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```
function chss2(pw, Path, Name)

%     dt=1/30;     % ######## ######### #############
    fmin=0.15; % ###### ####### - ######### ######## ########### #####
    dt=1/30;     % ######## ######### #############
    Nmed=1/(dt*fmin); % ######## #######
    PathHR=Path+replace(Name,"_nc","")+"_rPPG_output.csv";
    hr = LoadHR(PathHR);
    % PathHR=Path+replace(Name,"_nc","")+"_Mobi_RR-intervals.rr";
    % hr = LoadRR(PathHR);

Not enough input arguments.

Error in chss2 (line 6)
    PathHR=Path+replace(Name,"_nc","")+"_rPPG_output.csv";
```

C######## pw

```
    N   = length(pw); % ########## ######## pw
    win = 1024;
    res = N-win*floor(N/win);
    nPart = 20; % ########## ##### res
    res = floor(res/nPart); overlap = (win-res)/win;
    S = 1; Imin = 1; Imax = win;
    while Imax<=N
        ns(S) = S; % ##### ######## ######## pw
        Imin  = Imin+res;
        Imax  = Imax+res;
        S     = S+1;
    end
    S = S-1; % ###-## ############### ######### pw # ######## N
```

```
    NSF = win+res*(S-1); % ##### ########## ####### ##########
######## <= N
    for j=1:S
        for i=1:win
            k = (j-1)*res;
            spw(i,j) = pw(k+i); % ####### ####### pw ####### win
        end
    end
```

Set general parameters

```
    cad = 30;      % 30 ######/###
    dt  = 1.0/cad; % ######## ############# #######, ###
    tim(1) = 0.0;
    for i=2:N
        tim(i) = tim(i-1)+dt; % ##### # ########
    end
    % tim = tim';
    ns  = (1:S)'; % ###### ######### pw
    % fmp=zeros(S,1);
    for j=1:S % #### ## ######### pw
        %    L(j) = floor(cad/fmp(j)); % ###-## ######## #########
#### pw
        L(j) = floor(cad/1.5); % ###-## ######## ######### #### pw
    end
    L = L';
    K = 5; % ###-## ######## ### ######### ########
    M = K*max(L); % ######## ######## # ########### ############
```

SSA- ###### ########## pw

```
    nET = 4;   % ###-## ########## ##### ### ######### pw
    for j=1:S  % #### ## #########
```

SSA time series

```
      M = K*L(j); % ######## ######## # ########### ############

    [C,LBD,RC] = SSA(win,M,spw(:,j),nET);
```

Estimation of the spw(:,j) reconstructed with the pair of RC

```
    sET12(:,j) = sum(RC(:,1:2),2);
    %    sET34(:,j) = sum(RC(:,3:4),2);
```

Compare reconstruction and original time series

```
    if j==100 % ##### ######## pw ### ############
```

```
                figure('name','Covariance matrix'); clf;
                imagesc(C); axis square; set(gca,'clim',[-1 1]); colorbar;
                figure('name','Eigenvalues'); clf; plot(LBD,'o-');
                figure('name','Original time series and reconstruction');
clf;
                plot(tim(1:win),spw(:,j),'b-',tim(1:win),sET12(:,j),'r-');
                legend('Original','sET12'); xlabel("t,s",'interp','none');
ylabel("sET",'interp','none');
            end

        end
```

#########

pw

```
        lag  = floor(win/10); % ########## ### ### <= win/10
        lagS = 2*lag;
        for j=1:S
            Acf_sET12(:,j) = AcfMed(lagS,win,sET12(:,j)); % #############
### j-## ########
            %    Acf_sET12(:,j) = autocorr(sET12(:,j),'NumLags',lag); %
############# ### j-## ########
        end
```

pw

