Adaptive Echo Cancellation

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Aim: To remove Echo from the given voice signal.

Software used: Matlab

Theory:

Echo cancellation is a method used in telephony and telecommunication to improve voice quality by preventing echos from being captured or created, or possibly removing it in post-processing. The aim is to filter the echo that is either produced by acoustic means or a hybrid echo produced by line echo, electrical reflections or impedance mismatch.

Echo cancellation aims to remove the echo that is heard when talking on the phone, either via landline or digital communication such as VoIP. The echo is one's own voice being transmitted back from the other end due to various reasons. Echo can be very disruptive to a conversation; it can impair call quality and even increase used bandwidth. This is because more data gets transmitted because of additional sound information that has to be processed, and even when the transmission is supposed to be one way because only one person is talking and transmitting, echo from the other end causes the listener to also transmit the echo and additional static. A process called “silence suppression” is used to prevent this.

Types of echo and how they are cancelled:

- Acoustic echo – This occurs on the listener’s end when the microphone picks up the sound coming from the speakers which the one talking hears on the other end as echo. This is often the result of a very sensitive microphone, loud speakers or sound reflection from walls, especially in a confined space. To prevent this, a special microphone with very narrow pickup directions can be used. These microphones will only pick up sound directly in front of it and will usually not be able to pick up sounds coming from other directions, resulting in less echo. The speakers could also be turned down or headphones can be used.
- Hybrid echo – This is the result of the conversion from a two-wire system, which is the case for customer premises, to a four-wire system in the telco’s PBX office. The conversion from two to four wires does not usually perform good impedance matching, resulting in echo. To cancel the echo, proper impedance matching or an echo cancellation engine can be used, or a circuit that reads the original signal and then cancels any signal that is very similar to it following shortly after is utilized.

Program:-

```
clc
clear all
close all
tts('Welcome to LMS based Echo Cancellation Technique');
pause(1);
[x,Fs] =audioread('final.wav');
 sound(x,Fs);
   pause(2);
tts('Here is the Original input signal');
pause(1);
 t=0:1/Fs:(length(x)-1)/Fs;
  subplot(4,1,1);
  plot(t,x,'b');
  title('original signal')

 snr=4;

for i=1:5000
    for j=1:2
        k=zeros(i,j);
    end
end
y=[k;x]
```

```
   %sound(y,Fs);
   subplot(4,1,2)
   plot(y,'b')

   for i=1:10000
    for j=1:2
        l=zeros(i,j);
    end
end

   y1=[l;x]
   %sound(y1,Fs);
   subplot(4,1,3)
   plot(y1,'b')

   for i=1:20000
    for j=1:2
        m=zeros(i,j);
    end
end
   y2=[m;x]
   %sound(y2,Fs);
   subplot(4,1,4)
   plot(y2,'b')
   [rx cx]=size(x);
```

```
[ry cy]=size(y);
[ry1 cy1]=size(y1);
[ry2 cy2]=size(y2);

for i=1:ry2-rx
 for j=1:2
    x_z=zeros(i,j);
 end
end
  for i=1:ry2-ry
 for j=1:2
    y_z=zeros(i,j);
 end
end

   for i=1:ry2-ry1
 for j=1:2
    y1_z=zeros(i,j);
 end
end

x=[x;x_z];
y=[y;y_z];
y1=[y1;y1_z];
```

```
   for i=10000:ry2
    for j=1:cy2
        y3(i,j)=x(i,j)+y(i,j)+y1(i,j)+y2(i,j);
    end
end
 pause(1);


   sound(y3,Fs);
   figure, plot(y3,'b')
   title('original+echo');
    pause(1);
   tts('Generated Echo input signal');
pause(2);



   d =x;
mu=0.05;
 for i=1:ry2
    for j=1:2
        w=zeros(i,j);
    end
 end
   for i=1:ry2
    for j=1:2
    % predict next sample and error
```

```
    y_op(i,j) = w(i,j)'*y3(i,j);
    e(i,j)  = d(i,j) - y3(i,j);
    % adapt weight matrix and step size
    w(i,j) = w(i,j) + mu y3(i,j)conj(e(i,j));
    end
   end
    for i=1:ry2
    for j=1:2
    y4(i,j) = w(i,j)'*y3(i,j);
    end
    end
     pause(1);
   sound(y4,Fs);
   figure, plot(y4,'b')
   title('Recovered Output');
   tts('Here is the Signal after Echo Cancellation');
pause(2);
```

