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Novel approaches of synchronous averaging of gear and bearing vibrations

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Abstract
Synchronous averaging (SA) is a fundamental technique in synchronous vibration analysis. This article begins by reviewing the conventional SA method and offering new insights into its underlying characteristics. We then frame SA as a special case of identifying the signal that minimizes the mean squared error among a set of segments. Building on this, we present a theoretical analysis of how speed fluctuations impact the accuracy of the computed synchronous average. Finally, we propose a novel algorithm—Angular Synchronization SA—that enables accurate SA for bearing signals, even under fluctuating speed conditions. The effectiveness of the proposed algorithm is demonstrated through three experiments involving bearings with outer race spalls. Given that bearings are critical components in rotating machinery and are prone to failure, our approach has the potential to significantly advance vibration-based diagnostics. By enabling direct analysis of their synchronous average, the proposed method paves the way for improved diagnostic capabilities.

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The codes and the supporting materials are available here:
https://github.com/omriMatania/novel_approaches_of_synchronous_averaging_of_gear_and_bearing_vibrations

The data for the codes is available here:
https://drive.google.com/drive/folders/1PgCqfumW_ZIl3APUZDYNoz6DEeIQT0cb?usp=sharing

You have four main files: main_endurance.m, main_monitored.m, main_MFPT.m, and main_gear.m. In main_endurance.m and main_monitored.m files, you can choose the axis. Make sure to set records_path to the location where you placed the data. Some of the scripts may take approximately an hour to run.

```
3    % axis_name = 'Z' ;
4    axis_name = 'Y' ;
5
6    records_path = ['D:\data\papers\synchronous_average_for_bearing_vibrations\endurance\',axis_name,'\'] ;
```