```
        lgl = 1:lag; % ##### 3D-####### ###
        Time=0:dt:lag*dt-dt;
        figure('name','### ########### ##### sET12 ######### pw'); clf;
        %
mesh(ns,lgl,Acf_sET12(1:lag,:),'FaceAlpha',0.5,'FaceColor','flat');
colorbar;
        % xlabel("ns",'interp','none'); ylabel("lag",'interp','none');

mesh(ns,Time,Acf_sET12(1:lag,:),'FaceAlpha',0.5,'FaceColor','flat');
colorbar;
        xlabel("ns",'interp','none'); ylabel("lag,s",'interp','none');
        zlabel("Acf",'interp','none'); grid on;
```

abs(acf_sET12)

```
        for j=1:S % #### ## ######### ###
            absTS = abs(Acf_sET12(:,j));
            AT1   = absTS(1);
            AT2   = absTS(2);
            maxTS = zeros(lag,1); maxTS(1) = AT1;
            maxN  = zeros(lag,1); maxN(1)  = 1;
```

```
        Nmax = 1;
        for m=3:lag
            AT3 = absTS(m);
            if (AT1<=AT2)&&(AT2>=AT3)
                Nmax = Nmax+1; % ##### ########## #### ############
(####### ##########)
                maxN(Nmax) = m-1; % ##### ########## ######### ###
#### absTS
                maxTS(Nmax) = AT2; % ###### ########## ####
############
            end
            AT1 = AT2;
            AT2 = AT3;
        end
        Nmax = Nmax+1; % ########## ##### ############
        maxN(Nmax)  = lag; % ##### ####### absTS ########## ####
############
        maxTS(Nmax) = absTS(lag); % ###### absTS ########## ####
############
        NumMax = maxN(1:Nmax); % ###### ########## ## absTS
        % ############ ######### ###
        % 'pchip','cubic','v5cubic','makima','spline'
        EnvAcf_sET12(:,j) = interp1(NumMax,maxTS(1:Nmax),lgl,'pchip');
        AcfNrm_sET12(:,j) = Acf_sET12(1:lag,j)./EnvAcf_sET12(:,j); %
############# ###
    end
    figure('name','############# ### ########### ##### sET12 #########
pw'); clf;
    %
mesh(ns,lgl,AcfNrm_sET12(1:lag,:),'FaceAlpha',0.5,'FaceColor','flat');
colorbar;
    % xlabel("ns",'interp','none'); ylabel("lag",'interp','none');

mesh(ns,Time,AcfNrm_sET12(1:lag,:),'FaceAlpha',0.5,'FaceColor','flat');
colorbar;
    xlabel("ns",'interp','none'); ylabel("lag,s",'interp','none');
    zlabel("Acf_Nrm",'interp','none'); grid on;
```

sET12 ### ######### pw

```
    pi2 = 2.0*pi;
    for j=1:S % #### ## ######### ###
        PhaAcfNrm = abs(acos(AcfNrm_sET12(:,j))); % ########## ####
        pAcf = pchip(lgl,PhaAcfNrm); % ############ ############ pchip
        for m=2:lag
            FrcAcfNrm(m) = abs(pAcf.coefs(m-1,3))/pi2/dt; % ##########
######## ########-## ###, ##
        end
        FrcAcfNrm(1) = FrcAcfNrm(2);
        %    FrcAcfNrm = abs(diff(PhaAcfNrm))/pi2/dt; % ##########
######## ########-## ###, ##
```

```
        insFrc_AcfNrm(j) = median(FrcAcfNrm); % ####### ##########
 ######## j-## ######## pw
    end
    smo_insFrc_AcfNrm = smoothdata(insFrc_AcfNrm, 'rloess', 0.25*S); %
 smo_insFrc_AcfNrm = smooth(insFrc_AcfNrm,0.25*S,'rlowess');
    figure('name','####### ######-## ### ########-# ##### #########
 pw','Position', [0 0 800 600]); clf;
%            insFrc_AcfNrm=medfilt1(insFrc_AcfNrm,Nmed);
    p1 = plot(ns,insFrc_AcfNrm,'b','LineWidth',0.8); hold on;
    plot(ns,smo_insFrc_AcfNrm,'r','LineWidth',0.8); grid on;
    xlabel("ns",'interp','none');
 ylabel("insFrc_AcfNrm,Hz",'interp','none');
    title("####### ######-## ### ########-# ##### ######### pw");
%     legend(p1,'sET12');
    if length(hr)>100
        ns_hr = (length(ns)/length(hr) : length(ns)/length(hr) :
 length(ns))';
        % yyaxis right;
        plot(ns_hr,hr./60,'black'); ylabel("HR[bpm]",'interp','none');
        % legend(p1,'insFrc_AcfNrm','rloess','HR[bpm]');
        hr_med=medfilt1(hr,Nmed*5);
        hr_diff_med=hr-hr_med;
        plot(ns_hr,hr_med./60,'cyan--');

