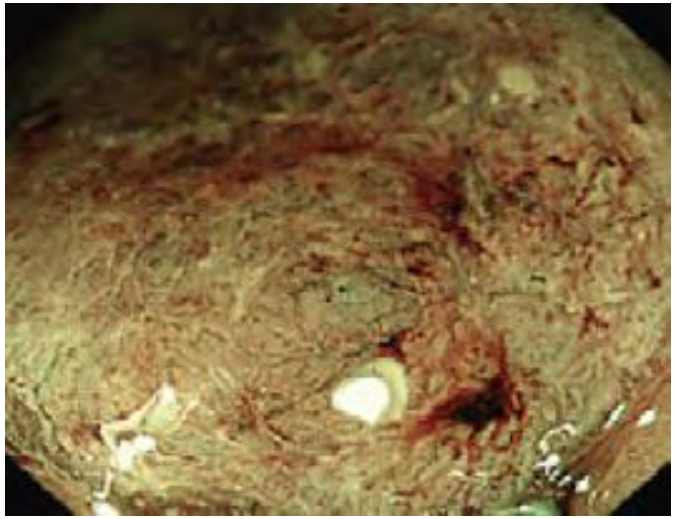
COLONIC POLYP TYPE IDENTIFICATION

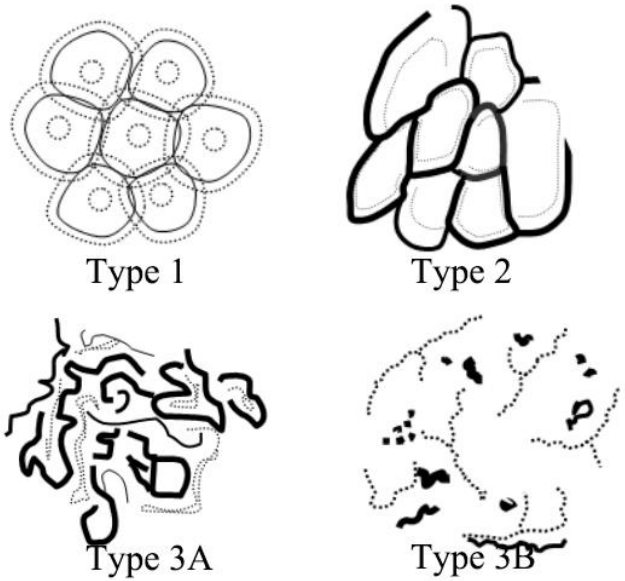
Colorectal Cancer

- High incidence
- Low survival rate of terminal colorectal cancer
- Missed diagnosis and misdiagnosis in the early stage
- NBI: focus on vessel shape



Motivation

- With the deterioration of the colonic polyps, the vessel smoothness lowers:
  - **Observation 1**: each vessel tends to have more sharp corners and distortions as cancer deteriorates-> # of corners per vessel may increase
  - **Observation 2**: there exits more dilation and breakage as cancer deteriorates-> standard deviation of diameter of each vessel may increase

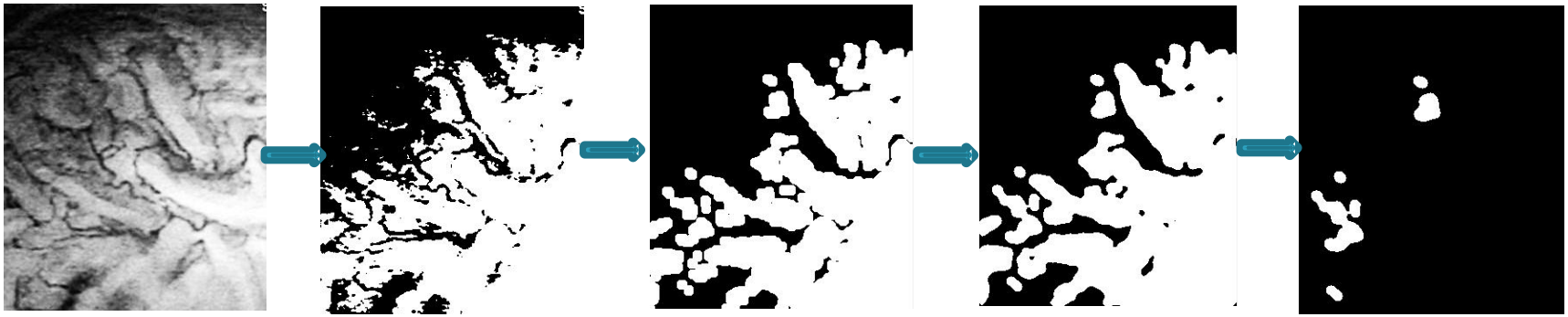


Vessel Smoothness

- Three feature has been designed to estimate the vessel smoothness regarding the corners and changes of vessel diameter:
  - Number of Vessel Corner (NVC)
  - Standard Deviation of Vessel Diameter (SDVD)
  - Number of Abnormal Vessel (NAV)

