



# IMPROVED DETECTION OF ELUSIVE POLYPS

<sup>1</sup>Mr Mahesh Basavaraj , <sup>2</sup>Sharon Zipporah Sebastian, <sup>3</sup>Abdul Faheem, <sup>4</sup>Sharona Sam

<sup>1</sup>Asst.Professor , <sup>2</sup>UG Student , <sup>3</sup>UG Student, <sup>4</sup>UG Student, <sup>5</sup>UG Student

<sup>1 2 3 4</sup>Department of Artificial Intelligence and Machine Learning

<sup>1 2 3 4</sup>City Engineering College, Bangalore, India

**Abstract :** This paper presents a novel approach for the improved detection of elusive polyps in medical images, with the aim of enhancing early diagnosis and treatment of colorectal cancer. The project leverages advanced machine learning techniques, utilizing a U-Net convolutional neural network (CNN) architecture tailored for polyp detection. The proposed solution encompasses a multi-layered abstraction approach, streamlining the development and deployment process while enhancing both efficiency and usability. Through data loading and preprocessing functions, the project standardizes image sizes and normalizes pixel values, ensuring robust model training. The U-Net model, trained on a dataset comprising images and corresponding ground truth masks, demonstrates high performance in polyp detection, achieving accuracy, recall, precision, and Intersection over Union (IoU) metrics. Inference on new medical images yields binary masks indicating detected polyp regions, facilitating computer-aided diagnosis (CAD) systems in clinical settings. The project's modular design enables experimentation with different model architectures and optimization techniques, fostering continuous advancements in medical image analysis. Overall, this project contributes to the advancement of healthcare technology, particularly in the domain of colorectal cancer screening and diagnosis.

**Index Terms –** Colorectal Cancer , Polyp Detection , Convolutional Neural Network(CNN) , Machine Learning, Computer Aided Detection (CAD),Image Processing

## I. INTRODUCTION

Colorectal cancer (CRC) poses a significant health challenge globally, necessitating early detection and intervention. Computer-aided diagnosis (CAD) systems offer promising solutions for improving polyp detection during colonoscopy. However, accurately identifying elusive polyps remains a challenge for existing CAD systems. In response, our research focuses on developing an innovative approach to enhance the detection of elusive polyps in medical images. Leveraging advanced machine learning techniques, particularly deep learning methodologies, we propose a novel convolutional neural network (CNN) architecture tailored for polyp detection. Our approach integrates state-of-the-art techniques in image preprocessing, feature extraction, and model optimization to improve sensitivity and specificity. The primary objective is to address limitations in existing CAD systems and enhance the accuracy of polyp detection in colorectal endoscopy. Through rigorous experimentation and evaluation, we aim to demonstrate the efficacy and clinical relevance of our proposed approach. Ultimately, our research contributes to advancements in healthcare technology and patient care by empowering healthcare professionals with a reliable tool for CRC screening and diagnosis.

## II. LITERATURE

**Authors:** Nguyen Thanh Duc, Nguyen Thi Oanh , Nguyen Thi Thuy , Tran Minh Triet , And Dinh Viet Sang (2022).

**Title:** “Colon Former: An Efficient Transformer Based Method for Colon Polyp Segmentation”

**Year:** 2022

The paper addresses the crucial task of accurately segmenting colon polyps in medical imaging, vital for early detection of colorectal cancer, guiding clinical decisions, and improving endoscopic procedures. Leveraging a hybrid architecture that integrates Transformer-based self-attention mechanisms with convolutional neural networks (CNNs), Colon Former offers a comprehensive solution for feature learning and representation. Its efficient Transformer backbone, based on the Mix Transformer (MiT), efficiently captures long-range dependencies and global context while minimizing computational complexity. The model incorporates a refinement module with reverse attention, enhancing polyp boundary delineation iteratively. Inspired by UPerNet, Colon Former's decoder architecture effectively fuses global context with multi-scale features from the MiT backbone,

facilitating accurate segmentation. By combining these features, ColonFormer streamlines medical imaging workflows, enhances diagnostic accuracy, and contributes to improved patient outcomes in gastroenterology and oncology[1].

