LAMPIRAN

Lampiran 1. Script MATLAB Data Akuisisi

```
%Script data acquisition using NI 9234
%Created: July 2019,
clear all;
clc;
close all;

tic;

s = daq.createSession('ni');
s.DurationInSeconds = 10;
Dur = s.DurationInSeconds;
s.Rate = 17066;
%s.addAnalogInputChannel('cDAQ1Mod1','ai0','Accelerometer');
s.addAnalogInputChannel('cDAQ1Mod1', 'ai1','Accelerometer');
%s.addAnalogInputChannel('cDAQ1Mod1','ai2','Accelerometer');
s.addAnalogInputChannel('cDAQ1Mod1', 'ai3', 'Tachometer');

s.Channels(1).Sensitivity = 97.60E-3; %mV/g Type 4507B
serial:11165

for i=1:50
data = s.startForeground();
%data_ch1 = data(:,1);
data_ch2 = data(:,2);
%data_ch3 = data(:,3);
data_ch4 = data(:,4);

rootname = '/Users/mac/Desktop/TA/Data_Gear/All_Normal/';
extension = '.mat';
namafile = [rootname,'Normal',num2str(i),extension];
data_all = [data_ch2] [data_ch4];
```

```
eval(['save ', namafile ,' data_all']);
pause(2)
pesan = ['Acquiring and saving data at loop',num2str(i)];
disp(pesan)
end
```

Lampiran 2. Script MATLAB *Time Synchronous Averaging*

```
% Script Time Synchronous Averaging (TSA)
clear all;
close all;
clc;

%Load data dan masukkan Input
load('/Users/mac/Desktop/TA/Data_Gear/TSABaru/TSANormal/normalTSA3.mat');
fs = 17066;                          %frekuensi sampling Hz (fs)
f0 = 10;              %Durasi pengambilan sampel (detik) (fo)
x = data_all (:,1);                              %semua data (x)
tacho = data_all (:,2);           %semua data tachometer (tp)
L = fs*f0;                   %panjang data (length of singnal)
NFFT = 2^nextpow2(L);       %next power of 2 from length of y
Y = fft (x,NFFT)/L;
[rpm,t,tp] = tachorpm(tacho,fs);
ta = tsa(x,fs,tp,'Numrotations',10);

L2 = length(ta);        %panjang data ke 2 (length of signal)
f = fs/2*linspace(0,1,NFFT/2+1);
Amplitude2 = 2*abs(Y2(1:NFFT/2+1));

%Plot Amplitude Domain Waktu
figure (1)
plot (x)
title('Domain Waktu sebelum TSA Gear Normal')
xlabel('sampel')
ylabel('Amplitude')
```

```
%Plot Single-Sided Amplitude Spectrum
figure (2)
plot (f,Amplitude)
title('Spectrum Sebelum TSA Gear Normal')
xlabel('Frequency (Hz)')
ylabel('Amplitude')

%Plot Amplitude Domain Waktu Setelah TSA
figure (3)
plot (ta)
title('Domain Waktu Setelah TSA Gear Normal')
xlabel('Sampel')
ylabel('amplitude')

%Plot Single-Sided Amplitude Spectrum Setelah TSA
figure (4)
plot (f,Amplitude2)
title('Spectrum Setelah TSA Gear Normal')
xlabel('Frequency (Hz)')
ylabel('Amplitude')
```

Lampiran 3. Script MATLAB Plot Domain Waktu

```
% Plot Domain Waktu
clear all;
close all;
clc;
%% Initialization
load('/Users/mac/Desktop/TA/Data_Gear/All_Normal/')
y1=data_all(:,1);

load('/Users/mac/Desktop/TA/Data_Gear/All_Level1Cacat/Leve')
y2=data_all(:,1);
```

```
load('/Users/mac/Desktop/TA/Data_Gear/All_Level2Cacat/Leve')
y3=data_all(:,1);

%% Plot Amplitudo of each Data
figure
subplot(3,1,1)
plot(y1(1:170660),'g')
axis([0 7000 -20 20])
legend('Normal')

subplot(3,1,2)
plot(y2(1:170660),'b')
axis([0 7000 -20 20])
legend('Cacat1')

subplot(3,1,3)
plot(y3(1:170660),'r')
axis([0 7000 -20 20])
legend('Cacat2')
xlabel('Sampel')
```

