

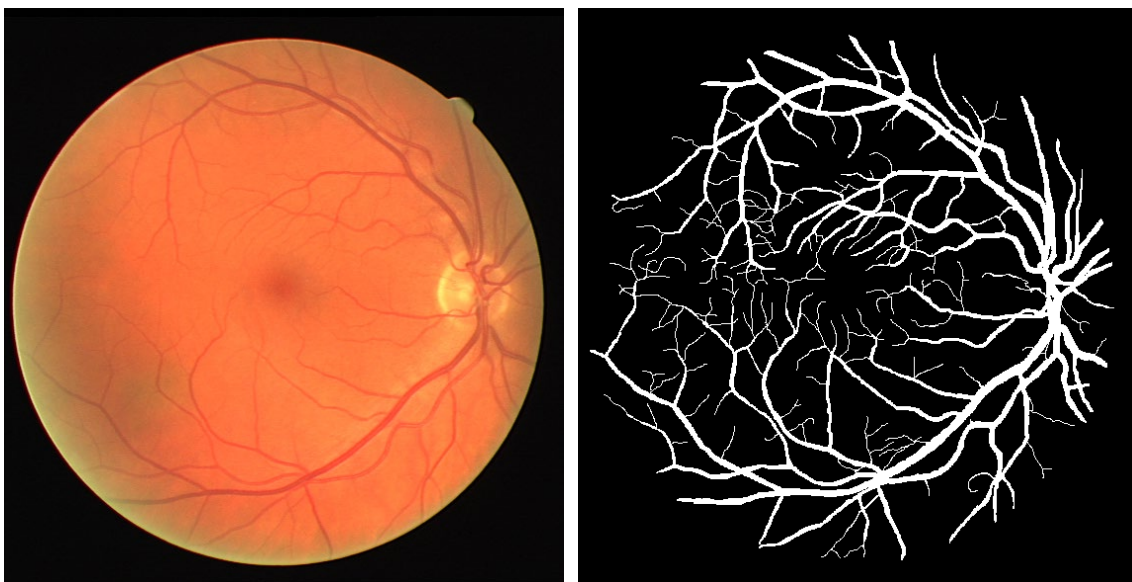
Project (30%)

Due: 4pm, Thursday, 30 April 2020

Automatic Retinal Vessel Segmentation / Detection from Image

Retinal vessel segmentation is an important part of computer-aided diagnosis of retinal diseases, like arteriosclerosis, vein occlusions, and diabetic retinopathy. A reliable assessment for these diseases can be achieved by regularly performing accurate measurement of the vessel width, tortuosity and proliferation. If abnormal signs are detected at early stage, timely treatment can be advised to perform on patients. Manual segmentation of retinal vessel is a tedious task that requires experience experts to annotate a huge amount of retinal images by hand, thus not feasible for large-scale research study and clinical utility. Vessel segmentation based on computer vision and image processing provides an efficient and economic benefit tool for retinal image analysis. Due to its importance, large amount of research work has been done in the past decades to develop effective automatic method of automatic vessel segmentation/detection from retinal image. Earlier efforts focused on applying various image processing techniques while the state-of-the-arts [1] [2] adopt pattern classification approach.

In this project, you are required to research on what image processing techniques and/or pattern classification approach can be applied to automatically segment/detect vessel from retinal image and implement them by a Matlab program. The Matlab program should load a color retinal image and output a detected/segmented vessel map. A sample retinal image and its vessel map are shown below where vessel pixels are manually detected by a human expert and indicated by white pixels in the vessel map. You can try to apply whatever image processing techniques and/or pattern classification approach to your Matlab program but you must clearly describe the principles of the techniques and explain how they help improve the segmentation/detection accuracy in your report.



