International Institute of Information Technology
Bangalore

Principles of Communication Systems Lab
ECE 303P

Time Division Multiplexing

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Introduction

Time Division Multiplexing is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. This method transmits two or more digital signals or analog signals over a common channel.

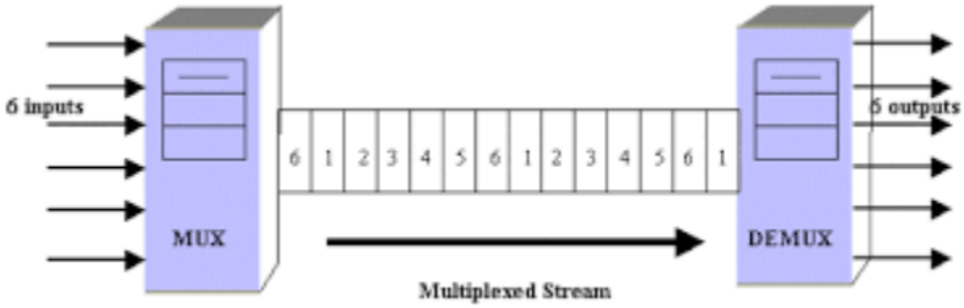

Figure 1: Time Division Multiplexing

1. Consider any two or more signals of your choice which may be sinusoidal, rectangular, triangular, ramp etc..
2. Transmit those signals using TDM technique.
3. At the receiver, Demultiplex those into seperate signals.The samples from each channel are filtered to reproduce the original message signal.

Method

Before beginning the implementation, we consider the following two sets of signals. The first set is a set of five ideal signals. The second set of signals is generated from three audio files. We use these signals as inputs to study and analyze time division multiplexing.