**Authors:** Pere Gilabert, Jordi Vitrna, Pablo Laiz, Carolina Malagelada, Angus Watson<sup>4</sup>, HagenWenzek<sup>5</sup> and Santi Segui

**Title:** “Artificial intelligence to improve polyp detection and screening time in colon capsule endoscopy”

**Year:** 2022

The paper introduces an AI-driven solution, the AI-Tool, designed to enhance polyp detection and reduce screening time in Colon Capsule Endoscopy (CCE). Using a Convolution Neural Network (CNN), the AI-Tool prioritizes images with a high probability of containing polyps, accelerating the review process. Collaborative testing demonstrated a sixfold reduction in screening time and an increase in polyp detection sensitivity from 81.08% to 87.80%. The AI-Tool's key features include CNN-based image analysis, probability scoring per frame, heat map visualization, and improved sensitivity. Its purpose is to streamline CCE procedures, addressing the critical need for efficient alternatives to traditional colonoscopy screening in colorectal cancer prevention[2].

**Authors:** Song-Toan Tran , Minh-Hoa Nguyen , Huu-Phuc Dang , And Thanh-Tan Nguyen

**Title:** “Automatic Polyp Segmentation Using Modified Recurrent Residual Unet Network”.

**Year:** 2022

This paper, we introduce a novel approach for automatic polyp segmentation, presenting the Modified Recurrent Residual Unet (mRR-Unet) model. The main objective is to enhance segmentation accuracy while reducing model size and training time. Leveraging recurrent convolution and residual structure within the Unet architecture, the mRR-Unet model demonstrates superior performance across multiple datasets, outperforming traditional Unet and state-of-the-art models. Key features include reduced model size through optimized feature map utilization, faster convergence during training, and efficient utilization of convolutional units. Experimental validation on CVC-ClinicDB, ETIS-LaribPolypDB, and CVC-ColonDB datasets confirms the effectiveness of the mRR-Unet model, showcasing its potential for real-time polyp segmentation tasks and its significance in early detection and treatment of colorectal cancer. Comparisons with existing methods underscore the model's superiority in terms of segmentation accuracy and efficiency, making it a valuable asset in medical image analysis[3].

**Authors:** Xinzi Sun, Pengfei Zhang, Dechun Wang, Yu Cao, Benyuan Liu

**Title:** “Colorectal Polyp Segmentation by U-Net with Dilation Convolution”.

**Year:** 2019

This paper presents a novel convolutional neural network (CNN) architecture designed for colorectal polyp segmentation, addressing the need for accurate and efficient segmentation methods in medical imaging. Recent advancements in deep learning-based approaches for colorectal polyp segmentation in endoscopic images have showcased notable features and purposes. These approaches leverage various architectures, including U-Net, FCN, and ResNet, to harness the power of convolutional neural networks (CNNs) for learning discriminative features from raw image data. Researchers utilize datasets such as GIANA, CVC-ColonDB, and ETIS-Larib Polyp DB for training and evaluation, which contain annotated endoscopic images with polyp masks, facilitating the development of robust segmentation algorithms. Additionally, preprocessing techniques such as data augmentation, normalization, and noise removal are employed to enhance the quality and diversity of training data. Evaluation metrics like Dice coefficient, precision, recall, and F1-score are utilized to assess the accuracy and efficacy of segmentation models, providing valuable insights into the performance of deep learning algorithms in this domain. Overall, these approaches aim to automate and improve the accuracy of colorectal polyp segmentation, ultimately contributing to early detection and treatment of colorectal cancer[4].