Lampiran 4. Script MATLAB Esktraksi Parameter Statistik Domain Waktu

```
%% PARAMETER STATISTIK DOMAIN WAKTU
% edited on 21/8/19

close all
clear all
clc

%% Normal Datasets
for d=(1:500)
signal_in=['/Users/mac/Desktop/TA/Data_Gear/All_Normal/Norma
l',int2str(d),'.mat'];
```

```
load (signal_in)

a=data_all(:,1);

RMS(d)=rms(a);
SD(d)=std(a);
Peak_Value(d)=((max(abs(a))-min(abs(a)))/2);
Kurtosis(d)=kurtosis(a);
Variance(d)=var(a);
Crest_Factor(d)=peak2rms(a);
Mean(d)=mean(a);
Entropy(d) = entropy(a);
Min(d)= min(a);

x=1:500;

Normaltrai=zeros(500,12);

RMS=RMS';
SD=SD';
Peak_Value=Peak_Value';
Kurtosis=Kurtosis';
Variance=Variance';
Crest_Factor=Crest_Factor';
Mean=Mean';
Entropy=Entropy';
Min = Min';
end

%% Cacat1
for di=(1:500)
signal_in=['/Users/mac/Desktop/TA/Data_Gear/All_Level1Cacat/
Level1Cacat',int2str(di),'.mat'];
load (signal_in)
```

```
b=data_all(:,1);

RMS1(di)=rms(b);
SD1(di)=std(b);
Peak_Value1(di)=((max(abs(b))-min(abs(b)))/2);
Kurtosis1(di)=kurtosis(b);
Variance1(di)=var(b);
Crest_Factor1(di)=peak2rms(b);
Mean1(di)=mean(b);
Entropy1(di) = entropy(b);
Min1(di)= min(b);

x1=1:500;

Cacattest=zeros(500,12);

RMS1=RMS1';
SD1=SD1';
Peak_Value1=Peak_Value1';
Kurtosis1=Kurtosis1';
Variance1=Variance1';
Crest_Factor1=Crest_Factor1';
Mean1=Mean1';
Entropy1=Entropy1';
Min1 = Min1';
end

%% Cacat2
for dii=(1:500)
signal_in=['/Users/mac/Desktop/TA/Data_Gear/All_Level2Cacat/
Level2Cacat',int2str(dii),'.mat'];
load (signal_in)
```

```
c=data_all(:,1);

RMS2(dii)=rms(c);
SD2(dii)=std(c);
Peak_Value2(dii)=((max(abs(c))-min(abs(c)))/2);
Kurtosis2(dii)=kurtosis(c);
Variance2(dii)=var(c);
Crest_Factor2(dii)=peak2rms(c);
Mean2(dii)=mean(c);
Entropy2(dii) = entropy(c);
Min2(dii)= min(c);
x2=1:500;

Cacat2test=zeros(500,12);

RMS2=RMS2';
SD2=SD2';
Peak_Value2=Peak_Value2';
Kurtosis2=Kurtosis2';
Variance2=Variance2';
Crest_Factor2=Crest_Factor2';
Mean2=Mean2';
Entropy2=Entropy2';
Min2 = Min2';
end

%% PLOTTING
%RMS
figure
s=14;
c='r';
scatter(x,(RMS),s,c,'v');
hold on
s=14;
```

```
c='b';
scatter(x1,(RMS1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(RMS2),s,c,'g');
hold on
axis([0 500 0 5])
title('Grafik RMS')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%SD
figure
s=14;
c='r';
scatter(x,(SD),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(SD1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(SD2),s,c,'g');
hold on
axis([0 500 0 5])
title('Grafik Standar Deviasi')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Peak
figure
s=14;
```

```
c='r';
scatter(x,(Peak_Value),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(Peak_Value1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Peak_Value2),s,c,'g');
