Asignment 3

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1 Problem 1

An adaptive filter has been found with LMS algorithm:

```

load assignment3problem1data1
d = assignment3problem1data1 ; % mother and baby
load assignment3problem1data2
x = assignment3problem1data2 ;  % mother
load assignment3problem1data3
t = assignment3problem1data3 ; %timestamps
load assignment3problem1data4
T = assignment3problem1data4 ;

[r, L] = size(t);

% filter coefficients
mu          =  2^(-8) ;  % (-), LMS adaptation constant
Npoints_w   =  2^6 ;  % (-), number of points in w
w = zeros(1, Npoints_w);
xn   =  zeros(1,Npoints_w) ;
% LMS algorithm
for i   =  1 : length(x) ,
    if   ( 1 <= (i) )   &&  ( (i) <= length(x) )   ,
        xn   =  [ x(i)  xn( 1 : (Npoints_w-1) ) ] ;
        u1   =  w * (xn .') ;
        e1   =  d(i) - u1 ;
        e(i) = e1 ;
        w    =   w  +  mu * e1 * xn ;
    end
end

%estimate BPM
last_i = 1;
delta_t = [];
for i = 2:length(x)-1
    if x(i) > max(x)/2
        if x(i) > x(i-1) && x(i) > x(i+1)
            delta_t = [delta_t (t(i) - t(last_i))];
```

```
            last_i = i;
        end
    end
end
BPM_mother = 60/mean(delta_t)

% for baby
last_i = 1;
delta_t = [];
for i = 2:length(e)-1
    if e(i) > max(e)/2
        if e(i) > e(i-1) && e(i) > e(i+1)
            delta_t = [delta_t (t(i) - t(last_i))];
            last_i = i;
        end
    end
end
BPM_bay = 60/mean(delta_t)
%plots
clf
subplot(311)
plot(t, x);
title('mother')
subplot(312)
plot(t, d);
title('mother and baby')
subplot(313)
plot(t, e);
title('baby estimated')

figure
stem(w)
```

Listing 1: Code for Problem 1

1.1 Mother's BPM

The results for the mother's BPM are 69.276 beats per minute.

1.2 Baby's BPM estimation

with the following results: a plot of the three waveforms can be seen in Fig 3 and the filter coefficients in Fig 7

however, the result for the estimated BPM are exactly the same, hence, the adaptive filter used is not filtering out the mothers signal effectively.