III. BLOCK DIAGRAM

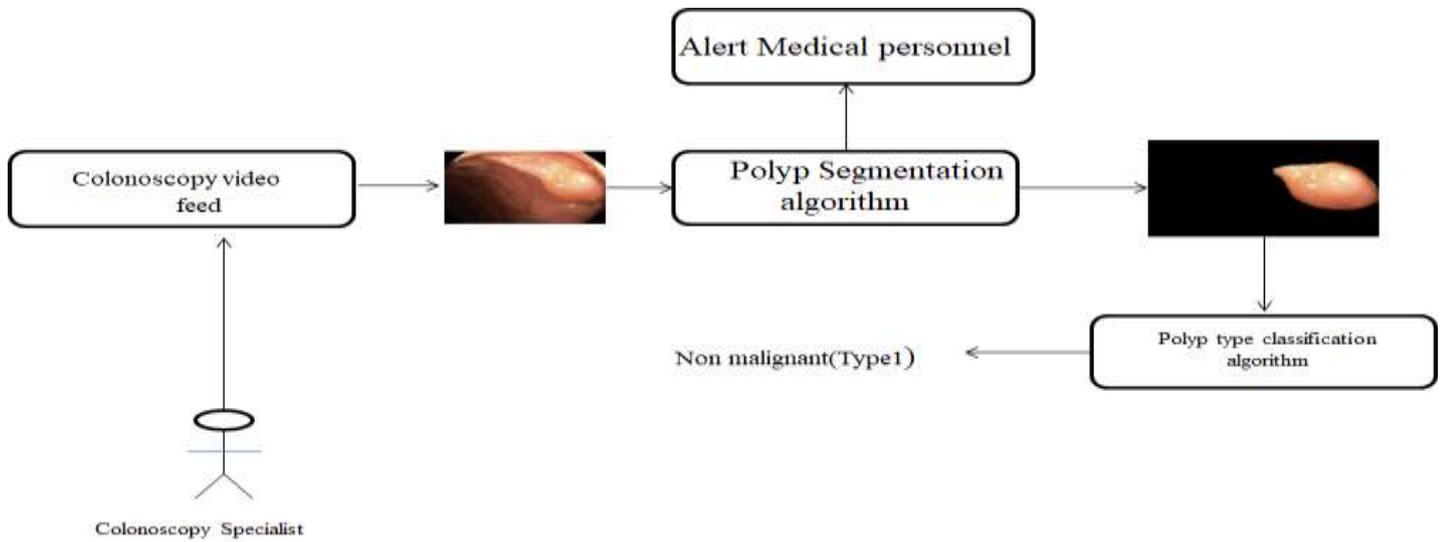


Fig.1 System block diagram

Colonoscopy video feeds are processed through a polyp segmentation algorithm, alerting medical personnel to identified polyps. Subsequent classification algorithms determine polyp size and malignancy, providing actionable results, such as non-malignant finding

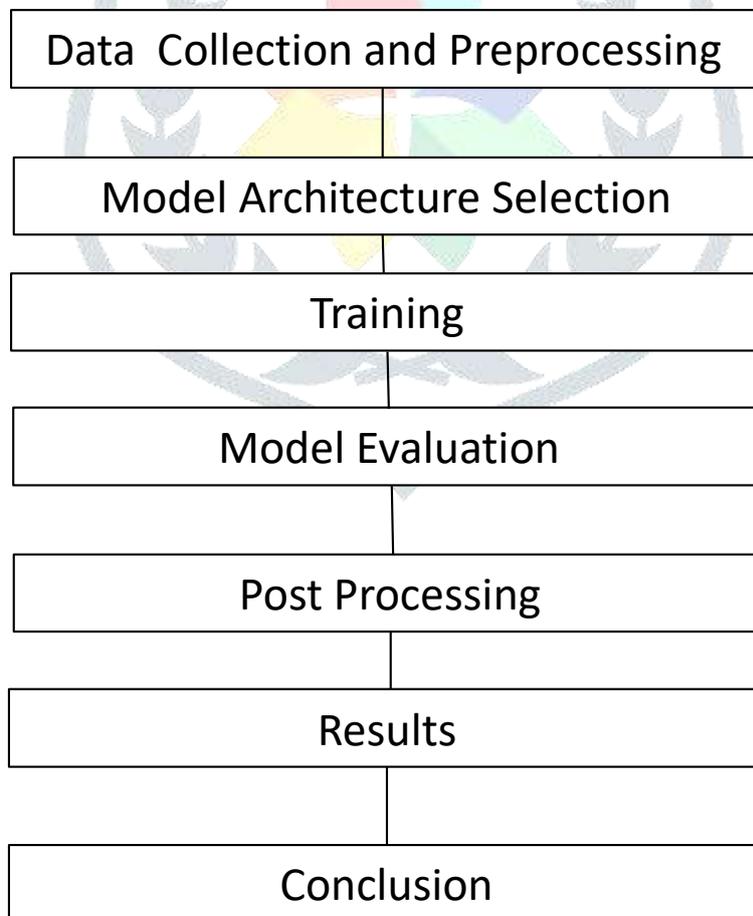


Fig 2 Flow Chart

## IV. METHODOLOGY

Methodology for developing a semantic segmentation model for polyp detection in colonoscopy images involves a systematic approach to address the research objectives while ensuring scientific rigor and reproducibility.

### 1) Problem Formulation and Data Acquisition:

The research begins with a clear formulation of the problem, which involves developing a deep learning-based model for semantic segmentation to detect polyps in colonoscopy images.

Data acquisition is crucial, and the CVC-ClinicDB (CVC-612) dataset is chosen for its relevance to the research problem. This dataset contains a diverse range of colonoscopy images with annotated polyp regions.