 plot(ns_hr,hr_diff_med./60,'magenta'); %ylabel("HR[bpm]",'interp','none');
        legend('insFrc AcfNrm','rloess','HR','HR[medfilt]','HR[HR-
medfilt1]')
    end
```

pw

```
    smopto = 3; % ######## ########### ############# #######
    for j=1:S
        %    disp(spw(:,j));
        pto_sET12(:,j) =
 periodogram(spw(:,j),blackmanharris(win),win); % ########-#######
        pto_sET12(:,j) = pmtm(sET12(:,j),smopto,win); % #############
 #######
    end
```

pw

```
    fmi  = 40.0/60.0;   % ####### ##### ### 40 ##/### (0.6667 ##)
    fma  = 240.0/60.0;  % ####### ##### ### 240 ##/### (4.0 ##)
    Nf   = 1+win/2;     % ###-## ######## #######
    df   = cad/(win-1); % ######## ############# #######, ##
    Fmin = fmi-10*df; Fmax = fma+10*df; % ####### # ##
    f(1) = 0.0;
```

```
    for i=2:Nf
        f(i) = f(i-1)+df; % ####### # ######
        if abs(f(i)-Fmin)<=df
            iGmin = i;
        end
        if abs(f(i)-Fmax)<=df
            iGmax = i;
        end
    end
    for i=1:iGmax
        fG(i) = f(i); % ##### ###### 3D-#######
    end
    f = f';
    figure('name','############# ####### sET12 ######### pw'); clf;

 mesh(ns,fG(iGmin:iGmax),pto_sET12(iGmin:iGmax,:),'FaceAlpha',0.5,'FaceColor','fla
    colorbar; grid on;
    xlabel("ns",'interp','none'); ylabel("f,Hz",'interp','none');
 zlabel("P(f)",'interp','none');
```

pw

```
    for j=1:S
        [B,I] = sort(pto_sET12(:,j),'descend');
        pto_fMAX12(j) = f(I(1)); % I(1) - ###### #######(##) #########
 pto_sET12(:,j)
    end
    pto_fMAX12 = pto_fMAX12';
    smo_pto_fMAX12 = smoothdata(pto_fMAX12,'rloess',0.3*S);
    % smo_pto_fMAX12 = smooth(pto_fMAX12,0.3*S,'rloess');
    figure('name','######## ######### #### sET #########
 pw','Position', [800 0 800 600]); clf;
%             pto_fMAX12=medfilt1(pto_fMAX12,Nmed);
    p=plot(ns,pto_fMAX12,'b'); hold on;
    plot(ns,smo_pto_fMAX12,'r','LineWidth',0.8); grid on;
    xlabel("ns",'interp','none'); ylabel("fMAX,Hz",'interp','none');
    title("######## ######### #### sET ######### pw");
    if length(hr)>100
        ns_hr = (length(ns)/length(hr) : length(ns)/length(hr) :
 length(ns))';
        % yyaxis right;
        plot(ns_hr,hr./60,'black'); ylabel("HR[bpm]",'interp','none');
        % legend(p,'pto_fMAX12','rloess','HR[bpm]');
        hr_med=medfilt1(hr,Nmed*5);
        hr_diff_med=hr-hr_med;
        plot(ns_hr,hr_med./60,'cyan--');

 plot(ns_hr,hr_diff_med./60,'magenta'); %ylabel("HR[bpm]",'interp','none');
        legend('pto sET12','smoothdata','HR[bpm]','medfilt1','hr-
medfilt1')
    end
```

