of developed methods. In this paper, we benchmark several recent state-of-the-art methods using KvasirSEG, an open-access dataset of colonoscopy images for polyp detection, localisation, and segmentation evaluating both method accuracy and speed. Whilst, most methods in literature have competitive performance over accuracy, we show that the proposed ColonSegNet achieved a better trade-off between an average precision of 0.8000 and mean IoU of 0.8100, and the fastest speed of 180 frames per second for the detection and localisation task. Likewise, the proposed ColonSegNet achieved a competitive dice coefficient of 0.8206 and the best average speed of 182.38 frames per second for the segmentation task. Our comprehensive comparison with various state-of-the-art methods reveals the importance of benchmarking the deep learning methods for automated real-time polyp identification and delineations that can potentially transform current clinical practices and minimize miss- detection rates.

Limitation

- High Cost

2.1.6 Role of Artificial Intelligence in Detecting Colonic Polyps during Intestinal Endoscopy

AUTHORS: Ankita Modi, 1, 2 Kishore B, 3 Dasharathraj K Shetty, 4,* Vijay Prakash Sharma, 5 Sufyan Ibrahim, 6, Reem Hunain, Sanjana Ganesh Nayak, 3 Sarvesh Kumar 8 and Rahul Paul

ABSTRACT

With the inter- and multi-disciplinary collaboration of the medical community with technologists in conjunction with a disproportionately alarming doctor-patient ratio, it has now become a matter of concern for researchers to enhance patient care with advanced technology along with the reduction of burden on medical professionals. Artificial Intelligence (AI) has now been accepted willingly in the healthcare sector, which has led to a tremendous increase in computational power and large data handling capabilities and is widely used in gastrointestinal endoscopy. The objective of this review is to explore the state of current literature on different AI -based methods applied in intestinal endoscopy for the detection of colonic polyps. A detailed non-systematic literature review was conducted to identify all relevant studies using PubMed/MEDLINE, Scopus, EMBASE, and Google Scholar databases. The technique of AI systems, model building steps, and diagnostic measuring techniques are also discussed. In the automated diagnosis of polyps, AI-based platforms have achieved clinically acceptable diagnostic efficiency. AI-based methods can be of clinical importance in gastroenterology, and as computing strength and algorithms enhance, the application is likely to grow and expand in the field.

Limitation

- Manual work is high
- More costly

2.1.7 Serrated Neoplasia Pathway As An Alternative Route Of Colorectal Cancer Carcinogenesis

AUTHORS: Soon Young Kim, Tae Il Kim

ABSTRACT

In the past two decades, besides conventional adenoma pathway, a subset of colonic lesions, including hyperplastic polyps, sessile serrated adenoma/polyps, and traditional serrated adenomas have been suggested as precancerous lesions via the alternative serrated neoplasia pathway. Major molecular alterations of sessile serrated neoplasia include BRAF mutation, high CpG island methylator phenotype, and escape of cellular senescence and progression via methylation of tumor suppressor genes or mismatch repair genes. With increasing information of the morphologic and molecular features of serrated lesions, one major challenge is how to reflect this knowledge in clinical practice, such as pathologic and endoscopic diagnosis, and guidelines for treatment and surveillance.

Limitation

- High Cost
- Time consuming

2.1.8 Usage of Narrow Band Imaging System in the Colorectum

AUTHORS: Hiroshi Kashida, M.D

ABSTRACT

Narrow Band Imaging (NBI) is a novel technique that uses spectral narrow-band optical filters instead of the full spectrum of white light. As a result, superficial fine vessels and deeper thick vessels are demonstrated as brownish lines and greenish lines, respectively. This function enables detailed inspection of microvasculature of various kinds of gastrointestinal pathologies. Here is review of literature and present status of NBI in the endoscopic examination of colorectal lesions. There have been only a few papers concerning the usefulness of NBI for detecting colorectal polyps. The results were somewhat conflicting, but it seems that NBI has a possibility to enable beginners to detect polyps more easily. NBI was useful for differentiating between massively invasive cancers and less invasive lesions. Some authors have reported on their trial of utilizing NBI for the detection of ulcerative clolitis-related neoplasia. These reports suggest that NBI may render invisible endoscopic findings more visible without any dye solution, but the efficacy of NBI has not been proven yet. There is some possibility that NBI may replace chromoendoscopy, but a further study is needed to clarify which is more suitable, chromoendoscopy or NBI in the diagnosis of colorectal lesions.

Limitation

- More Time
- Slow processing

2.2 SYSTEM ANALYSIS

2.2.1 EXISTING SYSTEM

ERCPMP is an Endoscopic Image and Video Dataset for Recognition of Colorectal Polyps Morphology and Pathology. Early detection is essential to improve patient prognosis and survival rates. Despite advances in medical imaging techniques, pancreatic cancer remains a challenging disease to detect. Endoscopic ultrasound (EUS) (ERCPMP) is the most effective diagnostic tool for detecting pancreatic cancer. models fail to strike a good trade-off between model diagnosis performance, model complexity and parameters size, rendering them unsuitable for real-world application. This dataset contains demographic, morphological and pathological data, endoscopic images and videos of colorectal polyps. Morphological data is included based on the latest international gastroenterology classification references such as Paris, and JNET classification. we created the first large-scale nasal endoscopy dataset, named 7-NasalEID, comprising 11,352 images that contain six common nasal diseases and normal samples.

2.2.1.1 ALGORITHM

- The Exist algorithm Endoscopic ultrasound (EUS) (ERCPMP) is the most effective diagnostic tool for detecting pancreatic cancer. models fail to strike a good trade-off between model diagnosis performance, model complexity and parameters size, rendering them unsuitable for real-world application.
- Jnet is a neural network prediction algorithm that works by applying multiple sequence alignments.

2.2.1.2 DISADVANTAGES

- Low Level Performance.
- Difficult skill to learn.
- Provide a poor estimation.
- Complexity and large parameters size.
- Over Sedation.
- Large-scale endoscopy dataset.

2.2.2 PROPOSED SYSTEM

The Proposed System ERCP is an Endoscopic Retrogerade Cholangiopancreatography. The polyps contains images and videos of 191 patients with colorectal polyps. are preprocessed using binarization, histogram equalization, median filtering and edge enhancement algorithms. The improved YoloV4 convolutional neural network algorithm is used to train the data set and perform high accuracy is detected in real time. Finally, the average accuracy of this algorithm has reached 91.59%. Pathological data includes the diagnosis of the polyps including Tubular, Villous, Tubulovillous, Hyperplastic, Serrated, Inflammatory and Adenocarcinoma with Dysplasia Grade & Differentiation. The algorithm proposed in this paper can make up for the shortcomings of manual detection in the original image detection system, improve the efficiency of detection, and at the same time as an auxiliary system can reduce detection misjudgments, and promote the development of automated and intelligent detection in the medical field.

