Motor Bearings Fault Classification using CatBoost Classifier

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Introduction

- Induction motors are used in all industries and are the **major element of energy consumption**.
- Faults in the motor degrade the **motor efficiency** and result in more energy consumption.
- **Bearing faults** are reported to be the major reason for the motor breakdown and a lot of papers have been reported to focus on bearing fault diagnostics.
- However, **low classification accuracy** is the main hurdle in adopting the available fault classification algorithms.
- This paper has presented **a novel classification algorithm using the Catboost classifier** and time-domain features.
- The developed algorithm was tested on the laboratory test setup. The fault **classification accuracy of 100 %** was achieved through the proposed method.

Design of Test Setup

- The experiments are conducted on the custom designed test set-up which consist of **a motor, a bearings and a variable frequency drive (VFD).**
- The data was acquired from the **vibration sensor** using National Instruments data acquisition system and then analyzed in the LabVIEW.
- The test rig of the developed system and damaged bearings have been shown in **Figure 1**. The interface has been shown in **Figure 2**.
- The time-domain features are shown in **Table 1**.

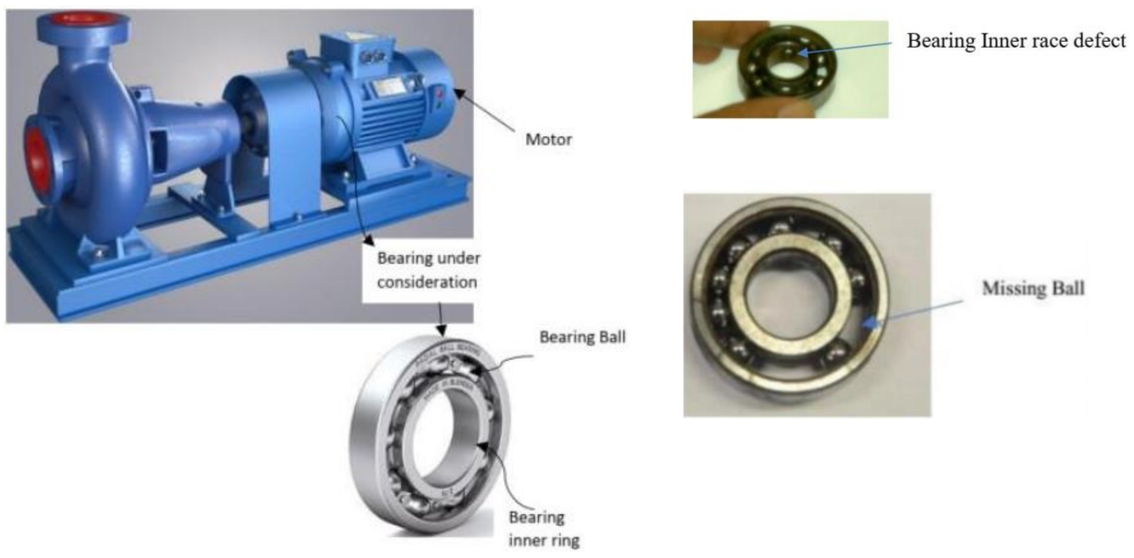

Fig. 1. The damaged gear and test rig

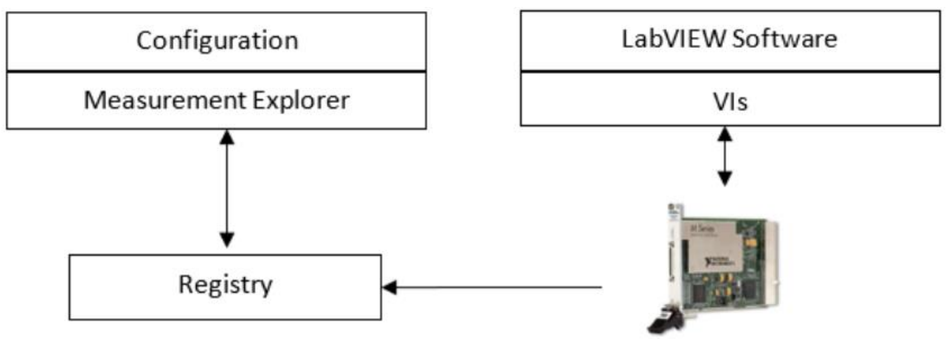

Fig. 2. The test rig interface

Table I. Extracted values of the features

Sr. No	Feature Name	Feature Value for HB	Feature Value for BD	Feature Value for IR