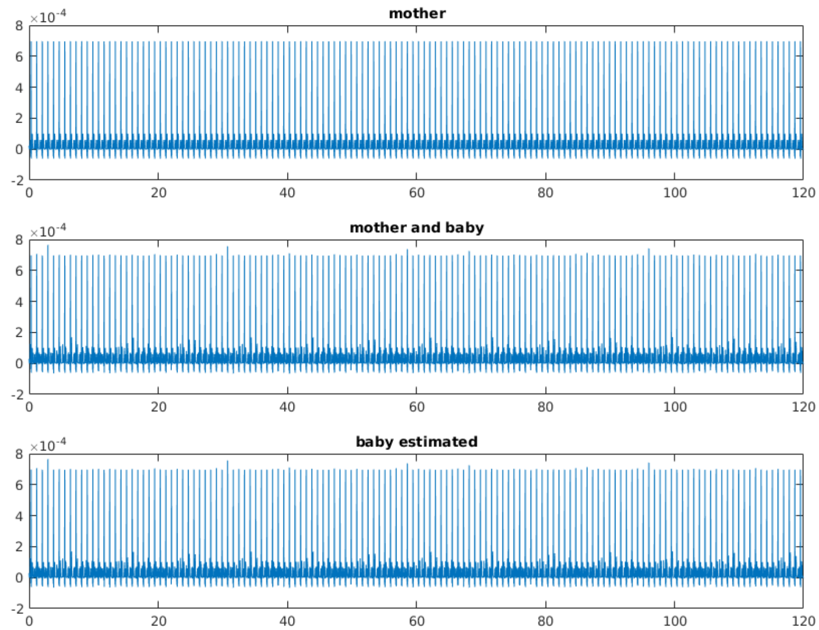

Figure 1: plots for heart beat estimation

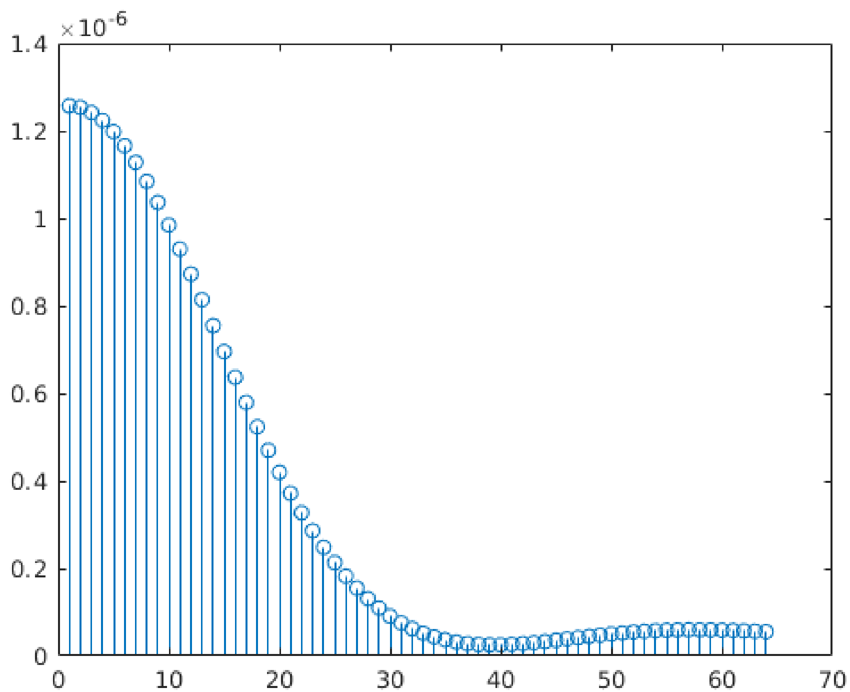

Figure 2: W filter coefficients

2 Problem 2

2.1 a

The channel is given by: `h = [1 0 0 0]`.

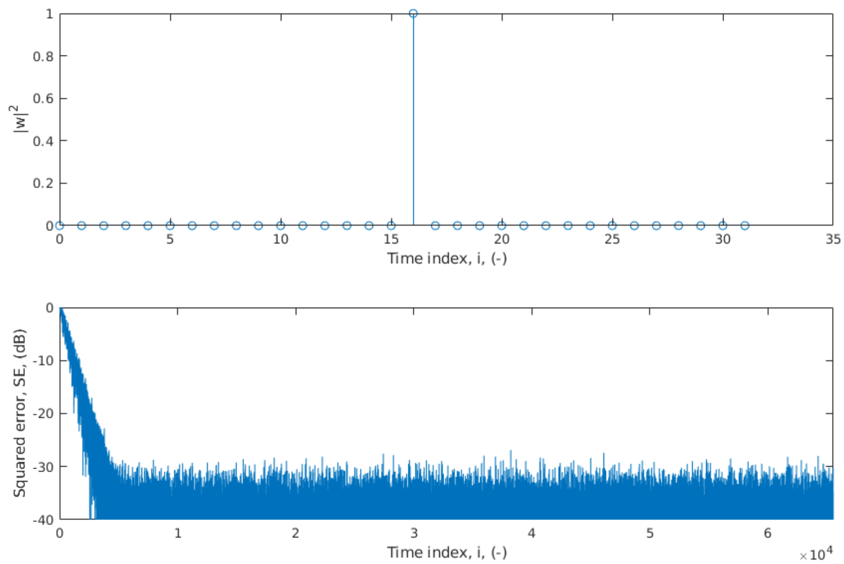

Figure 3: plots for h = [1 0 0 0]

2.2 b

The channel is given by: `h = [0 1 0 0]`.

The equalizer coefficients have been **shifted** one position to the left due to the corresponding shift in the channel filter.

2.3 c

The channel is given by: `h = [1 0.5 0.3 0.2]`.

after $\underline{w}$ converged, the convolution $\underline{h} * \underline{w}$ can be seen in Fig 6.

whit this result it is reasonable to conclude that the equalizer **has undone** the channel distortion.

2.4 d

The channel is given by: `h = [1 1 0 0]`.

after $\underline{w}$ converged, the convolution $\underline{h} * \underline{w}$ can be seen in Fig 8.