2.2.2.1 ALGORITHM

SQL Server

- MySQL is an Oracle-backed open source relational database management system (RDBMS) based on Structured Query Language (SQL).
- MySQL runs on virtually all platforms including Linux, UNIX and Windows.

Machine Learning

- The algorithm proposed in Machine learning this paper can make up for the shortcomings of manual detection in the original image detection system.

ML Lang detect

- Lang detect helps in The images are preprocessed using binarization, histogram equalization, median filtering and edge enhancement (ML)algorithms.
- YOLO algorithm divides an image into the grid system and in that each grid detects objects within itself.

2.2.2.2 ADVANTAGES

- It perform high accuracy.
- It detected in real time.
- Low risk, and cost effective.
- Scope of improvement.
- Efficient of handling a data.

2.3 SYSTEM SPECIFICATION

It represents the system requirements of software and hardware.

2.3.1 HARDWARE REQUIREMENTS

System	:	Pentium Dual Core
Hard Disk	:	120 GB
Monitor	:	15 LED
Input Devices	:	Keyboard, Mouse
Ram	:	1 GB

2.3.2 SOFTWARE REQUIREMENTS

Operating system	:	Windows 10
Coding Language	:	Python

2.4 SYSTEM DESCRIPTION

PYTHON

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. In July 2018, Van Rossum stepped down as the leader in the language community after 30 years.

Figure- 2.4.1 Python Logo

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms.

Python interpreters are available for many operating systems. CPython, the reference implementation of Python, is open source software and has a community-based development model, as do nearly all of Python's other implementations. Python and CPython are managed by the non-profit Python Software Foundation.

HISTORY

Python was conceived in the late 1980s, and its implementation began in December 1989[33] by Guido van Rossum at Centrum Wiskunde & Informatica (CWI) in the Netherlands as a successor to the ABC language (itself inspired by SETL) capable of exception handling and interfacing with the Amoeba operating system. Van Rossum remains Python's principal author.

Python 3.0 (initially called Python 3000 or py3k) was released on 3 December 2008 after a long testing period. It is a major revision of the language that is not completely backward-compatible with previous versions.

Python 2.7's end-of-life date was initially set at 2015, and then postponed to 2020 out of concern that a large body of existing code could not easily be forward-ported to Python 3. In January 2017, Google announced work on a Python 2.7 to go Tran's compiler to improve performance under concurrent workloads.

FEATURES

Python is a multi-paradigm programming language. Object-oriented programming and structured programming are fully supported, and many of its features support functional programming and aspect-oriented programming . Many other paradigms are supported via extensions, including design by contract and logic programming.

Python uses dynamic typing, and a combination of reference counting and a cycle-detecting garbage collector for memory management. It also features dynamic name resolution (late binding), which binds method and variable names during program execution.

Python's design offers some support for functional programming in the Lisp tradition. It has filter(), map(), and reduce() functions; list comprehensions, dictionaries, and sets; and generator expressions. The standard library has two modules that implement functional tools borrowed from Haskell and Standard ML.

The language's core philosophy is summarized in the document The Zen of Python (PEP 20), which includes aphorisms such as:

- Beautiful is better than ugly.
- Explicit is better than implicit.
- Simple is better than complex.
- Complex is better than complicated.
- Readability counts.

