MAFAULDA

Machinery Fault Database [Online]

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1. Database Description

1.1. Introduction

This database is composed of 1951 multivariate time-series acquired by sensors on a SpectraQuest's Machinery Fault Simulator (MFS) Alignment-Balance-Vibration (ABVT). The 1951 comprises six different simulated states: normal function, imbalance fault, horizontal and vertical misalignment faults and, inner and outer bearing faults. This section describes the database.

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1.2. Experimental Bench Specifications

The used SpectraQuest Inc. Alignment/Balance Vibration Trainer (ABVT) Machinery Fault Simulator (MFS).

Specification	Value	Unit
Motor	1/4	CV DC
Frequency range	700-3600	rpm
System weight	22	kg
Axis diameter	16	mm
Axis length	520	mm
Rotor	15.24	cm
Bearings distance	390	mm

Specification	Value	Unit
Number of balls	8	
Balls diameter	0.7145	cm
Cage diameter	2.8519	cm
FTF	0.3750	CPM/rpm
BPFO	2.9980	CPM/rpm
BPFI	5.0020	CPM/rpm
BSF	1.8710	CPM/rpm

1.3. Data Acquisition System

- Three **Industrial IMI Sensors, Model 601A01** accelerometers on the radial, axial and tangencial directions:

- **Sensibility**
  (±20%) 100 mV per g (10.2 mV per m/s^2);

- **Frequency range**
  (±3 dB) 16-600000 CPM (0.27-10.000 Hz);

- **Measurement range**
  ±50 g (±490 m/s^2).

- One **IMI Sensors triaxial accelerometer, Model 604B31**, returning data over the radial, axial and tangencial directions:

  - **Sensibility**
    (±20%) 100 mV per g (10.2 mV per m/s^2);

  - **Frequency range**
    (±3 dB) 30-300000 CPM (0.5-5.000 Hz);

  - **Measurement range**
    ±50 g (±490 m/s^2)

- **Monarch Instrument MT-190** analog tachometer

- **Shure SM81** microphone with frequency range of 20-20.000 Hz

- Two **National Instruments NI 9234** 4 channel analog acquisition modules, with sample rate of 51.2 kHz

1.4. Sequences

Each sequence was generated at a 50 kHz sampling rate during 5 s, totaling 250.000 samples. Below its a summary of each type of sequence:

Sequence	Measurements
Normal	49
Horizontal misalignment	197
Vertical misalignment	301
Imbalance	333
Underhang bearing	
Cage fault	188
Outer race	184
Ball fault	186
Overhang bearing	
Cage fault	188
Outer race	188
Ball fault	137
Total	**1951**

1.4.1. Normal Sequences

There are 49 sequences without any fault, each with a fixed rotation speed within the range from 737 rpm to 3686 rpm with steps of approximately 60 rpm.

1.4.2. Imbalance Faults

Simulated with load values within the range from 6 g to 35 g. For each load value below 30 g, the rotation frequency assumed in the same 49 values employed in the normal operation case. For loads equal to or above 30 g, however, the resulting vibration makes impracticable for the system to achieve rotation frequencies above 3300 rpm, limiting the number of distinct rotation frequencies. The table below presents the number of sequences per weight.

Weight (g)	Measurements
6	49
10	48
15	48
20	49
25	47
30	47
35	45
Total	**333**

1.4.3. Horizontal Parallel Misalignment

This type of fault was induced into the MFS by shifting the motor shaft horizontally of 0.5 mm, 1.0 mm, 1.5 mm, and 2.0 mm. Using the same range for the rotation frequency as in the normal operation for each horizontal shift, the table below presents the number of sequences per degree of misalignment.

Misalignment (mm)	Measurements
0.50	50
1.00	49
1.50	49
2.00	49
Total	**197**

1.4.4. Vertical Parallel Misalignment

This type of fault was induced into the MFS by shifting the motor shaft horizontally of 0.51 mm, 0.63 mm, 1.27 mm, 1.40 mm, 17.8 mm and 1.90 mm. Using the same range for the rotation frequency as in the normal operation for each vertical shift, the table below presents the number of sequences per degree of misalignment.

Misalignment (mm)	Measurements
0.51	51
0.63	50
1.27	50

1.40	50
1.78	50
1.90	50
Total	**301**

1.4.5. Bearing Faults

As one of the most complex elements of the machine, the rolling bearings are the most susceptible elements to fault occurrence. The ABVT manufacturer provided three defective bearing, each one with a distinct defective element (outer track, rolling elements, and inner track), that were placed one at a time in two different positions in the MFS experimental stand: between the rotor and the motor (underhang position), or in the external position, having the rotor between the bearing and the motor (overhang position). Bearing faults are practically imperceptible when there is no imbalance. So, three masses of 6 g, 20 g, and 35 g were added to induce a detectable effect, with different rotation frequencies as before.

Underhang

The table below presents the underhang cases with outer track faults.

Weight (g)	Measurements
0	49
6	48
20	49
35	42
Total	**188**

The table below presents the underhang cases with rolling elements faults.

Weight (g)	Measurements
0	49
6	49
20	49
35	37
Total	**184**

The table below presents the underhang cases with inner track faults.

Weight (g)	Measurements
0	50
6	49
20	49
35	38
Total	**186**

The underhang has a total of **558** sequences.

Overhang

The table below presents the overhang cases with outer track faults.

Weight (g)	Measurements
0	49
6	49
20	49
35	41
Total	**188**

The table below presents the overhang cases with rolling elements faults.

Weight (g)	Measurements
0	49
6	49
20	49
35	41
Total	**188**

The table below presents the overhang cases with inner track faults.

Weight (g)	Measurements
0	49
6	43
20	25
35	20
Total	**137**

The overhang sequences totaling **513**.

2. Machinery Fault Database [Online]

The following table contains links to entire parts of this database, joined in as a single package.

Description	Tgz File	Size (GB)	Zip File	Size (GB)
All Data	Download	13.0	Download	13.0
Normal (No fault)	Download	0.3	Download	0.3
Horizontal Misalignment	Download	1.4	Download	1.4
Vertical Misalignment	Download	2.1	Download	2.1
Imbalance	Download	2.3	Download	2.3
Underhang Bearing	Download	3.7	Download	3.7
Overhang Bearing	Download	3.4	Download	3.4

The database is composed by several **CSV** (*Comma-Separated Values*) files, each one with 8 columns, one column for each sensor, according to:

- **column 1**
  tachometer signal that allows to estimate rotation frequency;

- **columns 2 to 4**
  underhang bearing accelerometer (axial, radiale tangential direction);

- **columns 5 to 7**
  overhang bearing accelerometer (axial, radiale tangential direction);

- **column 8**
  microphone.

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