hold on
axis([0 500 1 30])
title('Grafik Peak Value')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Kurtosis
figure
s=14;
c='r';
scatter(x,(Kurtosis),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(Kurtosis1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Kurtosis2),s,c,'g');
hold on
axis([0 500 2 19])
title('Grafik Kurtosis')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')
```

```
%Variance
figure
s=14;
c='r';
scatter(x,(Variance),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(Variance1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Variance2),s,c,'g');
hold on
axis([0 500 0 18])
title('Grafik Variance')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Crest
figure
s=14;
c='r';
scatter(x,(Crest_Factor),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(Crest_Factor1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Crest_Factor2),s,c,'g');
hold on
```

```
axis([0 500 2 20])
title('Grafik Crest Factor')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Mean
figure
s=9;
c='r';
scatter(x,(Mean),s,c,'v');
hold on
s=9;
c='b';
scatter(x1,(Mean1),s,c,'x');
hold on
s=9;
c='h';
scatter(x2,(Mean2),s,c,'g');
hold on
axis([0 500 0 0.009])
title('Grafik Mean')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Entropy
figure
s=9;
c='r';
scatter(x,(Entropy),s,c,'v');
hold on
s=9;
c='b';
scatter(x1,(Entropy1),s,c,'x');
hold on
```

```
s=9;
c='h';
scatter(x2,(Entropy2),s,c,'g');
hold on
axis([0 500 2 4])
title('Grafik Entropy')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Min
figure
s=9;
c='r';
scatter(x,(Min),s,c,'v');
hold on
s=9;
c='b';
scatter(x1,(Min1),s,c,'x');
hold on
s=9;
c='h';
scatter(x2,(Min2),s,c,'g');
hold on
axis([0 500 -60 -8])
title('Grafik Minimum')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%Skweness
figure
s=14;
c='r';
scatter(x,(Skewness),s,c,'v');
hold on
```

```
s=14;
c='b';
scatter(x1,(Skewness1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Skewness2),s,c,'g');
hold on
axis([0 500 -0.1 0.25])
title('Grafik Skewness')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')

%max
figure
s=14;
c='r';
scatter(x,(Max),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(Max1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Max2),s,c,'g');
hold on
axis([0 500 0 60])
title('Grafik Max')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')
%Median
figure
s=14;
```

```
c='r';
scatter(x,(Median),s,c,'v');
hold on
s=14;
c='b';
scatter(x1,(Median1),s,c,'x');
hold on
s=14;
c='h';
scatter(x2,(Median2),s,c,'g');
hold on
axis([0 500 -0.05 0.05])
title('Grafik Median')
xlabel('Sampel'),ylabel('Amplitudo')
legend ('Normal','Cacat1','Cacat2')
```

