Introduction:

In the 1940s, an upper limit of communication capacity was proposed for Nyquist signal in an additive white Gaussian noise (AWGN) channel, now known as the Shannon limit. Initially, the communication capacity is enough for the traditional data and voice services. However, with the exponential growth of data traffic due to bandwidth-intensive applications such as high definition TV and mobile video, the communication capacity gradually approaches Shannon limit nowadays. Increasing the spectral efficiency is a key challenge to meet the increasing demand for higher capacity over communication channels. Faster-than-Nyquist (FTN) signal was first proposed by Mazo in 1970s to improve the spectral efficiency. As the name implies, FTN signal can achieve a symbol rate faster than Nyquist rate. Therefore, it has been widely investigated in high-capacity wireless and optical communications.

FTN signal achieves higher spectral efficiency and capacity compared to Nyquist signal due to its smaller pulse interval or narrower subcarrier spacing. Shannon limit typically defines the upper-limit capacity of Nyquist signal. In this paper, we first give the mathematical expression for the capacity limit of FTN NOFDM signal. The mathematical expression shows that FTN signal has the potential to achieve a higher capacity limit compared to Nyquist signal. In this paper, we demonstrate the principle of FTN NOFDM by taking fractional cosine transform-based NOFDM (FrCT-NOFDM) for instance. FrCT-NOFDM is first proposed and implemented by both simulation and experiment. When the bandwidth compression factor α is set to 0.8, the subcarrier spacing is equal to 40% of the symbol rate per subcarrier, thus transmission rate is about 25% faster than Nyquist rate

Performance Task for Lab Report: (your ID = AB-CDEFG-H)

ID=18-39261-3

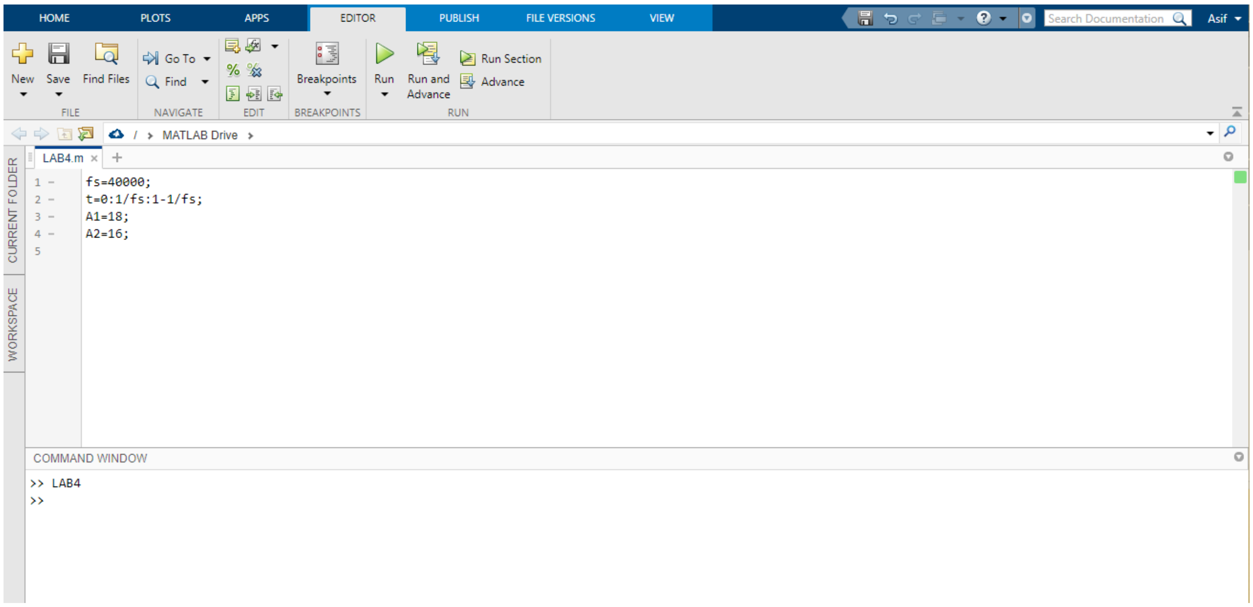
x = A1 sin(2π(C*100)t) + A2 cos(2π(G*100)t) + s*randn(size(t));

(a) Select the value of the amplitudes as follows: let A1 = AB, A2 = AF and s=AH

(b) Calculate the SNR value of the composite signal.

