%Program for Retinal Blood Vessel Extraction

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%Program Description

%This program extracts blood vessels from a retina image using Kirsch's Templates.

%Spatial Filtering of the input retina image is done with the Kirsch's

%Templates in different orientations. Followed by thresholding, results in

%the extracted blood vessels. The threshold can be varied to fine tune the

%output.

function bloodVessels = VesselExtract(inImg, threshold)

%Kirsch's Templates

h1=[5 -3 -3;

5 0 -3;

5 -3 -3]/15;

h2=[-3 -3 5;

-3 0 5;

-3 -3 5]/15;

h3=[-3 -3 -3;

5 0 -3;

5 5 -3]/15;

h4=[-3 5 5;

-3 0 5;

-3 -3 -3]/15;

h5=[-3 -3 -3;

-3 0 -3;

5 5 5]/15;

h6=[ 5 5 5;

-3 0 -3;

-3 -3 -3]/15;

h7=[-3 -3 -3;

-3 0 5;

-3 5 5]/15;

h8=[ 5 5 -3;

5 0 -3;

-3 -3 -3]/15;

%Spatial Filtering by Kirsch's Templates

t1=filter2(h1,inImg);

t2=filter2(h2,inImg);

t3=filter2(h3,inImg);

t4=filter2(h4,inImg);

t5=filter2(h5,inImg);

t6=filter2(h6,inImg);

t7=filter2(h7,inImg);

t8=filter2(h8,inImg);

s=size(inImg);

bloodVessels=zeros(s(1),s(2));

temp=zeros(1,8);

%

for i=1:s(1)

for j=1:s(2)

temp(1)=t1(i,j);temp(2)=t2(i,j);temp(3)=t3(i,j);temp(4)=t4(i,j);

temp(5)=t5(i,j);temp(6)=t6(i,j);temp(7)=t7(i,j);temp(8)=t8(i,j);

if(max(temp)>threshold)

bloodVessels(i,j)=max(temp);

end

end

end

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%Program Description

%This program is the main entry of the application.

%This program extracts blood vessels from a retina image using Kirsch's Templates.

%Clear Memory & Command Window

clc;

clear all;

close all;

%Read Input Retina Image

inImg = imread('Input.bmp');

dim = ndims(inImg);

if(dim == 3)

%Input is a color image

inImg = rgb2gray(inImg);

end

%Extract Blood Vessels

Threshold = 10;

bloodVessels = VesselExtract(inImg, Threshold);

%Output Blood Vessels image

figure;

subplot(121);imshow(inImg);title('Input Image');

subplot(122);imshow(bloodVessels);title('Extracted Blood Vessels');