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# Identification of bearing failure using signal vibrations

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**Abstract**. Vibration analysis can be used to identify damage to mechanical systems such as journal bearings. Identification of failure can be done by observing the resulting vibration spectrum by measuring the vibration signal occurring in a mechanical system. Bearing is one of the engine elements commonly used in mechanical systems. The main purpose of this research is to monitor the bearing condition and to identify bearing failure on a mechanical system by observing the resulting vibration. Data collection techniques based on recordings of sound caused by the vibration of the mechanical system were used in this study, then created a database system based bearing failure due to vibration signal recording sounds on a mechanical system. The next step is to group the bearing damage by type based on the databases obtained. The results show the percentage of success in identifying bearing damage is 98%.

## 1. Introduction

Bearing conditions in a mechanical system are crucial to the performance of a machine. There are a number of mechanisms that can cause damage to engine element bearings such as mechanical damage, crack damage, wear damage, lubricant deficiency, corrosion and plastic deformation, which in turn leads to damage to the engine system as a whole, other machine components. By knowing the type of damage occurring in a bearing appropriately, it will be able to reduce the use of new spare parts that require the manufacture of natural resources as raw materials and fuel is not small, reduce maintenance costs and or repair costs significantly, also can avoid the risk of accidents due to engine system damage.

The degree of bearing damage can be identified in several ways, such as observation of vibration signals, vibration signal recording, and sound signal recording. Over the past two decades, the identification of bearing damage has been the subject of extensive research. S. Simani, C. Fantuzzi [1] identified bearing damage based on vibration signal observation, while Trendafilova [2] identified bearing damage based on vibration signal recording. According to Kardille [3] that identify the type of damage to the fan-based recording sound signals from the induction motor, the advantages of a device identification system detection or engine-based recording vibration signal and voice signal recording is more easily measured, has a high level of accuracy and reliability.

Data retrieval techniques based on vibration signal recording can be seen in Trendafilova [1]. Trendafilova [1] identifies the type of damage to roller bearings, which is based on pattern recognition and analysis of key components of the measured vibration signal. The recorded signal has been processed before by applying the wavelet transform to extract high frequency areas. Four categories of signals considered, i.e. no signal indicating damage, deep race damage signals, outbreak damage signals, and roller element damage signals.

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## 2. Methodology

This research will develop a bearing damage identification system based on noise, noise level removal by measuring the magnitude produced by sound signal from bearing rotation in real time. The stages in this study as a whole are given in Figure 1. The design of the software for the identification module is useful for matching sound (magnitude quantities) identified by reference to which the software has been designed in the database module. The results of the integration of both software modules are useful for the degree of damage to the bearing of an engine element. In the final stages of the study there are two targets: first, the intelligent computing system technology package that records the complete database, identifies the damage and matches it to the database and detects the level of damage in real-time.

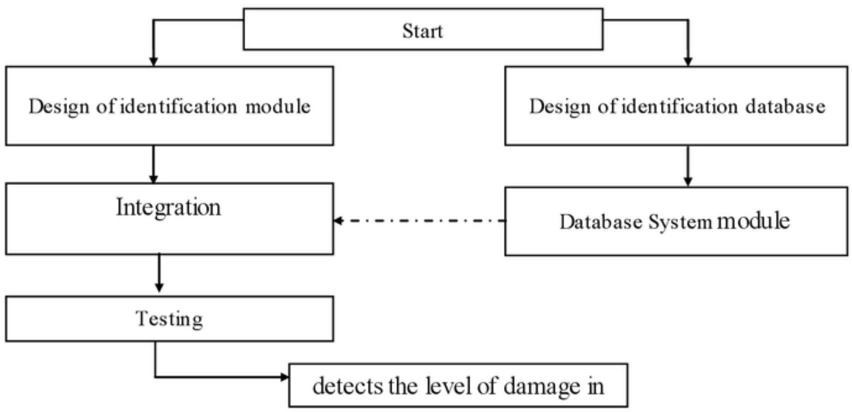


**Figure 1**. Identification system.

The data collection process has two stages, the first process of soaking bearing in $H_2SO_4$ 3% with 4 variations period that is 5, 10, 15 and 20 days. The second process is the sound recording of the bearing vibration with the testing tool as the initial data for database creation, in this process will get the sound data bearing with wma format. Furthermore, the sound data is analyzed vibration to get the magnitude to be used as database module. The next step is to test for identification of bearing damage by recording bearing sounds randomly.

## 3. Results and Discussion

The result of sound magnitude analysis of the resulting vibration can be seen from the following figure.

