Contents

1 Signal Based PM

Signal-Based Predictive Maintenance.

General

Workflow

1.1 Sensors

Sensors comparison, cost.

1.2 Data exploring

Data has been collect from 8 types of sensors corresponding table **??**:

Signal name	Description
FlowExtrusin	Flow sensor
FlowContraction	Flow sensor
AirPressure	Pressure sensor
AccelerometerMoving_axisY	Accelerometer
AccelerometerMoving_axisY	Position encoder
	Accelerometer
	Temperature sensor
	Proximity sensor
	Strain gauge
	Microphones

Table 1: Measured signals

There are 660 measurements with different parameters system parameters **??**.

Adjusting valve 1	
Adjusting valve 2	

Table 2: Device parameters

Dataset was divided to 5 main categories.

Data has been accumulated to ".mat" files. Each file contains signals from sensors during 10 seconds measurements with different pneumatic actuator configuration. Example results from one experiment are represented in figures **??**, **??**.

1.3 Data management

Data Ensembles Data files have been reshaped to Data Ensembles format used for Condition monitoring purposes. This format allows processing data without copying the whole dataset to memory at once but processes them one by one. In large datasets it gives an option to manipulate with data without problems with allocated memory.

1.4 Preprocessing

Measured signals require preprocessing concerning the preservation of the information base. For smoothing data Moving Average function were used. As an example, the figure **??** is shown the "raw" and filtered signals. The whole dataset of preprocessed data is relatively big. For time-saving, parallel computing was used for all computationally demanding parts of the code.

1.5 Condition Indicators extraction

For classification task purpose from the signals have been extracted statistical features such as mean, median, peak to peak value, etc. As a condition "FaultCode" variable were used. This variable represent configuration of pneumatic actuator during the measurement.

All calculated features were added to the dataset and were ranked by Kruskal-Wallis ANOVA algorithm. Following table **??** contain 5 first best features ranked for classification purpose.

1.	LeverPosition_Stat_Var	Lever position variance
2.	StrainGauge_Stat_Mean	Strain gauge mean value
3.	StrainGauge_Stat_Skewness	Strain gauge Skewness value
4.	LeverPosition_Stat_RMS	Lever position Root mean square level
5.	LeverPosition_Stat_mean	Lever position mean value

Table 3: First 5 ranked features

1.5.1 Microphones

Cheap

1.6 Classification Task

The main goal of the classification task is to train a model that can predict the "FaultCode" of pneumatic actuator configuration by calculated features. Respecting to table **??**, the first five features have been used to find the best classification model for our data. Principal component analysis (PCA) has been used to reduce the number of features and chose the best representants. The trained model has been exported to **models/** directory. The confusion matrix of the trained classification model shown in figure **??**. Model accuracy on validation data is $\approx 93\%$ **??**.