2.5 SYSTEM ARCHITECTURE

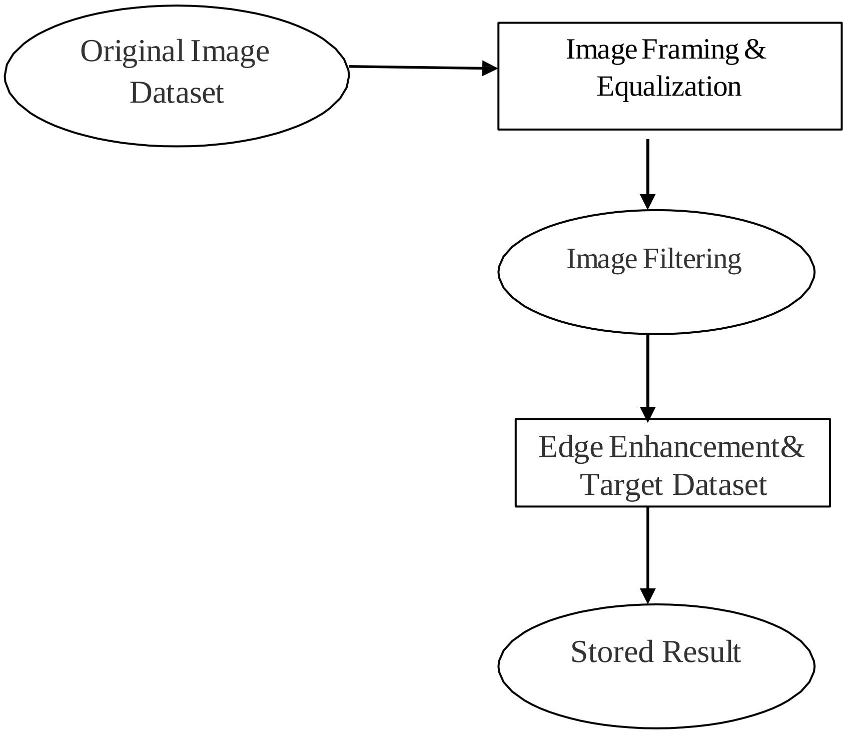

Figure 2.5.1 System Architecture

2.6 USE CASE DIAGRAM

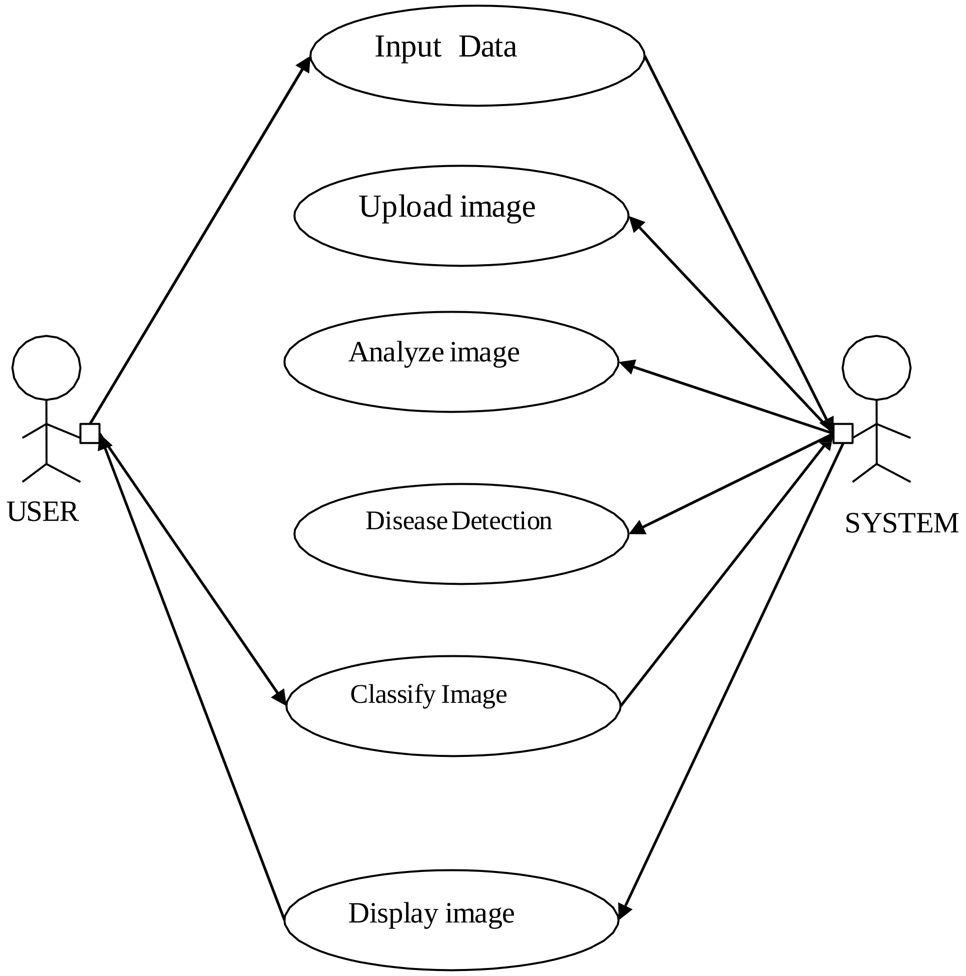

Figure 2.6.1 Use Case Diagram

2.7 SEQUENCE DIAGRAM

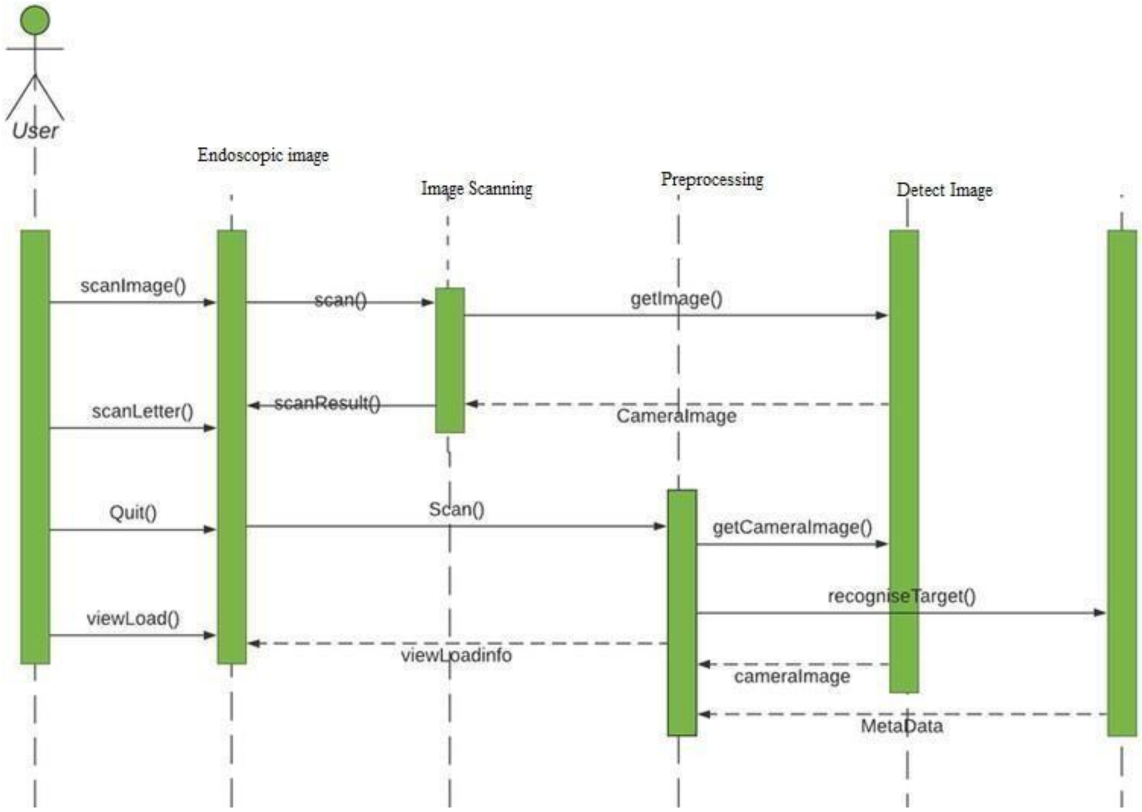

Figure 2.7.1 Sequence Diagram

2.8 ACTIVITY DIAGRAM

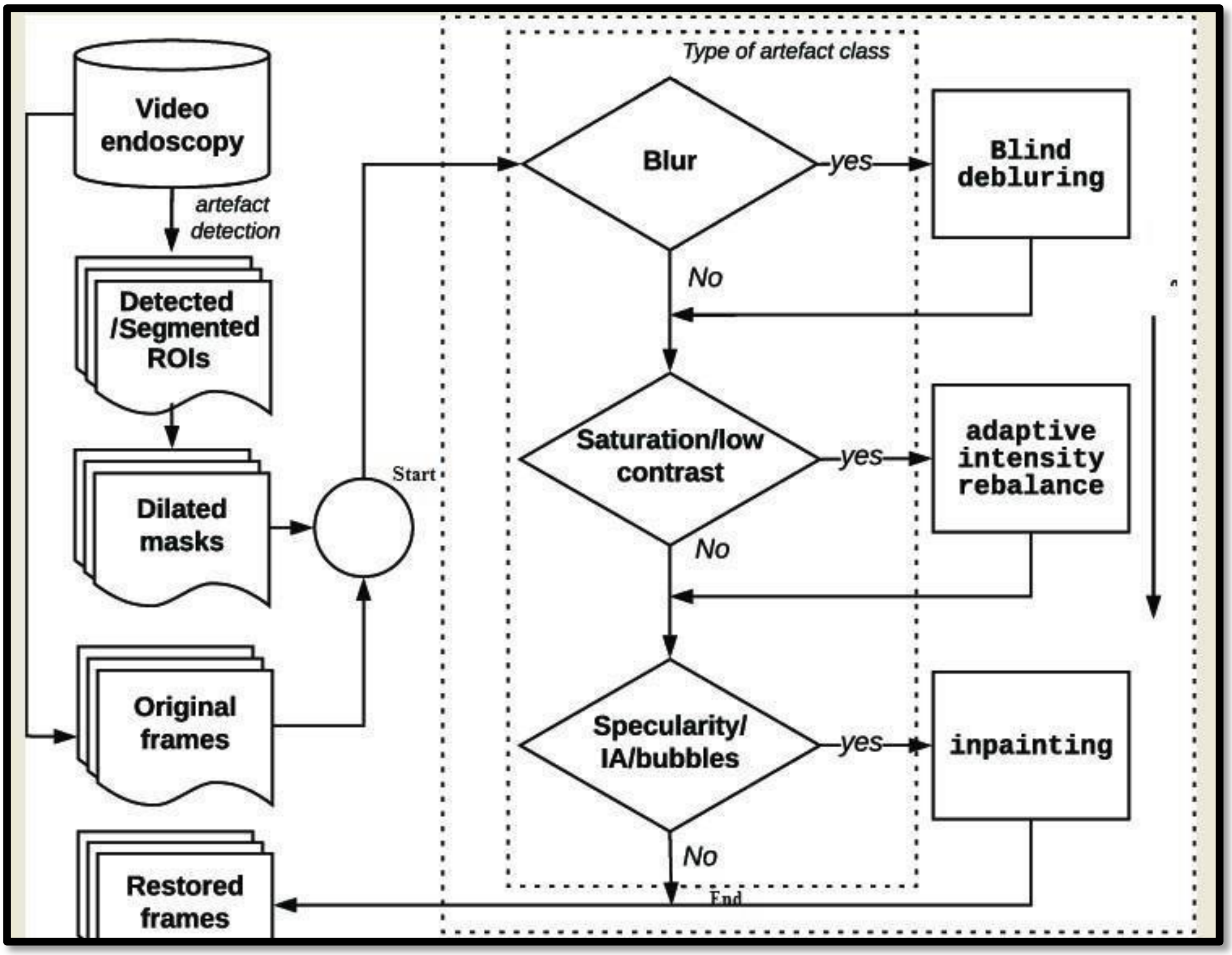

Figure-2.8.1 Activity Diagram

2.9 MODULES

IP provide a wide range of functions for tasks such as image manipulation, analysis, computer vision, and more. Here are some notable image processing modules.

2.9.1 LIST OF MODULES

- ACQUISITION OF DATA SET
- IMAGE PREPROCESSING
- IMAGE GRAYING AND ENHANCEMENT
- EDGE EXTRACTION
- HISTOGRAM EQUALIZATION

2.9.2 MODULE DESCRIPTION

ACQUISITION OF DATASET

At present, there are few data sets of medical ultrasound annotation image classification. This article is based on the framing and annotation of the medical ultrasound endoscopy training video of the People's Medical Publishing House. The video data contains the medical classification and annotation of dozens of visceral endoscopic images including the gallbladder, pancreas, etc., which provides a scientific and rigorous image source for the construction of the data set. Through the framing of the image and video, enough frames are obtained to form an image data set.

Figure-2.9.2.1 Acquisition of dataset

IMAGE PREPROCESSING