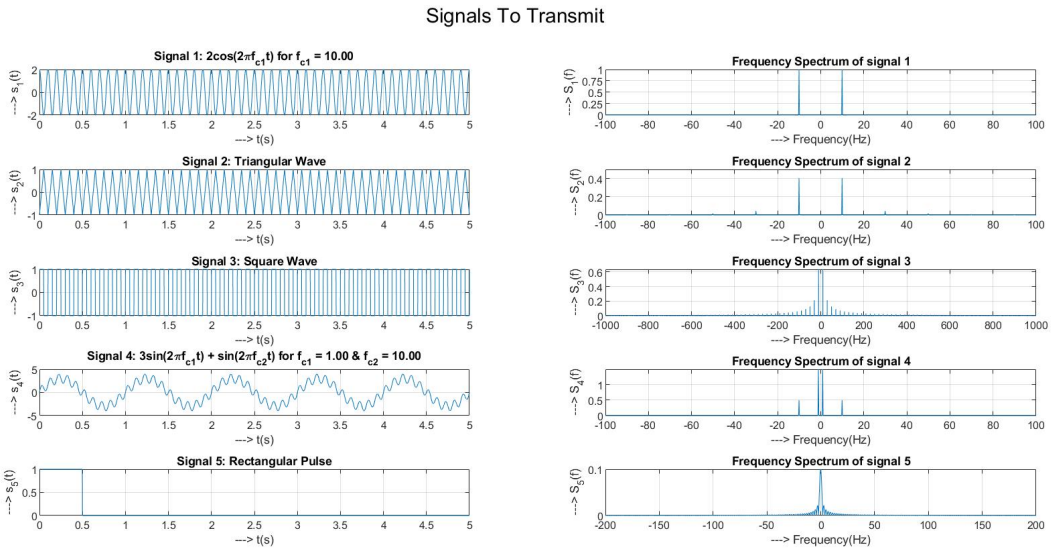

Figure 2: Input Signals

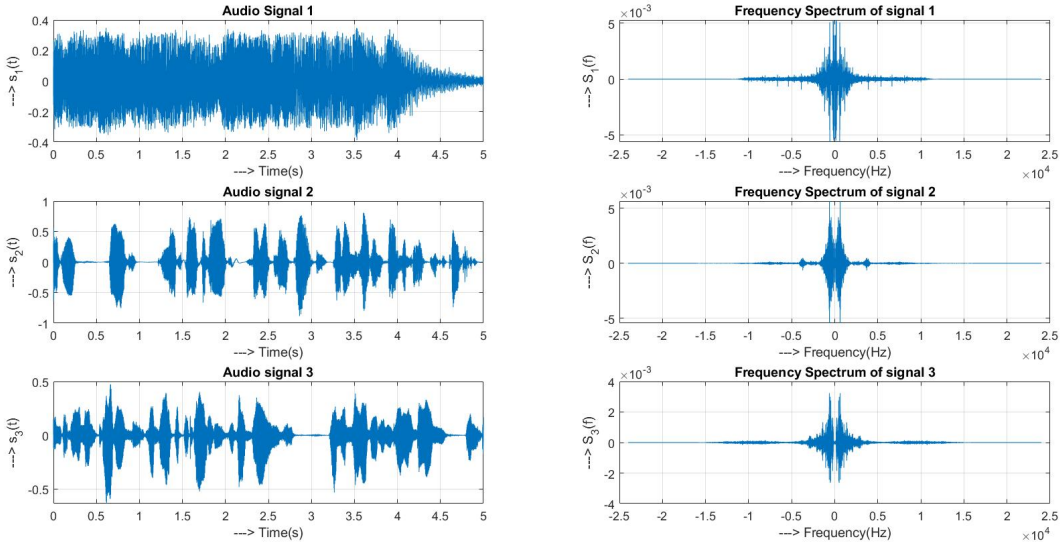

Figure 3: Input Audio Signals

The function used for time division multiplexing and demultiplexing the signals are as follows:

```
%FUNCTION FOR MULTIPLEXING THE SIGNALS
function [trans, transtime] = transmitterCommutator(crt, signals, noOfSig, time)
    trans = [];                     %Transmission signal
    transtime = [];                 %Time for transmission
    j = 1;                          %Current signal index
    delT = crt/noOfSig;             %Switching time
    T = 0;                          %T keeps track of time to switch
    k = 1;
    for i=1:length(time)
        if(time(i) ≥ T)
            trans(k) = signals(j ,i);
            transtime(k) = T;
            T = T + delT;
            k = k + 1;
            j = j + 1;
            if(j > noOfSig)
                j = 1;
            end
        end
    end
end

%FUNCTION FOR DEMULTIPLEXING THE SIGNALS
function [decoded, timestamps] = demultiplexer(crt, transmission, noOfSig, time)
    for j = 1:noOfSig
        i = 1;
        while (j+noOfSig*(i-1)) ≤ length(transmission)
            decoded(j, i) = transmission(j+(noOfSig*(i-1)));
            timestamps(j, i) = time(j+(noOfSig*(i-1)));
            i = i + 1;
        end
    end
end
```

Results and Analysis

The ideal signals with commutator rotation time of 1 ms

First we band limit the signals by passing the signals through low pass filter. The band limited signals are shown below:

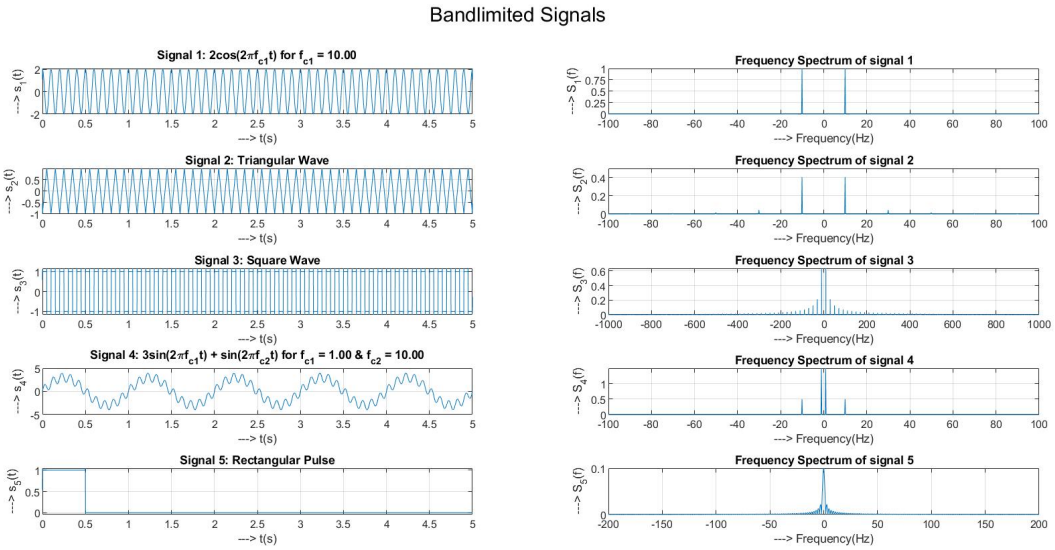

Figure 4: The Bandlimited signals

On multiplexing, we get the following transmission signal:

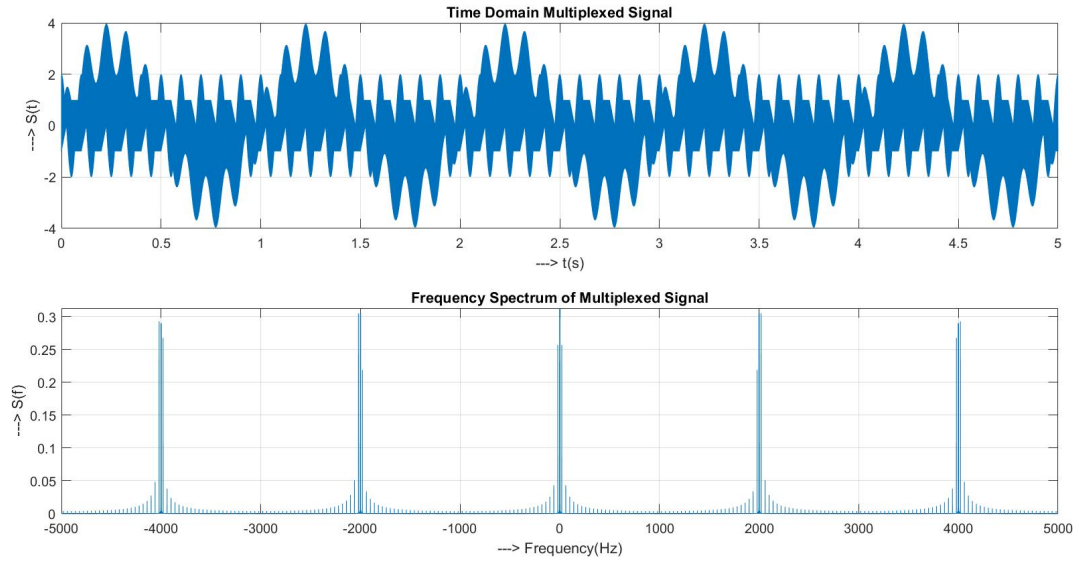

Figure 5: The transmission signal

We can visualize the input signals in the transmission signal as shown below:

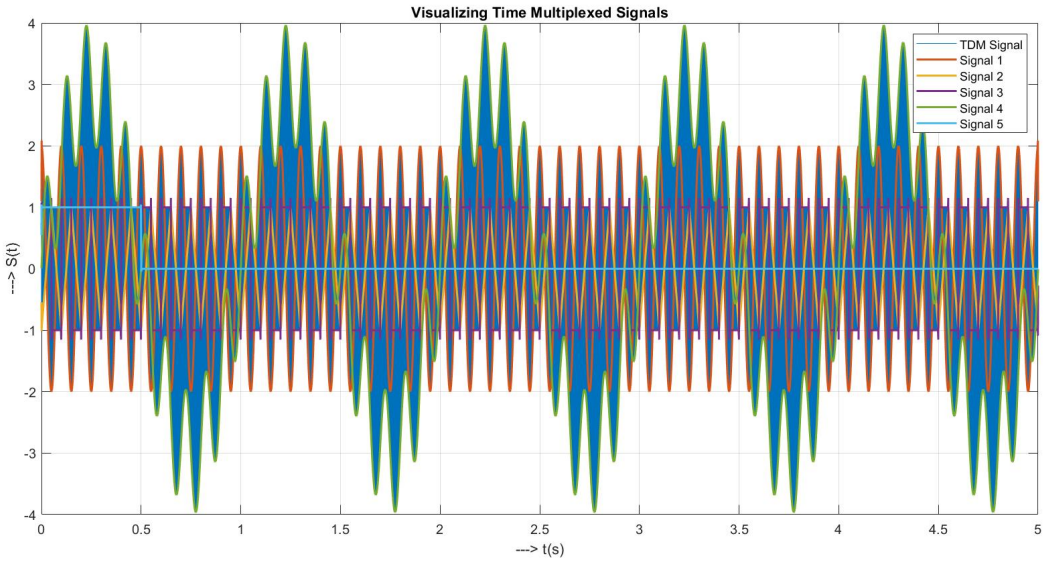

Figure 6: Visualisation of the transmission signal

The demultiplexed signals are shown below. We see that we have successfully demultiplexed the signal.

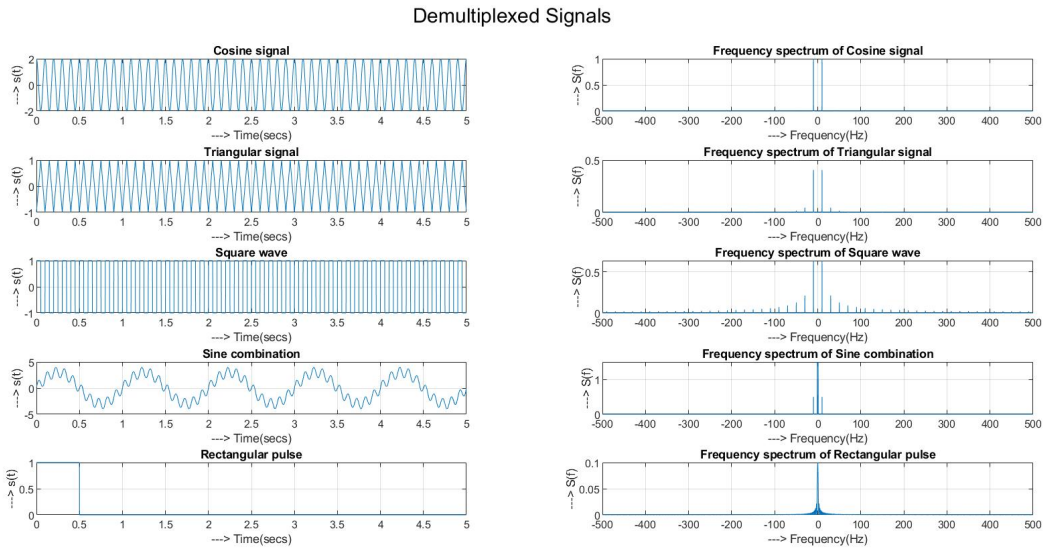

Figure 7: Demultiplexed signals

Ideal signals with commutator rotation time of 0.1 seconds

The transmission signal for commutator rotation time of 0.1 seconds is shown below:

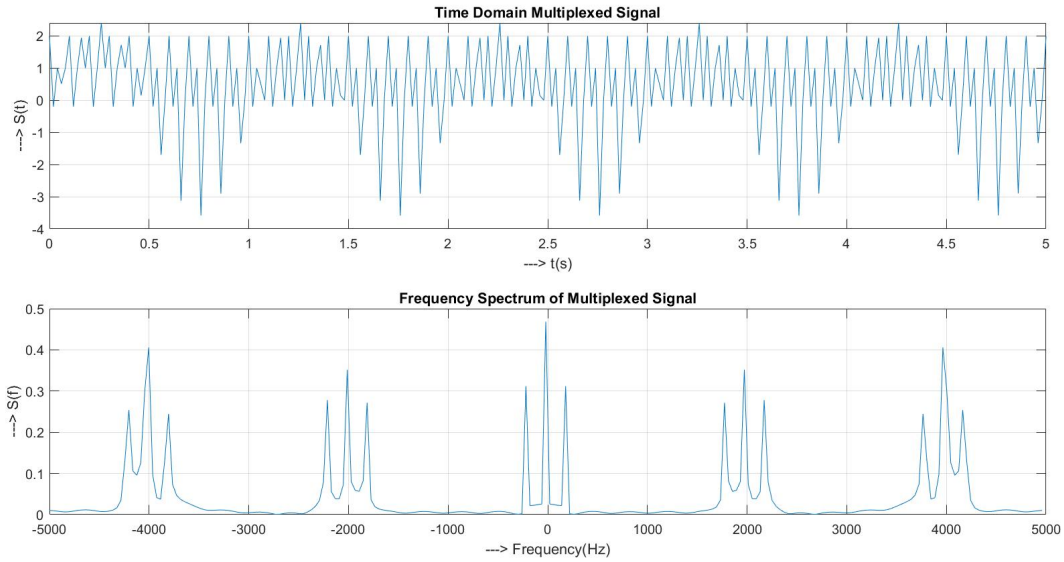

Figure 8: The transmission signal

The demultiplexed signals are shown below. Here, we see that the demultiplexed signals are different from the expected output. This is because the commutator rotation time is too large. Hence, we see that if the commutator rotation time becomes large, we cannot demultiplex the time domain multiplexed signals.

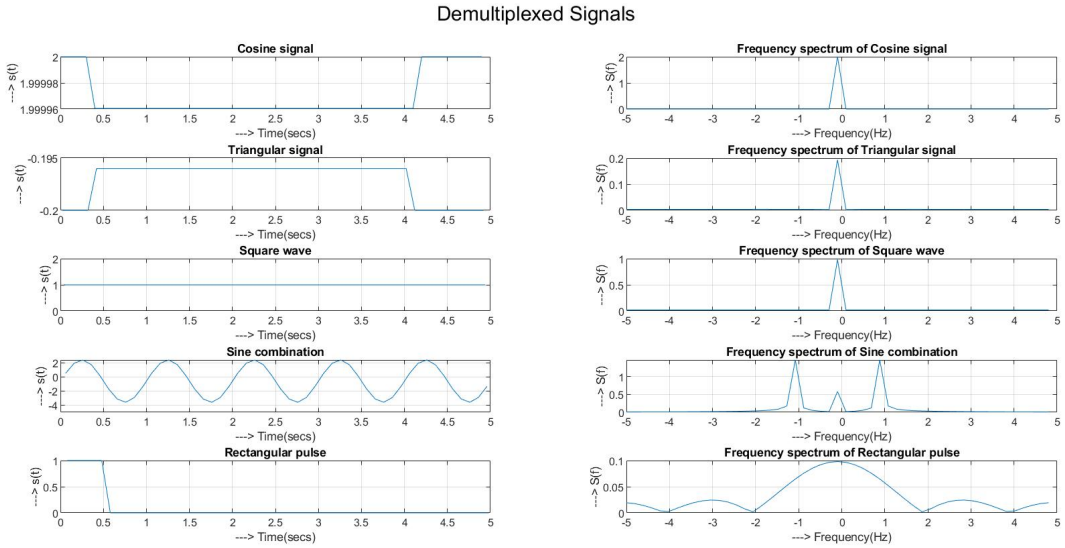

Figure 9: Demultiplexed signals

Signal with white gaussian noise(SNR=30)

Here, we add noise to the transmission signal. The signal to noise ratio is 30. Since the Signal to ratio is large enough, we are able to demultiplex the signal successfully without losing much information.