Lampiran 5. Script MATLAB Seleksi Parameter Statistik

```
% Relief Feature Selection
clear;
close all;
clc;

% Datasets Preparation
load /Users/mac/Desktop/TA/Data_SVM/21819_SVM.mat;
X = input;                                    % Predictor
Y = Kondisi;                                  % Response

% Selection Process
[ranks,weights] = relieff(X,Y,1500);
ClassName = ranks;

% Plotting
bar(weights(ranks));
xlabel('Predictor rank');
```

```
ylabel('Predictor importance weight');
h = gca;
h.XTickLabel = ({'Peak
Value','Minimum','Maximum','Kurtosis','Entropy','Crest
Factor','S D','RMS','Variance','Median','Skewness','Mean'});
h.XTickLabelRotation = 45;
title('Relieff Feature Selection');
hold on
```

Lampiran 6. Script MATLAB Klasifikasi *Binary SVM*

```
%% BINARY SVM
clear all;
close all;
clc;

%% INPUT DATA
load /Users/mac/Desktop/TA/Data_SVM/21819_SVM.mat;
X = Data_Training(1:700,[3,4]);
X1 = Data_Testing(1:300,[3,4]);
Y = Kondisi1(1:700);

% TRAINING DATASETS
X_train = X;
% N&C1
Y_train = jenis;                                                    %
N&C1

% TESTING DATASETS
X_test = X1;
Y_test = jenis1;

%% Train Optimal Hyperparameter
Mdl = fitcsvm(X_train,Y_train,'KernelFunction','rbf',...
```

```
'OptimizeHyperparameters','auto','HyperparameterOptimization
Option',...
    struct('AcquisitionFunctionName','expected-improvement-
plus',...
    'ShowPlots',true));

ClassOrder = Mdl.ClassNames;

%% Training Model Evaluation Process
[Label,Score] = predict(Mdl,X_test);
Accuracy = sum(predict(Mdl,X_test) ==
Y_test)/length(Y_test)*100;

%% Hyperplane
sv = Mdl.SupportVectors;

%% Plotting Training
figure;
legend('Normal','Cacat 1','Support Vector');
xlabel ('Peak Value')
ylabel ('Kurtosis')
hold on

%% Plotting Testing
figure;
gscatter(X_test(:,1),X_test(:,2),Y1,'br','vx',6);
title('Testing Normal dan Cacat 1');
xlabel ('Peak Value')
ylabel ('Kurtosis')
hold on
```

Lampiran 7. Script MATLAB Klasifikasi *Multi-Class SVM*

```
%% KLASIFIKASI MULTI-CLASS SVM
clear;
close all;
clc;

%% Prepare Datasets
load /Users/mac/Desktop/TA/Data_SVM/21819_SVM.mat;
%% Training Datasets
X = Data_Training(1:1050,[3 4]);
Y = Kondisi1(1:1050,:);

X_train = X;
Y_train = Y;
%%
t = templateSVM('KernelFunction','rbf');
Mdl =
fitcecoc(X_train,Y_train,'Coding','onevsall','Learners',t,'P
rior','uniform','ClassNames',{'Normal','Cacat1','Cacat2'},..
'Verbose',0,'OptimizeHyperparameters','auto','Hyperparameter
OptimizationOptions',...
    struct('AcquisitionFunctionName','expected-improvement-
plus'));

ClassOrder = Mdl.ClassNames;
%%
Mdl.ClassNames

%% Testing Data
X_test = Data_Testing(1:450,[3 4]);
Y_test = Kondisi2(1:450,:);

%% confusion matrix
CVMdl = crossval(Mdl);
[Label,Score] = predict(Mdl,X_test);
```

```
ConfMat = confusionmat(Y_test,Label);
[n,p] = size(X_test);
isLabels = unique(Y_test);
nLabels = numel(isLabels); tabulate(categorical(Y_test));
[~,grpOOF] = ismember(Label,isLabels);
oofLabelMat = zeros(nLabels,n);
%% Plot Confusion Matrix
figure;
plotconfusion(YMat,oofLabelMat);
h = gca;
%% Plot Training Data
jenis1 = grp2idx(Y_train);

%%
figure;
gscatter(X_train(:,1),X_train(:,2),jenis1);
legend('Normal','Cacat1','Cacat2');
title('Training Data Multiclass')
xlabel('Kurtosis'),
ylabel('SNR'),
legend('Normal','Cacat1','Cacat2');
hold on
%% PLOT TESTING
jenis2 = grp2idx(Y_test);

%%
figure;
gscatter(X_test(:,1),X_test(:,2),jenis2);
legend('Normal','Cacat1','Cacat2');
title('Testing Data Multiclass')
xlabel('Kurtosis'),
ylabel('SNR'),
legend('Normal','Cacat1','Cacat2');
hold on
```