Aiming at the following quality problems in endoscopic ultrasound images: (a) Interference and noise interference caused by the useless burr of the image itself. (b) Image blur and ghosting caused by image framing. (c) The local salt and pepper noise and global Gaussian noise of the image. In this paper, an image preprocessing algorithm based on OpenCV is used to optimize the image data set of medical ultrasound endoscopy.

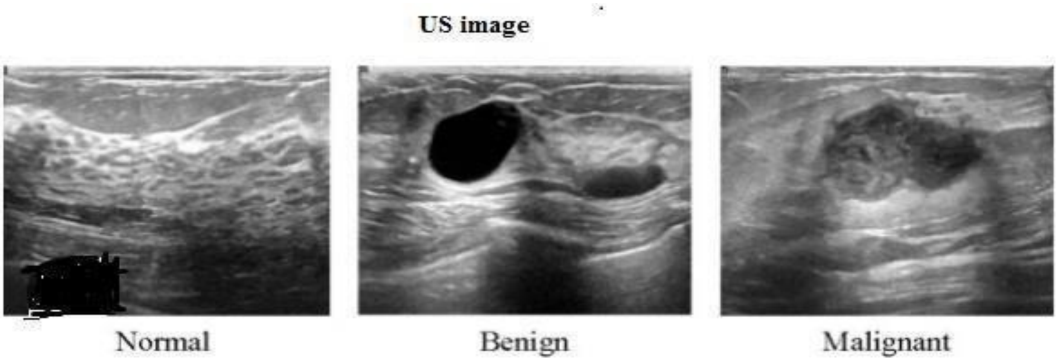

Figure-2.9.2.2 Image Preprocessing

IMAGE GRAYING AND ENHANCEMENT

The color interface in the data set is composed of RGB (Red, Green,Blue) three channels, and its characteristics only indicate the optical characteristics of the image, and cannot reflect the morphological characteristics of the target object. RGB image does not help to solve the identification of ultrasonic internal organs, and the redundant information it contains will increase the amount of features and calculations.

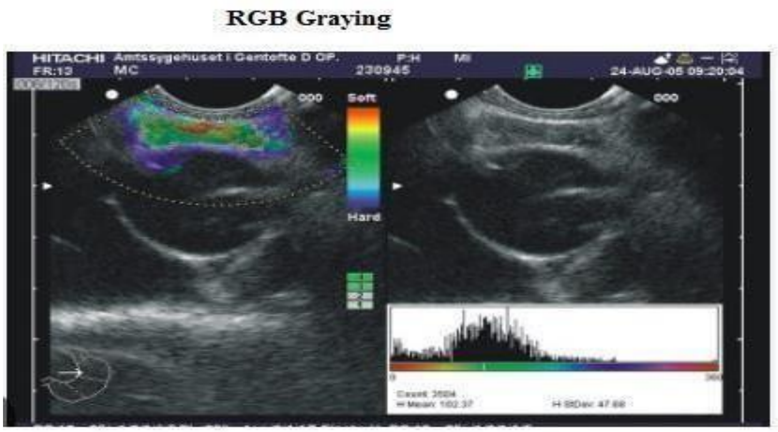

Figure-2.9.2.3 Image graying and enhancement

EDGE EXTRACTION

Edge extraction involves highlighting boundaries and sharp transitions in an image, aiding in the identification of structures and patterns. ML algorithms can leverage these extracted edges for more accurate feature recognition and analysis. By applying edge extraction methods to ultrasound and endoscopic images, subtle anatomical details and abnormalities can be emphasized, contributing to improved diagnostic precision.

