Homework 3 - Shaft Health Assessment

Table of Contents

Group 1 - Shashank Iyengar, Johann Koshy, Ashwin Kumat, Ketan Shah 1
Data Acquisition 1
Feature extraction 2
Logistic Regression and Health Value Assessment 24

Group 1 - Shashank Iyengar, Johann Koshy, Ashwin Kumat, Ketan Shah

```
close all
clear all
clc
set(0,'DefaultAxesFontName', 'Times New Roman')
set(0,'DefaultAxesFontSize', 15)
set(0,'defaultlinelinewidth',.5)
set(0,'DefaultLineMarkerSize', 5)
set(0,'defaultAxesFontWeight','bold')
```

Data Acquisition

Training - Healthy Data

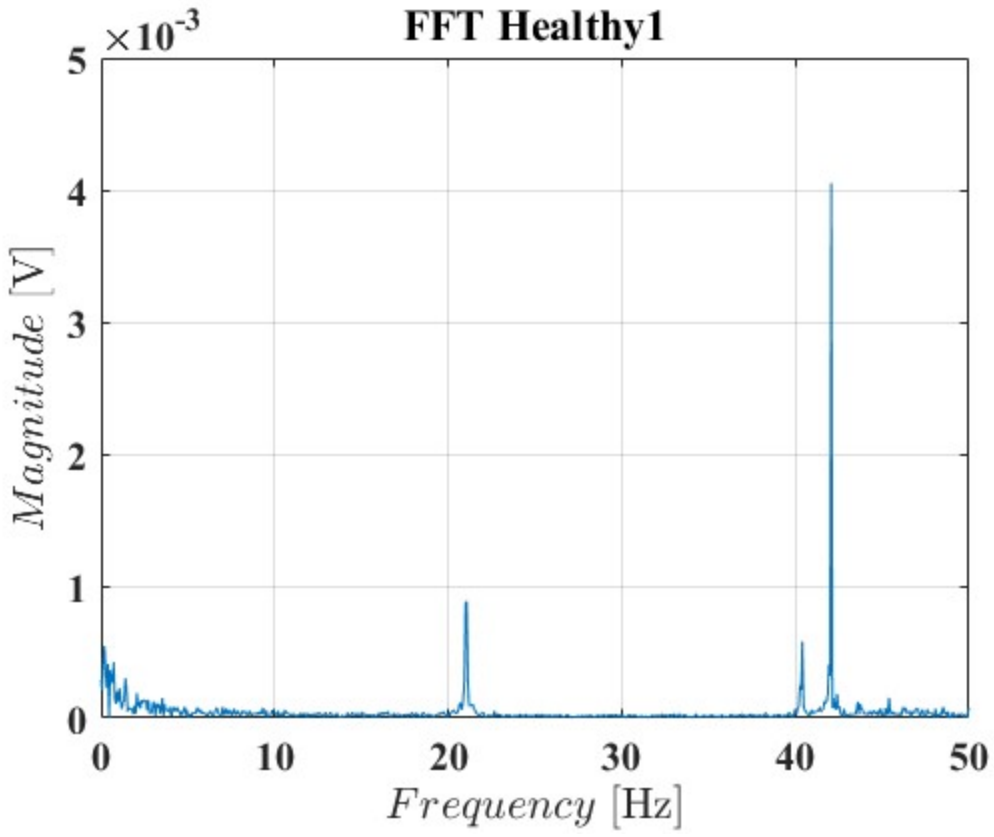
```
testfiledir = 'C:\Users\johan\Desktop\UC_Spring2019\Big_data
\HW3\Training\Healthy';
matfiles = dir(fullfile(testfiledir, '*.txt'));
nfiles = length(matfiles);
data  = cell(nfiles);
for i=1:nfiles
    data{i} = dlmread(fullfile(testfiledir, matfiles(i).name), ' ', 5,
 0);
end

% Splitting the data array to parts
train_healthy=[];
for i=1:nfiles
    train_healthy(i,:)=cell2mat(data(i,1));
end

% Training - Faulty Data
testfiledir = 'C:\Users\johan\Desktop\UC_Spring2019\Big_data
\HW3\Training\Faulty';
matfiles = dir(fullfile(testfiledir, '*.txt'));
nfiles = length(matfiles);
data  = cell(nfiles);
```

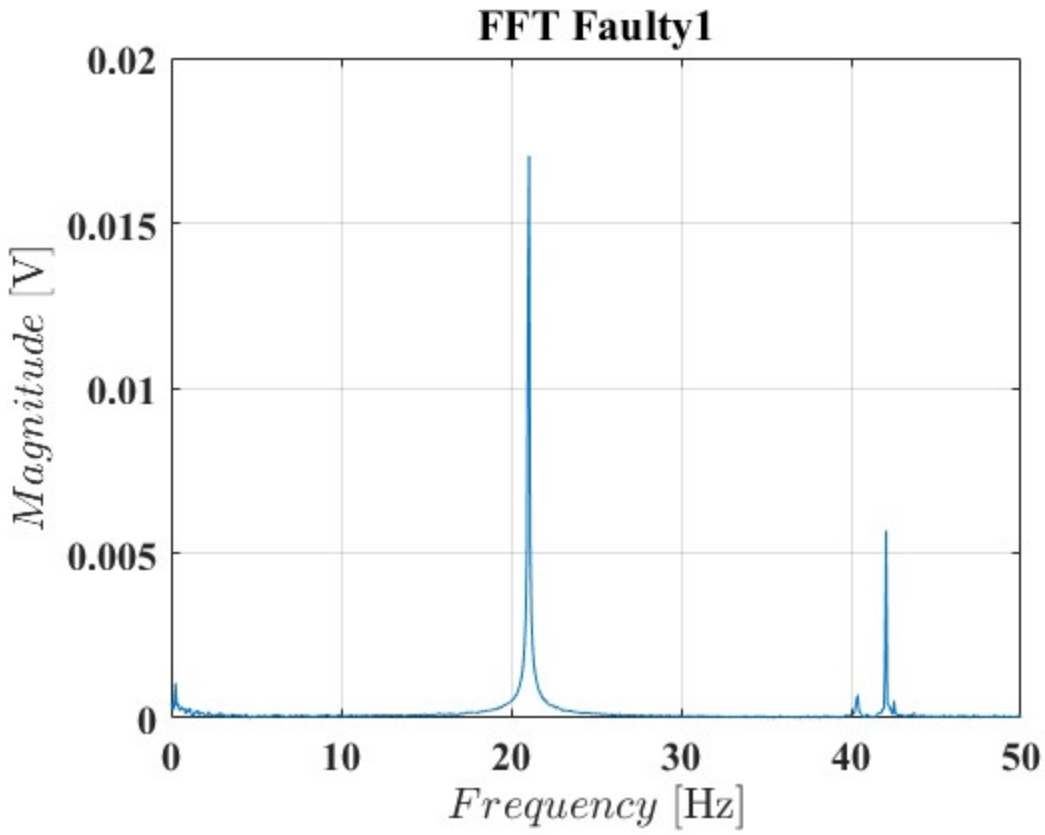
```
for i=1:nfiles
    data{i} = dlmread(fullfile(testfiledir, matfiles(i).name), ' ', 5,
 0);
end

% Splitting the data array to parts
train_faulty=[];
for i=1:nfiles
    train_faulty(i,:)=cell2mat(data(i,1));
end

% Testing Data (30 Sets)
testfiledir = 'C:\Users\johan\Desktop\UC_Spring2019\Big_data
\HW3\Testing\Testing';
matfiles = dir(fullfile(testfiledir, '*.txt'));
nfiles = length(matfiles);
data  = cell(nfiles);
for i = 1 : nfiles
    data{i} = dlmread(fullfile(testfiledir, matfiles(i).name), ' ', 5,
 0);
end

% Splitting the data array to parts
test_data=[];
for i=1:nfiles
    test_data(i,:)=cell2mat(data(i,1));
end
```

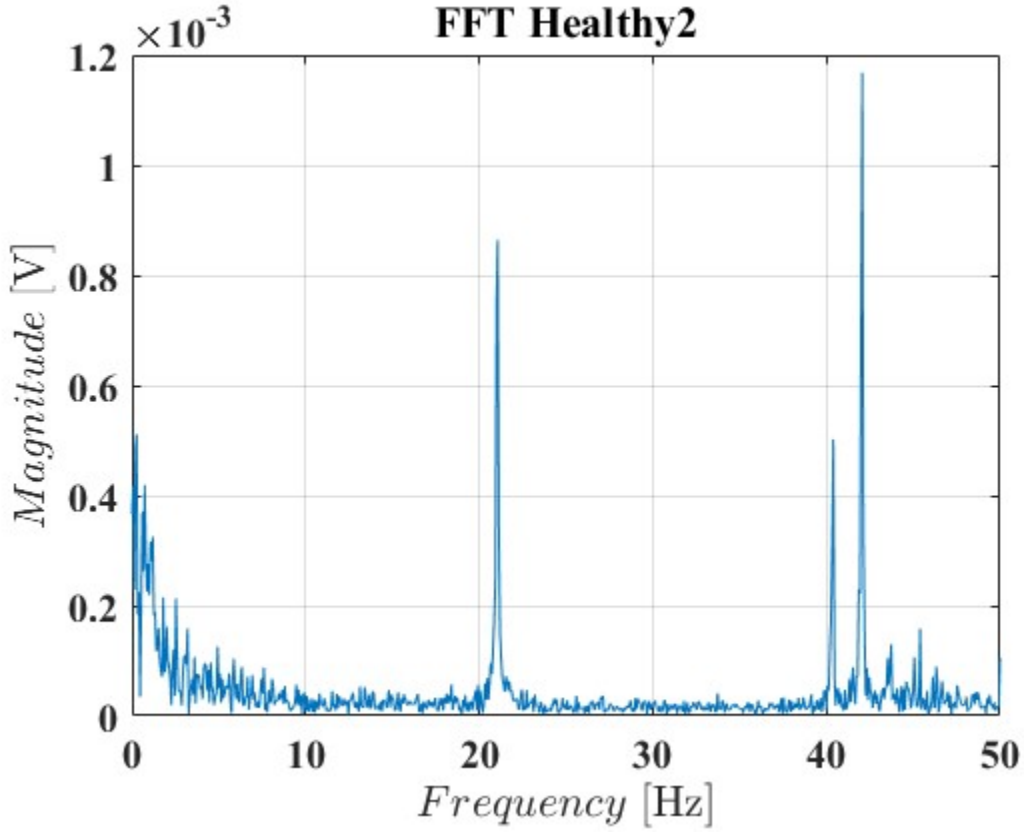
Feature extraction

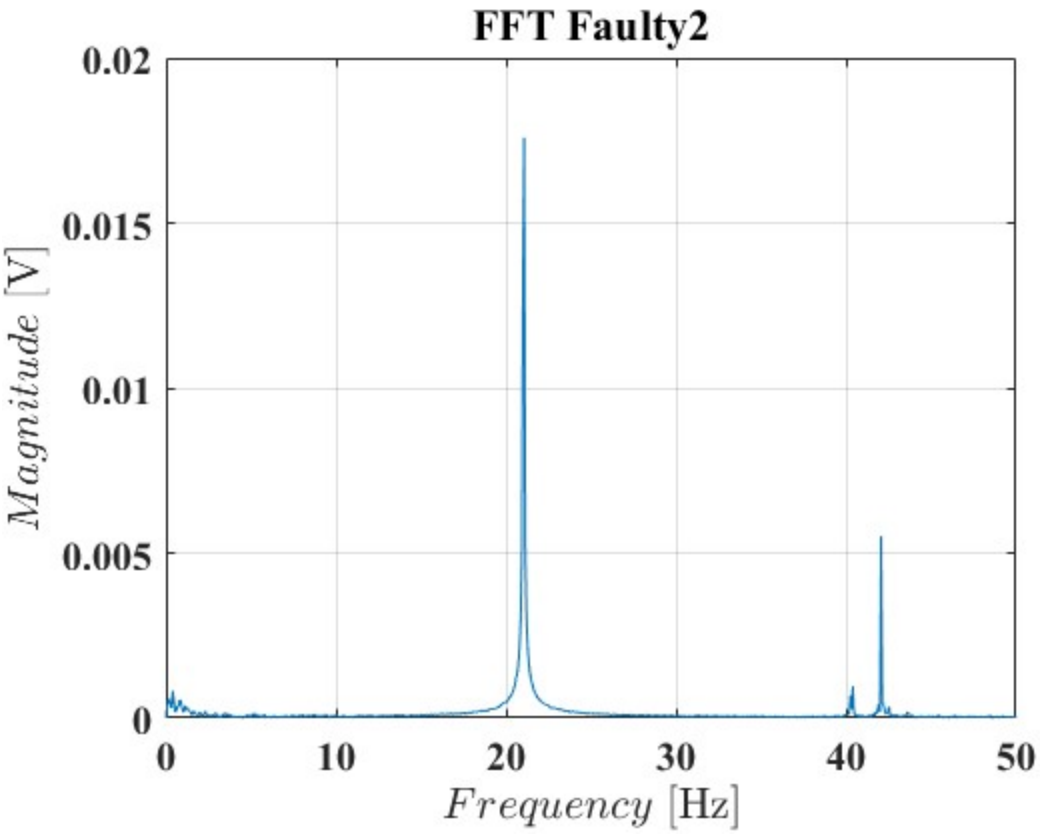
```
Fs = 2560;          % Sampling frequency
dt = 1/Fs;          % Time step
Ntime = 38400;      % Number of data points
Ttotal = 15;        % Total time
df = 1/Ttotal;      % Fundamental frequency

for i=1:20
    train_healthy_fft(i,:)=fft(train_healthy(i,:));
    train_faulty_fft(i,:)=fft(train_faulty(i,:));

    figure(i)
    plot((0:Ntime/2-1)/Ttotal,(2/
Ntime)*abs(train_healthy_fft(i,1:Ntime/2)))
    xlabel(['$ Frequency \;\mathrm{[Hz]} $'],'interpreter','latex')
    ylabel(['$ Magnitude \;\mathrm{[V]} $'],'interpreter','latex')
    txt=['FFT Healthy', num2str(i)];
    title(txt)
    grid on
    xlim([0 50])
    figure(i+20)
    plot((0:Ntime/2-1)/Ttotal,(2/
Ntime)*abs(train_faulty_fft(i,1:Ntime/2)))
    xlabel(['$ Frequency \;\mathrm{[Hz]} $'],'interpreter','latex')
```

