Abstract

Endoscopy is a standard procedure for disease surveillance, monitoring inflammations, detect cancer and tumour. The procedure lasts from twenty minutes to one hour. During the procedure the organs are visualized. Artefacts, an artificial effect is found to be present in the resultant images. They play a dominant role in increasing procedure time by more than an hour. Hence an efficient algorithm to detect, segment and restore could assist clinician.

The artefacts present in an endoscopic image include saturation, specular reflections, blur, bubbles, contrast, blood, instruments and miscellaneous artefacts. The presence of these artefacts acts as a barrier when investigating the underlying tissue for identifying clinical abnormalities. It also affect post processing steps where most of the images captured are discarded due to the presence of artefacts which in turn affects information storage and extracting useful frame for report generation.

Endoscopic artefact detection dataset is the only available public dataset holding endoscopic images with annotations for multiple artefacts. To add more images, a custom dataset is curated containing endoscopic images of Indian patients. The custom dataset is annotated using the same annotation protocol of endoscopic artefact detection dataset to maintain homogeneity. The algorithms are trained and tested with images from both public and custom dataset for artefact detection.

State of the art object detection algorithms such as YOLOv3, YOLOv4 and faster R-CNN are used for detecting artefacts in endoscopic images. The algorithms are tuned, trained and tested with images from both the dataset. The trained algorithms are evaluated individually for their performance. Later the algorithms are ensembled. The detection algorithm focusses on three important performance parameters namely mean average precision, intersection over union and inference time. The ensemble model outperformed well across all the performance parameters compared with literature. The inference time is reduced by 8.63%, whereas the mAP and IoU are increased by 61.67% and 63.47% respectively.

Various segmentation algorithms are tuned and trained with various data augmentation techniques for the purpose of artefact segmentation. After simulations, it is decided to use U-Net with EfficientNetB3 backbone, Link-Net with EfficientNetB3 backbone and U-Net with SE-ResNeXt101 backbone. The performance of U-Net and Link-Net with specific backbones accomplished best results. The results are assessed with performance parameters like F2 score and Jaccard score. The results proves a phenomenal increase in Jaccard score by 17.36% and F2 Score by 17.42% respectively.

An image, if found to have artefacts after artefact detection, the affected region will be segmented by the proposed segmentation algorithm. To visualize the scope and need of artefact detection and segmentation, a simple application is developed to restore the artefacts. The segmented output contains a binary mask using which fast marching algorithm will restore the segmented area. Hence the resulting restored image gives the clinician a better view of the organ. A simple CNN based classifier is proposed to classify polyp. It is found that the classifier's performance is improved by 3.09% when the artefacts in the images are restored.

Thus such outcomes when implemented in real time could effectively have a control over the false diagnosis rate, which is the rate at which the disease is misclassified, procedure time and clinician's fatigue as well.