Experiment 14
Detection of Pitch Period

Aim

To find the pitch period of a speech signal using correlation.

Theory

Physical Significance of Pitch Period

The pitch period is the fundamental frequency of vibrations of the vocal cords which depends on the length of vocal cords. The vocal cords form a sort of tuning fork. This is a periodic excitation given to the vocal tract filter which generates the speech output. The speech signal consists of voiced part and unvoiced part. The voice part of the utterance contains the voicing information. Unvoiced part is a random signal and has no periodicity. We have to use voiced part of the utterance to find the pitch period.

Experiment

MATLAB code uses one ".wav" file recorded using a sound recorder facility. The reader is encouraged to record a speech file for himself/herself and use it for the experiment. We can plot the file and see where the voiced part of the utterance is. The voiced part has more energy and we can see repetition of the waveform as is clear from the waveform of the signal plotted in Figure 1. The reader is required to select the offset using visual inspection of the file on the screen and use this offset in the "fseek" command. The voiced part has a pitch period that is a certain period in terms of number of samples after which the waveform is found to repeat.

The waveform is pseudo-periodic in the sense that the period does not remain exactly constant but is more or less constant. The correlation is found in the program which is plotted in the output and it shows that correlation is also periodic with period of about 135 samples. The interval between two successive maxima of the correlation gives the pitch period. It is in terms of number of samples. The unvoiced part of utterance has no repetition.

Teaser *The reader is required to write a MATLAB program to find the local maximum of the correlation function and track the distance between the two successive maxima to find the pitch period in terms of number of samples.*

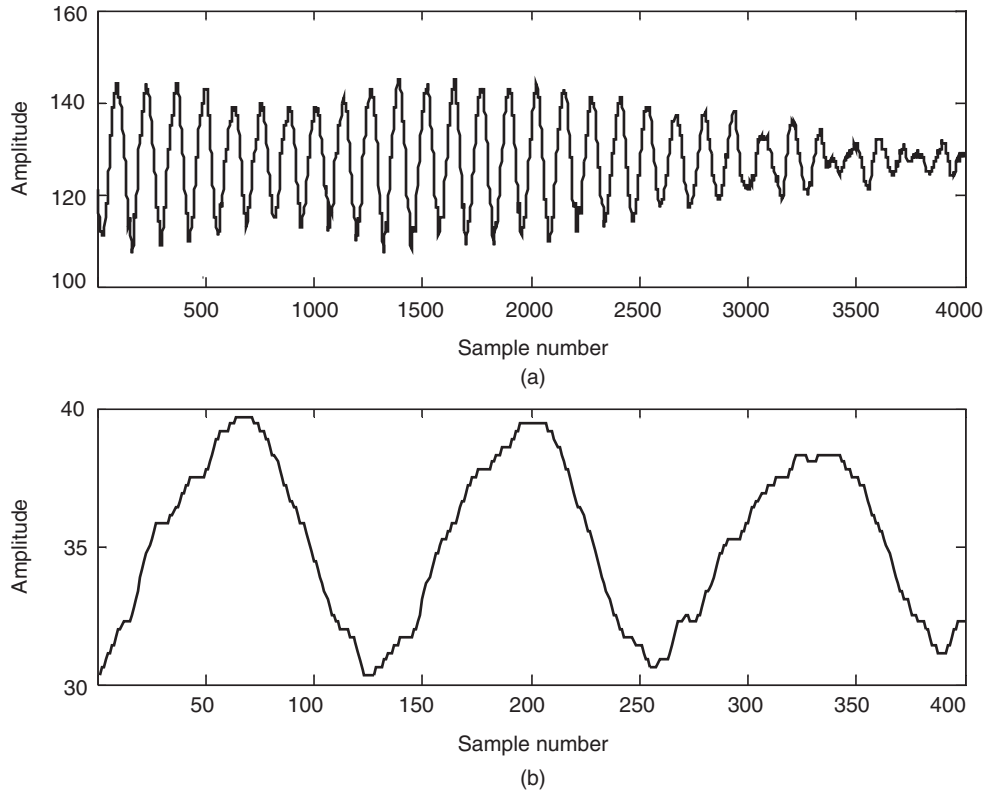

Figure 1 (a) Plot of voiced part of a signal; (b) plot of correlation of a signal.

Note: The reader is familiar with the term correlation in communication and signals and system. To find the correlation, we have to write a program similar to calculation of convolution, except that first step of calculating the time-reversed sequence in convolution, is to be omitted here for correlation.

The MATLAB program is as follows.

```
%to find pitch period of the signal
clear all;
fp=fopen('watermark.wav');
fseek(fp,8000,-1);
a=fread(fp,4000);
subplot(2,1,1);plot(a);title('plot of voiced part of a
signal');
xlabel('sample no.');ylabel('amplitude');
for k=1:400,
    sum(k)=0;
end
```

```
for k=1:400,
for i=1:300,
    sum(k)=sum(k)+abs(a(i)*a(i+k));
       sum(k)=sum(k)/400;
end
end
subplot(2,1,2);plot(sum);title('plot of correlation of a
signal');
xlabel('sample no.');ylabel('correlation');
```

Result of Execution of MATLAB Code

The result of execution of a MATLAB program is shown in Figure 1. Here it is found that the pitch period is 135 samples. The autocorrelation is found to be maximum at 65th and 200th sample. The difference between the two maximums is $200 - 65 = 135$ samples. The next segment has pitch period of 134 samples. We see that the pitch period is not exactly constant but it is closer. The speech waveform is said to be pseudo-periodic.