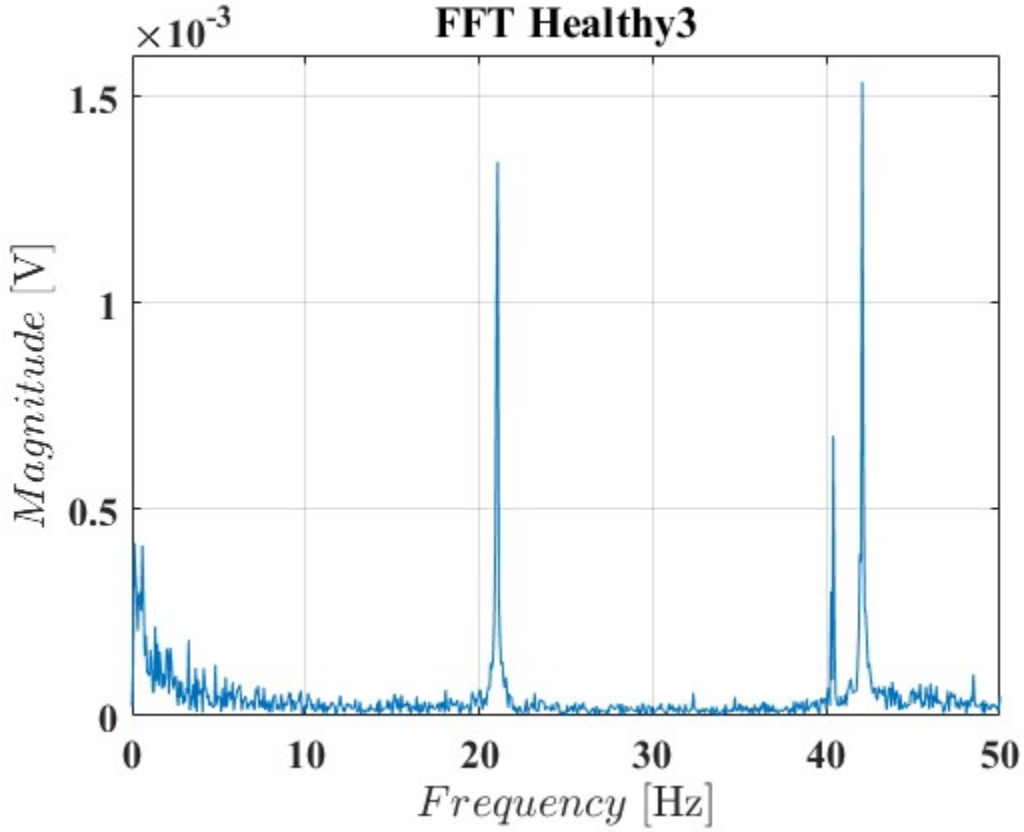
```
    ylabel(['$ Magnitude \;\mathrm{[V]} $'],'interpreter','latex')
    txt=['FFT Faulty', num2str(i)];
    title(txt)
    grid on
    xlim([0 50])

    amplitude_healthy(i)=max(((2/
Ntime)*abs(train_healthy_fft(i,1:750/2))));
    amplitude_faulty(i)=max(((2/
Ntime)*abs(train_faulty_fft(i,1:750/2))));
end
for i=1:30
    testset(i,:) = fft(test_data(i,:));
    amplitude_testset(i) = max(((2/Ntime)*abs(testset(i,1:750/2))));
end

figure
plot(1:20,amplitude_healthy,'-ko')
hold on
plot(1:20,amplitude_faulty,'-r*')
xlabel(['$ Samples\;\mathrm{} $'],'interpreter','latex')
ylabel(['$ Amplitude\;\mathrm{[V]} $'],'interpreter','latex')
legend('Healthy Amplitudes','Faulty Amplitudes')
txt=['Feature extraction'];
title(txt)
grid on
```

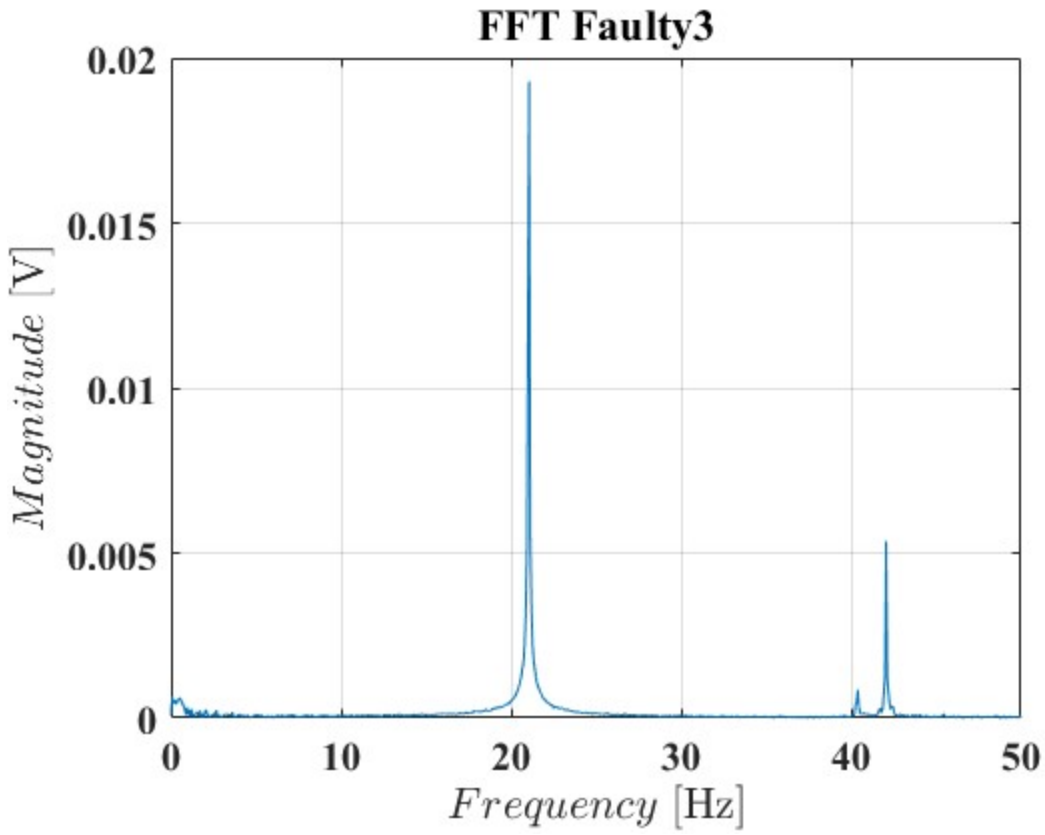


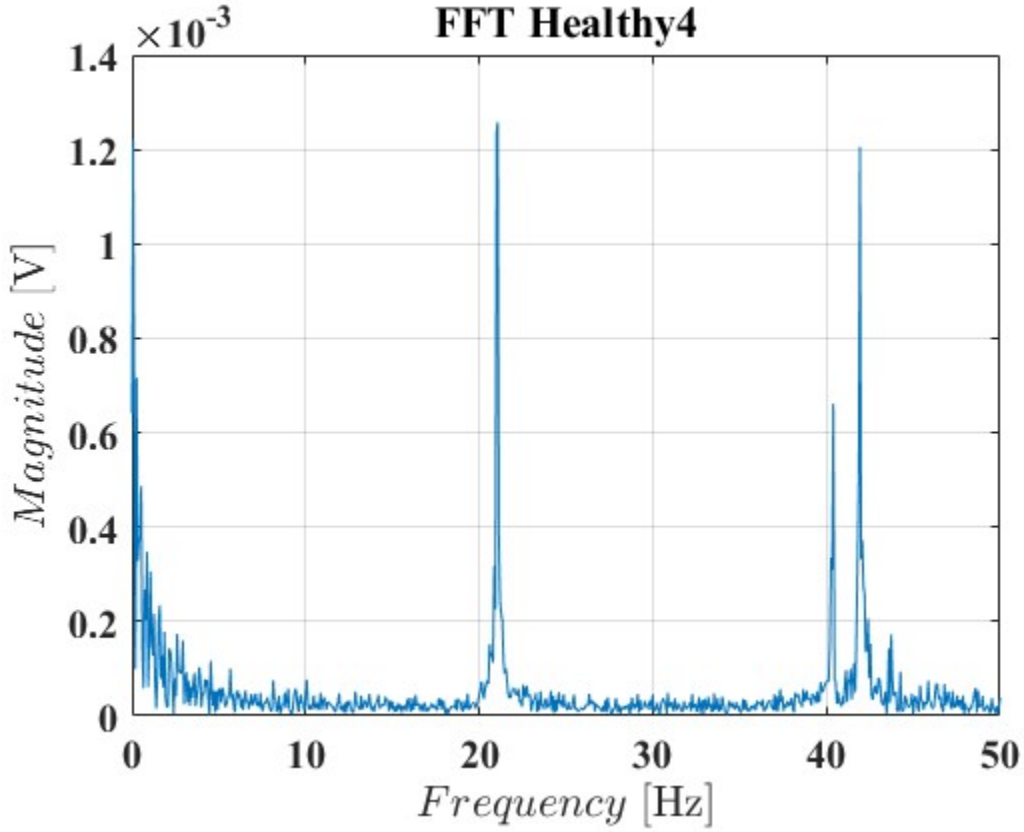

FFT Faulty1
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

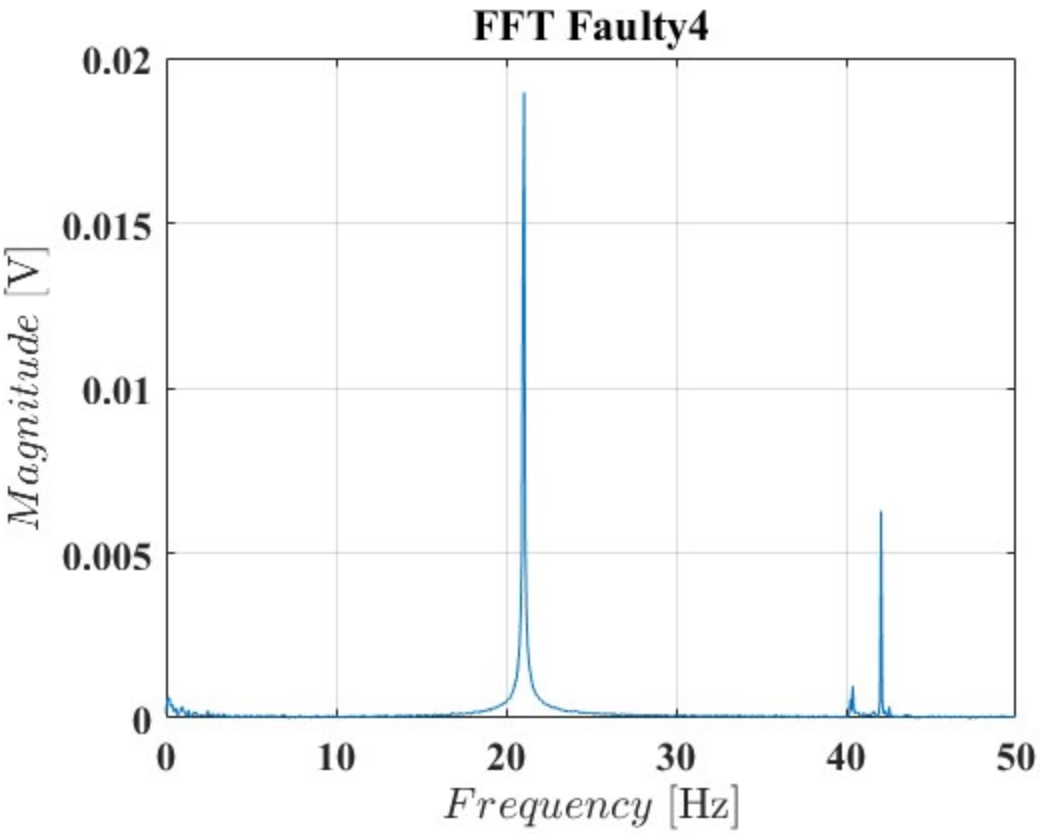

FFT Healthy2
×10-3
1.2
1
0.8
0.6
0.4
0.2
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