Preprocessing

- Binarization
- Mathematical morphology
- Median filter to remove noise
- Clear border regions



Original Image | After Binarization | After Mathematical Morphology | After Applying Median Filter | After clearing Border regions

- For each focal zone image, suppose there are n vessels $v_i, i = 1, 2, 3, \ldots, n$

Number of Vessel Corner (NVC)

- Use Harris corner detection method to calculate average number of vessel corner per vessel, where num_corner is the total number of corners in the image, n is number of vessels.

$$NVC = \frac{num\_corner}{n}$$

image

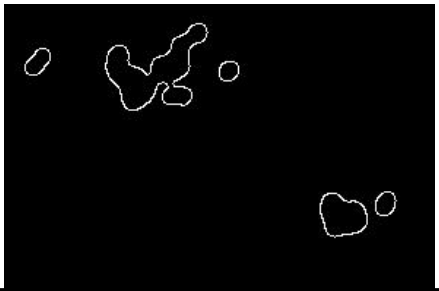
After Harris corner detection

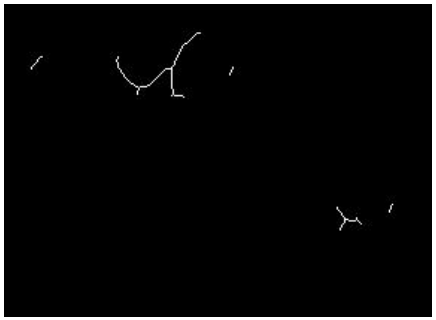
Standard Deviation of Vessel Diameter (SDVD)

- Get edge image I_{edge} and thinned image $I_{thinned}$ to find averaged SDVD, where $dist_{(x,y)}$ is the shortest distance from the point in I_{edge} to $I_{thinned}$ of each vessel, dist_hist is an array that contains these data, n is number of vessels in the focal zone image.

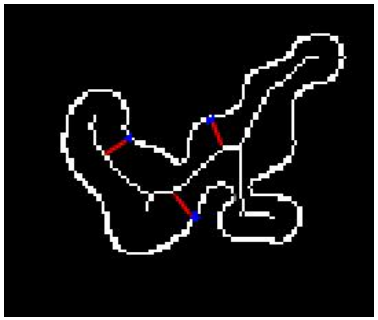
$$dist_{(x,y)} = \min(||I_{edge}(x,y) - I_{thinned}(i,j)||_1)$$

