Polyp Localization In Colonscopy Videos

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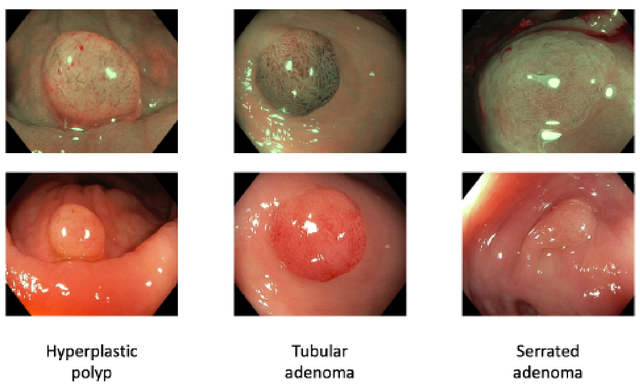
1. Introduction

Colorectal polyps are abnormal growths of tissue in the colon surface that have the potential to evolve into colorectal cancer. High survival rates in colon cancer can be achieved when it is detected in early states, when polyps are identified and removed before developing into cancer. The primary method for colon cancer screening is the endoscopic examination of the colon, known as colonoscopy. But some colons might not be detected during colonoscopy due to human errors. This work aims is to detect these polyps by making use of state-of-the-art object detection networks like SSD [1].

2. Motivation

To cater missing rates during colonoscopy, the development of computer aided systems that assist the expert can help to improve the detection rate. Localization of polyps is a challenging task, because of the variability of polyps in shape, illumination, and variation in size due to the distance between camera and the polyp.



3. Dataset

Initially, I worked with the CVC-ColonDB dataset [3] as training set and ETIS-Larib dataset [4] as the Validation and Test data, from Automatic polyp detection 2015 of Endovis challenge.

Mode	Dataset	No. of Images
Training	CVC-ColonDB	380
Validation	ETIS-Larib	96
Test	ETIS-Larib	100

And then I worked with the clinical database acquired by clinicians from the endoscopy department at Klinikum rechts der Isar, Munich. This consists of colonoscopy videos from 34 different patients.

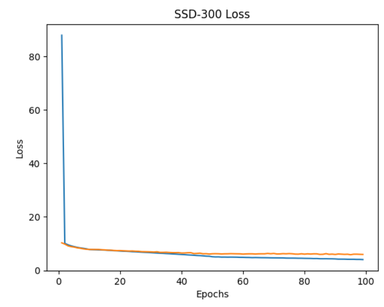
Mode	No. of Images
Training	2000
Validation	500
Test	500

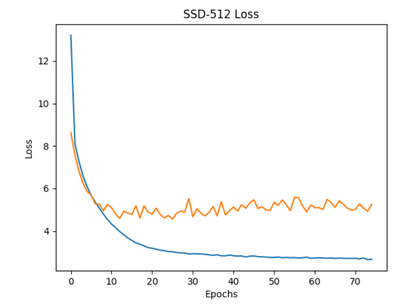
4. Training

After an extensive hyperparameter search during training, it was found that SSD outperforms Faster R-CNN in terms of compute time as well as accuracy. During training photometric distortions like random brightness, contrast and saturation were applies to training images.

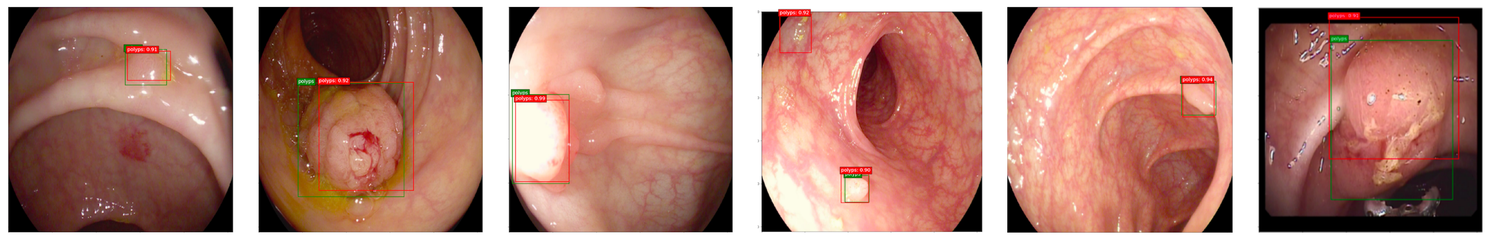
Team	Architecture	Dataset	Precision	Recall	F1-Score
Ours	Faster-RCNN	ETIS-Larib	59.7%	26%	36.2%
Ours	SSD-300	ETIS-Larib	**61.2%**	30.6%	**40.8%**
ETIS-Larib	Hybird	ETIS-Larib	6.9%	**49.5%**	12.1%
Ours	SSD-300	Hospital	66.7%	26%	37.4%
Ours	SSD-512	Hospital	**94%**	**52.2%**	**67.1%**

Hyperparameters	Value
Optimizer	Adam
IoU Threshold	0.5
Batch Size	4
Learning Rate	0.0001
Aspect Ratio	[(1,1), (1,2), (2,1), (1,3), (3,1)]
Scale	[0.07, 0.15, 0.33, 0.69, 0.87]