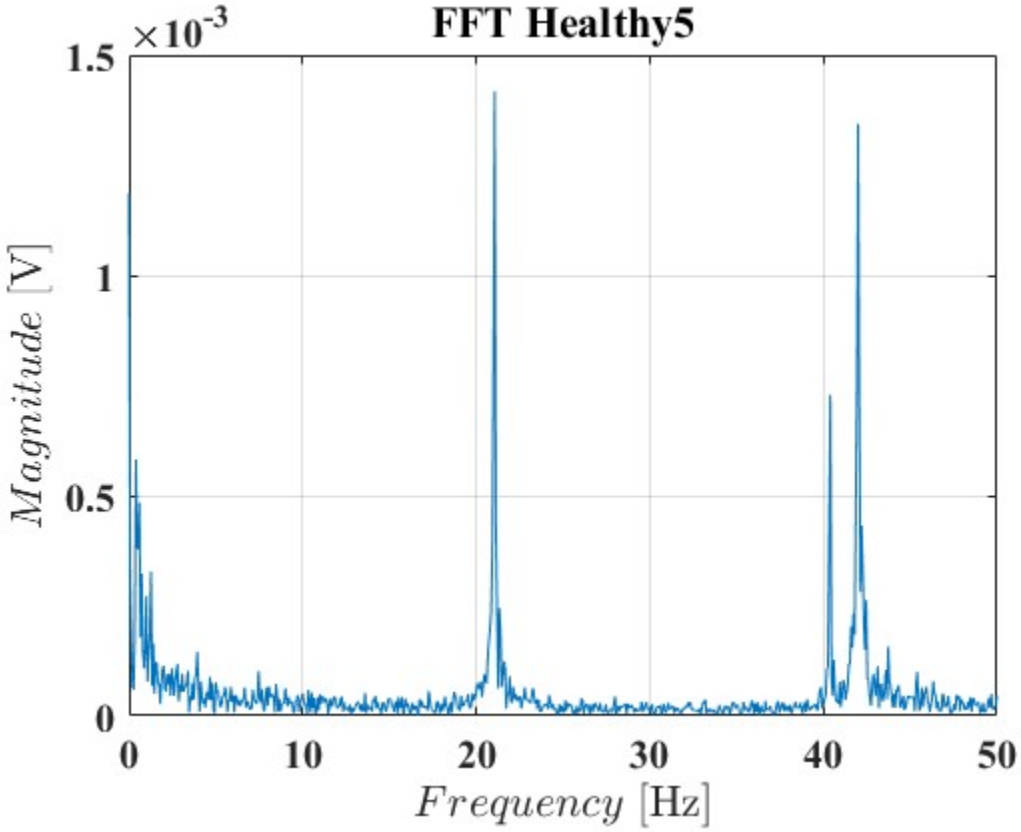

FFT Faulty2
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

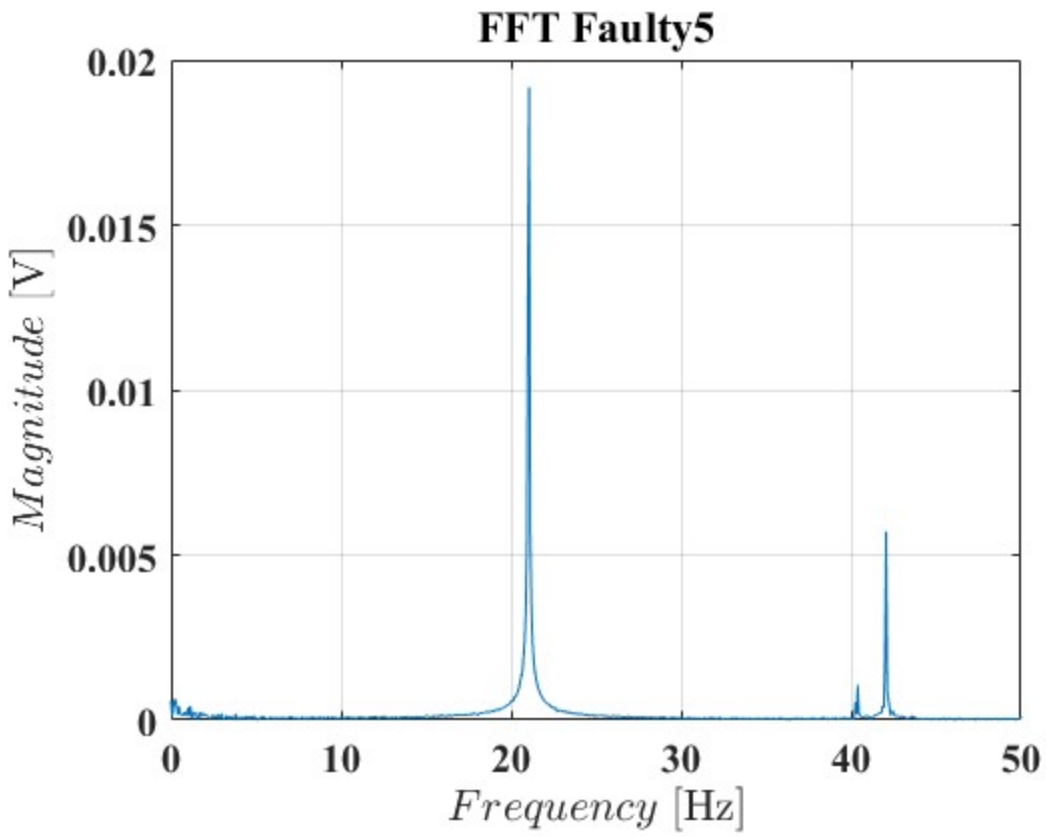

FFT Healthy3
×10-3
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

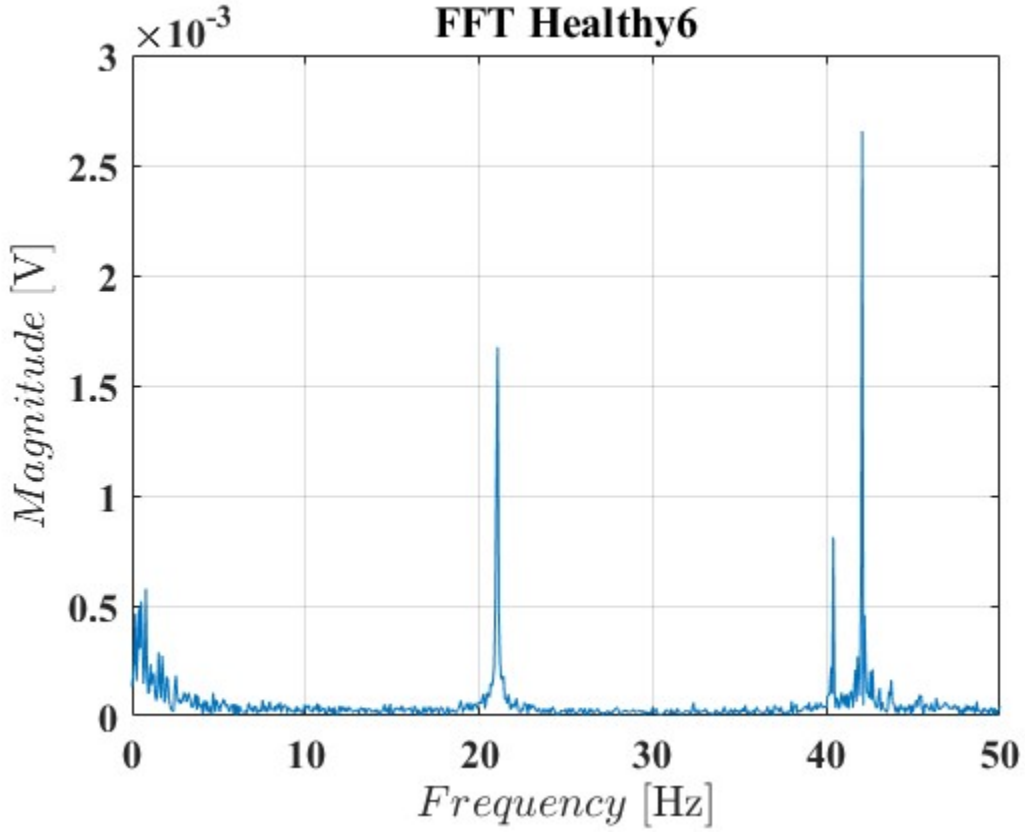

FFT Faulty3
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

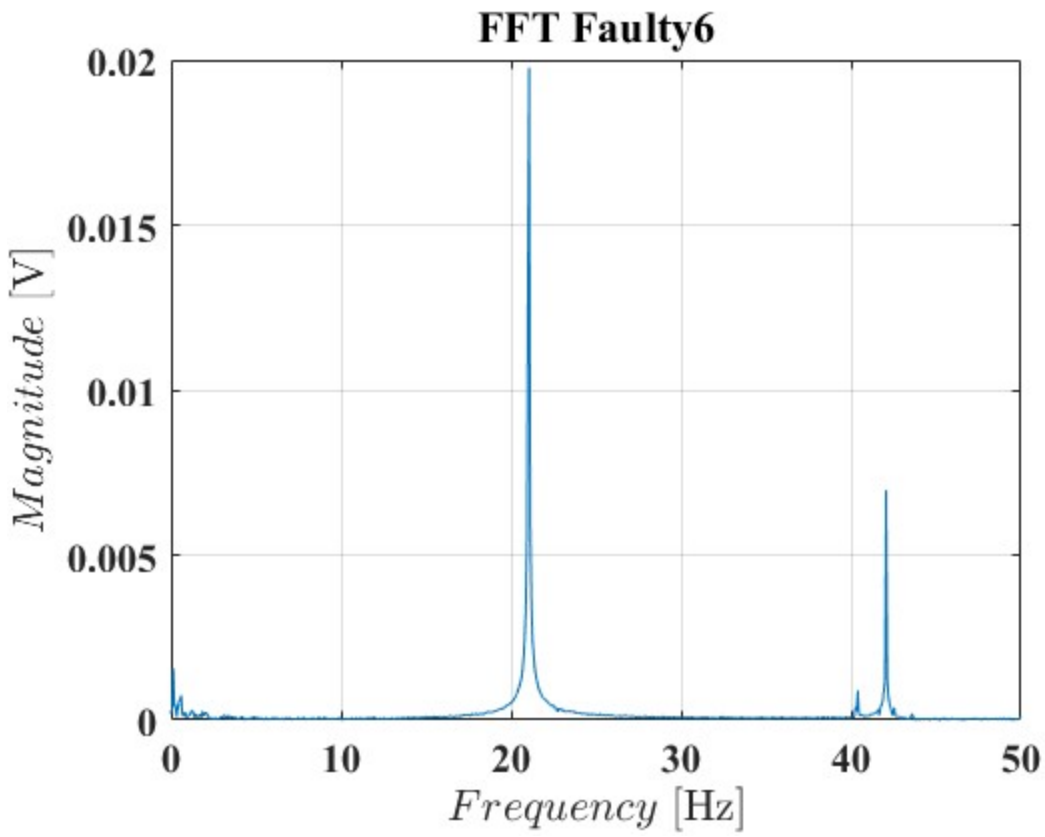

FFT Healthy4
×10-3
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

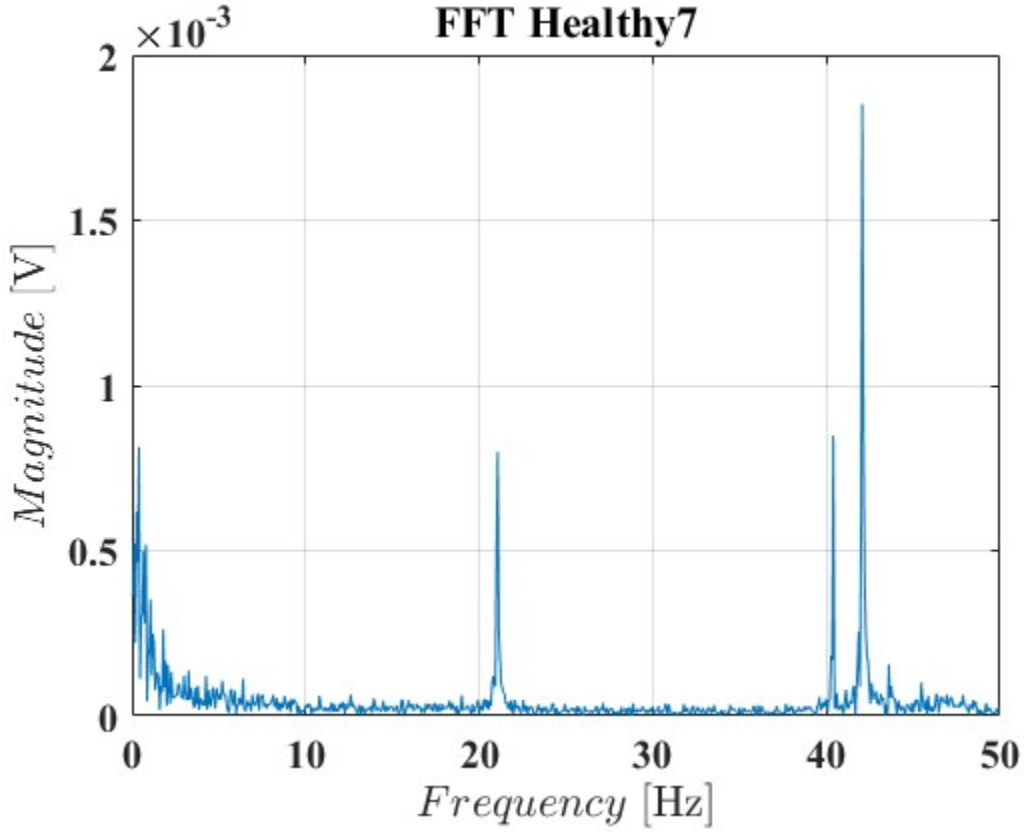

FFT Faulty4
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

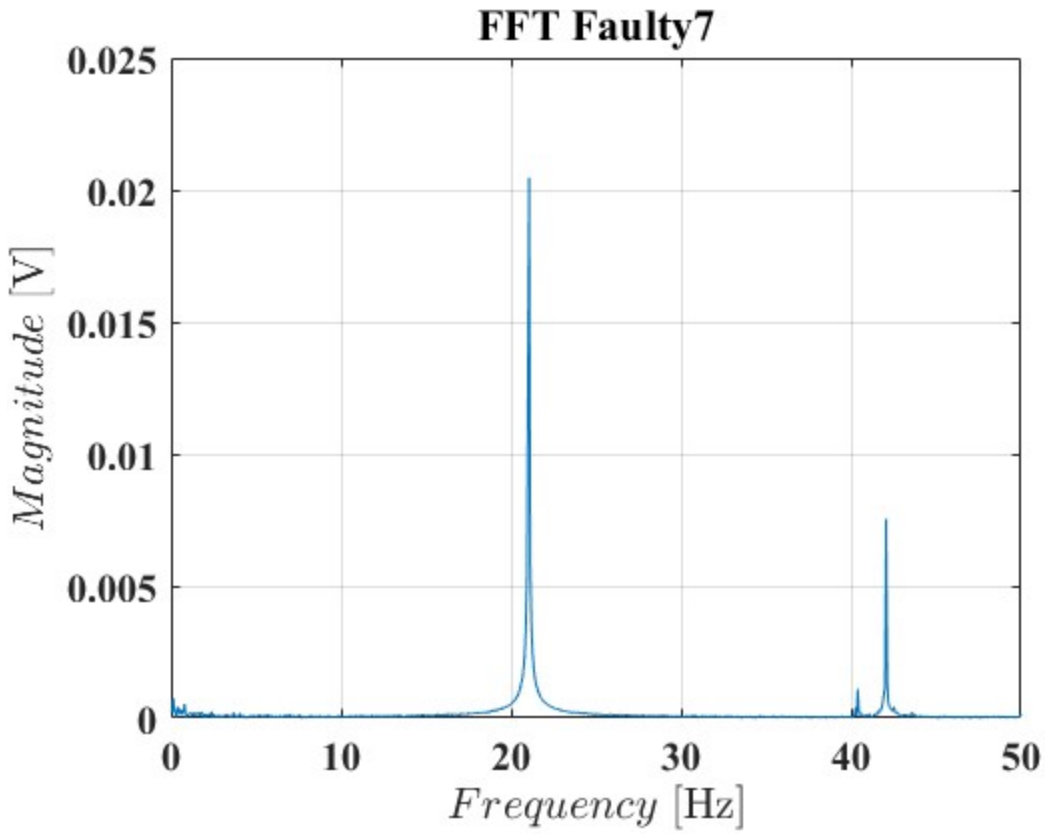

FFT Healthy5
