clear;

% close all;

clc;

[t,rawSig] = importfile('ekg1.csv');

rawSig = 10 \* (rawSig - mean(rawSig)); % artificial removal of the DC component

t = t + abs(t(1));

fs = length(t)/t(end);

figure(1);

subplot(4,1,1);

plot(t,rawSig);

ylabel('Raw signal');

% hihpass filter

d = fdesign.highpass('n,fc', 4, 0.05, fs);

hh = design(d,'butter');

hpSig = filter(hh,rawSig);

subplot(4,1,2);

plot(t,hpSig);

ylabel('Highpassed signal');

% lowpass filter

d = fdesign.lowpass('n,fc', 4, 30, fs);

hl = design(d,'butter');

lpSig = filter(hl,hpSig);

subplot(4,1,3);

plot(t,lpSig);

ylabel('Lowpassed signal');

% notch filter

d = fdesign.notch('n,f0,bw', 4, 50, 2, fs);

hn = design(d,'butter');

notchSig = filter(hn,lpSig);

subplot(4,1,4);

plot(t,notchSig);

ylabel('After notch');

xlabel('Time');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

sig = notchSig;

[pksR, locsR, wR, pR] = findpeaks(sig, 'MinPeakHeight', max(sig) / 2);

figure(2);

plot(t,sig);

hold on;

plot(locsR/fs, pksR, '^r');

hold off;

[pksS, locsS, wS, pS] = findpeaks(-sig, 'MinPeakHeight', max(-sig) / 2);

hold on;

plot(locsS/fs, -pksS, 'sg');

hold off;

% wave identification by means of cross-correlation

sampleSig = sig(locsR(1) : locsR(end)); % artificial supression of the seignal segments before first peak and after last peak

[c,lag] = xcorr(sampleSig);

figure(3);

subplot(2,1,1);

plot(sampleSig);

subplot(2,1,2);

plot(lag,c);

% heart rate detection

rr\_interval = diff(locsR) / fs;

instantaneous\_hr = 60./ rr\_interval;

hr = mean(instantaneous\_hr)

hrv = std(instantaneous\_hr)

% SIMPLE pacemaker model

atrial\_pacing\_delay = 50e-3;

ventricular\_pacing\_delay = 100e-3;

pulseLen = 25e-3;

bradycardiaThreshold = 500e-3;

atrial\_pacing\_pulses = zeros(size(sig));

ventricular\_pacing\_pulses = zeros(size(sig));

for i = 1 : length(rr\_interval)

startIdx = locsR(1) + sum(rr\_interval(1:i-1) \* fs);

if rr\_interval(i) > bradycardiaThreshold

atrial\_pacing\_pulses(startIdx + bradycardiaThreshold \* fs + atrial\_pacing\_delay \* fs : startIdx + bradycardiaThreshold \* fs + atrial\_pacing\_delay \* fs + pulseLen) = 1;

ventricular\_pacing\_pulses(startIdx + bradycardiaThreshold \* fs + ventricular\_pacing\_delay \* fs : startIdx + bradycardiaThreshold \* fs + ventricular\_pacing\_delay \* fs + pulseLen) = 1;

end

end

figure(4);

subplot(2,1,1);

plot(t,sig);

subplot(2,1,2);

plot(t,atrial\_pacing\_pulses, 'r','LineWidth',2);

hold on;

plot(t,ventricular\_pacing\_pulses, 'g','LineWidth',2);

hold off;