Introduction

Industrial systems are prone to defects and failures, which may lead to various undesirable consequences. Industrial practitioners and managers, therefore, are motivated to leverage real-time system monitoring techniques to mitigate the risk of failures, reduce machinery downtime, and have optimum productivity by performing efficient maintenance strategies.

Vibration signals are widely used for fault detection in industrial/manufacturing machinery and the subject of current research on developing machine learning (ML)-based models for analyzing vibration signals for industrial systems' health monitoring.

Initial Dataset

- The dataset includes vibration signals of normal and four different types of fault conditions and their corresponding ground-truth labels for two different operational conditions.
- Vibration signals have been divided into smaller segments using window size of 200 data points to reduce the computational time.
- Vibration signals are available in three directions (x, y, z). Participants are free to use either one direction or any combination of them.
- Results should be written based on the model's performance trained and tested on the initial dataset over a five-fold cross-validation approach. The same model should be used for both operational conditions.

Final Test Set

- Students need to submit their model's predicted labels on the final test set for both operational conditions (1500_10 and 2700_25) in separate ".csv" files.

Dataset Description

The test rig consists of a driving motor, two-stage planetary gearbox, two-stage parallel gearbox and magnetic brake as shown in *Figure 1*. The experiment just focuses on the planetary gearbox, and the detailed parameters are described in Table *1*. The test rig is driven by an alternative current motor, and its rotating speed ranges from 0 to 6000 revolution per minute (rpm), which is adjusted by a speed transducer. The torque is applied to the output shaft of the parallel gearboxes by the magnetic brake. Due to the heavy alternative stress and impact, sun gear teeth on the second stage of the planetary gearbox are more likely to suffer damages in practical application, and thus four common sun gear faults, i.e. surface wear, chipped, crack and tooth missing, are created as shown in Figure *2*. The vibration signals are acquired by the portable data acquisition system of National Instruments (NI), of which the acquisition card is NI PXI-4498. The acceleration sensor is 356A01 manufactured by PCB Piezotronics, which is mounted on the second stage of the planetary gearbox to acquire the vibration signals. The vibration signals for this data challenge have been acquired under two different operating conditions, as represented in Table *2*. Each vibration signal is recorded in three directions (x, y, z), for a period of five minutes, and with a sampling frequency of 10 kHz. The examples of time-domain signal acquired in different operating conditions are displayed in Figure *3* and Figure *4*.

Table 1. Specifications of planetary gearbox

Parameters	First stage			Second stage		
	Sun gear	Planet gear	Ring gear	Sun gear	Planet gear	Ring gear
Teeth number	20	40	100	28	36	100
Gear number	1	3	1	1	4	1
Reduction ratio	6:1			32:7		

Table 2: The operational condition for two experiments

	Motor speed (rpm)	Load (Nm)
Exp. 1	1500	10
Exp. 2	2700	25

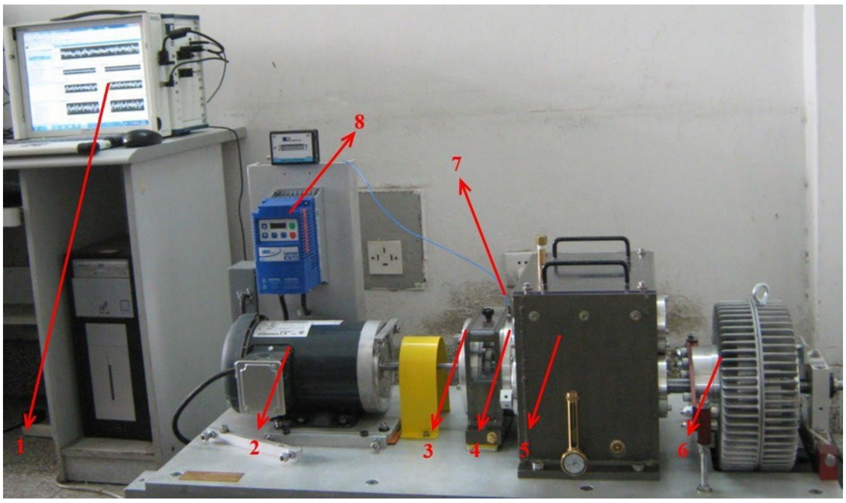

Figure 1. Test rig. 1-Portable data acquisition system, 2-Motor, 3-First stage of planetary gearbox, 4-Second stage of planetary gearbox, 5-Parallel gearbox, 6-Magnetic brake, 7-Acceleration sensor, 8-Speed transducer