×10-3
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

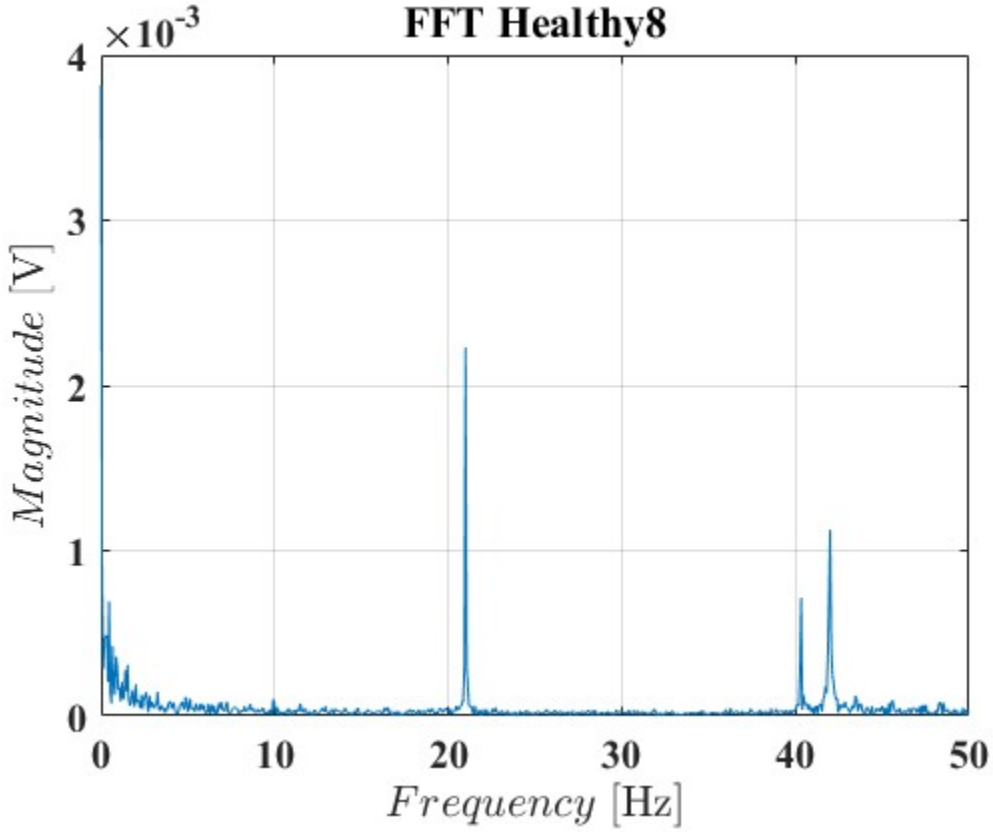

FFT Faulty5
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

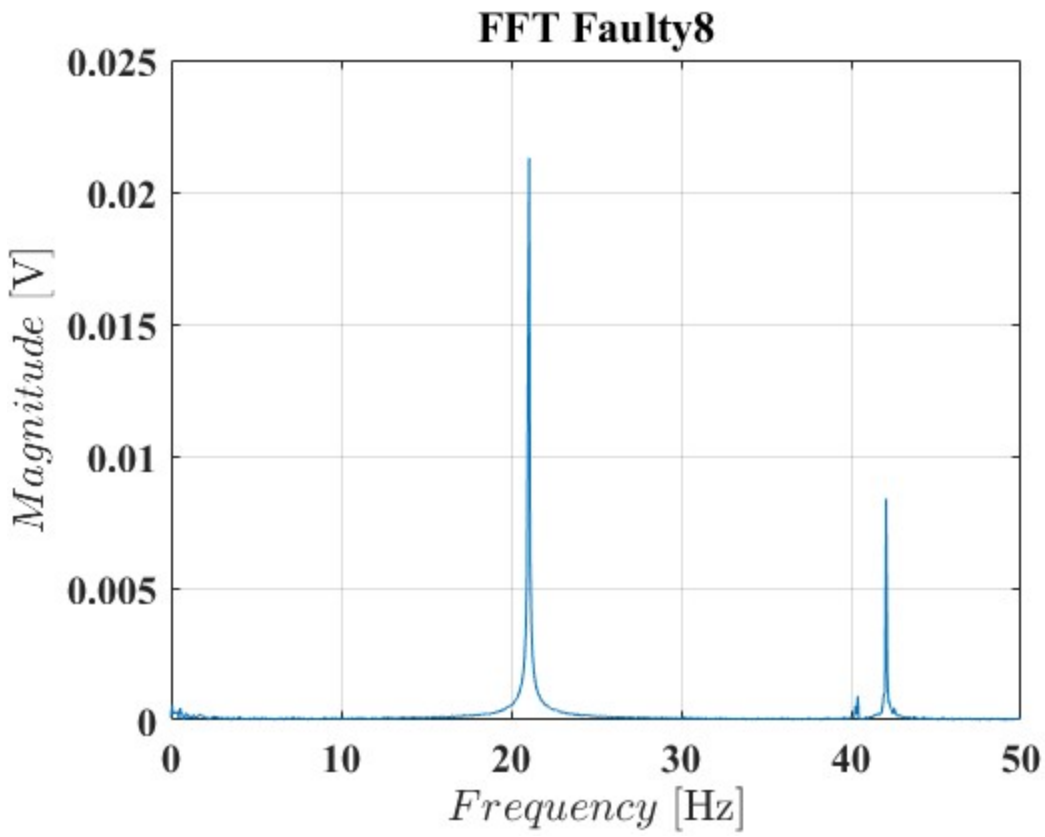

FFT Healthy6
×10-3
3
2.5
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

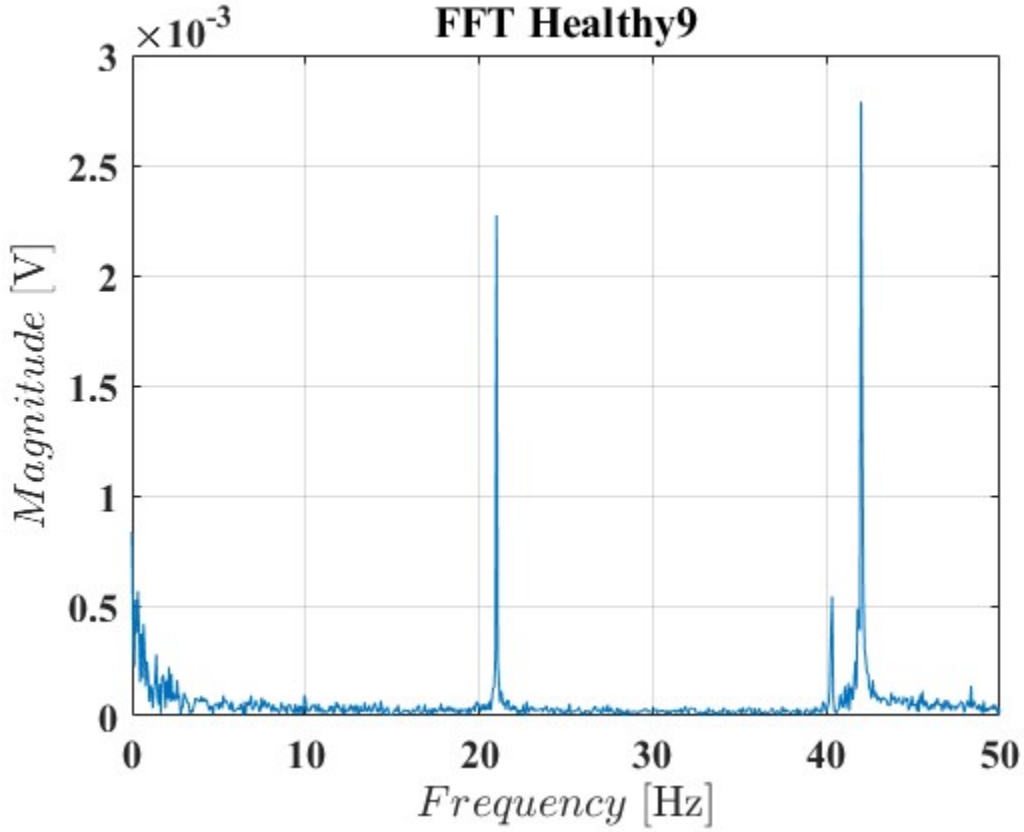

FFT Faulty6
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

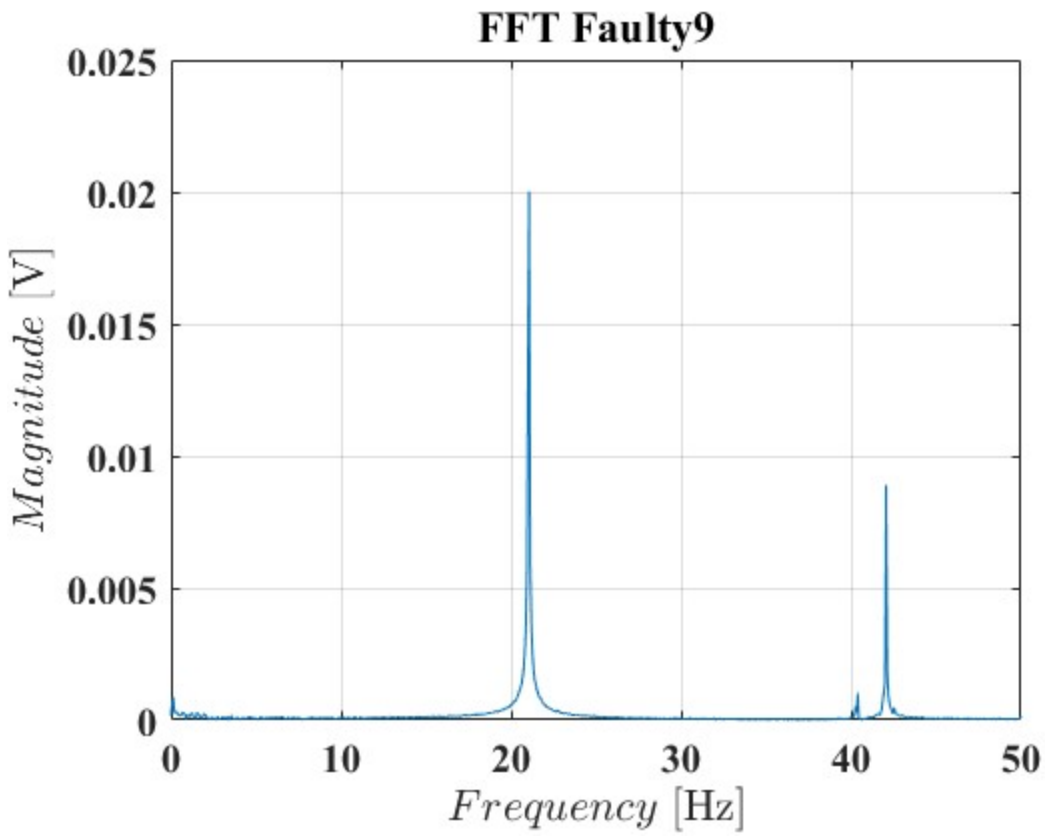

FFT Healthy7
×10-3
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

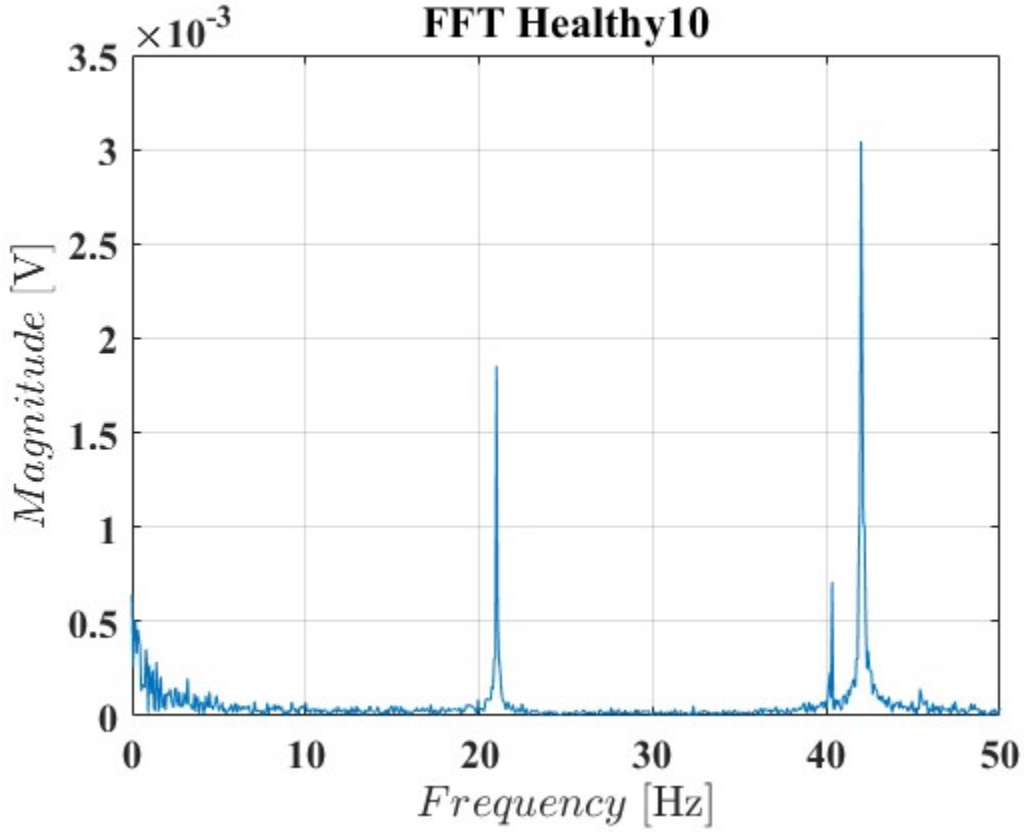

FFT Faulty7
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