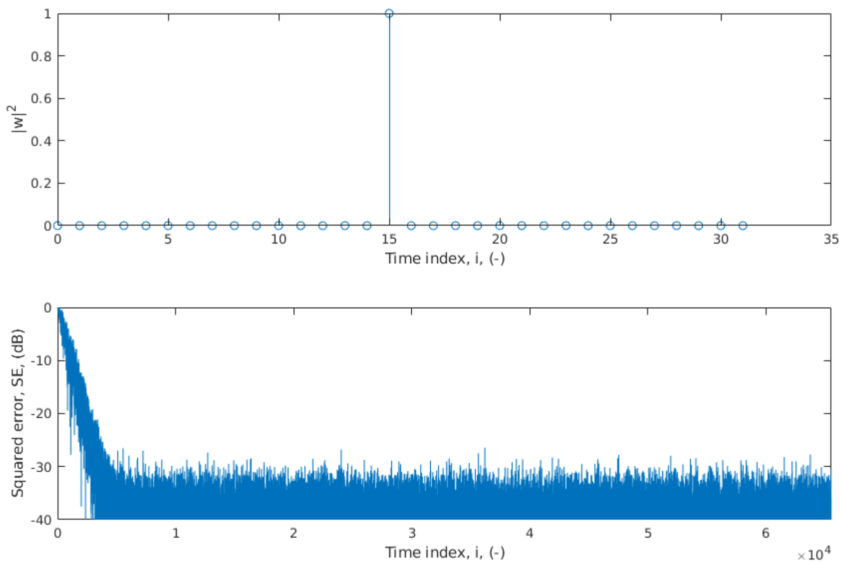

Figure 4: plots for h = [0 1 0 0]

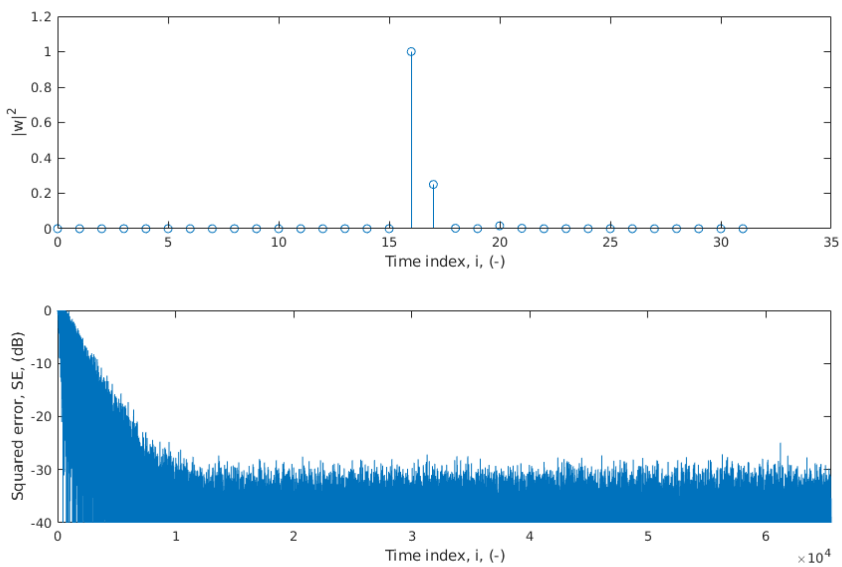

Figure 5: plots for h = [1 0.5 0.3 0.2]

2.5 e

In time-domain, the adaptive filter cannot undo the distortion because our channel, $\underline{h}$ is a combination of two equally weighted samples. This means, as the noise is a random process, this two samples will have different values