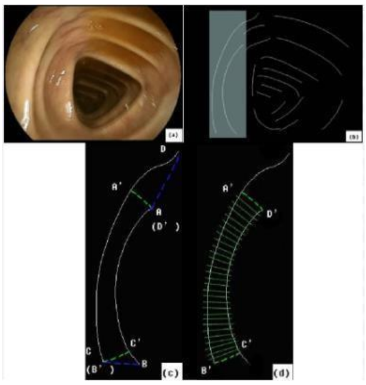

Figure-2.9.2.4 Edge Extraction

HISTOGRAM EQUALIZATION

The incorporation of histogram equalization plays a significant role. By employing this technique, the contrast in both ultrasound and endoscopic images can be enhanced, ensuring that subtle details are more distinguishable. The grayscaled image has uneven distribution of brightness. In order to improve the overall pixel grayscale distribution and contrast of the image, it is necessary to transform an image with a known grayscale distribution into a uniformly distributed grayscale image. By improving the irregular distribution of pixels, the range of pixel distribution is enlarged, and the contrast of the image is further improved. This pre-processing step is particularly valuable in medical imaging applications, as it optimizes the input data for machine learning algorithms. The improved contrast achieved through histogram equalization aids ML models in extracting relevant features and patterns, ultimately contributing to more accurate and precise diagnostic outcomes. The combination of ML algorithms with enhanced images from both ultrasound and endoscopy holds promise for advancing medical diagnostics and improving patient care

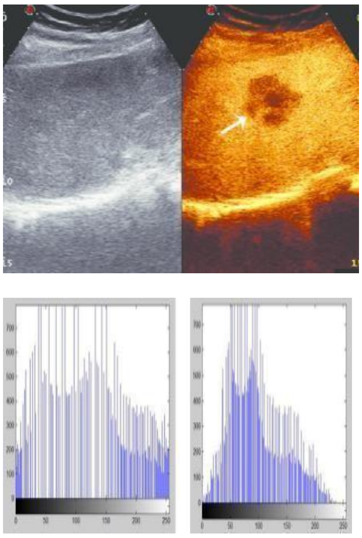

Figure-2.9.2.5 Histogram Equalization

CHAPTER 3

CONCLUSION AND FUTURE ENHANCEMENT

3.1 CONCLUSION

Recently, our study has successfully demonstrated the potential of leveraging data mining and Machine learning techniques for the recognition of endoscopic ultrasound images. The application of Machine learning, particularly convolutional neural networks (CNNs), has shown remarkable accuracy in feature extraction and image classification. The amalgamation of data mining methodologies, including data preprocessing and feature selection, has significantly enhanced the model's performance. This research underscores the promising role of these integrated approaches in improving diagnostic capabilities in the field of endoscopic ultrasound. We anticipate that the findings from this study will contribute to the early detection and diagnosis of various gastrointestinal diseases, particularly cancers, ultimately leading to more effective and timely medical interventions. Nonetheless, it is imperative to address challenges such as dataset quality, model interpretability, and real-world clinical applicability in future research to ensure the continued advancement and adoption of these technologies in the medical field.

3.2 FUTURE ENHANCEMENT

The expanding and diversifying dataset, holds immense potential for further advancing its clinical utility. To enhance the effectiveness of this technology, several key areas of development warrant attention, holds significant potential for future enhancements. To advance the dataset, several critical areas can be explored. First, it is essential to continually expand the dataset by gathering a more extensive and diverse range of endoscopic imagery, encompassing various clinical scenarios and capturing different polyp types and pathologies. Rich annotations, specifying the precise location, size, polyp type, and associated pathologies, will be indispensable for enabling machine learning and computer vision techniques to yield more accurate results. Integrating clinical data, such as patient histories and outcomes, alongside the endoscopic imagery can provide insights into the clinical relevance of the dataset. The inclusion of histopathological data to validate endoscopic findings further enhances its value. Data formats should be standardized for compatibility with various analytical tools. Additionally, data augmentation techniques, privacy considerations, continuous updates, and community collaboration will all play pivotal roles in shaping the future development and utility of the expanding and diversifying the dataset. This ongoing effort is crucial for advancing the understanding and diagnosis of colorectal polyps, ultimately leading to improved patient care and medical research.