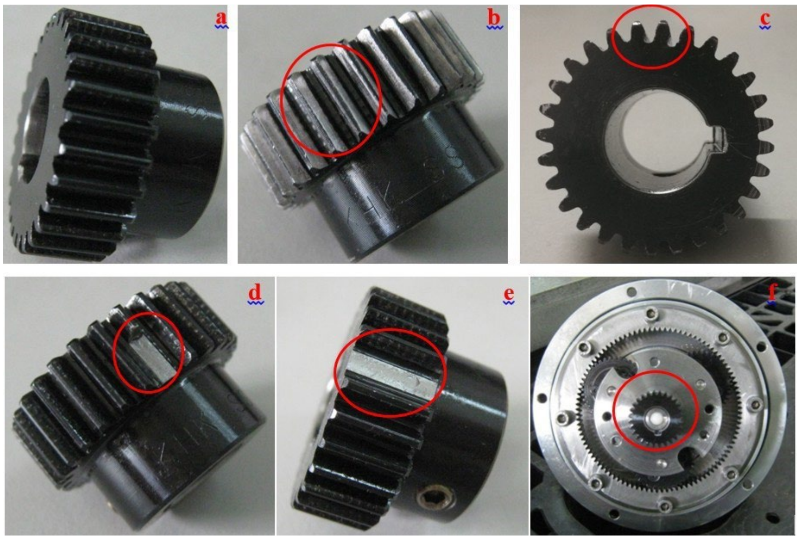

Figure 2. Pictures of the measured sun gear. a-normal, b-surface wear, c-crack, d-chipped, e-tooth missing, f-the measured sun gear

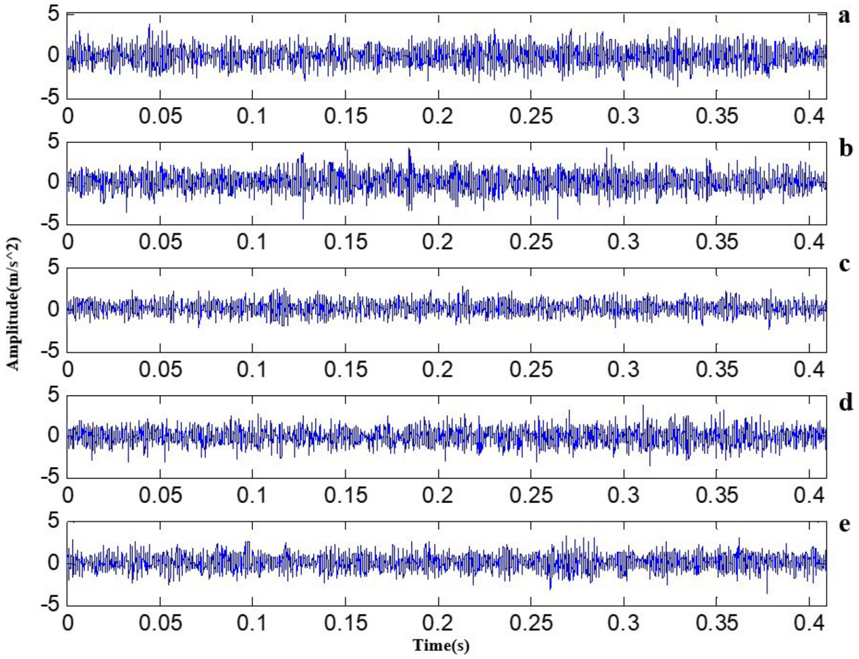

Figure 3. Time domain vibration signals under operational condition of 1500-rpm motor speed and 10Nm load. (a) normal, (b) surface wear, (c) crack, (d) chipped, (e) tooth missing

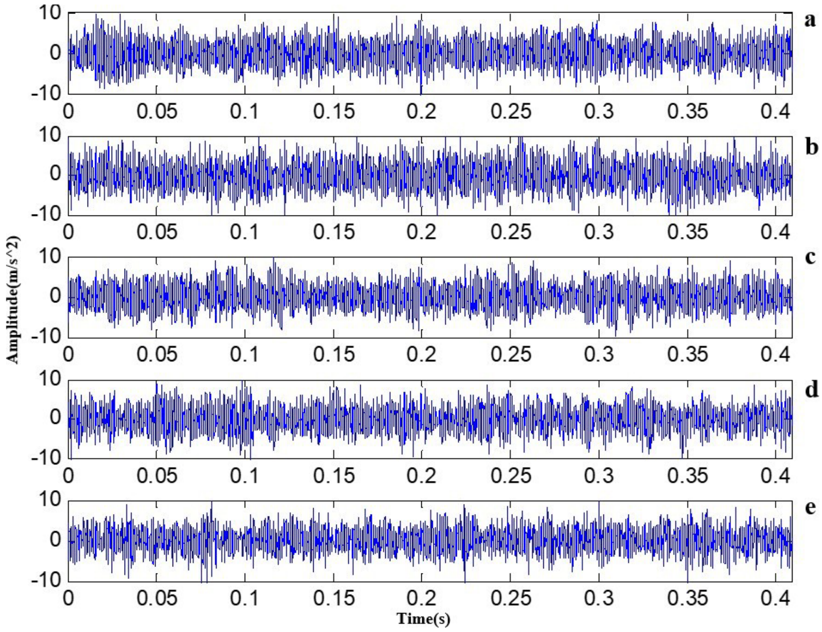

Figure 4. Time domain vibration signals under operational condition of 2700-rpm motor speed and 25Nm load. (a) normal, (b) surface wear, (c) crack, (d) chipped, (e) tooth missing