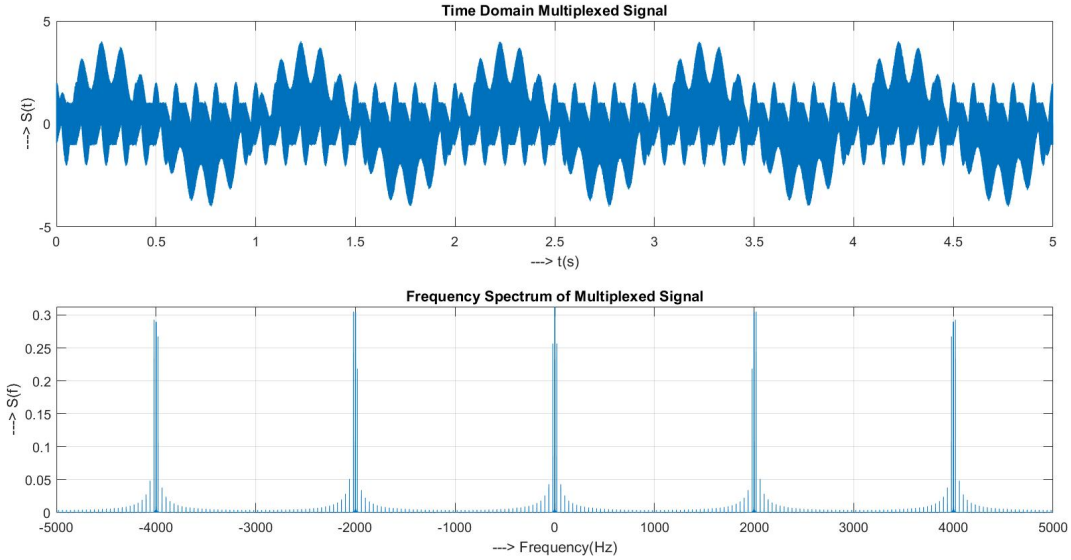

Figure 10: The transmission signal

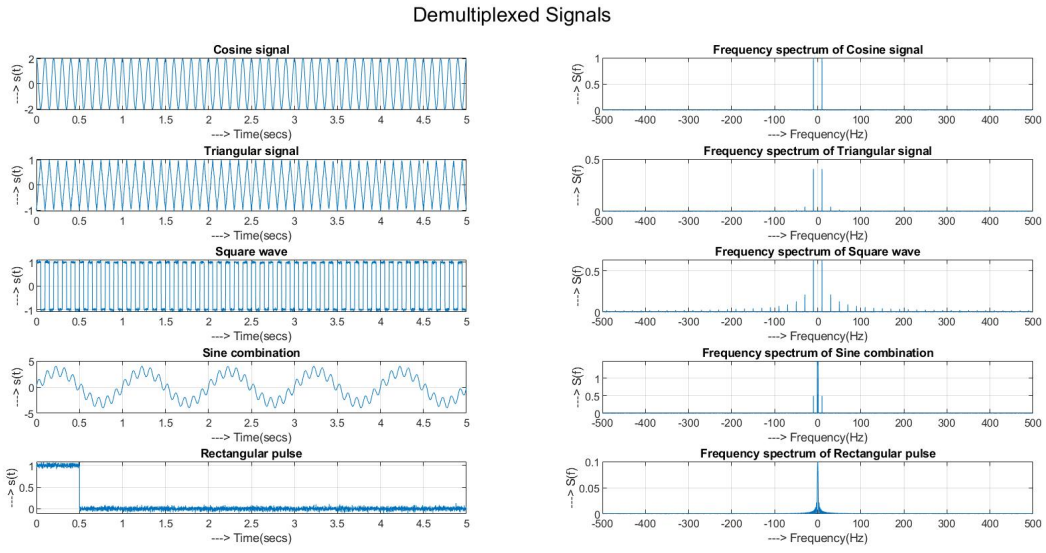

Figure 11: Demultiplexed signals

Signal with white gaussian noise(SNR=10)

Here, we add noise to the signal with signal to noise ratio of 10. Since the signal to noise ratio is small, the demultiplexed signal is much distorted.