(c) Find the bandwidth of the signal and calculate the maximum capacity of the channel. (d) What will be the signal level to achieve the data rate?

(A)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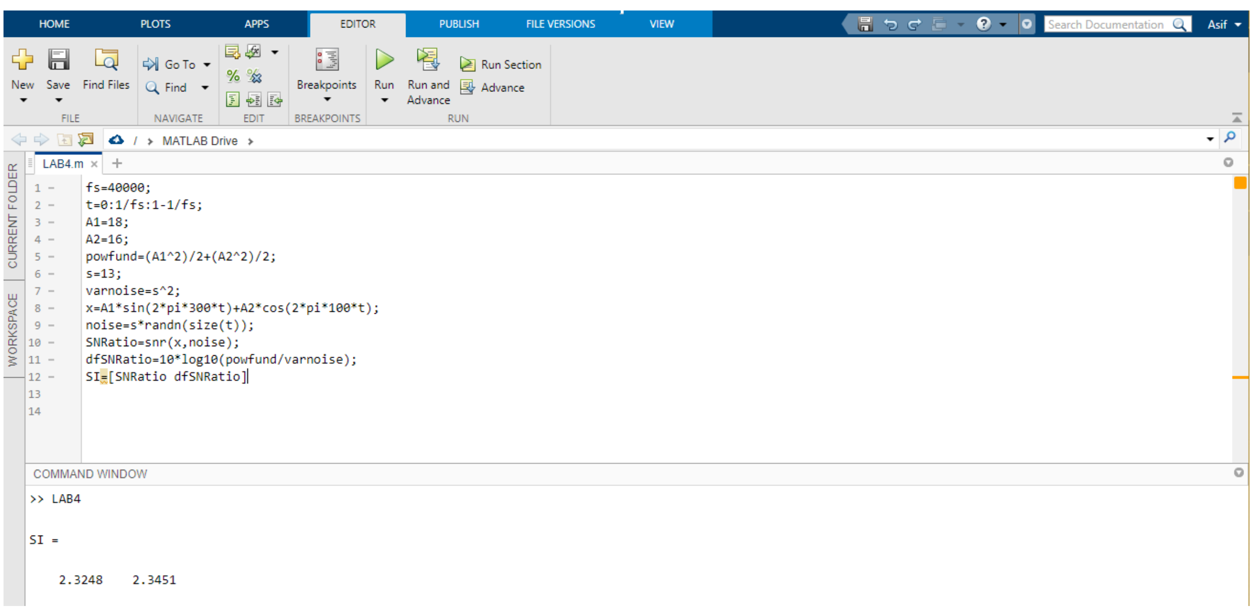
Go To
Find
Breakpoints
Run
Run and Advance
Run Section
Advance
FILE
NAVIGATE
EDIT
BREAKPOINTS
RUN
MATLAB Drive
LAB4.m
CURRENT FOLDER
WORKSPACE
fs=40000;
t=0:1/fs:1-1/fs;
A1=18;
A2=16;
COMMAND WINDOW
>> LAB4
>>

