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ABSTRACT

The increasing dependence of internal combustion engine in multitudes of application has mandated a detailed study on most of its subsystems. This paper focuses on predictive maintenance using machine learning based models. The transmission system of any power pace is often challenged due to sudden variation in applied load. Any fault in the transmission system could lead to the catastrophic failures hence need for this work. This paper deals with the identification of various fault conditions that happen in a transmission system using vibration signals acquired by an accelerometer. The acquired signals are processed to extract the statistical and spectral features. These features are used to build a machine learning model using decision tree or Random forest algorithm. The best combination of features and algorithm is evaluated and the results are presented.

Keywords: Accelerometer, Condition Monitoring, Confusion Matrix, J48 Decision Tree, Pinion Gear, Random Forest

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INTRODUCTION

India is the sixth largest producer of commercial vehicle in the world. According to the statistical analysis, India produces more than 3.9 million units of commercial vehicle per year (http). All vehicles, aircraft and water craft included, requires transmission system in order to enable torque and speed conversion. Transmissions are distinguished in accordance with their function and purpose for e.g. gearboxes, steering boxes and power take-offs. (Harald Nauheimer, 2011)

The transmission system consists of clutch, gear box, propeller shaft which transmits the torque from the gear box to the rear axle through a differential gear to distribute the final torque to the driving wheels. (H.Bayrakceken, 2007)

The functions of the transmission system are:

1. To disconnect the engine from the road wheels when desired.
2. To connect the engine to the driving wheels without shock.
3. To vary the leverage between the engine and the driving wheel.
4. To vary the engine speed permanently in a fixed ratio.

The transmission system consists of a union joint, pinion bearings and planetary gears. Failure in the transmission system components covers one fourth of the on road automobile failures (Harald Nauheimer, 2011). Failures due to Manufacturing and design, maintenance, raw material and user originated ones are some of the other common failures that are observed in the automobile (H.Bayrakceken, 2007). The possible faults that are observed in the system are on a) the universal joints which are situated on either side of the propeller shaft, b) faults at the Gear box, c) in the differential and d) on the pilot bearing which is coupled on to the pinion gear. In this paper the failures that the authors have simulated on the vehicle transmission system are given in Table 2.

Gears form a major part of the transmission system in the heavy vehicles. The common faults that are observed are tooth failure, pitting and wear. These damage types limit the load capacity of the gear wheels. The major factors affecting the performance are:

1. Operating conditions
2. Selection of materials
3. Gear geometry
4. Selection of lubricant
5. Manufacturing accuracy
6. Surface treatment and surface roughness (Harald Nauheimer, 2011)

Transmission system vibration monitoring for fault detection and diagnosis is one of the important task in the vehicle maintenance because when monitoring is done on the vehicles one will be able to reduce the catastrophic failures and effective replacement of the worn out parts before failure is possible. Diagnosing a gear system by examining the vibration signals is the commonly used method. A literature review of the simulated faults is presented below.
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