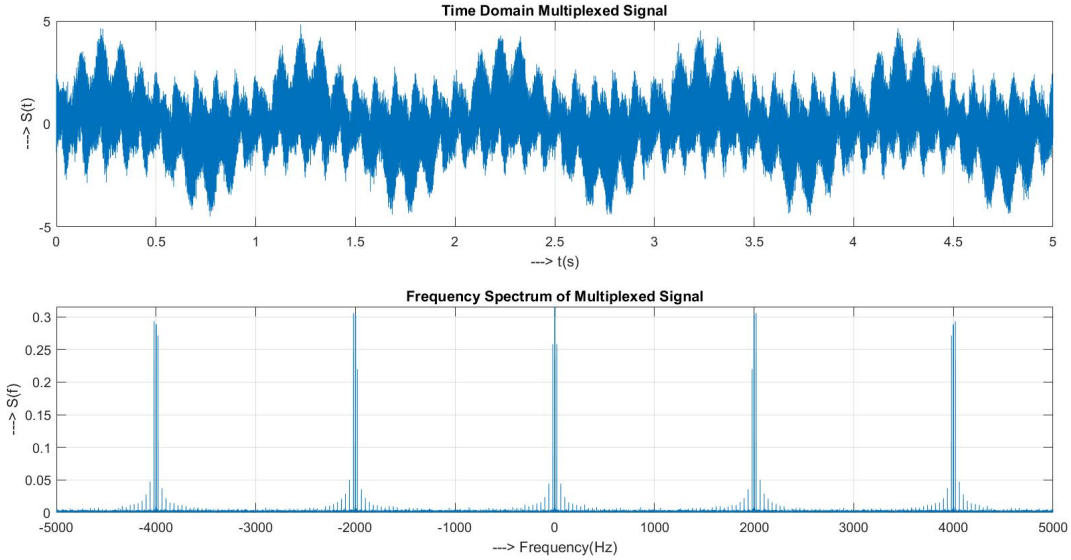

Figure 12: The transmission signal

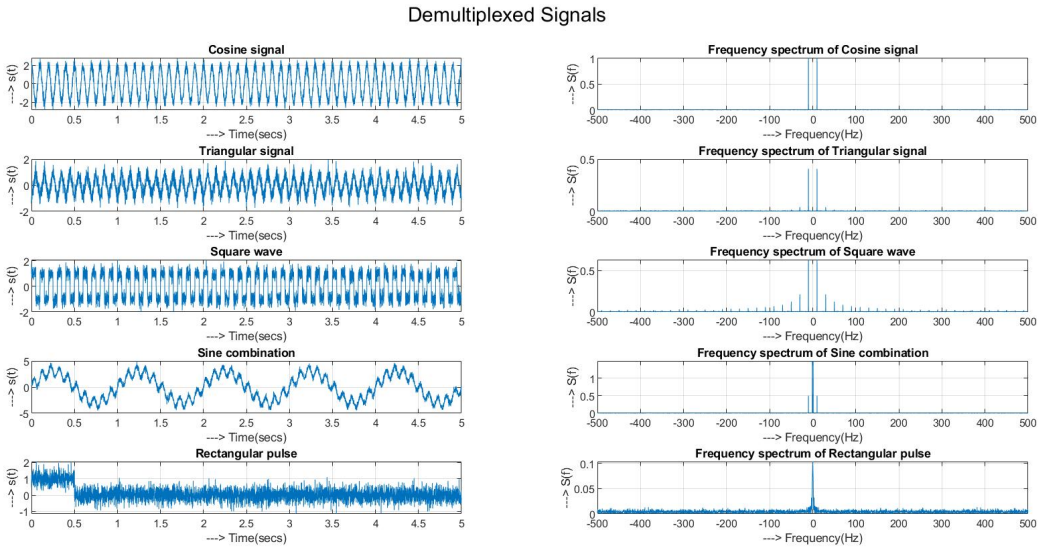

Figure 13: Demultiplexed signals

Asynchronous commutator

Here, we experiment with the commutator rotation time of receiver module. The given demutiplexed signals are obtained when the commutator rotation time of transmission module is 1 ms and the commutator rotation time of receiver module is 2 ms.

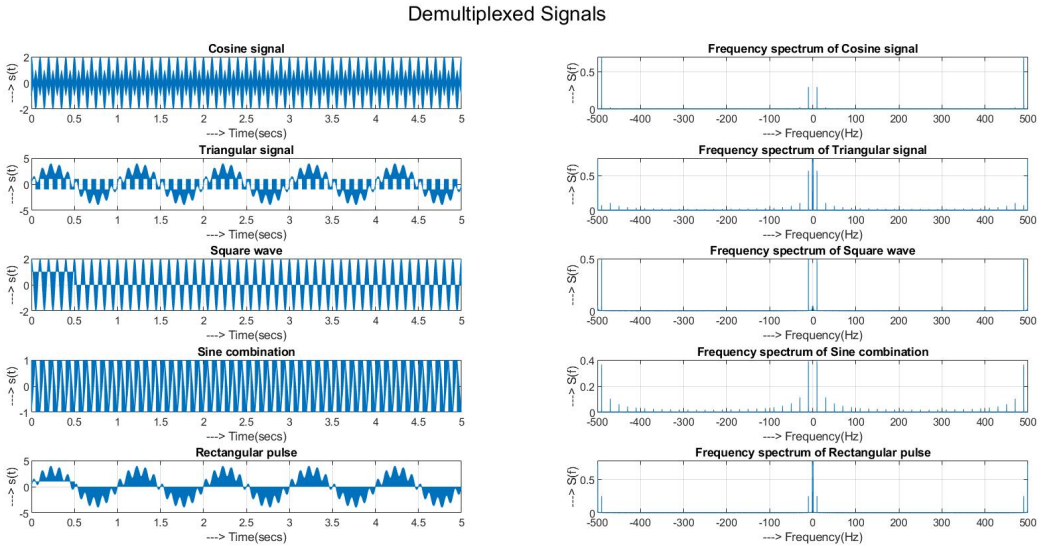

Figure 14: Demultiplexed signals

Working with real audio signals

The transmission signal and the demultiplexed signals are shown below. We see that we have successfully demodulated the transmission signal and the demultiplexed signals are identical to the transmitted signals.