A very simple baseline Matlab program that worked out by me in 2 hours is shown below:

```

% A very simple baseline Matlab program for retinal vessel detection/
segmentation coded by Jiang Xudong
x = imread('24_training.tif');           %load the color image
figure(1); imshow(x);                   %display the color image
% figure(2); imshow(x(:,:,1));          %display one channel the color image
% figure(3); imshow(x(:,:,2));          %display one channel the color image
% figure(4); imshow(x(:,:,3));          %display one channel the color image
% xs = rgb2gray(x);                     %convert the color image into gray
image
% figure(5); imshow(xs);
xg = x(:,:,2);                          %decide to work on green channel image
figure(5); imshow(xg);

%Segment the image area
xt = xg;
m1 = mean(mean(xt));
xt(find(xt>m1)) = m1;
%figure(6); imshow(xt, []);
m2 = mean(mean(xt));
xt(find(xt>m2)) = m2;
%figure(7); imshow(xt, []);
m3 = mean(mean(xt));
xt(find(xt<m3)) = 0;
xt(find(xt>=m3)) = 1;
figure(8); imshow(xt, []);
n = sum(sum(xt));

%Segment the vessel
xin = xg.*xt;
xout = xin;
m1 = sum(sum(xout))/n;
xout(find(xout>m1)) = m1;
m2 = sum(sum(xout))/n;
xout(find(xout>m2)) = m2;
m3 = sum(sum(xout))/n;

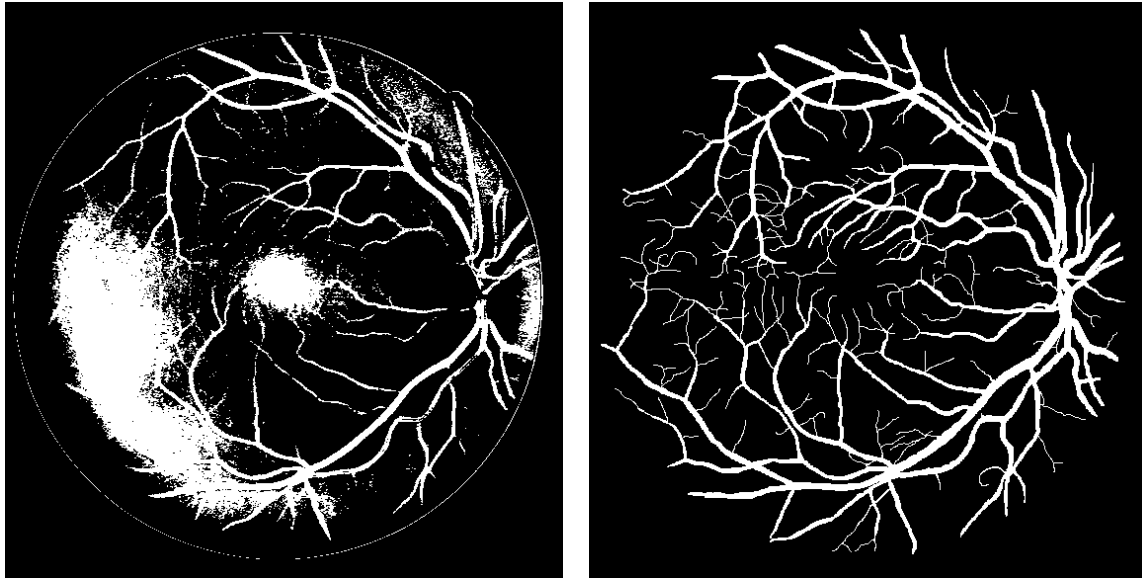
xout(find(xout>m3)) = 0;
xout(find(xout>0)) = 255;
figure(9); imshow(xout, []);
imwrite(xout, '24_trainingmap.tif', 'tiff')

%load the vessel ground truth
truth = imread('24_manuall.gif');
figure(10); imshow(truth, []);

%Evaluate the segmentation accuracy
[h,w] = size(xout);
tst = zeros(h,w);
tst(find(xout==truth))=1;
figure(11); imshow(tst, []);
accuracy = 100*sum(sum(tst))/(h*w)

```

This very simple baseline Matlab program outputs the vessel map below:



Comparing it (left image) with the vessel map manually detected by a human expert (right image), the vessel detection/segmentation accuracy is computed. The accuracy is 85.5389%

You are required to:

1. Submit a report including your Matlab program that automatically segments/detects vessel pixels from retinal image. The report should describe every step of your program and the principles of the image processing techniques and/or pattern classification approach you used in your program and explain why and how the techniques help improve the segmentation accuracy. Give out the vessel map and the segmentation accuracy generated by your program working on this sample retinal image '[24_training.tif](#)'.
2. Apply your Matlab program on another retinal image assigned to you and include the resulting vessel map produced by your Matlab program in the report.

Please complete your Project (30%) by emailing me by 4pm, Thursday, 30 April 2020 your report (either Word or Pdf file). Please use your name followed by your matric number as your submitted file name. Please also submit your Assignment (20%) in the same email using above file name followed by 'assign'. Thank you.

Reference: (for your information only)

- [1] X. Wang, X. Jiang, J. Ren, "[Blood Vessel Segmentation from Fundus Image by a Cascade Classification Framework](#)," *Pattern Recognition*, vol. 88, pp. 331-341, Apr 2019.
- [2] X. Wang, X. Jiang, "[Retinal Vessel Segmentation by a Divide-and-conquer Funnel-structured Classification Framework](#)," *Signal Processing*, vol. 165, pp. 104-114, Dec 2019.

