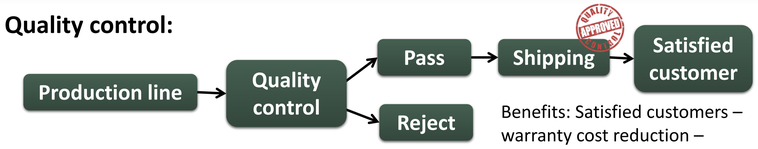
Advanced Fault Detection and Diagnosis

Centre for Mechatronics and Hybrid Technology
Mechanical Engineering McMaster University
Mahmoud Ismail

EECOMOBILITY (ORF) & HEVPD&D CREATE

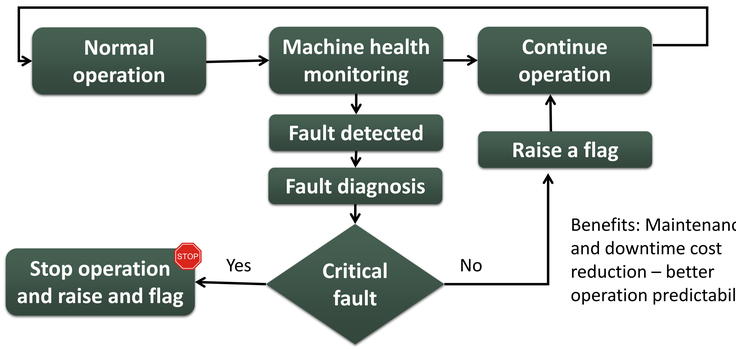
WHY FALUT DETECTION & DIAGNOSIS?

Quality control:



Benefits: Satisfied customers – warranty cost reduction – downtime cost reduction

Proactive Maintenance:



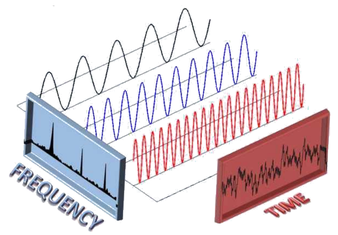
Benefits: Maintenance and downtime cost reduction – better operation predictability

WHY SOUND & VIBRATION IS COMPLEX

Amplitude

Many systems reject products that produce noise levels above a certain threshold but that is not enough as many faults and production problems such as excessive lubricant (grease) can result in quieter noise levels

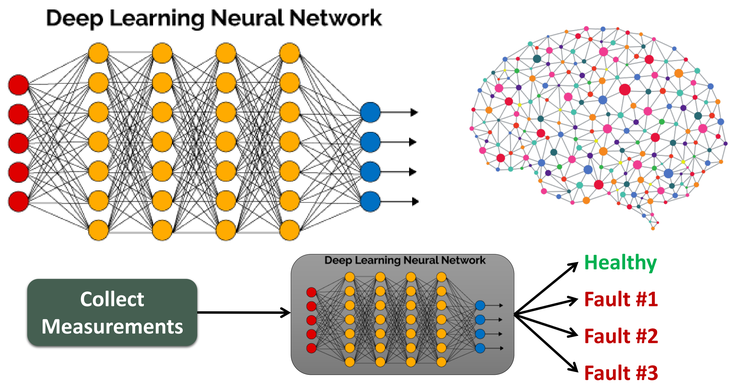
Spectrum



Spectrum analysis can be very useful as it shows another dimension of sound and vibration measurements in the frequency domains. However it is very hard to relate the changes in frequency domain to the machine condition which makes its usage limited.

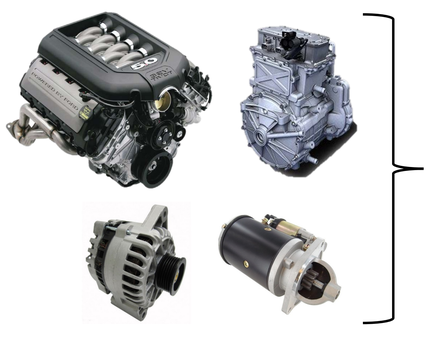
Complexity: to successfully use sound and vibration measurements to detect and diagnose faults, the analysis algorithm should take into consideration the changes in both time and frequency domains. Whether the changes are an increase of a decrease in sound and vibration levels.

DEEP-LEARNING AI

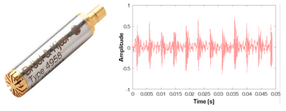


Deep Learning is the leading Artificial Intelligence algorithm in many industries such as speech and image recognition. The Centre for Mechatronics and Hybrid Technology (CMHT) applied Deep Learning on fault detection and diagnosis applications, 100% fault detection success rates were acquired and 97.6% accuracy for fault diagnosis.

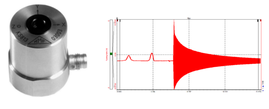
SOUND & VIBRATION



Sound



Vibration



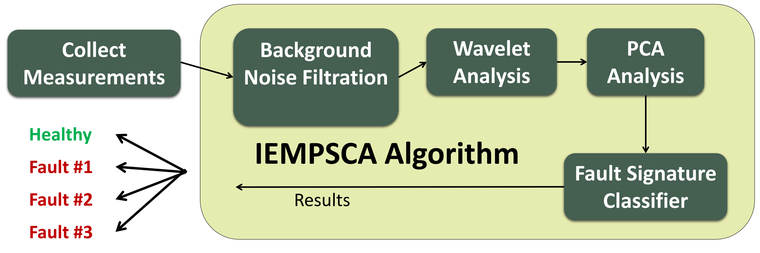
- The sound and vibration signals produced by rotary equipment is a result of their design, materials, and operating conditions. When a rotary equipment is fault, it produces different sound and vibration signatures than the healthy baseline.
- Being able to detect the sound and vibration difference, different faults can be detected and diagnosed as well.

IEMSPCA

Background noise filtration is an important step to eliminate any confusion in the results.

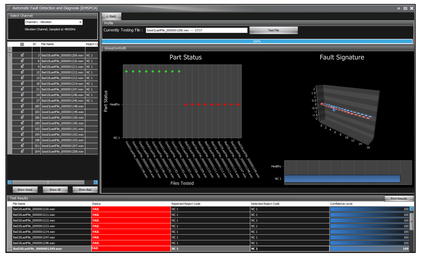
Wavelet analysis is able to analyze the measurements both in time and frequency domains.

PCA is able to detect any changes in the time and frequency domains produced by wavelet analysis



IEMSPCA algorithm uses the difference in time and frequency domains to detect any deviation from the baseline measurements. If there is any deviation than baseline measurements, further analysis are done on the fault signature to diagnose the fault type. IEMPSCA was tested and it is able to acquire 100% fault detection rates and 96.8% for fault diagnosis.

COMMERCIAL IMPLEMENTATION D&V



Both technologies, IEMSPCA and Deep Learning are implemented for commercial use in D&V Electronics SV-PRO software. which is designed to provide different tools for sound and vibration analysis including traditional and advanced analysis types.

We acknowledge the support of the Ontario Research Fund: Research Excellence Program.

We acknowledge the support of the Natural Sciences and Engineering Council of Canada (NSERC), which invests annually over $1 billion in people, discovery and innovation.