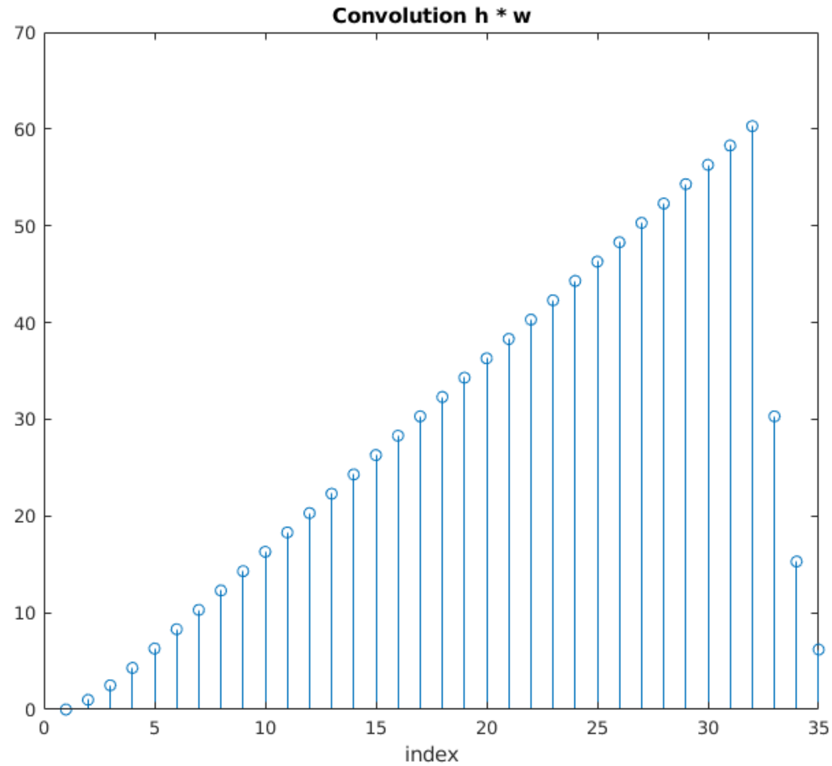

Figure 6: convolution result

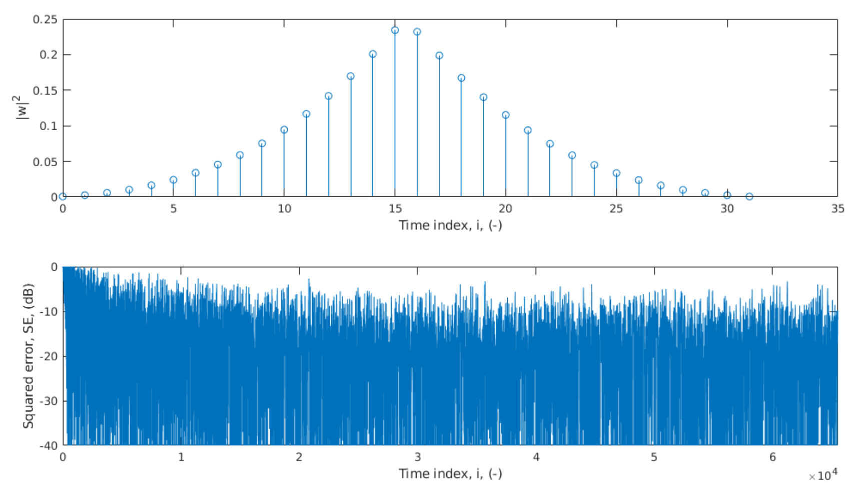

Figure 7: plots for h = [1 1 0 0]

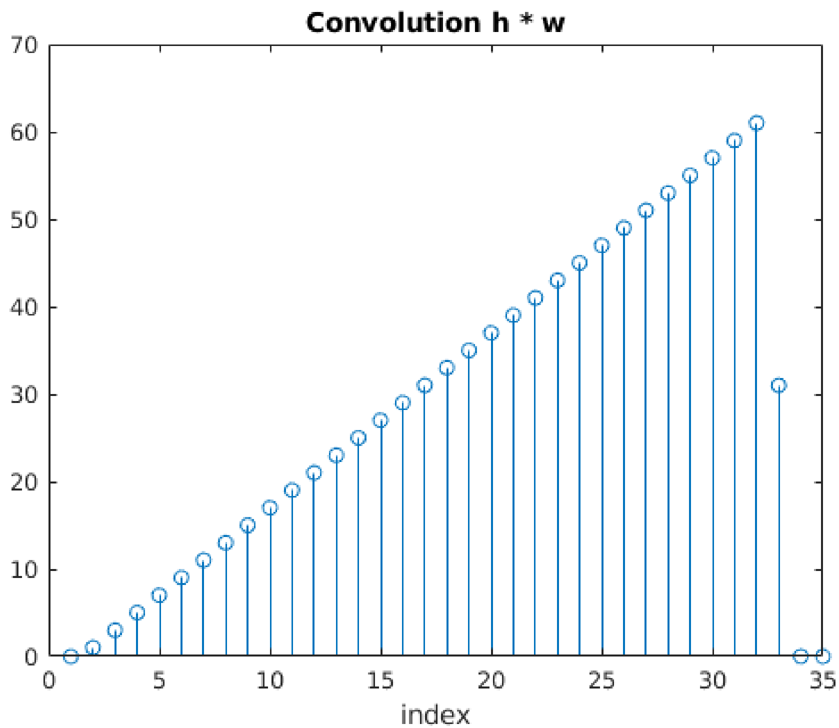

Figure 8: convolution result