Output:-

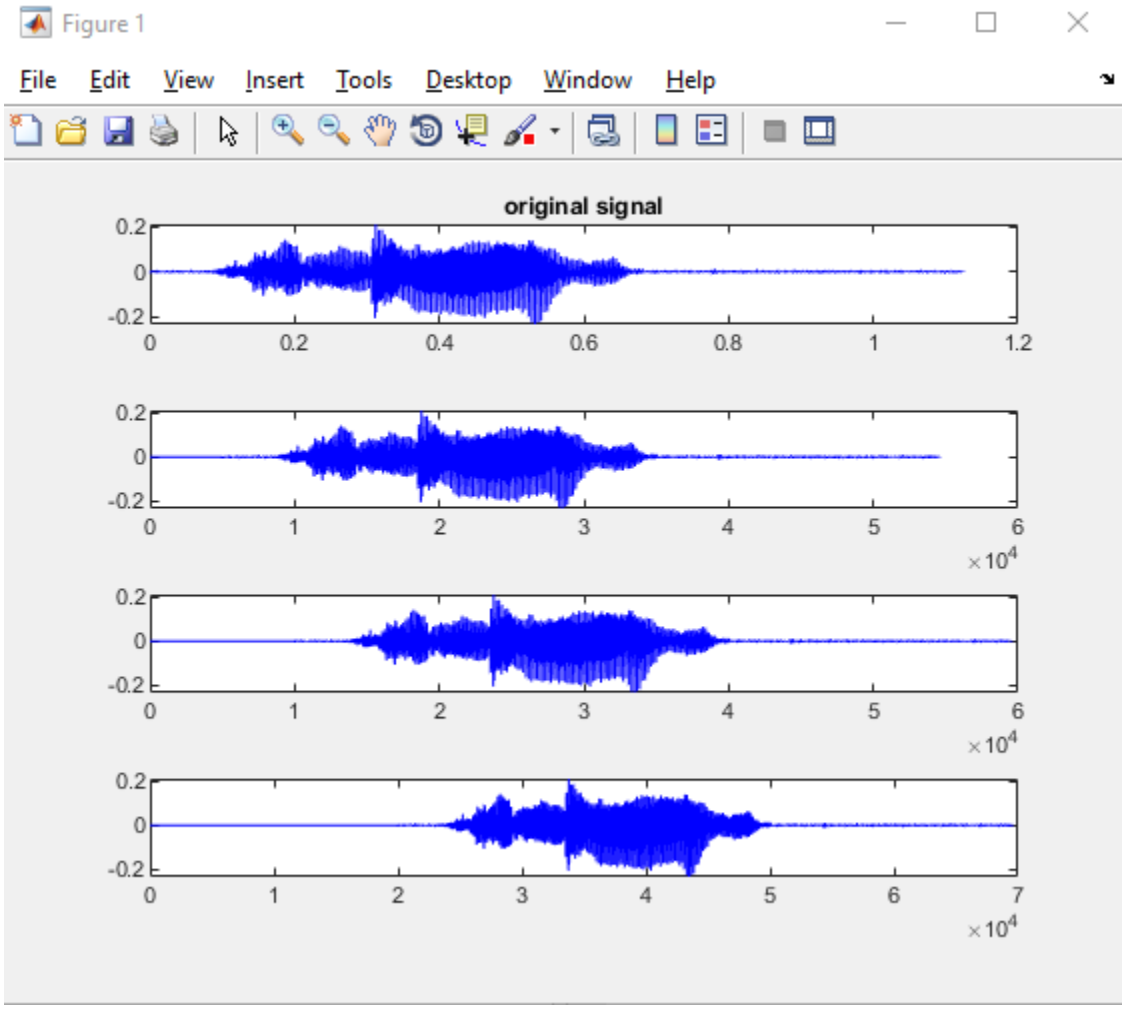


Figure 1
File Edit View Insert Tools Desktop Window Help
original signal
0.2
0
-0.2
0 0.2 0.4 0.6 0.8 1 1.2
0 1 2 3 4 5 6
×10^4
0 1 2 3 4 5 6
×10^4
0 1 2 3 4 5 6 7
×10^4