APPENDIX A
SOURCE CODE

```
# Importing the libraries
import tensorflow as tf
import numpy as np

import * from tensorflow.keras.models
import * from sklearn import metrics
from keras.preprocessing import image
import matplotlib.pyplot as plt train_set
= 'data/train'
val_set = 'data/val'
test_set= 'data/test'
import os
lst = os.listdir(train_set)
for i in lst:
plt.bar(3*lst.index(i)-0.75, len(os.listdir(train_set + '/' + i)), label = 'Train'+str(i)[1:])
plt.bar(3*lst.index(i), len(os.listdir(val_set + '/' + i)), label = 'Val'+str(i)[1:])
plt.bar(3*lst.index(i)+0.75, len(os.listdir(test_set + '/' + i)), label = 'Test'+str(i)[1:])
plt.legend() plt.show()
train_datagen = ImageDataGenerator(
rotation_range=15,
shear_range=0.2,

zoom_range=0.2, horizontal_flip=True,
width_shift_range=0.1,
height_shift_range=0.1)
```

```
# image addressing
train_generator = train_datagen.flow_from_directory(
train_set,
target_size=(224, 224), # chosen image size by model
batch_size=16,
class_mode='categorical')
validation_generator = validation_datagen.flow_from_directory( val_set,
target_size=(224, 224),
batch_size=16, shuffle=True,
class_mode='categorical')
test_generator = test_datagen.flow_from_directory(
test_set,
target_size=(224, 224), batch_size=16,
class_mode='categorical', shuffle=False)
base_model = tf.keras.applications.EfficientNetB2(weights='imagenet',
input_shape=(224,224,3), include_top=False)
train_datagen = ImageDataGenerator(
rotation_range=15, shear_range=0.2,
zoom_range=0.2, horizontal_flip=True,
width_shift_range=0.1,
height_shift_range=0.1)
validation_datagen = ImageDataGenerator(
rotation_range=15,
shear_range=0.2, zoom_range=0.2,
horizontal_flip=True,
```

```
width_shift_range=0.1,
height_shift_range=0.1
validation_datagen = ImageDataGenerator(
rotation_range=15,
shear_range=0.2,
zoom_range=0.2,
horizontal_flip=True,
width_shift_range=0.1,
height_shift_range=0.1)
test_datagen = ImageDataGenerator(
rotation_range=15, shear_range=0.2,
zoom_range=0.2,
horizontal_flip=True,
width_shift_range=0.1,
height_shift_range=0.1)
plt.title("Learning curve")
plt.plot(history.history["precision"], label="precision")
plt.plot(history.history["val_precision"], label="val_precision")
plt.plot( np.argmax(history.history["val_precision"]),
np.max(history.history["val_precision"]), marker="x", color="r", label="best
model")
plt.xlabel("Epochs")
plt.ylabel("value  of precision")
plt.legend()
plt.show()
```

```
# ploting confusion matrix using sklearn
plt.figure(figsize=(22, 20))
cf_matrix = metrics.confusion_matrix(test_generator.classes,
np.argmax(model.predict(test_generator), axis=1))
cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels=test_generator.class_indices.keys())
cm_display.plot()
plt.xticks(rotation=45)
# image addressing
train_generator = train_datagen.flow_from_directory(
train_set,
target_size=(224, 224),  # chosen image size by model batch_size=16,
class_mode='categorical')
validation_generator =validation_datagen.flow_from_directory(val_set,
 target_size=(224, 224),
batch_size=16, shuffle=True,
class_mode='categorical')
test_generator = test_datagen.flow_from_directory(
test_set,
target_size=(224, 224),
 batch_size=16,

class_mode='categorical',
shuffle=False)
plt.legend()
plt.show()
# image addressing
train_generator = train_datagen.flow_from_directory(
```

```
train_set,
target_size=(224, 224), # chosen image size by model
batch_size=16,
class_mode='categorical')
validation_generator = validation_datagen.flow_from_directory(
val_set,
target_size=(224, 224),
batch_size=16,
shuffle=True,
class_mode='categorical')
test_generator = test_datagen.flow_from_directory(
test_set,
target_size=(224, 224),
batch_size=16,
class_mode='categorical',
shuffle=False)
base_model = tf.keras.applications.EfficientNetB2(weights='imagenet',
input_shape=(224,224,3), include_top=False)
# Freeze the base model
for layer in base_model.layers:
layer.trainable=False
# Create new model on top model =
Sequential() model.add(base_model)
model.add(GaussianNoise(0.35))
for layer in base_model.layers:
layer.trainable=False
```

```
model.add(Dropout(0.2))
model.add(Dense(4, activation='softmax'))
model.summary()
plt.ylabel("value of loss function")
plt.legend()
plt.show()
# ploting confusion matrix using sklearn
plt.figure(figsize=(22, 20))
cf_matrix = metrics.confusion_matrix(test_generator.classes,
np.argmax(model.predict(test_generator), axis=1))
cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels=test_generator.class_indices.keys())
cm_display.plot()
plt.xticks(rotation=45)
plt.xlabel("Epochs")
plt.ylabel("value of loss function")
plt.legend()
plt.show()
plt.xlabel("Epochs")
plt.ylabel("value  of  precision")
plt.legend()
plt.show()
```

```
plt.title("Learning curve")
plt.plot(history.history["accuracy"], label="accuracy")
plt.plot(history.history["loss"], label="training loss")
plt.plot(history.history["val_loss"], label="val_loss")
plt.plot(np.argmin(history.history["val_loss"]), np.min(
 history.history["val_loss"]), marker="x", color="r", label="best model")
plt.title("Learning curve")
plt.plot(history.history["accuracy"], label="accuracy")
plt.plot(history.history["loss"], label="training loss")
plt.plot(history.history["val_loss"], label="val_loss")
plt.plot(np.argmin(history.history["val_loss"]), np.min(
history.history["val_loss"]), marker="x", color="r", label="best model")
plt.xlabel("Epochs")
plt.ylabel("value of loss function")
plt.legend()
plt.show()

# ploting confusion matrix using sklearn plt.figure(figsize=(22, 20))
  cf_matrix = metrics.confusion_matrix(test_generator.classes,
  np.argmax(model.predict(test_generator), axis=1))

  cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
  display_labels=test_generator.class_indices.keys())

  cm_display.plot()
  plt.xticks(rotation=45)
  plt.show()
```