1.	Standard Deviation	0.732009	0.789520	0.764368
2.	Variance	1.24979	1.308426	1.297852
3.	Skewness	0.0255599	0.0296752	0.02719852
4.	Kurtosis	-0.224665	-0.156523	-0.187625

Results & Discussions

- The vibration data was collected and a sample plot has been shown in **Figure 3**.
- The statistical features (**standard deviation, variance, skewness, kurtosis**) were extracted from the time domain data and were used in the Catboost algorithm.
- The parameters of the algorithm are learning_rate=0.001, depth=10, loss_function='MultiClass'.
- The values of the extracted features are given in **Table I**.
- In machine learning, the confusion matrix is used to indicate the performance of the algorithm. It indicates the error performance by indicating that how many samples were misclassified by the algorithm.
- The confusion matrix has been shown in **Figure 4**.
- The confusion matrix indicates that all classes have been correctly classified with **100 % classification accuracy** which indicates the strength of the catboost classifier for condition monitoring applications.

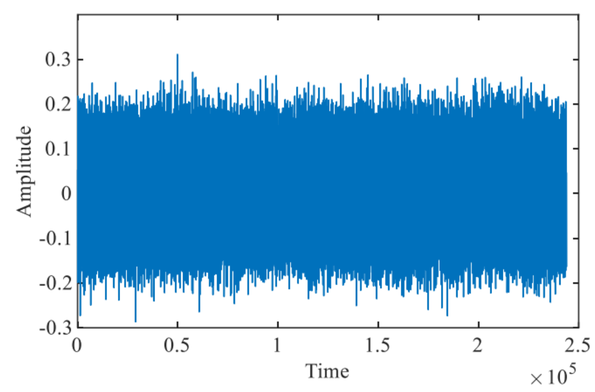

Fig. 3. The plot of the vibration data

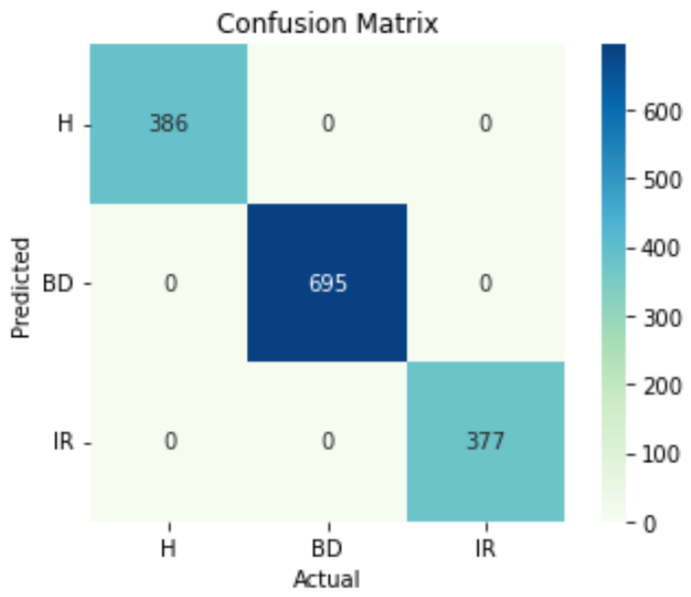

Fig. 4. The confusion matrix

Conclusions

- This paper has focused on developing a bearing fault classification system using a Catboost classifier.
- The vibration data has been collected and statistical features have been segregated.
- The three situations of the bearing labeled as healthy bearing, inner race faults and ball defects have been studied.
- The experimental results indicate that the classifier was able to classify the three classes with **100 % accuracy**.