(B)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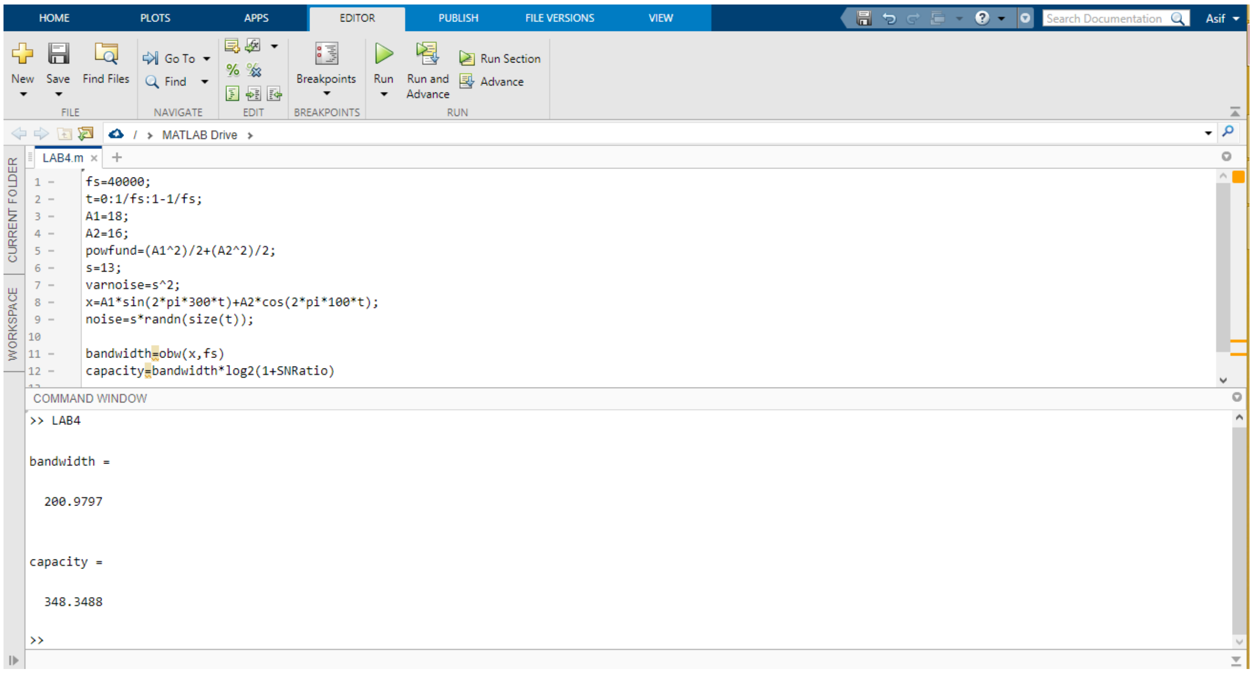
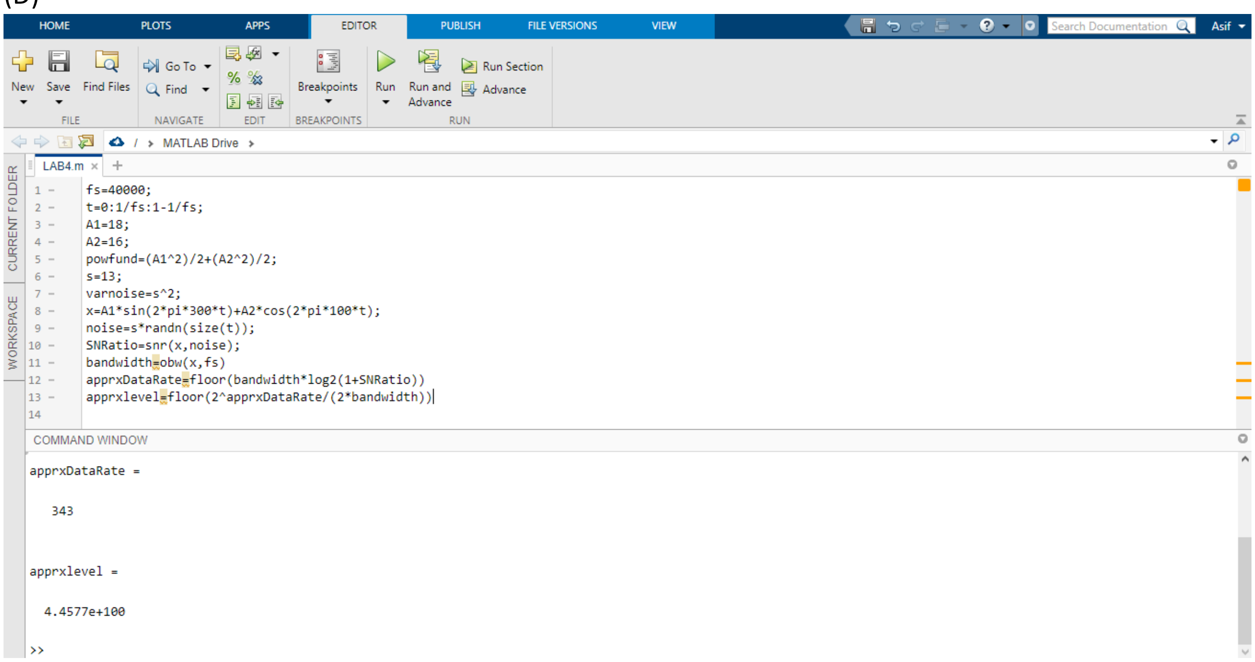
Breakpoints
Run
Run and Advance
Run Section
Advance
FILE
NAVIGATE
EDIT
BREAKPOINTS
RUN
MATLAB Drive
LAB4.m
CURRENT FOLDER
WORKSPACE
fs=40000;
t=0:1/fs:1-1/fs;
A1=18;
A2=16;
powfund=(A1^2)/2+(A2^2)/2;
s=13;
varnoise=s^2;
x=A1*sin(2*pi*300*t)+A2*cos(2*pi*100*t);
noise=s*randn(size(t));
SNRatio=snr(x,noise);
dfSNRatio=10*log10(powfund/varnoise);
SI=[SNRatio dfSNRatio]
COMMAND WINDOW
>> LAB4
SI =
2.3248 2.3451