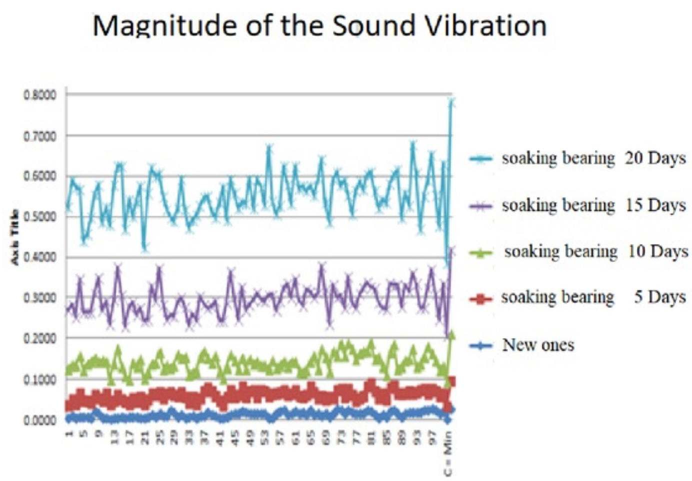


**Figure 2**. Magnitude of Sound Vibration.

The new bearing is as the initial size parameter with corrosion bearing $H_2 SO_4$ 3% as the test material is seen a significant comparison with other words a metal that has been exposed element $H_2 SO_4$ then corrosion propagation can occur significantly. From the analysis of the existing spectrum wave magnitude shapes, it can be seen that bearing variations have different magnetic spectrum images. This shows that the corrosion rate of the bearings has an influence on the wave magnitude. Values of Sound Magnitude (dB) Bearings can be seen in the following table.

**Table 1**. Table Values of Sound Magnitude (dB) Test Bearings.

| Nomor | Baru | 5 hari | 10 hari | 15 hari | 20 hari |
|---|---|---|---|---|---|
| 1 | 0.0066000 | 0.0360000 | 0.0920000 | 0.1880000 | 0.3191000 |
| 2 | 0.0086000 | 0.0343000 | 0.0958000 | 0.1171000 | 0.2204000 |
| 3 | 0.0104000 | 0.0382000 | 0.1152000 | 0.1490000 | 0.2247000 |
| 4 | 0.0272000 | 0.0424000 | 0.1051000 | 0.1260000 | 0.2555000 |
| 5 | 0.0053000 | 0.0542000 | 0.0972000 | 0.1440000 | 0.2448000 |
| 6 | 0.0106000 | 0.0437000 | 0.1149000 | 0.1569000 | 0.3085000 |
| 7 | 0.0086000 | 0.0573000 | 0.1010000 | 0.1423000 | 0.2386000 |
| 8 | 0.0250000 | 0.0428000 | 0.1012000 | 0.1249000 | 0.2166000 |
| 9 | 0.0191000 | 0.0373000 | 0.0788000 | 0.1788000 | 0.2325000 |
| 10 | 0.0077000 | 0.0538000 | 0.0934000 | 0.2035000 | 0.2292000 |
| : | : | : | : | : | : |
| 96 | 0.0193000 | 0.0464000 | 0.0777000 | 0.1898000 | 0.2828000 |
| 97 | 0.0227000 | 0.0462000 | 0.0877000 | 0.1360000 | 0.2747000 |
| 98 | 0.0289000 | 0.0421000 | 0.0729000 | 0.1502000 | 0.2956000 |
| 99 | 0.0278000 | 0.0425000 | 0.0631000 | 0.2032000 | 0.2693000 |
| 100 | 0.0175000 | 0.0441000 | 0.0651000 | 0.1657000 | 0.2632000 |
| MIN | 0.0053000 | 0.0314000 | 0.0600000 | 0.1158000 | 0.2106000 |
| MAX | 0.0289000 | 0.0595000 | 0.1152000 | 0.2066000 | 0.3634000 |

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**Table 2**. Results of Bearing Identification Testing.

| Number | Magnitudo (dB) | Status |
|---|---|---|
| 1 | 0.0298000 | Detected |
| 2 | 0.0382000 | Detected |
| 3 | 0.0328000 | Detected |
| 4 | 0.0543000 | Detected |
| 5 | 0.0400000 | Detected |
| : | ... | ... |
| : | ... | ... |
| 80 | 0.0564000 | Detected |
| 81 | 0.0672000 | Not detected |
| : | ... | ... |
| 86 | 0.0550000 | Detected |
| 87 | 0.0597000 | Not detected |
| 88 | 0.0455000 | Detected |
| : | ... | ... |
| : | ... | ... |
| 100 | 0.0441000 | Detected |

From the experimental table, the results obtained from 100 times the test there are 98 data that was successfully detected in accordance with the database that was built while the undetectable voice data only reached 2 votes only. So the percentage of detection matches between voice data and train data is 98%.

## 4. Conclusion

From the previous description, it can be concluded that among others is.

1. Bearing failure occurring in this case is confirmed by several mutually supportive factors, namely the increase in the value of significant vibrations, the emergence of the natural frequency of bearing failure on the spectrum, and the characteristics of the spectrum, i.e. the appearance of sub-sync frequencies in the spectrum.
2. One of the natural frequencies detected is the natural frequency of the cage.

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