The following list (next page) shows the retinal image file name assigned to you:

Student Name	Retinal image file name
ANDERSEN SIMEN PERSCH	01_test
ANG PHUAY WEE EUGENE	02_test
BAI LU	03_test
BAI TIAN	04_test
BI CHENG	05_test
CAI CHEN	06_test
CAI RIZHAO	07_test
CAO HAOZHI	08_test
CHEN JINNAN	09_test
CHEN YIHUANG	10_test
CHEN ZHIHUAN	11_test
CHENG HAO	12_test
CHETMI MERIEM	13_test
DENG ZICHAO	14_test
DING HONGYUAN	15_test
DU BOYANG	16_test
DU KAIWEN	17_test
FANG HAOYU	18_test
FENG ZIJIAN	19_test
GE YIHUI	20_test
GUO LANQING	21_test
HONG XUENONG	22_test
HU YIDAN	23_test
HUANG CHAORAN	24_test
HUANG JIAXING	25_test
HUO LILI	26_test
JIANG HAOGUO	27_test
JO YONGJUN	28_test
KONG LINGDONG	29_test
LAN TIAN	30_test
LANGE ERIK	31_test
LEE SEE HIAN	32_test
LEI ANLAN	01_test
LEI YIRAN	02_test
LI CHANGHAO	03_test
LI CHUYUN	04_test
LI GUANKAI	05_test
LI HAOSANG	06_test
LI HESHAN	07_test
LI RUIBO	08_test
LI SITAN	09_test
LI TIANLEI	10_test
LIU TIANYI	11_test
LIU XIANGYU	12_test
LIU YIZHENG	13_test
LOUATI AKRAM	14_test
LU YUJING	15_test

LU YUNCHENG	16_test
LU ZHAN	17_test
LUO LINGFENG	18_test
LUO YANGZHI	19_test
LUO ZHIPENG	20_test
LYU ZIANG	21_test
MHAROLKAR SANAT RAJESH	22_test
MU YUSHAN	23_test
NIE BOYA	24_test
NING SHUQI	25_test
OCHSENIUS MARVIN ADRIAN	26_test
OOI WEN RUI KENNETH	27_test
PENG XINGGAN	28_test
REN BING	29_test
REN HEYU	30_test
RITO BRIAN YSHMAEL DIMAUNAHAN	31_test
SHE HANQING	32_test
SHEN FAWEN	01_test
SHI HANYU	02_test
SHI QIUSHI	03_test
SONG NAN	04_test
SU JINGYI	05_test
TAN JUN KIAT	06_test
TANAZEFTI OUAEL	07_test
TANG ZHIFEI	08_test
TU YIXUAN	09_test
VIVEK MOHAN	10_test
WAN JIAXIN	11_test
WANG BINGYU	12_test
WANG DONGLIANG	13_test
WANG HAO	14_test
WANG KAIYUAN	15_test
WANG SIQI	16_test
WANG XI	17_test
WANG XINGLI	18_test
WANG YANQING	19_test
WANG YIMING	20_test
WANG ZHISHENG	21_test
WANG ZHIXIANG	22_test
WANG ZHIXING	23_test
WEI SHUYANG	24_test
XI YIHONG	25_test
XIANARI DUOLAN	26_test
XIAO XINHAO	27_test
XIE MINXIN	28_test
XIONG XINCHENG	29_test
XU SIYUAN	30_test
YAN RUDAI	31_test

YAN YUMING	32_test
YANG ZE	01_test
YAO YUANZHE	02_test
YAO YUHAN	03_test
YAO YUJIE	04_test
YE HAOXUAN	05_test
YE YINGJIAN	06_test
YOU XINCHI	07_test
YU CHENGSHUO	08_test
YU HAOHANG	09_test
YU YINGCHEN	10_test
ZENG YU	11_test
ZHAN LIJUAN	12_test
ZHANG HAOBO	13_test
ZHANG JINGYI	14_test
ZHANG RAN	15_test
ZHANG SHIYU	16_test
ZHANG XIRUI	17_test
ZHANG ZHENGYUAN	18_test
ZHANG ZIQING	19_test
ZHAO CHENGLIN	20_test
ZHAO CHUNYANG	21_test
ZHAO LINXUAN	22_test
ZHAO XINGE	23_test
ZHENG BOWEN	24_test
ZHENG HONGZHI	25_test
ZHENG TIANYUE	26_test
ZHENG XINGYU	27_test
ZHU HUIHUI	28_test
ZHU JIARUI	29_test
ZHU ZHEYU	30_test
ZHU ZIXIAO	31_test
ZOU YUXUAN	32_test

Have a nice, interesting and fun project! -- Jiang Xudong