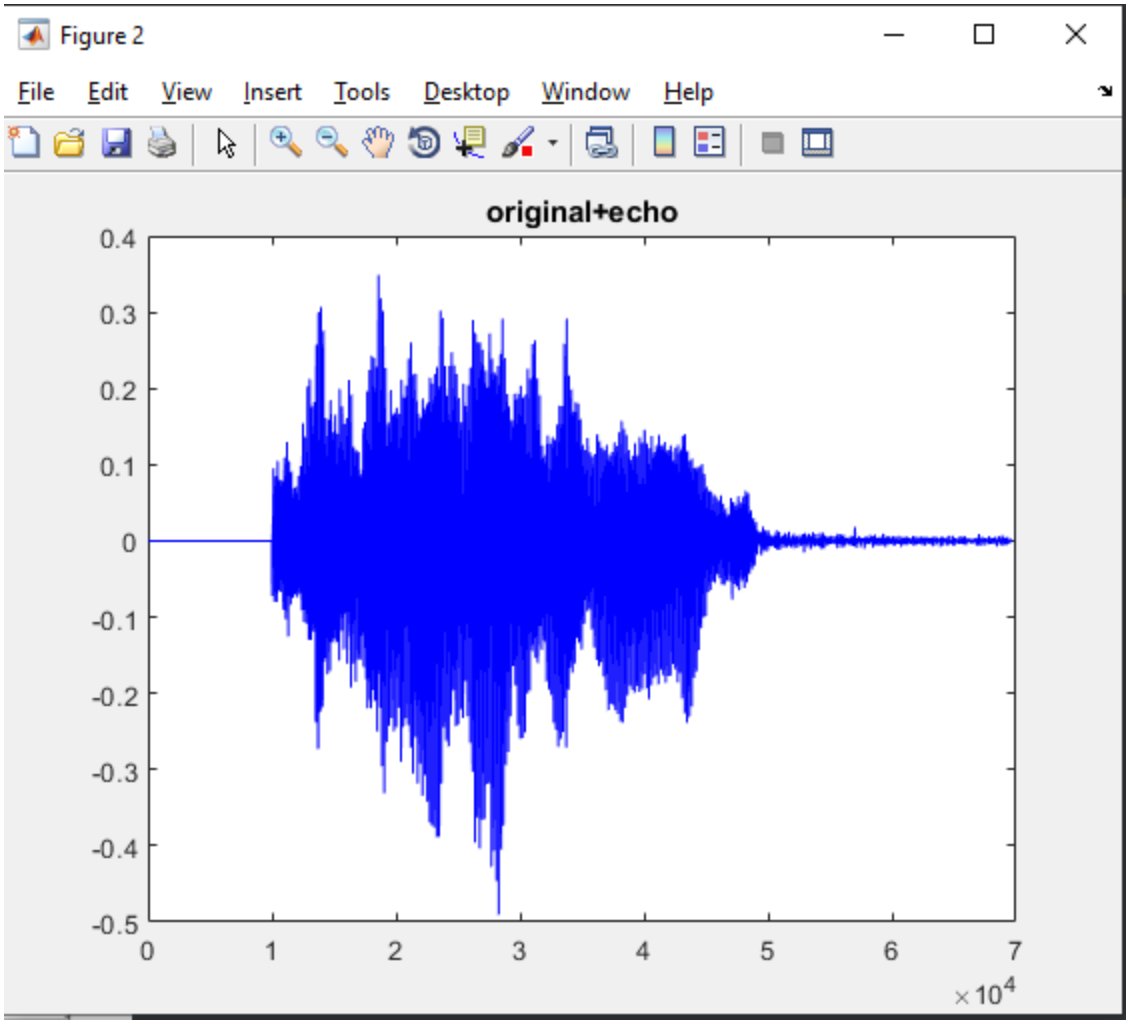
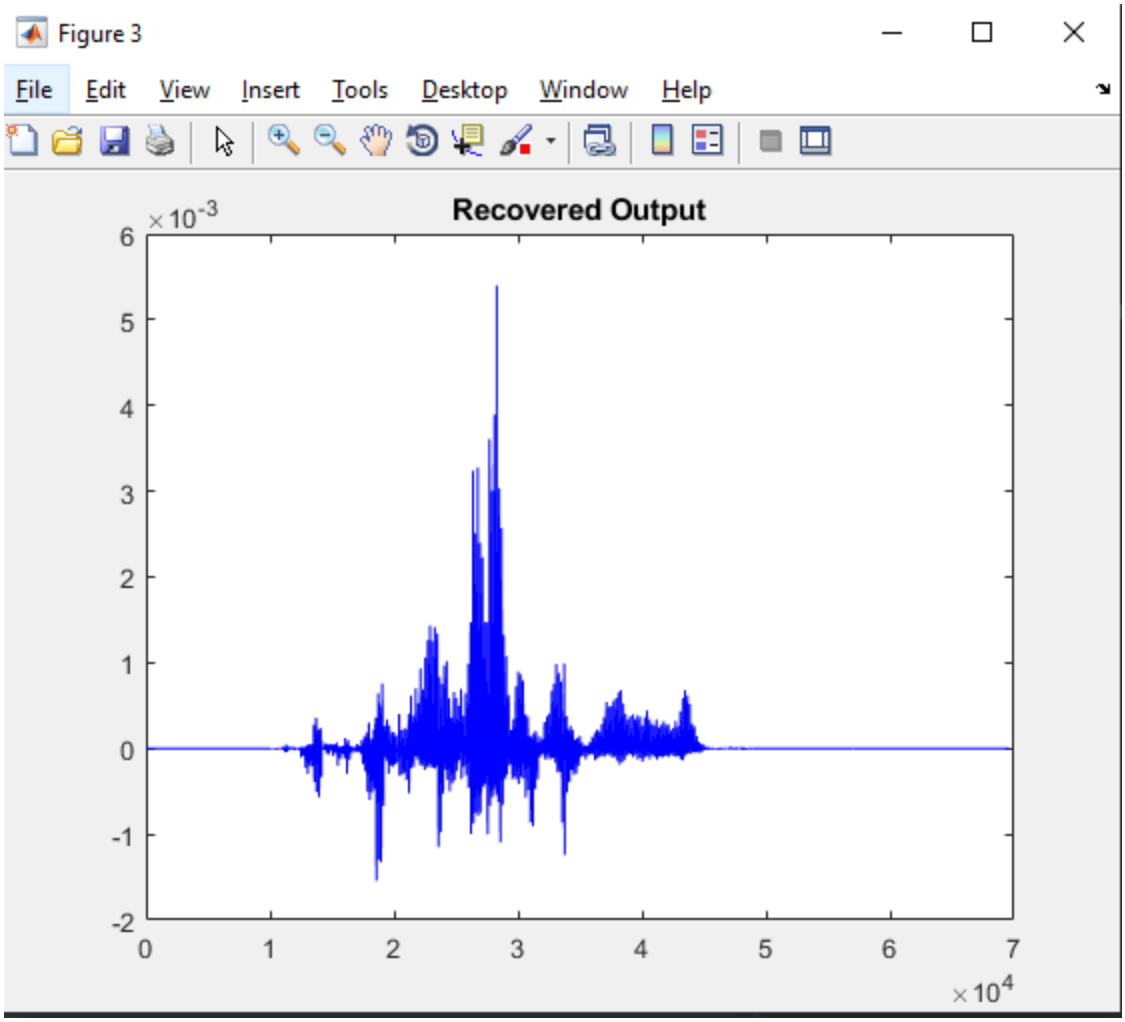


Figure 2
File Edit View Insert Tools Desktop Window Help
original+echo
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0 1 2 3 4 5 6 7
×10^4



Conclusion:- Speaker phones, conferencing devices & wireless audio are gaining popularity due to their innovative features & immersive sound quality. Acoustic echo cancellation is a well-known concept behind getting the smooth and flawless voice quality. Acoustic echo cancellation removes the echo, reverberation and unwanted noise caused by acoustic coupling between the microphone and loudspeaker. Hence Echo is removed from the signal using MATLAB.