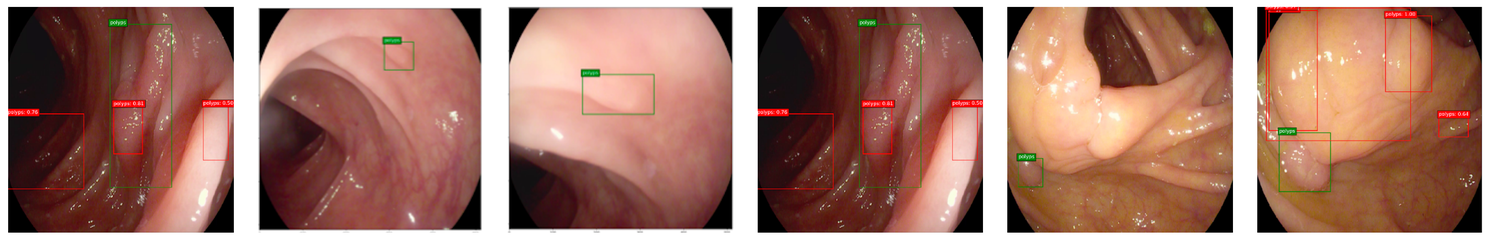




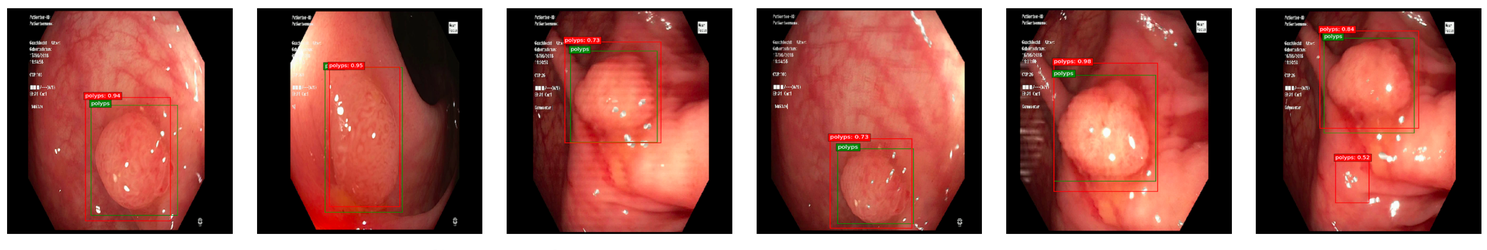
5. Results



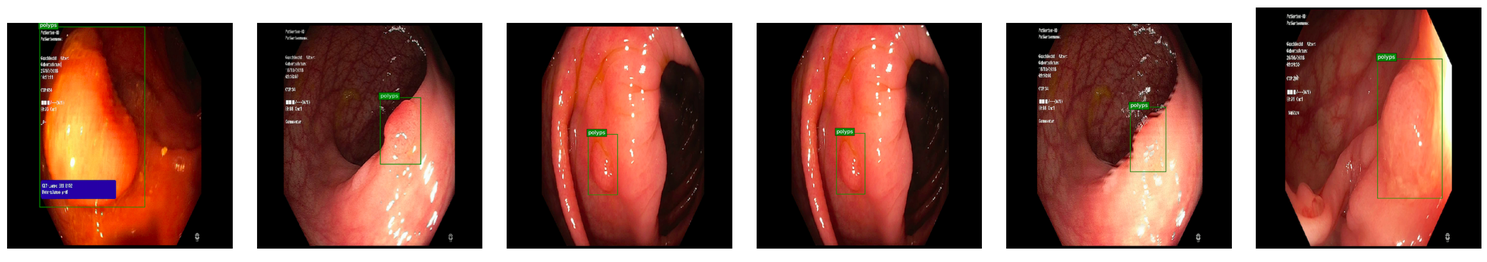
Successful Detection on ETIS-Larib dataset



Failed(FP and FN) Detection on ETIS-Larib dataset



Successful Detection on hospital dataset



Failed Detection on hospital dataset

6. Contributions and Future Work

To conclude, following are tasks achieved at end of this work.

1. To the best of my knowledge, this is the first approach that uses Single Shot Multibox Detector for the purpose of detecting polyps.
2. Comparable results on ETIS-Larib dataset are achieved.
3. Re-training SSD with different configurations achieved precision of 94% on clinical database.

The next steps would be to improve the detection accuracy further and train the same network to detect different types of polyps namely Hyperplastic, Tubular adenoma and Serrated adenoma (most harmful).

7. References

[1] Wei Liu, Dragomir Anguelov, Dumitru Erhan, Christian Szegedy, Scott Reed, Cheng-Yang Fu, and Alexander C. Berg. Ssd: Single shot multibox detector, ECCV 2016.

[2] Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun. Faster r-cnn: Towards real-time object detection with region proposal networks, 2015.

[3] Jorge Bernal, F. Javier Sanchez, and Fernando Vilariño. Towards automatic polyp detection with a polyp appearance model, 2012.

[4] Juan S. Silva, Aymeric Histace, Olivier Romain, Xavier Dray, and Bertrand Granado. Towards embedded detection of polyps in wce images for early diagnosis of colorectal cancer, 2014.