### 2) Data Preprocessing:

Before model development, the acquired dataset undergoes preprocessing steps to ensure consistency and suitability for training. This includes resizing images to a standard resolution, normalizing pixel values, and potentially augmenting the dataset to increase variability and robustness.

### 3) Model Selection and Architecture Design:

The choice of model architecture is critical and should align with the complexity of the task and the characteristics of the dataset. In this research, the UNet architecture is selected for its proven effectiveness in biomedical image segmentation tasks.

The UNet architecture is customized and adapted to suit the specific requirements of polyp segmentation in colonoscopy images. This may involve modifying the number of layers, filter sizes, and incorporating skip connections for feature fusion.

### 4) Training and Evaluation:

The dataset is split into training, validation, and test sets to facilitate model training and evaluation. Care is taken to ensure balanced distributions of images across the sets.

The model is trained using appropriate optimization algorithms, loss functions, and evaluation metrics tailored to the task of semantic segmentation. Training progress is monitored, and hyperparameters are tuned using cross-validation techniques.

Model performance is evaluated comprehensively using quantitative metrics such as accuracy, precision, recall, F1-score, and Intersection over Union (IoU). Qualitative assessment through visual inspection of predicted masks also provides valuable insights into the model's performance.

### 5) Analysis and Interpretation:

The research culminates in the analysis and interpretation of results to draw meaningful conclusions. This involves comparing the model's performance against existing benchmarks and discussing its strengths, limitations, and potential areas for improvement.

Additionally, attention is given to potential biases, uncertainties, and ethical considerations associated with deploying the model in real-world clinical settings.

### 6) Validation and Reproducibility:

To ensure the validity and reproducibility of the research findings, rigorous validation procedures are followed, including cross-validation, sensitivity analysis, and external validation using independent datasets if available.

Detailed documentation of the methodology, codebase, and experimental setup is provided to facilitate transparency and reproducibility by the broader research community.

## V. SOFTWARE IMPLEMENTATION

The software implementation of your project involves the following components and tools:

**1) Programming Language:** Python is utilized as the primary language for developing the project due to its popularity and extensive support for machine learning and computer vision tasks.

**2) Deep Learning Framework:** TensorFlow is chosen as the core deep learning framework for implementing the UNet architecture and training the semantic segmentation model. TensorFlow offers high-level APIs and tools that streamline the development and training of complex neural networks.

**3) Libraries and Tools:** OpenCV (Open Source Computer Vision Library) is employed for various image processing tasks such as loading, preprocessing, and manipulation.

NumPy is used for numerical computations and array manipulation, particularly for handling image data efficiently.

Scikit-learn may be utilized for additional data preprocessing, evaluation metric computation, and model evaluation.

TensorBoard, a visualization tool provided by TensorFlow, is utilized for monitoring training progress, visualizing model graphs, and analyzing training metrics.

**4) Development Environment:** Visual Studio Code (VS Code) is the chosen Integrated Development Environment (IDE) for project development. VS Code provides a lightweight yet powerful environment for writing, debugging, and running Python code, with support for various extensions and plugins that enhance productivity.

### 5) Project Structure:

The project follows a structured organization with multiple Python scripts, each responsible for specific tasks such as data loading (data.py), model architecture definition (model.py), training (train.py), evaluation (predict.py), and visualization (visualize.py).

The CVC-612 dataset is utilized for training, validation, and testing. The dataset comprises colonoscopy images and corresponding ground truth masks, facilitating the development and evaluation of the semantic segmentation model.

## VI.RESULTS

The final epoch value in the table given below

METRICS	VALUE
Loss	0.0930
Accuracy	0.9840
Recall	0.9001
Precision	0.9558
IoU	0.4978
Validation Loss	0.1437
Validation Accuracy	0.9636
Validation Recall	0.6945
Validation Precision	0.8911
Validation IoU	0.3670

Some of the sample shot of test results are given below.