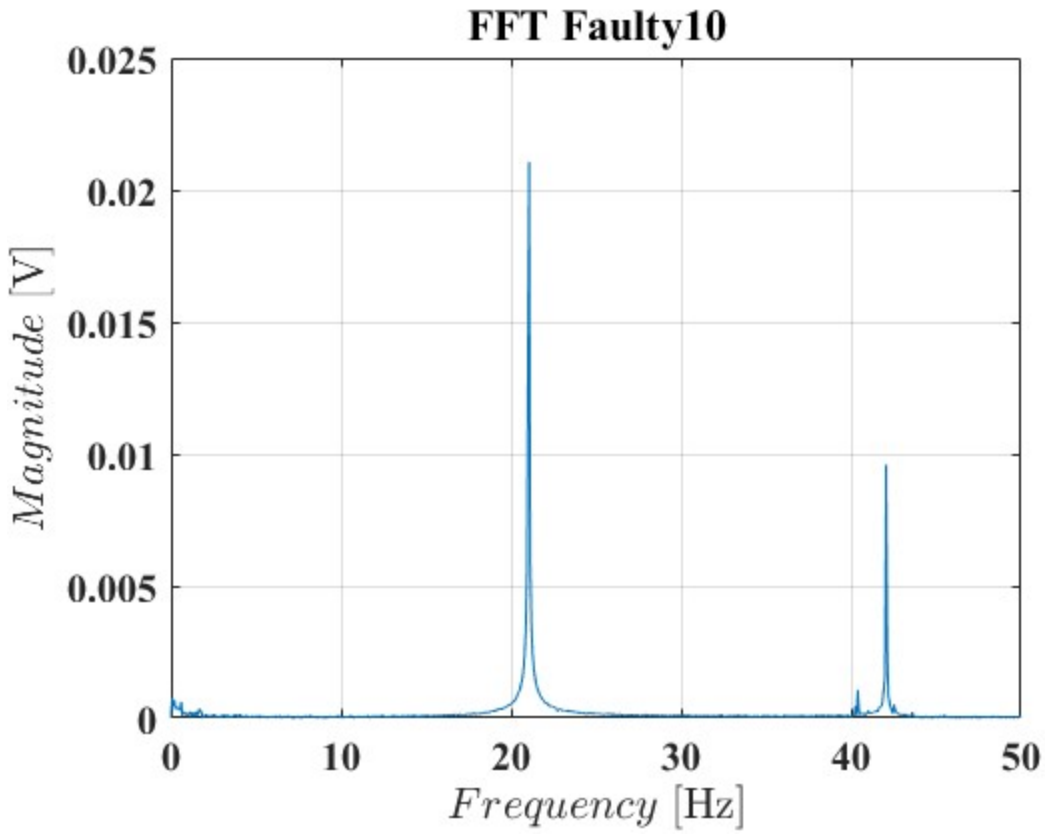

FFT Healthy8
×10-3
4
3
2
1
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

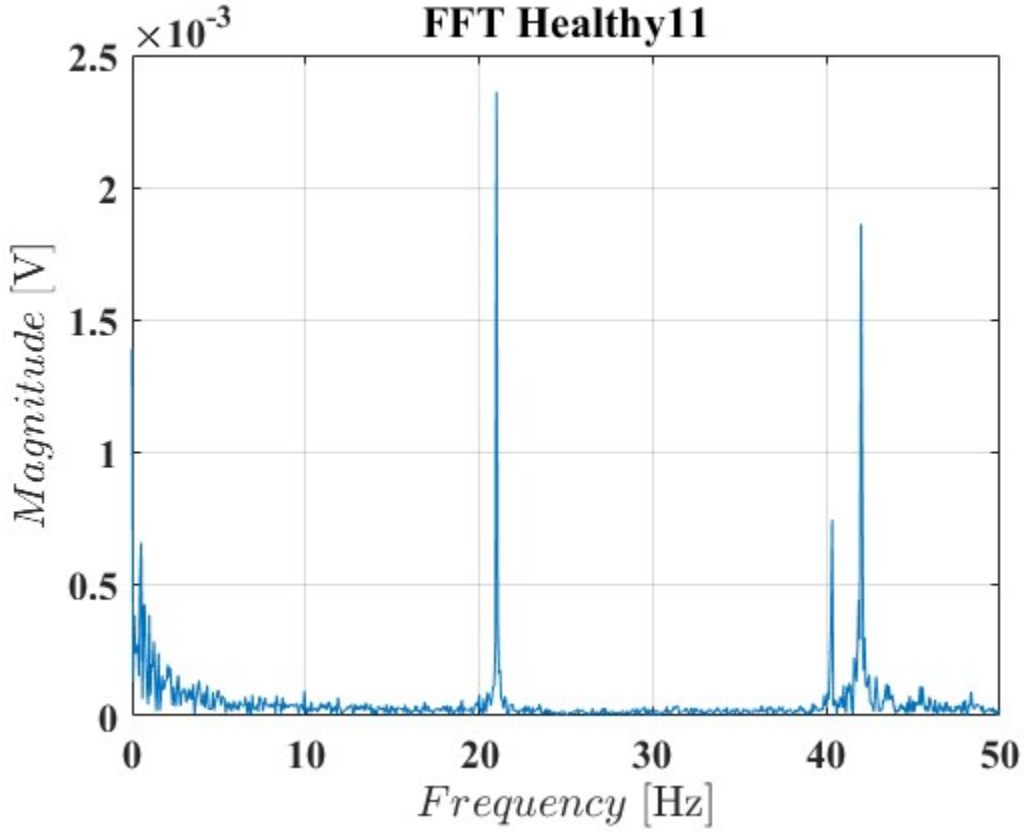

FFT Faulty8
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

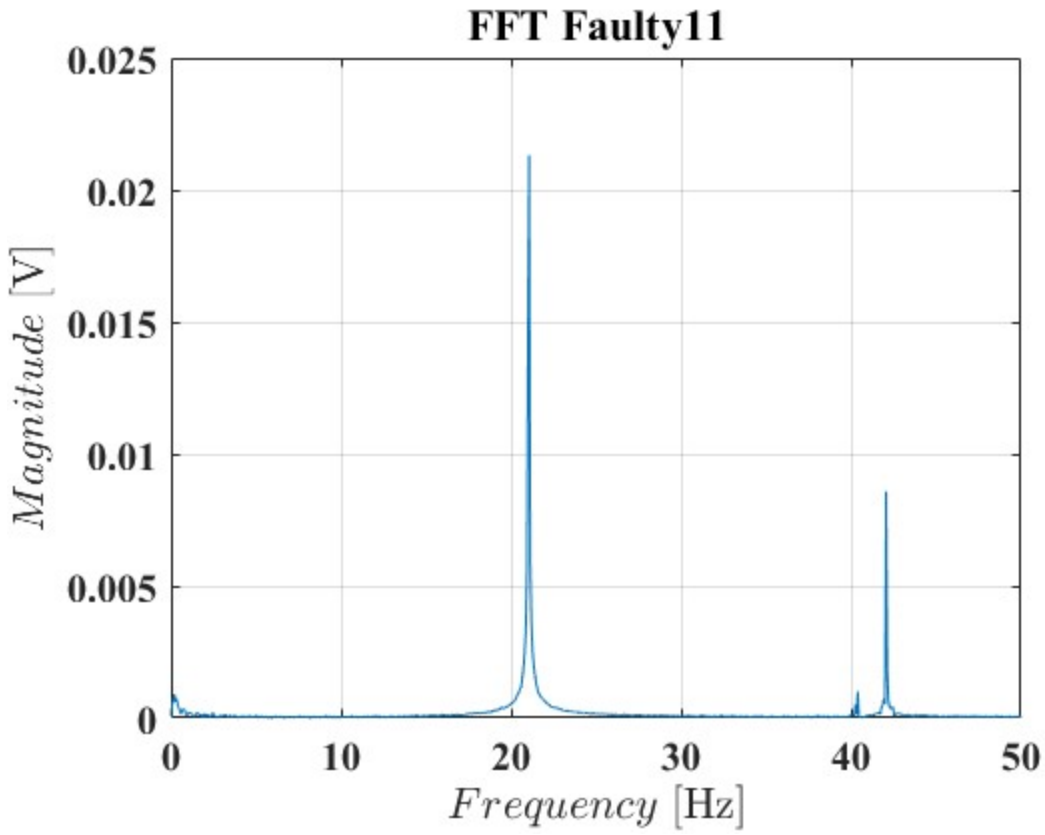

FFT Healthy9
×10-3
3
2.5
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

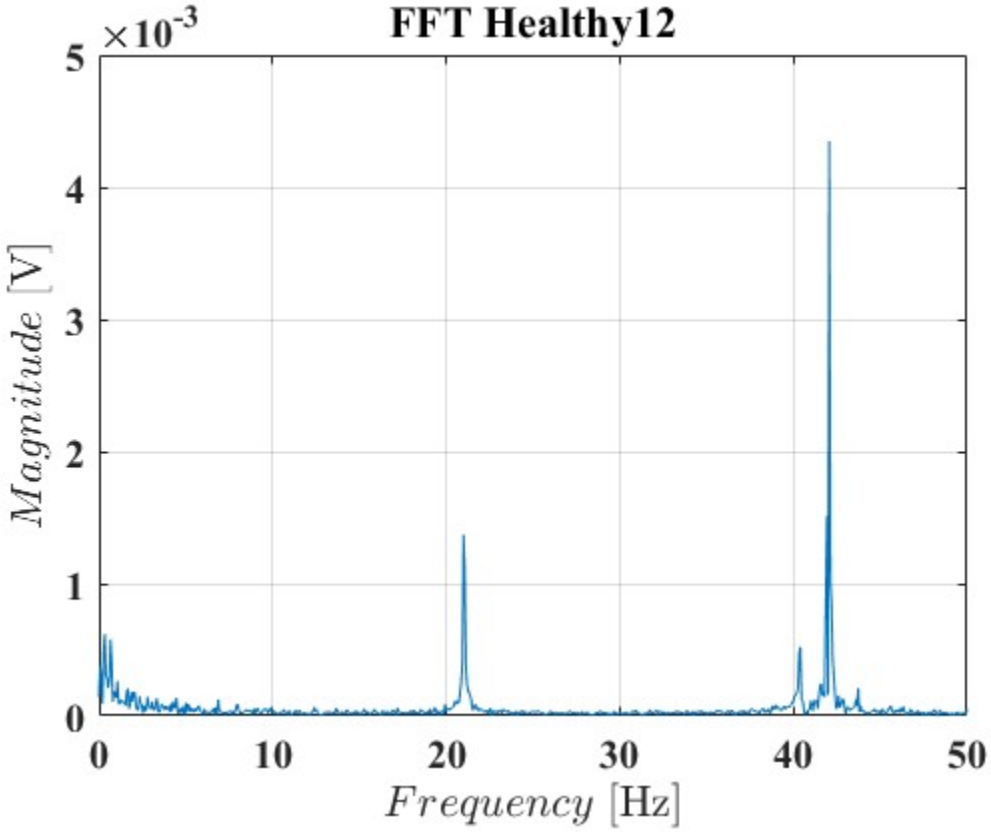

FFT Faulty9
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

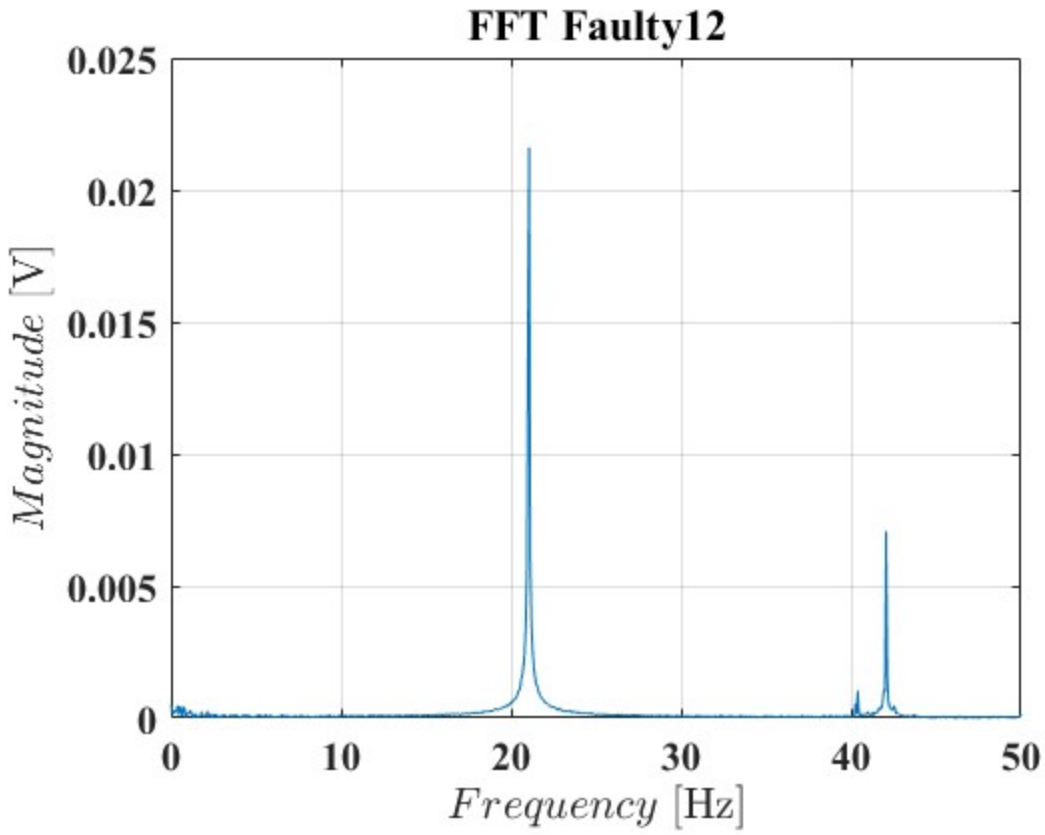

FFT Healthy10
×10-3
3.5
3
2.5
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