APPENDIX B

SCREENSHOTS

IMAGE PROCESSING

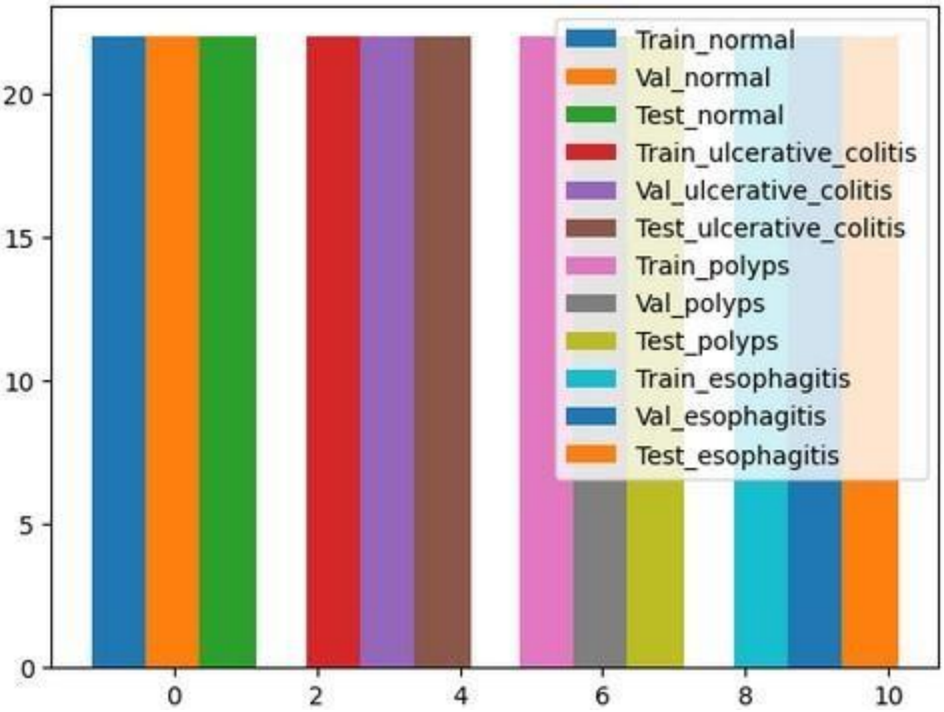

Figure-B.1 Image Preprocessing result

MODEL COMPILATION & TRAINING

```
Epoch 1/20
20/20 [==============================] - 454s 23s/step - loss: 0.6441 - accuracy: 0.7688 - precision: 0.7879 - recall: 0.7312 -
auc: 0.9395 - val_loss: 0.3707 - val_accuracy: 0.9010 - val_precision: 0.9339 - val_recall: 0.8475 - val_auc: 0.9853
Epoch 2/20
20/20 [==============================] - 459s 24s/step - loss: 0.2752 - accuracy: 0.9000 - precision: 0.9022 - recall: 0.8938 -
auc: 0.9852 - val_loss: 0.3109 - val_accuracy: 0.9030 - val_precision: 0.9299 - val_recall: 0.8695 - val_auc: 0.9887
Epoch 3/20
20/20 [==============================] - 599s 31s/step - loss: 0.3210 - accuracy: 0.8938 - precision: 0.9035 - recall: 0.8781 -
auc: 0.9795 - val_loss: 0.3188 - val_accuracy: 0.8900 - val_precision: 0.9170 - val_recall: 0.8670 - val_auc: 0.9841
Epoch 4/20
20/20 [==============================] - 698s 36s/step - loss: 0.2402 - accuracy: 0.9344 - precision: 0.9369 - recall: 0.9281 -
auc: 0.9863 - val_loss: 0.2807 - val_accuracy: 0.8990 - val_precision: 0.9144 - val_recall: 0.8865 - val_auc: 0.9863
Epoch 5/20
20/20 [==============================] - 734s 38s/step - loss: 0.1172 - accuracy: 0.9563 - precision: 0.9591 - recall: 0.9531 -
auc: 0.9958 - val_loss: 0.2346 - val_accuracy: 0.9150 - val_precision: 0.9254 - val_recall: 0.9000 - val_auc: 0.9902
Epoch 6/20
20/20 [==============================] - 716s 37s/step - loss: 0.1630 - accuracy: 0.9594 - precision: 0.9594 - recall: 0.9594 -
auc: 0.9904 - val_loss: 0.2718 - val_accuracy: 0.8880 - val_precision: 0.9060 - val_recall: 0.8770 - val_auc: 0.9871
Epoch 7/20
20/20 [==============================] - 629s 33s/step - loss: 0.1504 - accuracy: 0.9625 - precision: 0.9683 - recall: 0.9531 -
auc: 0.9944 - val_loss: 0.3297 - val_accuracy: 0.8720 - val_precision: 0.8890 - val_recall: 0.8570 - val_auc: 0.9817
Epoch 8/20
20/20 [==============================] - 660s 34s/step - loss: 0.1623 - accuracy: 0.9438 - precision: 0.9467 - recall: 0.9438 -
auc: 0.9936 - val_loss: 0.2653 - val_accuracy: 0.9030 - val_precision: 0.9144 - val_recall: 0.8870 - val_auc: 0.9874
Epoch 9/20
20/20 [==============================] - 657s 34s/step - loss: 0.1322 - accuracy: 0.9594 - precision: 0.9623 - recall: 0.9563 -
auc: 0.9947 - val_loss: 0.2580 - val_accuracy: 0.9065 - val_precision: 0.9156 - val_recall: 0.9005 - val_auc: 0.9871
Epoch 10/20
20/20 [==============================] - 655s 34s/step - loss: 0.1514 - accuracy: 0.9406 - precision: 0.9492 - recall: 0.9344 -
auc: 0.9959 - val_loss: 0.2480 - val_accuracy: 0.9115 - val_precision: 0.9201 - val_recall: 0.9040 - val_auc: 0.9890
Epoch 11/20
20/20 [==============================] - 704s 37s/step - loss: 0.1594 - accuracy: 0.9594 - precision: 0.9653 - recall: 0.9563 -
```

Figure-B.2 Model Compilation and training

EVALUATE THE TRAIN GENERATOR

```
200/200 [==============================] - 408s 2s/step - loss: 0.0493 - accuracy: 0.9825 - precision: 0.9846 - recall: 0.9822
- auc: 0.9993

Out[20]: [0.04926253855228424,
 0.9825000166893005,
 0.984649121761322,
 0.9821875095367432,
 0.9993296265602112]
```

Figure-B.3 Evaluate the train generator

EVALUATE THE TEST GENERATOR

```
50/50 [==============================] - 131s 3s/step - loss: 0.3143 - accuracy: 0.8900 - precision: 0.8951 - recall: 0.8850 -
auc: 0.9838

Out[22]: [0.3142570085323333374,
          0.8899999856948853,
          0.8950695395469666,
          0.8849999904632568,
          0.9838138222694397]
```