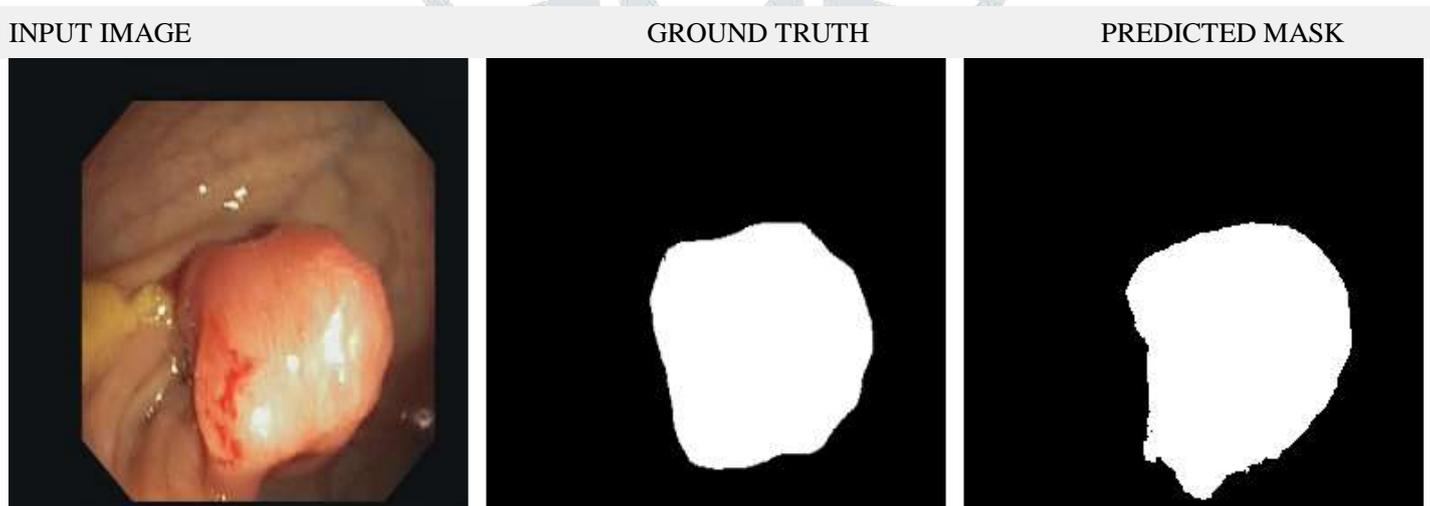


Figure. 1

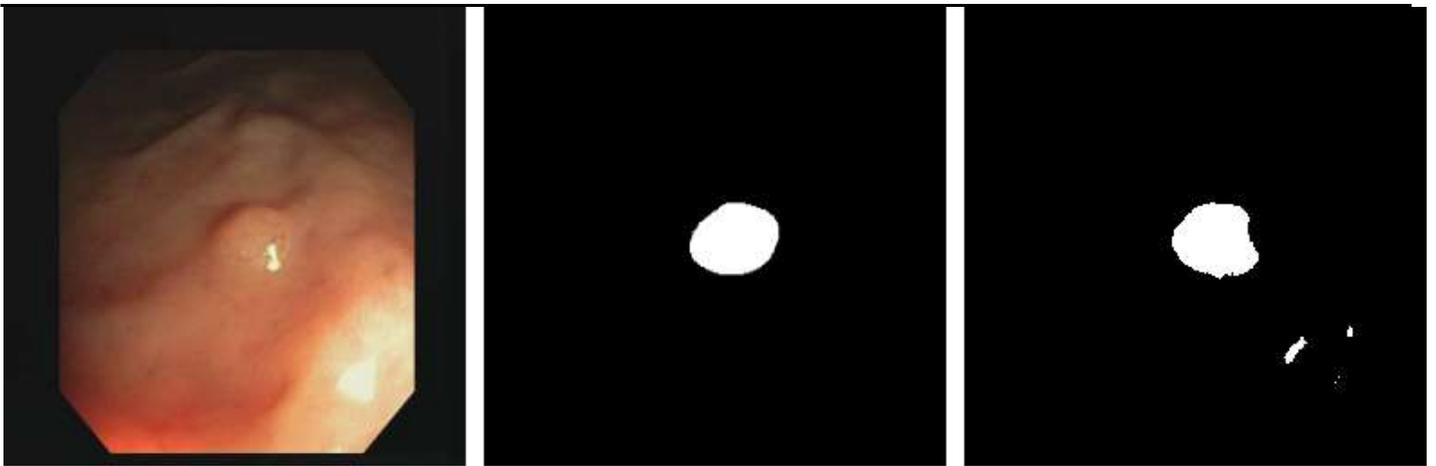


Figure.2



Figure.3

## VII.CONCLUSION

The study showcases the UNet architecture's effectiveness in accurately detecting polyps in colonoscopy images, offering promising prospects for aiding clinical diagnosis. With strong segmentation performance and potential clinical utility, further refinement and exploration of advanced techniques hold promise for enhancing model robustness and facilitating broader adoption in real-world medical settings.

## VIII. ACKNOWLEDGEMENT

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