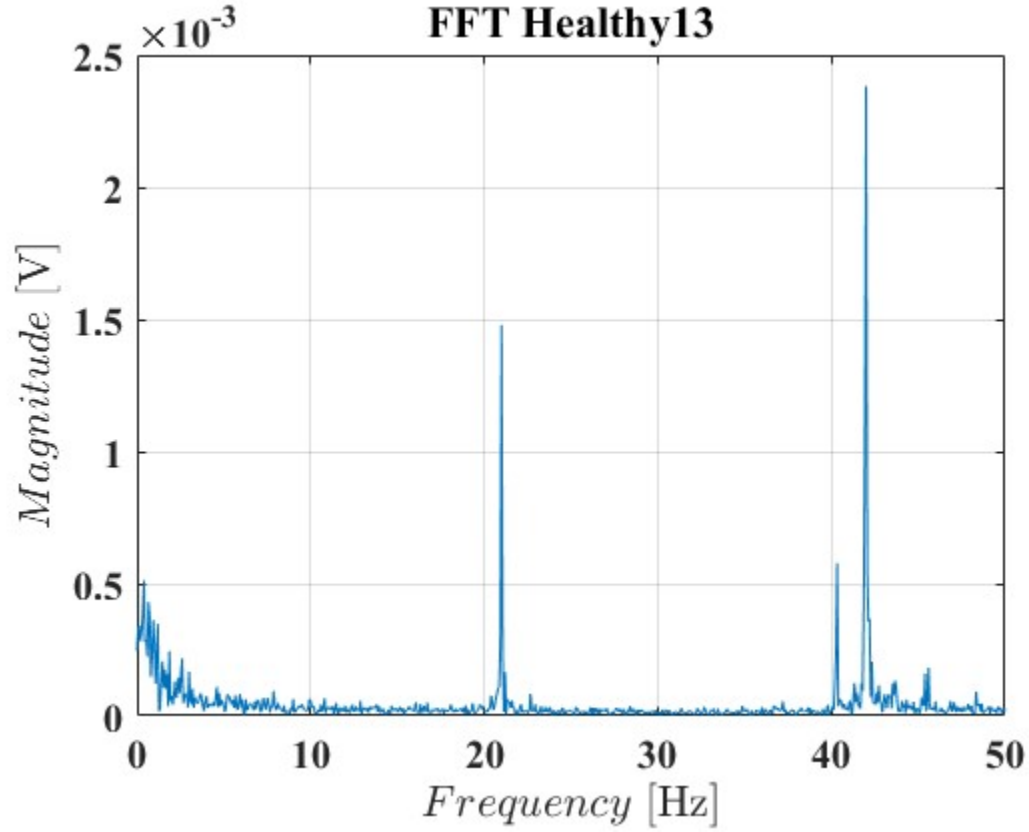

FFT Faulty10
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

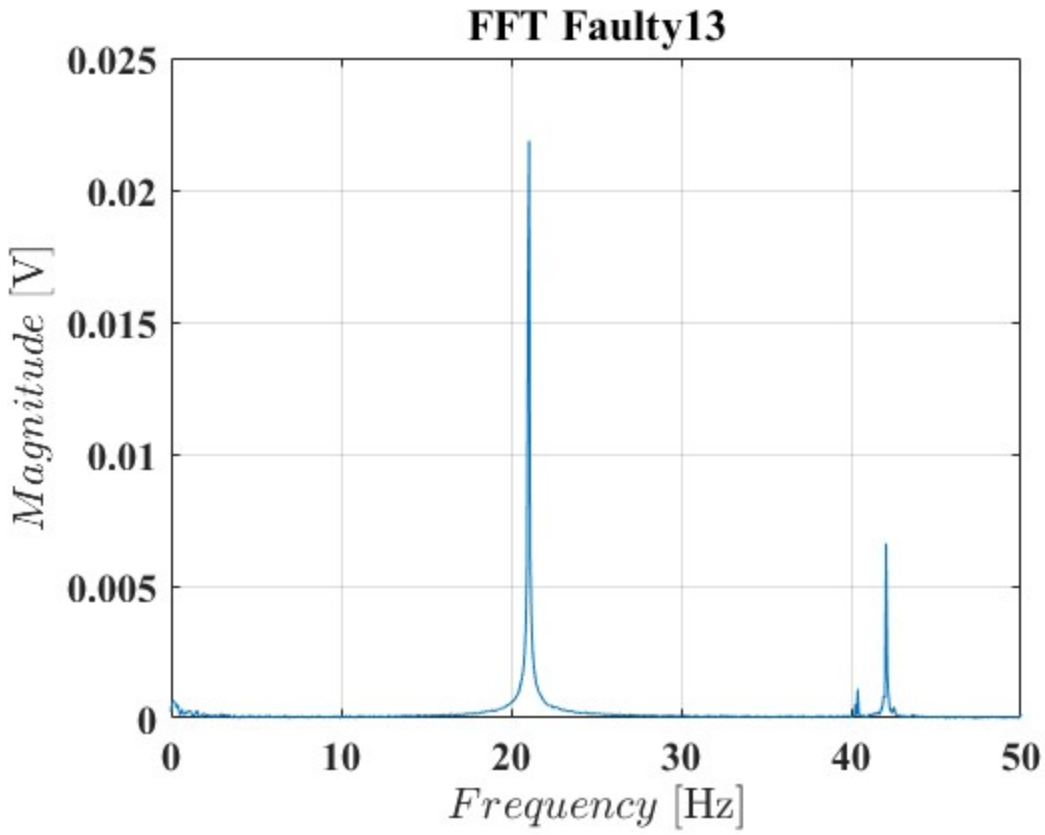

FFT Healthy11
×10-3
2.5
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

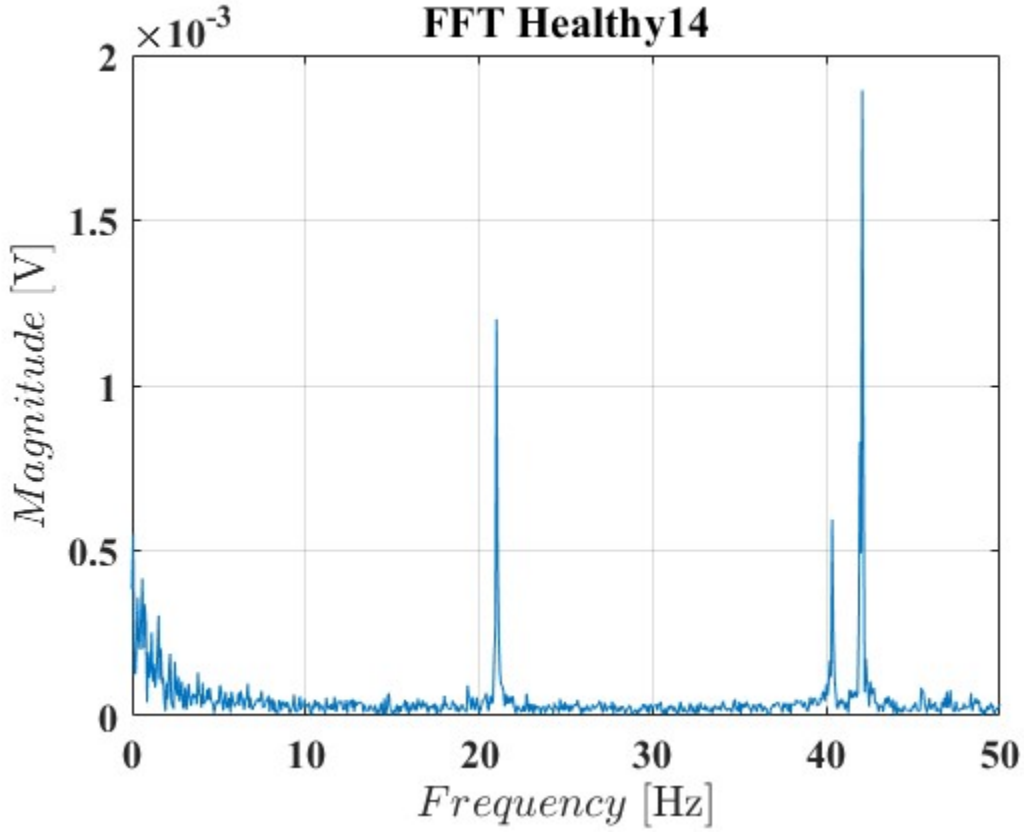

FFT Faulty11
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

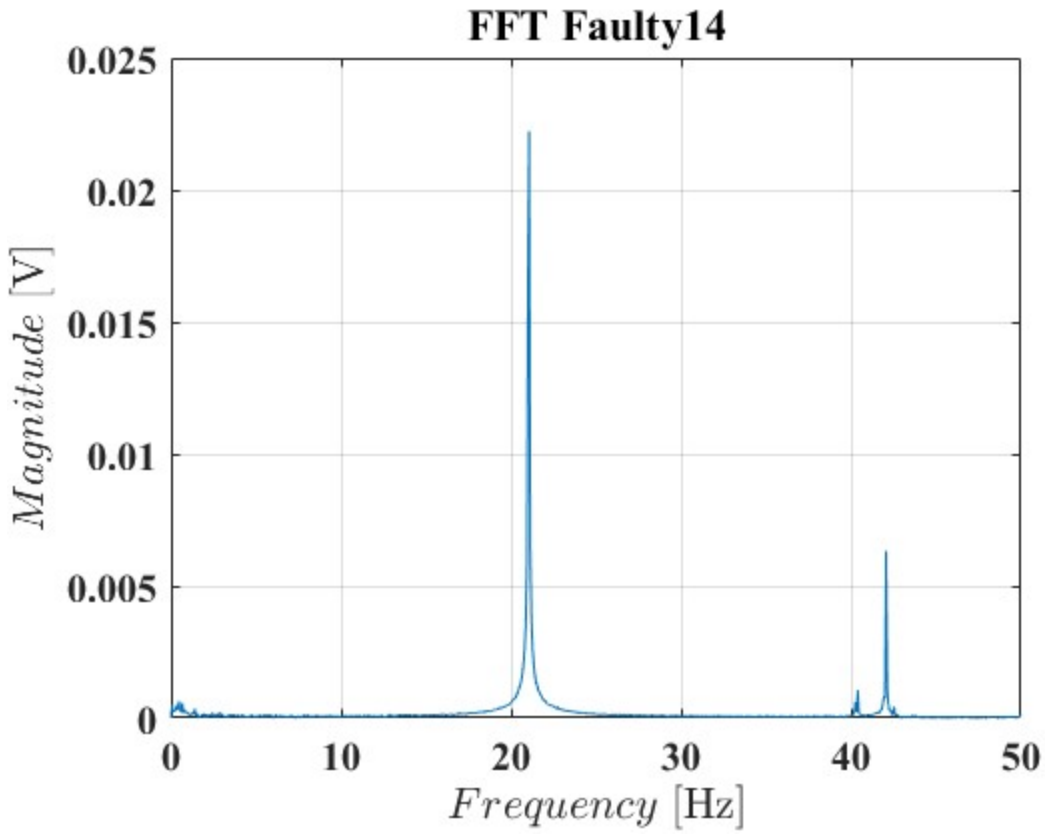

FFT Healthy12
×10-3
5
4
3
2
1
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Faulty12
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Healthy13
×10-3
2.5
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Faulty13
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Healthy14
×10-3
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Faulty14
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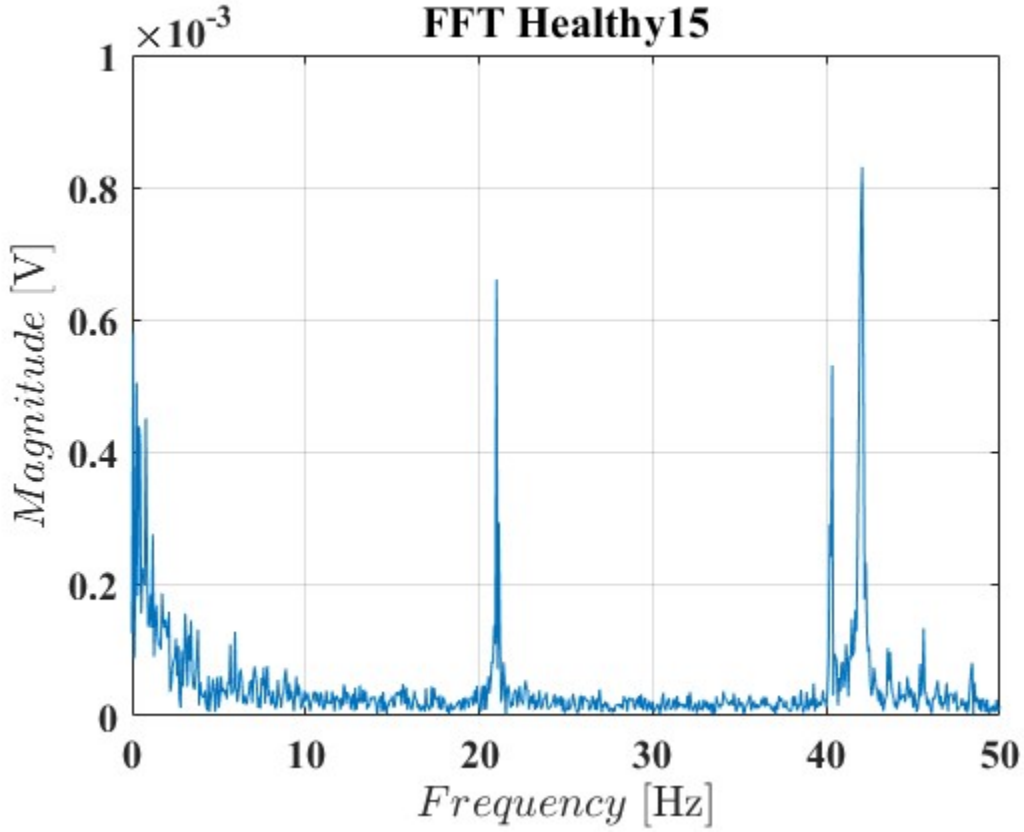
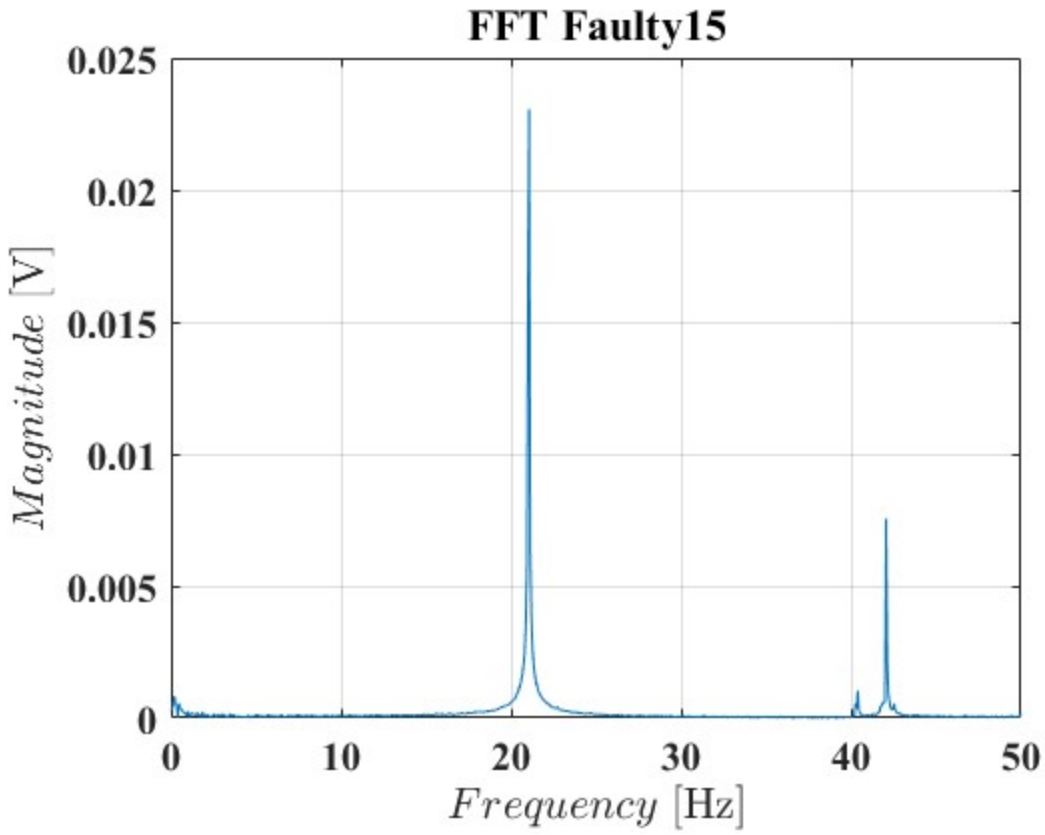
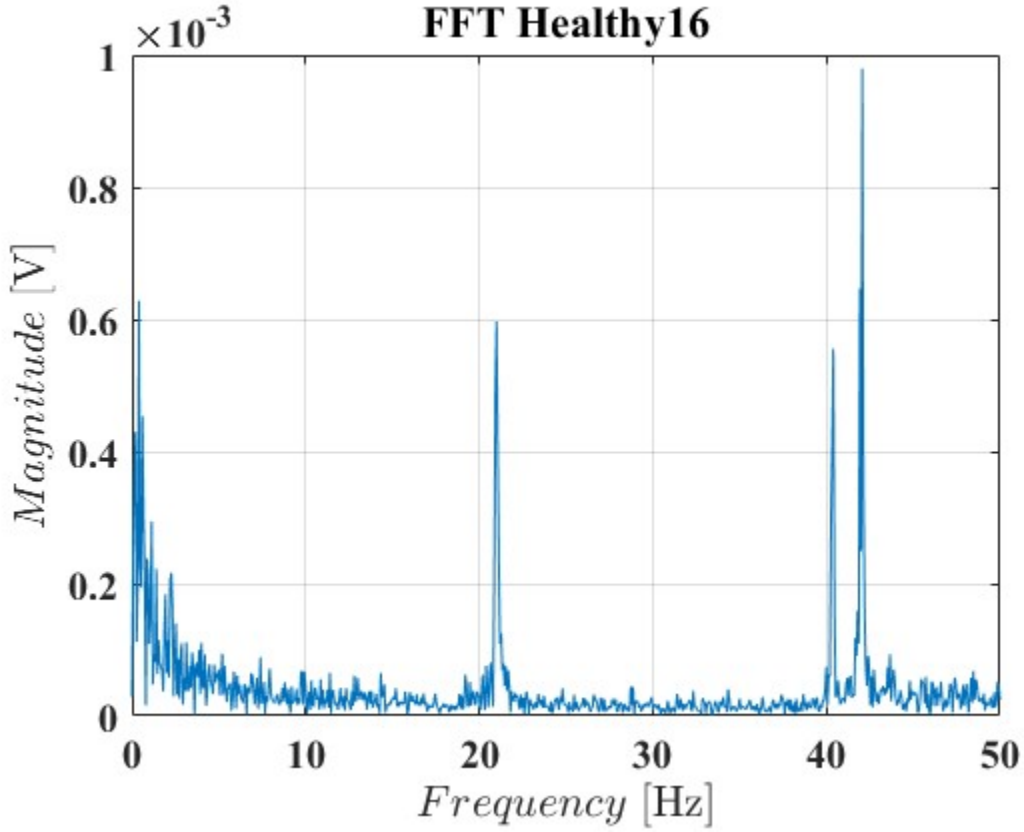
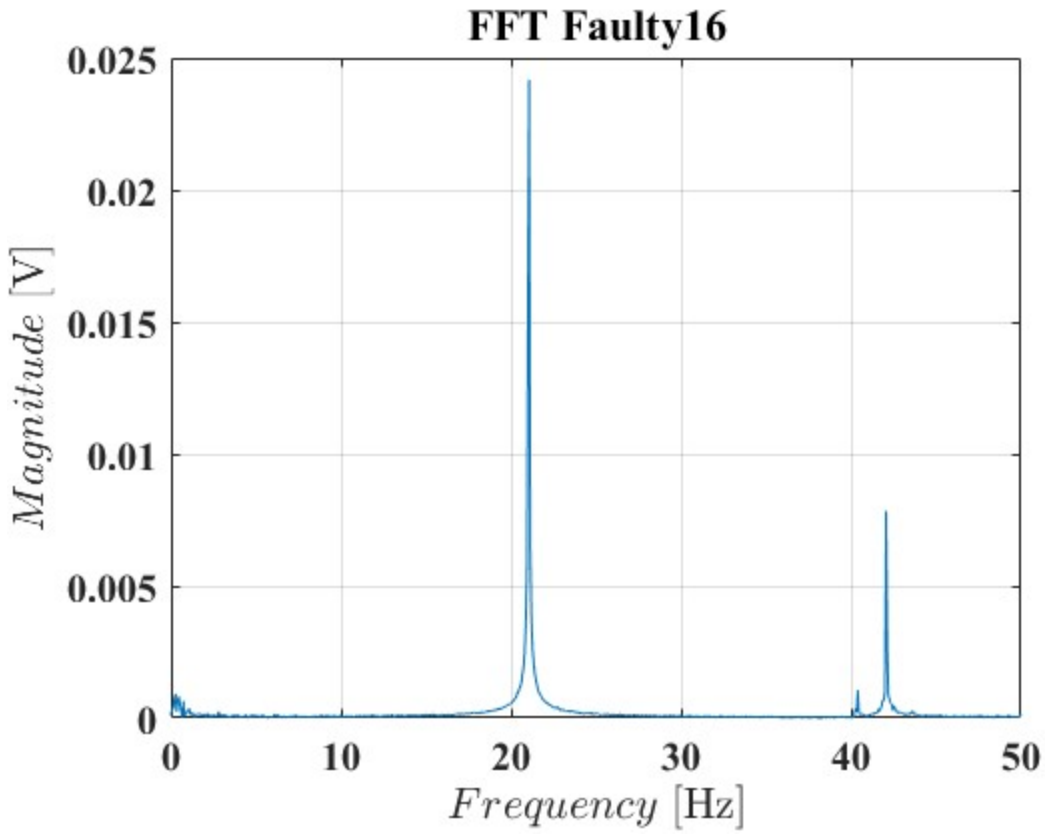
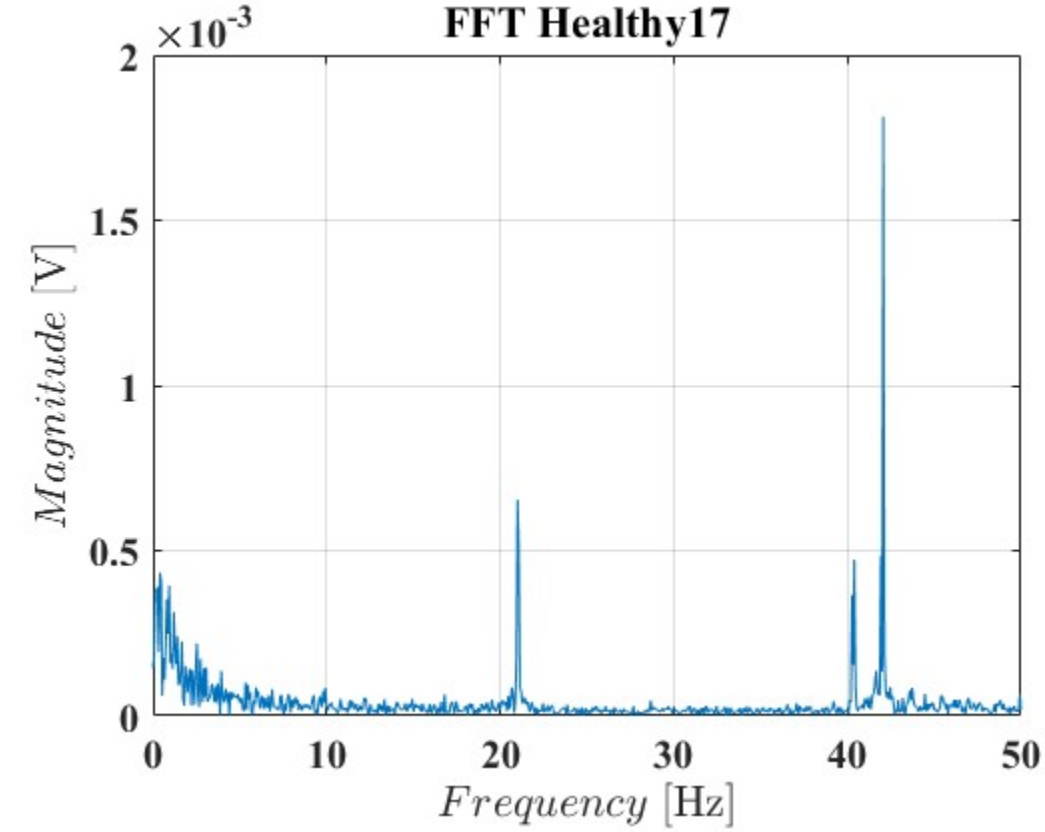
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