Figure-B.4 Evaluate the Test Generator

PLOTTTING FUNCTION

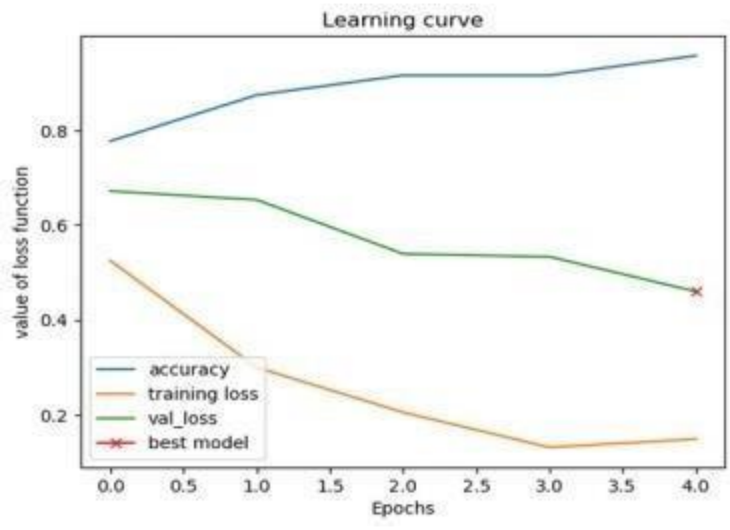

Figure-B.5 Plotting Function

PLOTTING RECALL

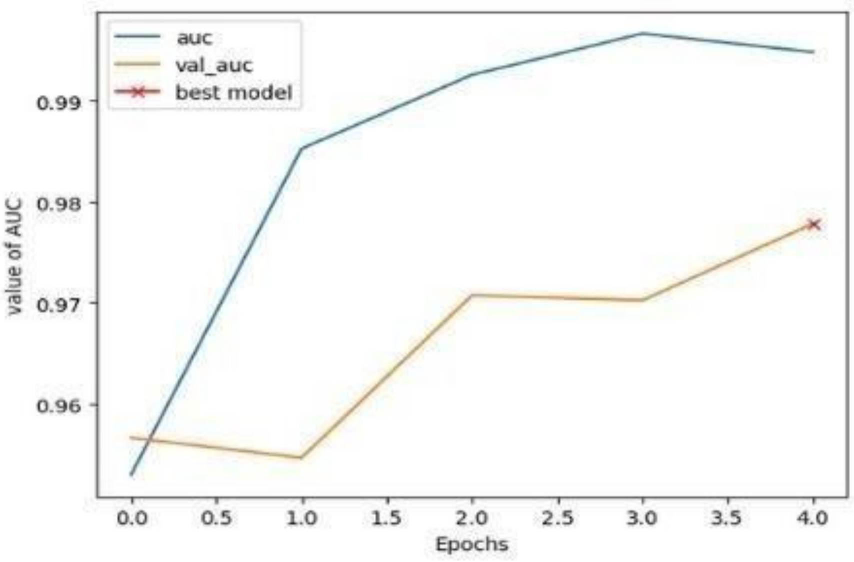

Figure-B.6 Plotting Recall

PLOTTING AUCCURACY

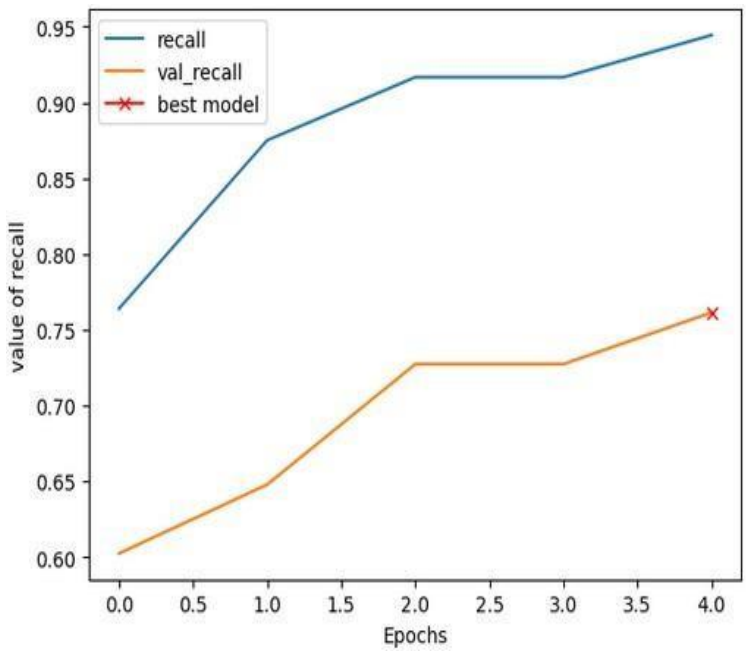

Figure-B.7 Plotting Accuracy

PLOTING CONFUSION MATRIX USING SKLEARN

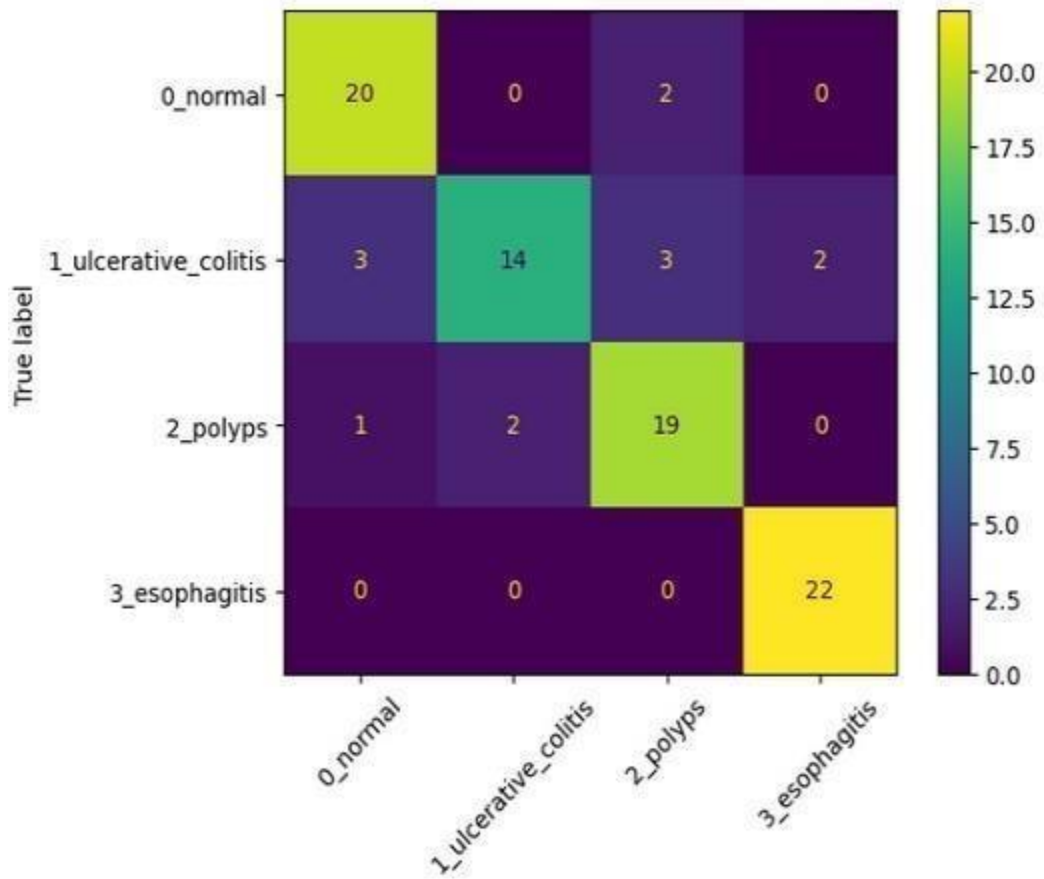

Figure-B.8 Plotting Confusion Matrix Using Sklearn

MODEL PREDICTION

```
1/1 [==============================] - 4s 4s/step
[[0.00676619 0.8942302  0.06518672 0.03381686]]
Ulcerative colitis
```

Figure-B.9 Model Prediction

CALCULATION OF PRECISION, RECALL, F1-SCORE, SUPPORT

```
50/50 [==============================] - 111s 2s/step
```

	precision	recall	f1-score	support
0_normal	0.90	1.00	0.95	200
1_ulcerative_colitis	1.00	0.61	0.76	200
2_polyps	0.77	0.97	0.86	200
3_esophagitis	0.96	0.98	0.97	200
accuracy			0.89	800
macro avg	0.91	0.89	0.88	800
weighted avg	0.91	0.89	0.88	800

Figure-B.10 Calculation of Precision , Recall , F1-Score , Support

APPENDIX C

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