```
    saveas(p,Path+Name+'_###_sET.png');
```

cpw

```
    [NumS,cpw_avr,cpw_med,cpw_iqr] = wav(NSF,S,win,res,sET12);
    % figure('name','Pulse wave'); clf;
    % plotwave(1,NSF,tim,cpw_avr,cpw_med,cpw_iqr);
```

cpw

cpw = cpw_avr; % ###### ######## ######## #####

```
    cpw = cpw_med; % ###### ######### ######### #####
    cutoff = pi; pi2 = 2.0*pi;
    H_cpw = hilbert(cpw);
    insE_cpw = abs(H_cpw); % ########## #########
    unwPha = unwrap(angle(H_cpw),cutoff); % ########### ##########
 ####
    % ############-(#) # #########-(d) ########## ############
 ########## ####
    unwPc_cpw(1) = unwPha(1); unwPd_cpw(1) = 0.0;
    for i=2:NSF
        dif = unwPha(i)-unwPha(i-1);
        unwPc_cpw(i) = unwPc_cpw(i-1); % ############
        unwPd_cpw(i) = unwPd_cpw(i-1); % #########
        if dif>=0.0
            unwPc_cpw(i) = unwPc_cpw(i)+dif;
        else
            unwPd_cpw(i) = unwPd_cpw(i)+dif+pi2;
        end
    end
    unwPc_cpw = unwPc_cpw'; unwPd_cpw = unwPd_cpw';
    figure('name','Unwrape phase pulse wave'); clf;
    sp1 = subplot(2,1,1); plot(tim(1:NSF),unwPc_cpw); grid on;
    xlabel("t,s",'interp','none'); ylabel("Phase
 cont",'interp','none');
    title(sp1,'############ ############ #### pw');
    sp2 = subplot(2,1,2); plot(tim(1:NSF),unwPd_cpw); grid on;
    xlabel("t,s",'interp','none'); ylabel("Phase
 disc",'interp','none');
    title(sp2,'######### ############ #### pw');
```

######

######

```
    t = 1:NSF;
```

```
    p = pchip(t,unwPc_cpw);
    insF_cpw(1) = 0.0;
    for i=2:NSF
        insF_cpw(i) = p.coefs(i-1,3)/pi2/dt; % ########## ####### ############ ########## cpw, ##
    end
    insF_cpw(1) = insF_cpw(2);
    insF_cpw = insF_cpw';
    smo_insF_cpw = smoothdata(insF_cpw, 'rloess', 0.03*NSF);
    % smo_insF_cpw = smooth(insF_cpw,0.03*NSF,'rloess');
    res_insF_cpw = insF_cpw-smo_insF_cpw; % ####### #######
    dev_insF_cpw = smoothdata(res_insF_cpw.^2, 'rloess', 0.03*NSF);
    % dev_insF_cpw = smooth(res_insF_cpw.^2,0.03*NSF,'rloess');
    std_insF_cpw = abs(sqrt(dev_insF_cpw));
    figure('name','Frequencie and energy pulse wave'); clf;
    sp1 = subplot(2,1,1); plot(tim(1:NSF),insF_cpw); hold on;
    plot(tim(1:NSF),smo_insF_cpw,'Color','r','LineWidth',0.8);
 hold on;
    % plot(tim(1:NSF),std_insF_cpw);
    xlabel("t,s",'interp','none'); ylabel("insF,Hz",'interp','none');
    grid on; title(sp1,'########## ####### cpw'); ylim([1.0 3.0]);
    sp2 = subplot(2,1,2); plot(tim(1:NSF),insE_cpw.^2);
    xlabel("t,s",'interp','none'); ylabel("insE^2",'interp','none');
    grid on; title(sp2,'########## ####### cpw');
    save(Path+Name+"_nc"+".mat");

end
```

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