(C)


HOME
PLOTS
APPS
EDITOR
PUBLISH
FILE VERSIONS
VIEW
MATLAB Drive
LAB4.m
fs=40000;
t=0:1/fs:1-1/fs;
A1=18;
A2=16;
powfund=(A1^2)/2+(A2^2)/2;
s=13;
varnoise=s^2;
x=A1*sin(2*pi*300*t)+A2*cos(2*pi*100*t);
noise=s*randn(size(t));
bandwidth=obw(x,fs)
capacity=bandwidth*log2(1+SNRatio)
COMMAND WINDOW
>> LAB4
bandwidth =
200.9797
capacity =
348.3488
>>

(D)


HOME
PLOTS
APPS
EDITOR
PUBLISH
FILE VERSIONS
VIEW
MATLAB Drive
LAB4.m
fs=40000;
t=0:1/fs:1-1/fs;
A1=18;
A2=16;
powfund=(A1^2)/2+(A2^2)/2;
s=13;
varnoise=s^2;
x=A1*sin(2*pi*300*t)+A2*cos(2*pi*100*t);
noise=s*randn(size(t));
SNRatio=snr(x,noise);
bandwidth=obw(x,fs)
apprxDataRate=floor(bandwidth*log2(1+SNRatio))
apprxlevel=floor(2^apprxDataRate/(2*bandwidth))
COMMAND WINDOW
apprxDataRate =
343
apprxlevel =
4.4577e+100
>>

Conclusion:

Characterized sampled channel capacity as a function of sampling rate for different sampling methods, thereby forming a new connection between sampling theory and information theory. We show how the capacity of a sampled analog channel is affected by reduced sampling rate and identify optimal sampling structures for several classes of sampling methods, which exploit structure in the sampling design.