PVT based Blood Vessel Segmentation and Polyp Size Estimation in Colonoscopy Images

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What did we want to do and why?

- **Colorectal cancer** is the second most **deadly cancer BUT** it is one of **the easiest to prevent**.

- In 80% of the cases, colon cancers develop from a benign. BUT 2 to 3% of them develop, grow and eventually turn into a malignant tumor (or cancer). Transformation takes an average of 5 to 10 years.

- The risk of an adenoma or polyp turning into cancer depends on Type of adenoma and **Size: the larger the polyp, the higher the risk of cancer**.

- Our target is **to estimate the exact size of the polyp** from a colonoscopy video: It is hard to estimate the exact size only by observing the video sequence.

How others treated this problem ?

Experience of medical doctor

The depth map prediction of the polyp remains a difficult task

Use of reference objects

Reference objects are not always in the field of view

How did we do it ?

- Blood vessels is present in almost every colonoscopy, with a perfect fit to the colonic walls and a low variation in size. The diameter in pixels is used as a relative size.

- Once this relative size is calculated, an estimate of the blood vessel in mm is provided (the blood vessel size is slightly variable for human) and the polyp size in mm is deduced.

- Assuming that this diameter is 1 mm and the distance between the polyp and the selected root vessel, we can establish a proportional conversion standard to estimate the size of the polyp.

How about results ?

The segmentation of the largest blood vessel (the one we are interested in) has an accuracy of 90.56% of

$$DSC(A,B) = \frac{2|A \cap B|}{|A| + |B|}$$

Task	mDice
Segmentation of all blood vessels using U-Net	10.58%
Segmentation of all blood vessels using Polyp-PVT	75.32%
Segmentation of largest blood vessels using U-Net	10.58%
Segmentation of largest blood vessels using Polyp-PVT	90.56%
Segmentation of all polyps using Polyp-PVT	74.54%
Segmentation of SUN extracted polyps using Polyp-PVT	94.64%

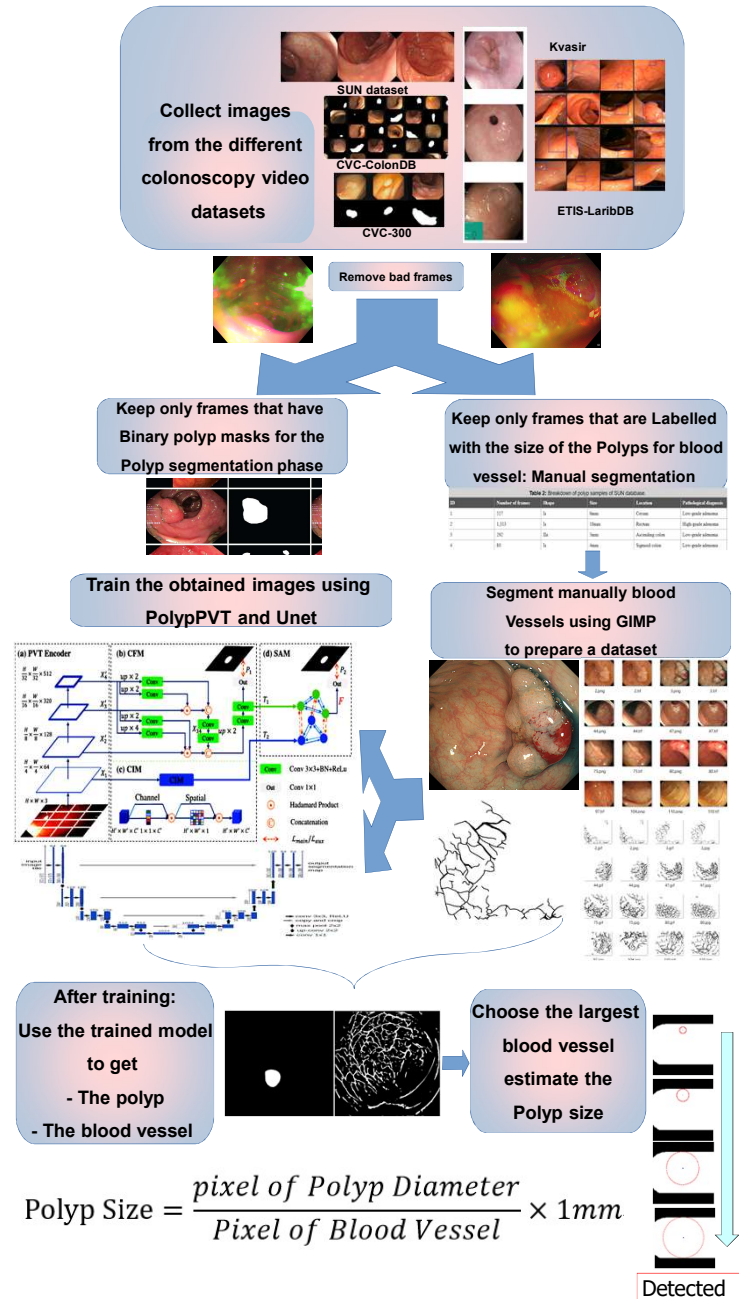| Binary Segmented Polyps Used	Average Error Rate AER
Ground truth polyp masks	1.91
Binary polyp masks using PolyPVT	2.63

PCC: Percentage of Correct Classification

n: number of polyps

N: number of correctly classified.

$$PCC(A,B) = \frac{n}{N} \times 100$$

Mask used	PCC benign ($< 6mm$)	PCC malignant ($\geq 6mm$)
Groundtruth Masks	85.71%	78.26%
Predicted Masks	85.61%	73.92%

Methodology

Collect images from the different colonoscopy video datasets

Kvasir, SUN dataset, CVC-ColonDB, CVC-300, ETIS-LaribDB

Remove bad frames

Keep only frames that have Binary polyp masks for the Polyp segmentation phase

Keep only frames that are Labelled with the size of the Polyps for blood vessel: Manual segmentation

Train the obtained images using PolypPVT and Unet

Segment manually blood Vessels using GIMP to prepare a dataset

After training: Use the trained model to get
- The polyp
- The blood vessel

Choose the largest blood vessel estimate the Polyp size

Detected

$$Polyp\ Size = \frac{pixel\ of\ Polyp\ Diameter}{Pixel\ of\ Blood\ Vessel} \times 1mm$$

The approach was validated by two medical doctors. It is assumed that the chosen root of the blood vessel is the closest to the polyp. In some cases, this case occurs generally when the area near the polyp does not contain blood vessels.

Future Work: Integration of the temporal information, and track the blood vessel would give better information about the closeness of the blood to the polyp in the video stream. Combining the 3D shape and size is extended research.

What can you find our work ?

Codes on github :**https://github.com/yelhamer/Polyp-Size-Recovery**

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