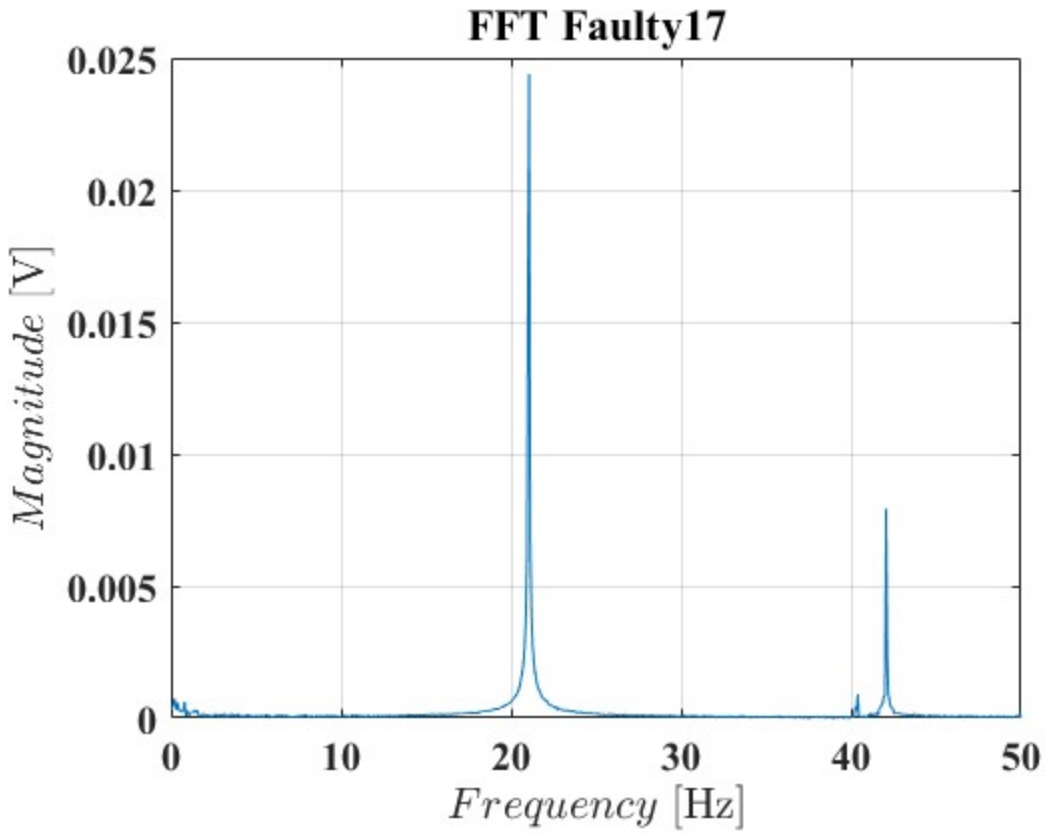

FFT Healthy15
×10-3
1
0.8
0.6
0.4
0.2
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

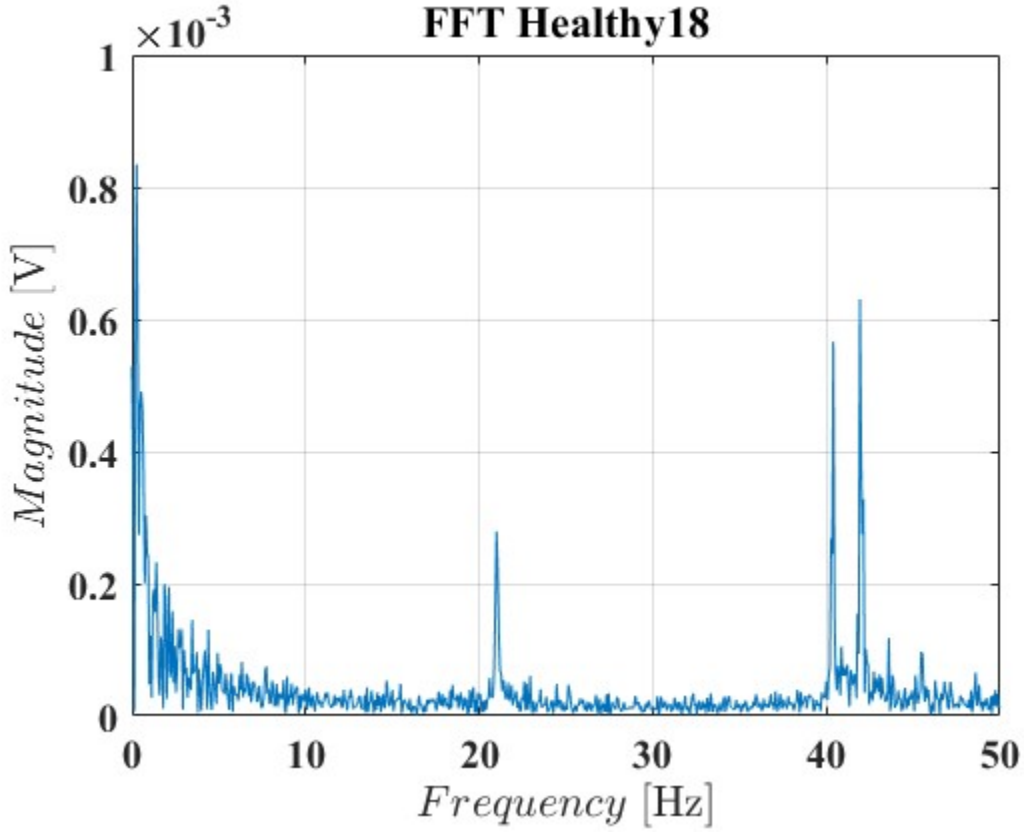

FFT Faulty15
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

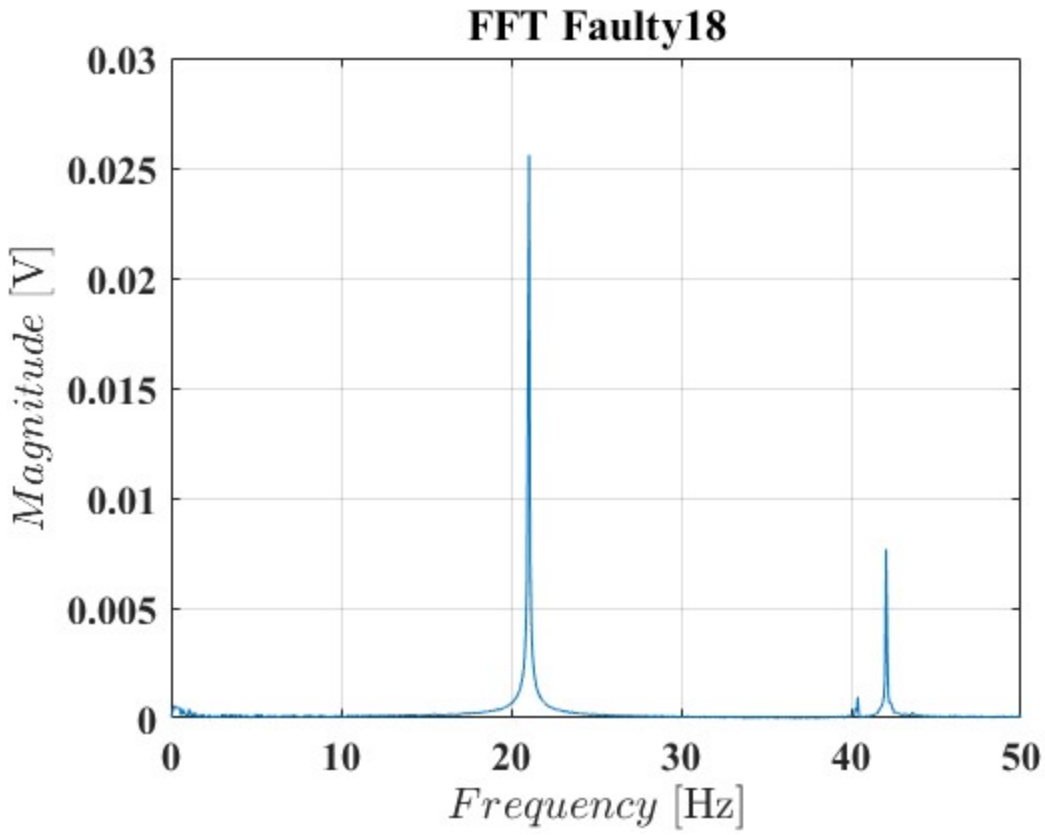

FFT Healthy16
×10-3
1
0.8
0.6
0.4
0.2
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