$$\text{SDVD} = \frac{\sum_{k=1}^{n} std(dist\_hist)}{n}$$





Thinned image



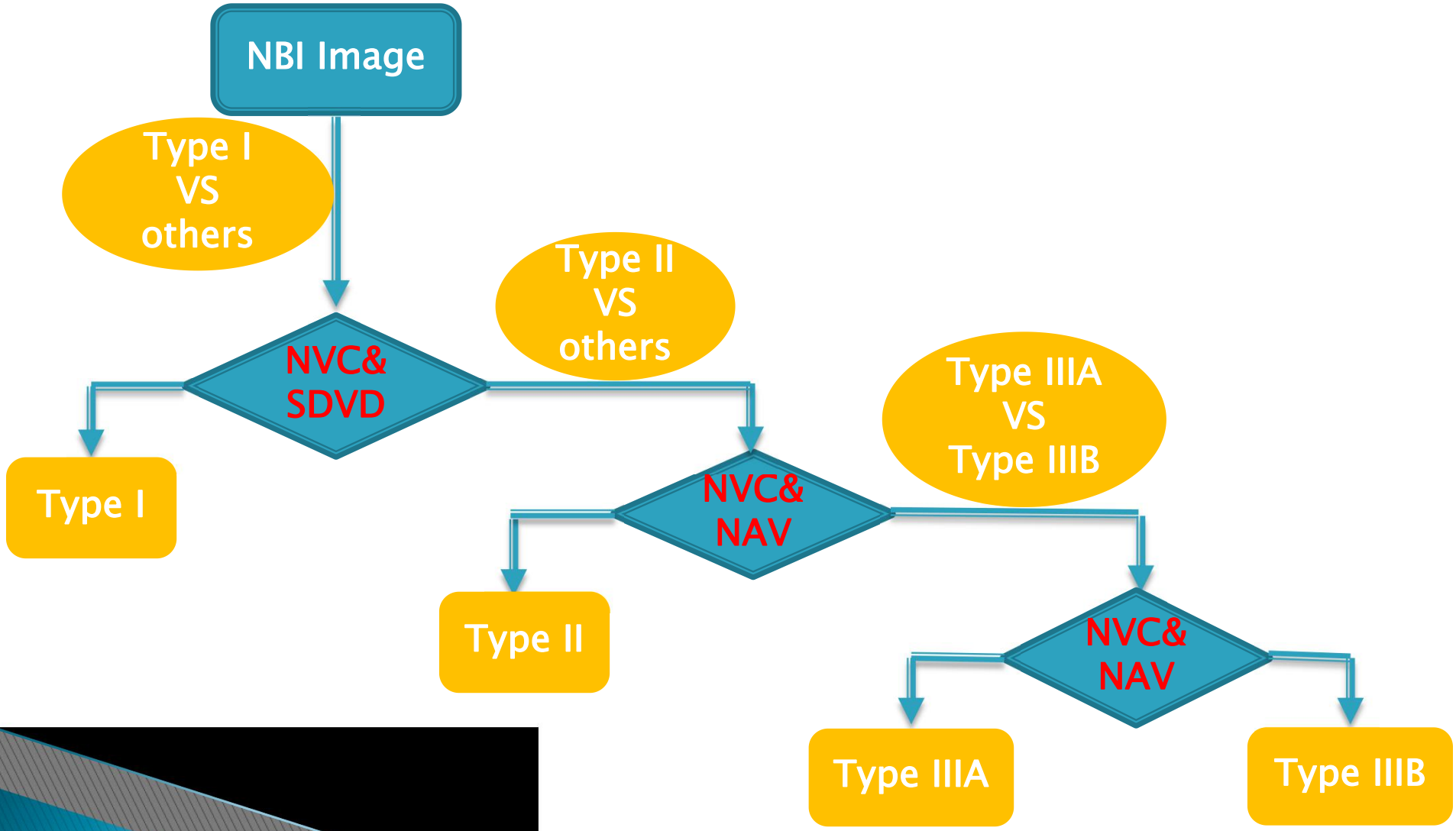
Each point has one shortest distance

Number of Abnormal Vessel (NAV)

- Given a threshold ϑ, if the SDVD of the vessel is greater than ϑ, such vessel is referred to as an abnormal vessel.
- NAV is defined as the ratio of number of abnormal vessels in the image to the total number of vessels n:

$$\mathrm{NAV}=\frac{num\_abnormal}{n}$$

Feature Usage



Experiment Result–K-means cluster

- Using the same database of 55 samples, containing 5 Type I samples; 24 Type II samples; 19 Type IIIA samples; 7 Type IIIB samples.
- K-means cluster is trained for each classification task.

Accuracy	Proposed Method	Comparison Method
Type I vs others	81.82%	65.5%
Type II vs Type IIIA & IIIB	50%	60%
Type IIIA vs Type I	69.23%	61.9%

Experiment Result–Linear SVM

- Using the same database of 55 samples, containing 5 Type I samples; 24 Type II samples; 19 Type IIIA samples; 7 Type IIIB samples.
- A linear SVM is trained for each classification task.

Accuracy	Proposed Method	Comparison Method
Type I vs others	84.173%	81.16%
Type II vs Type IIIA & IIIB	59.513%	60.79%
Type IIIA vs Type I	81.22%	74.20%

* Comparison Method: Hsu C C, Yang Z Y, Hsu C M. An Automatic Colonic Polyp Type Identification System by Narrow-Band Imaging and Focal Zone Features of Vascular Shapes and Patterns[C]//Innovations in Bio-Inspired Computing and Applications (IBICA), 2012 Third International Conference on. IEEE, 2012: 144-147.

Analysis– Type I VS others

- 1.Type I VS others:
  - The accuracy of our methods is no less than that of comparison method.
  - There are some vessels are oval- or bar-shaped in Type II, the comparison method may mistake Type II for Type I if there are too many oval-shaped vessels.
  - Our methods calculate corners and standard deviation of a vessel, which can avoid this situation.

Analysis– Type II VS Type IIIA & IIIB

- Type II VS Type IIIA & IIIB:
  - Although we don't get ideal result by using our method, we still believe that it's a right direction to find methods to distinguish a vessel is normal or not.
  - The vessels in Types I and II have regular shape, they are normal; those vessels that have irregular shape in Types IIIA and IIIB are abnormal.
  - Irregular shape blood vessels have more corners and larger standard deviation, the question is to find a threshold to distinguish between normal and abnormal vessels by using standard deviation, maybe we used improper threshold. We will focus on finding a better way to define abnormal vessel.

Analysis- Type II VS Type IIIB

- Type IIIA VS Type IIIB:
  - Apparently we get the satisfactory result. This proves that we need to find some features to judge a vessel is normal or not, or describe the degree of abnormal vessel. Type IIIB has more abnormal vessels, and these vessels have more corners, so our two features can get a high accuracy.

Conclusion and Future Work

1. Number of Vessel Corner is an appropriate feature that measures deterioration degree of colonic polyps, we need to improve corner detection algorithm to increase the accuracy.
2. Standard Deviation of Vessel Diameter is not good at Adenoma Classification, maybe it's because we used inappropriate image processing method.
3. When we calculate the number of abnormal vessel, the threshold is important, we need to do more experiments to find an appropriate value.