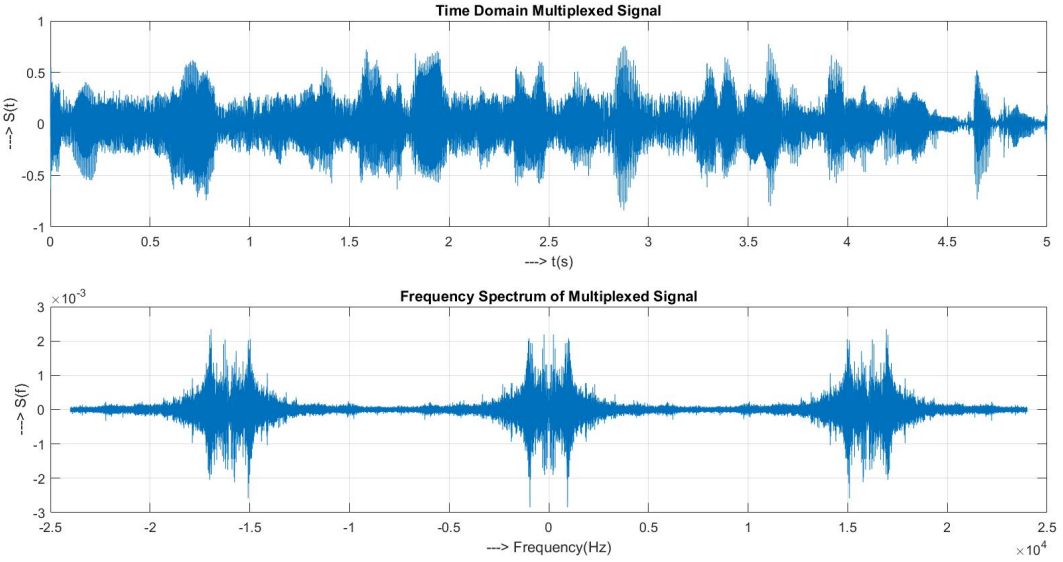

Figure 15: The transmission signal

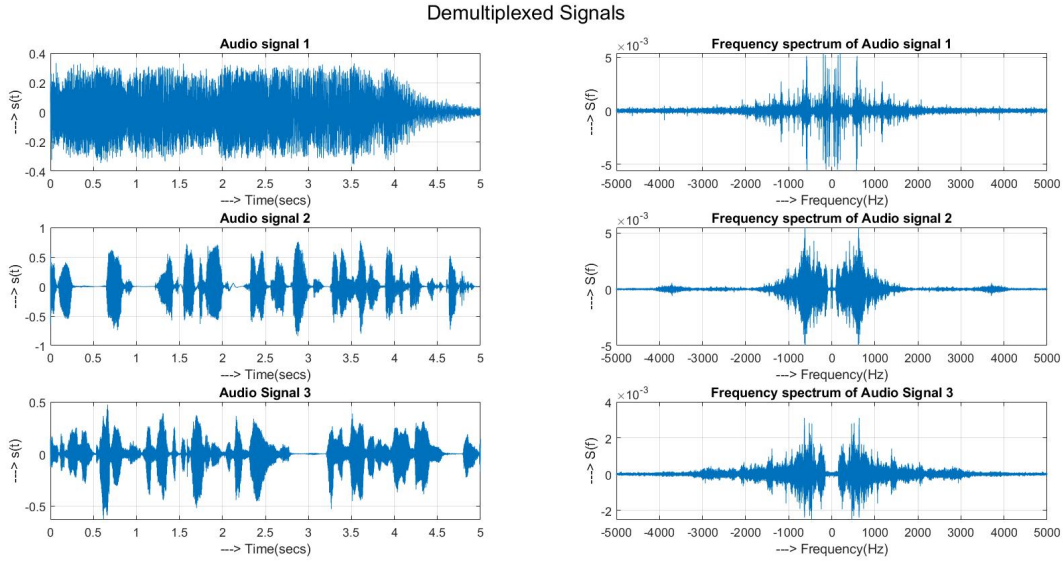

Figure 16: The demultiplexed signal

Audio Error with White gaussian noise(SNR = 30)

The original signals, the transmitted signal and the demultiplexed signal is shown below:

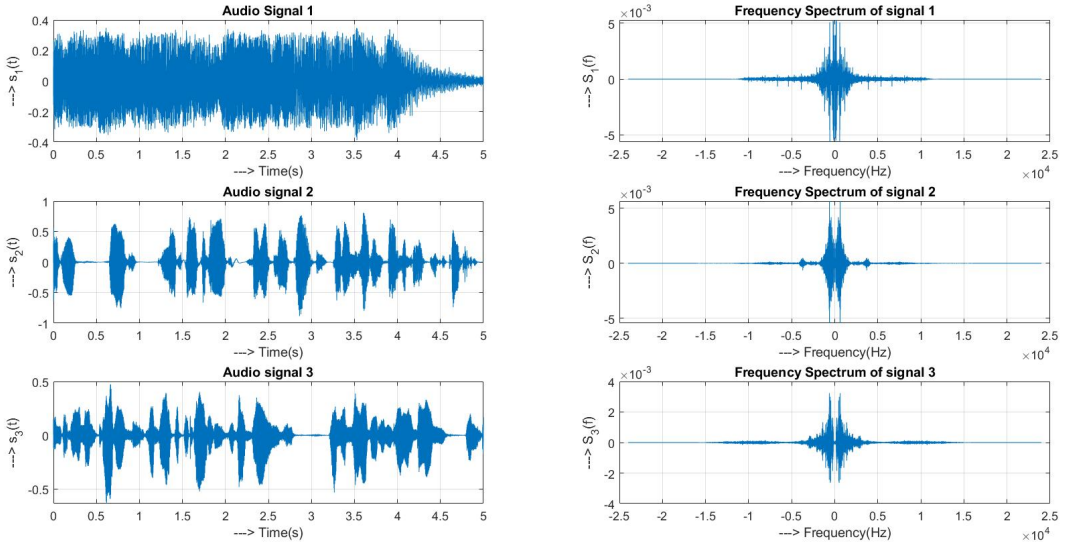

Figure 17: The original signal

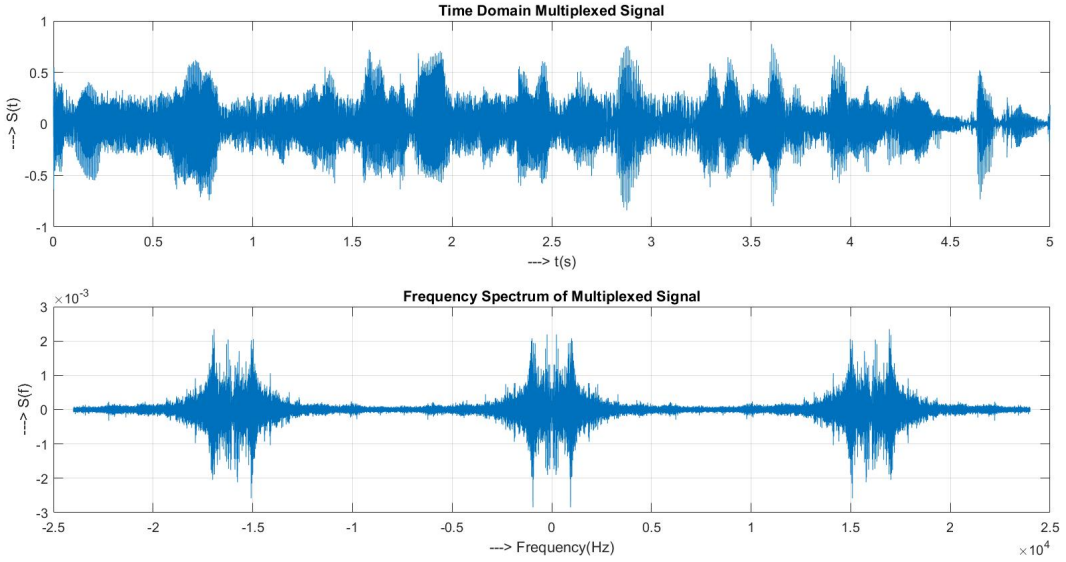

Figure 18: The transmission signal

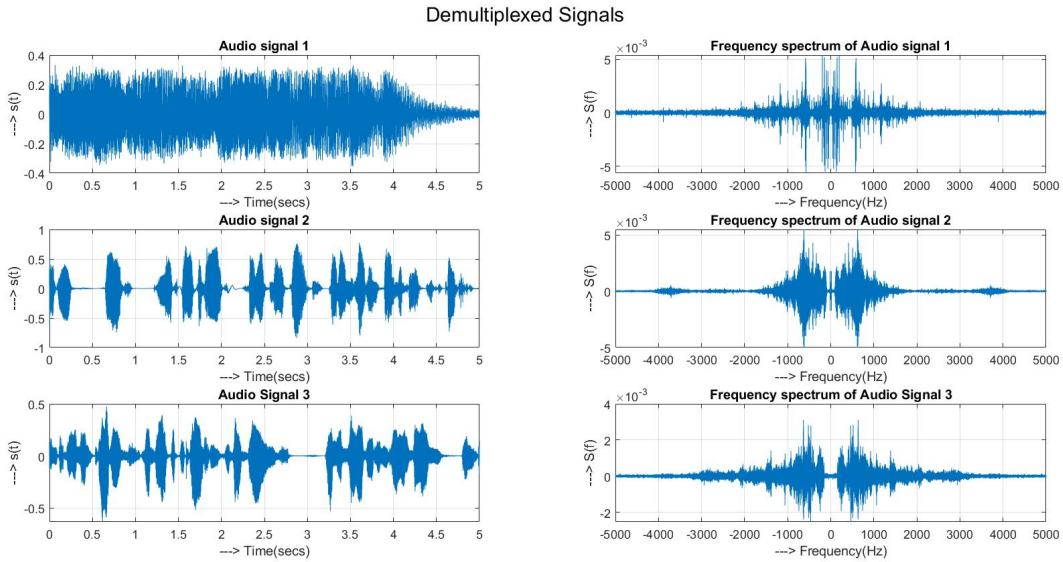

Figure 19: The demultiplexed signal

Discussion and Conclusion

We have successfully implemented time division multiplexing and analyzed the effects of various types of errors on the output of the system.