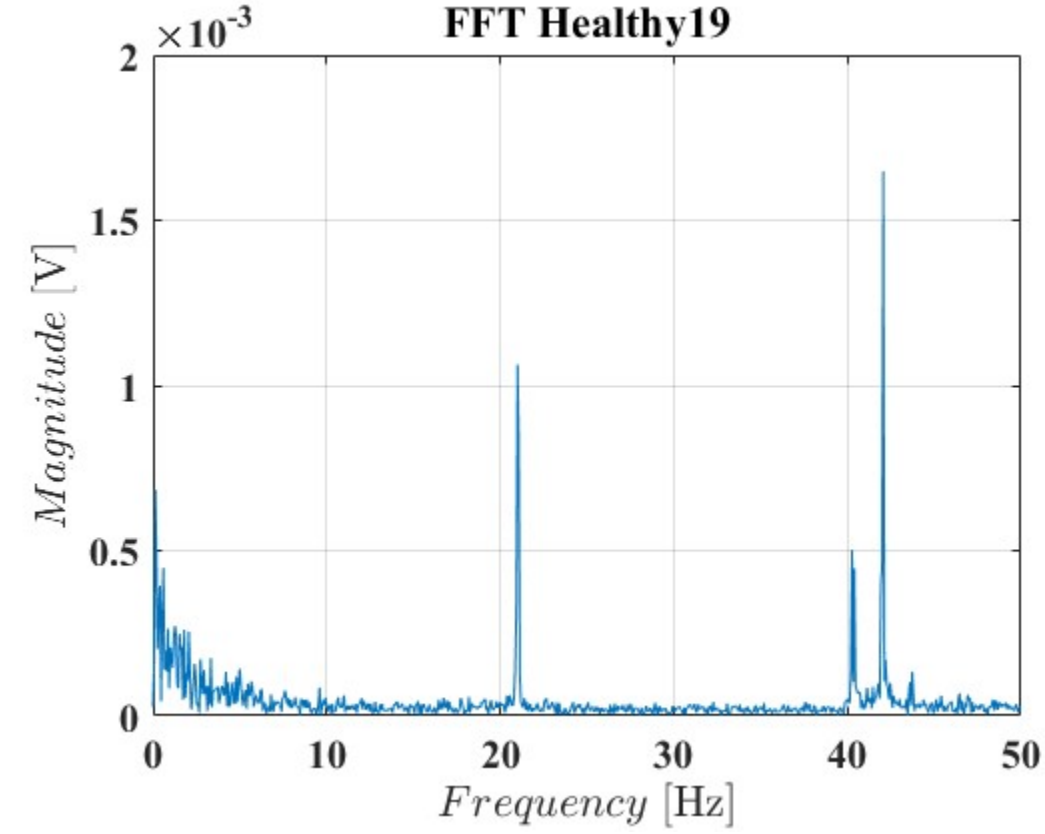

FFT Faulty16
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

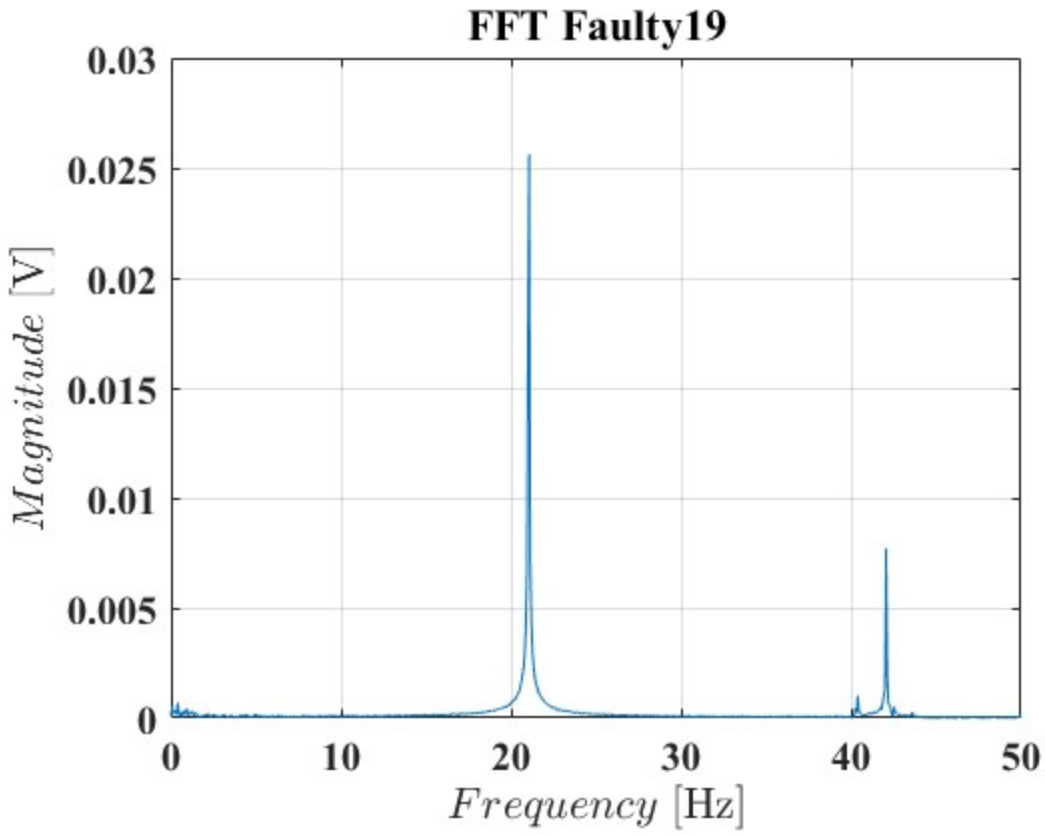

FFT Healthy17
×10-3
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

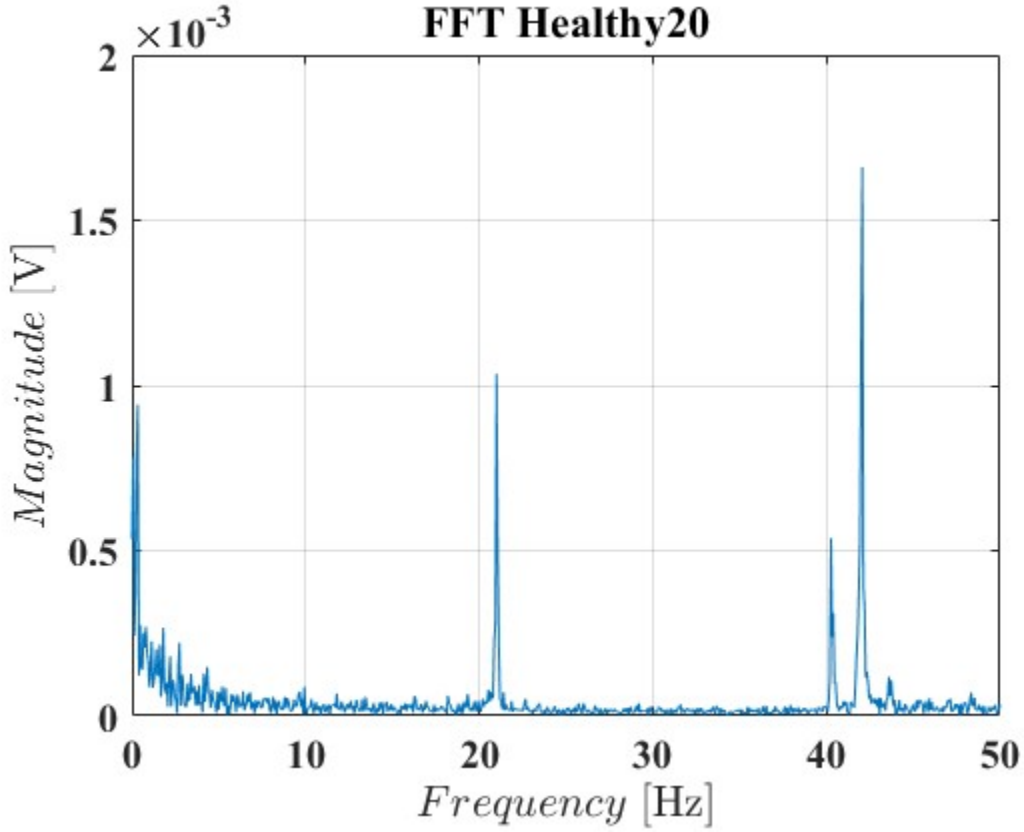

FFT Faulty17
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

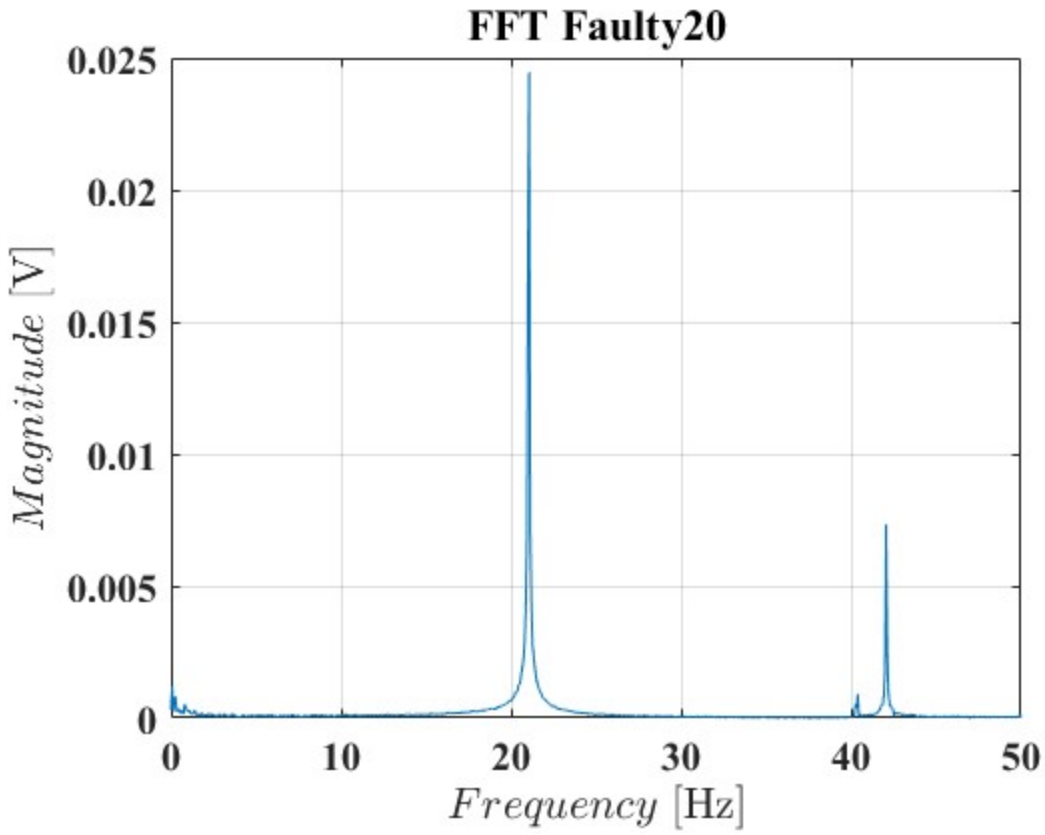

FFT Healthy18
×10-3
1
0.8
0.6
0.4
0.2
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

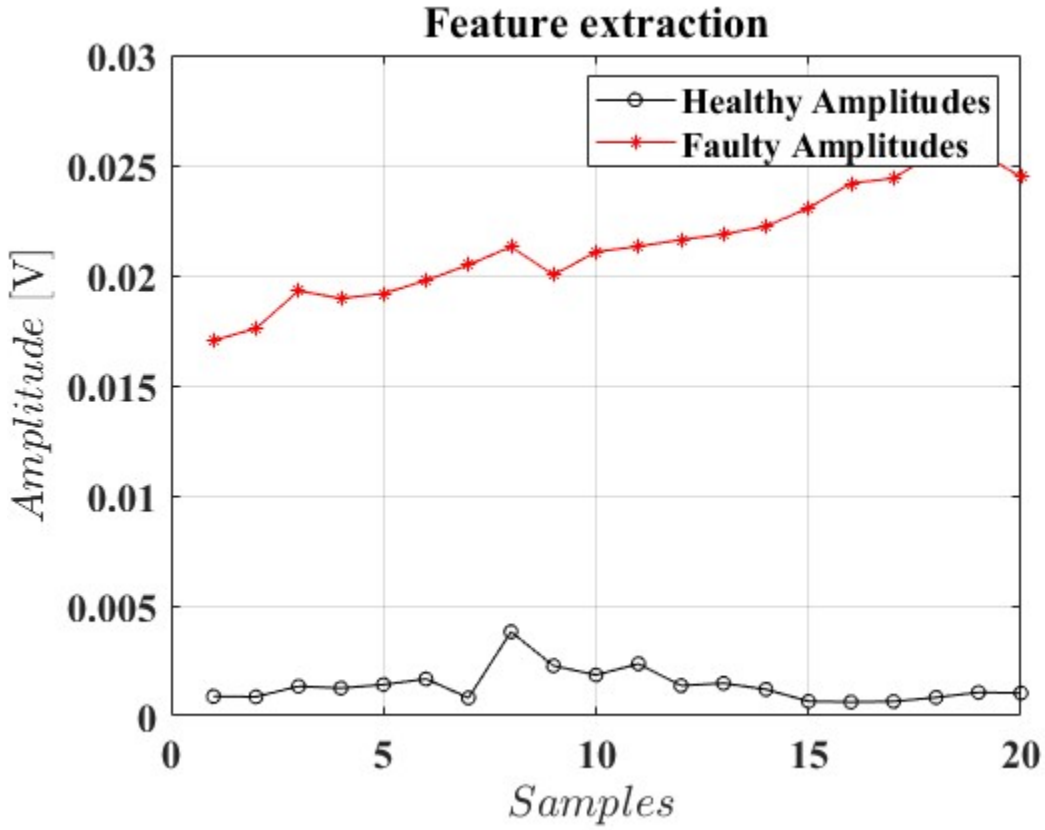

FFT Faulty18
0.03
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Healthy19
×10-3
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Faulty19
0.03
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]


FFT Healthy20
×10-3
2
1.5
1
0.5
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

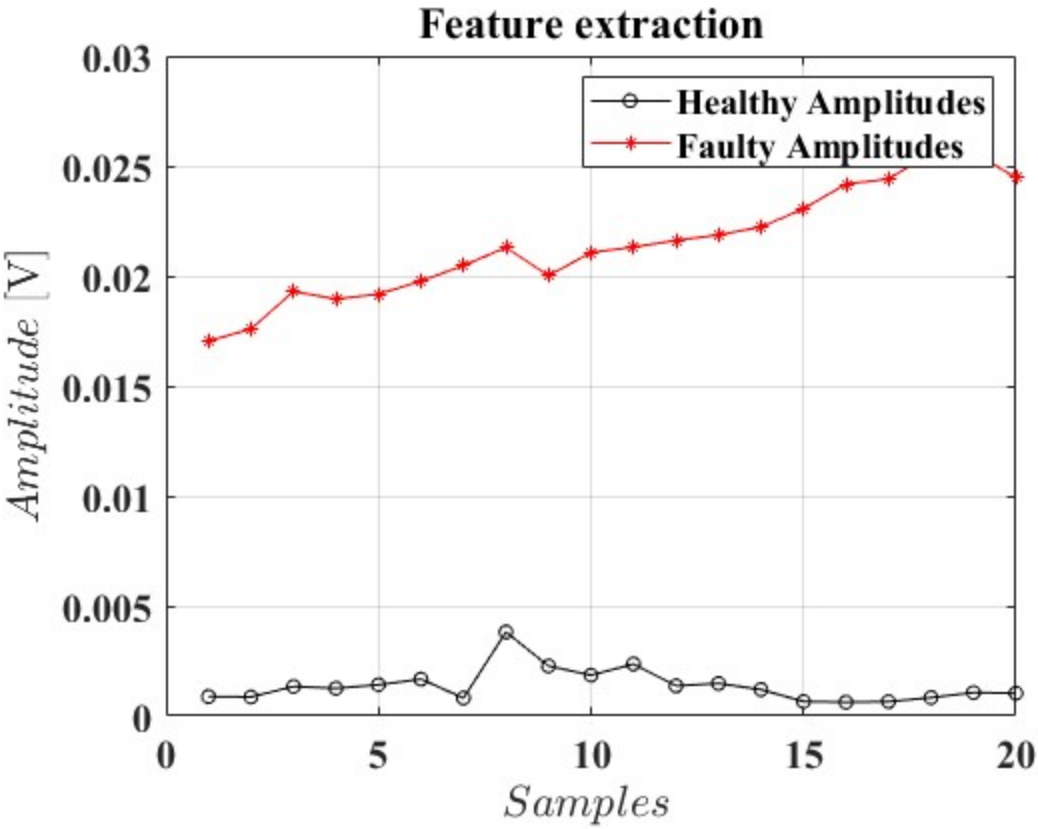

FFT Faulty20
0.025
0.02
0.015
0.01
0.005
0
Magnitude [V]
0
10
20
30
40
50
Frequency [Hz]

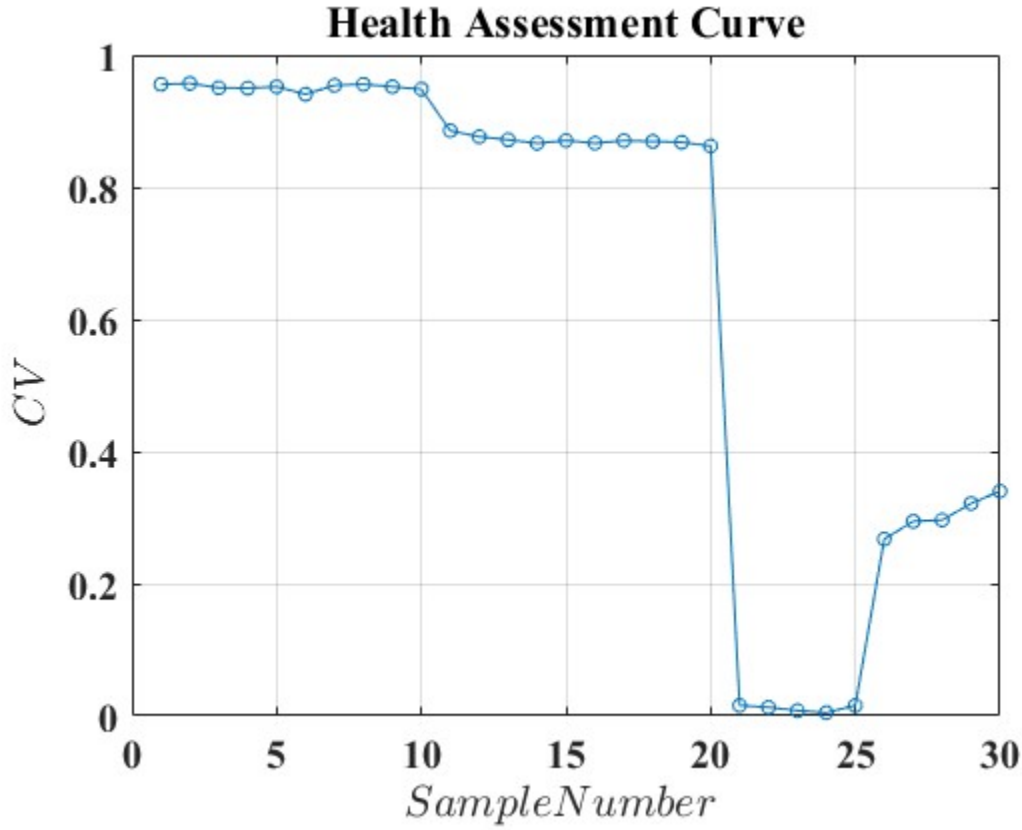

Feature extraction
Healthy Amplitudes
Faulty Amplitudes
0.03
0.025
0.02
0.015
0.01
0.005
0
Amplitude [V]
0
5
10
15
20
Samples

Logistic Regression and Health Value Assessment

```
X = [sort(amplitude_faulty) sort(amplitude_healthy)]';
Xtest = [sort(amplitude_testset)]';
Xtest1 = [(amplitude_testset)]';
y1 = repmat(0.05,1,20);
y2 = repmat(0.95,1,20);
y = [y1 y2]';

b = glmfit(X,y,'binomial','link','logit')
yfit = glmval(b,Xtest1,'logit');

output_training=1./exp(-(b(1)+X*b(2)));
% figure
% plot(output_training,'-o')

% figure
% plot(X, y,'o',Xtest1,yfit,'-','LineWidth',2)
% grid on
% xlabel(['$ x\;\mathrm{} $'],'interpreter','latex')
% ylabel(['$ \pi(x)\;\mathrm{} $'],'interpreter','latex')
% title('LR Curve')
% % legend('Training Data','Logistic Binomial Fit')

figure
plot(1:30,yfit,'-o')
grid on
xlabel(['$ Sample Number\;\mathrm{} $'],'interpreter','latex')
ylabel(['$ CV\;\mathrm{} $'],'interpreter','latex')
title('Health Assessment Curve')
```

```
b =

    3.2823
 -296.2269
```


Feature extraction
Healthy Amplitudes
Faulty Amplitudes
Amplitude [V]
Samples
0.03
0.025
0.02
0.015
0.01
0.005
0
0
5
10
15
20


Health Assessment Curve
CV
SampleNumber
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30

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