MachineSense™
Machine Wearables & Analytics

Bearing Fault Detection Using MachineSense **Component Analyzer**

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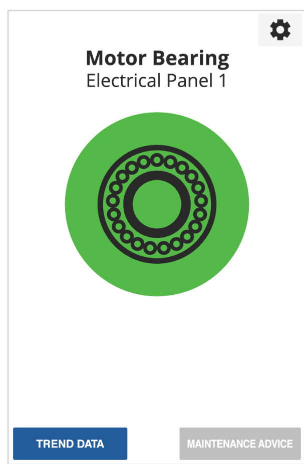
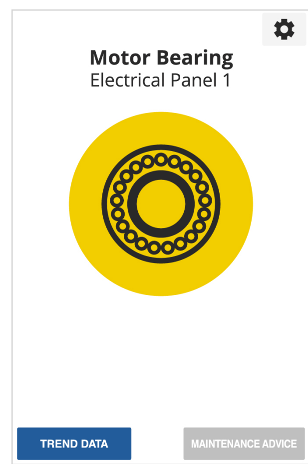
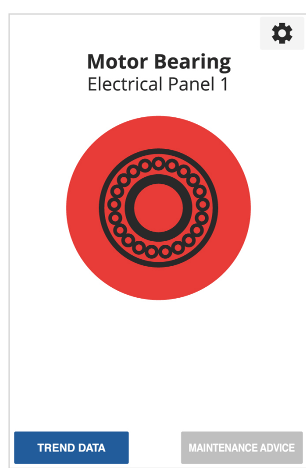
The MachineSense Component Analyzer is a multi-sensing MEMS based sensor which captures vibration, magnetic field, and infrared radiation from a machine. Depending on the type of machine and the failure, the sensor can be configured to detect common faults of the machinery. For example, **the MachineSense Component Module** can detect an electrical winding failure in a motor by detecting its asymmetric magnetic field. It can also detect a bearing failure in the rotor by detecting unusual vibrations. Bearing defect is the most common fault in any rotating machine. Four kinds of bearing faults are widely known: cage fault, outer raceway fault, inner raceway fault and bearing defects. Each of the faults produce characteristic frequencies of their own when viewed in a vibrational spectrum.

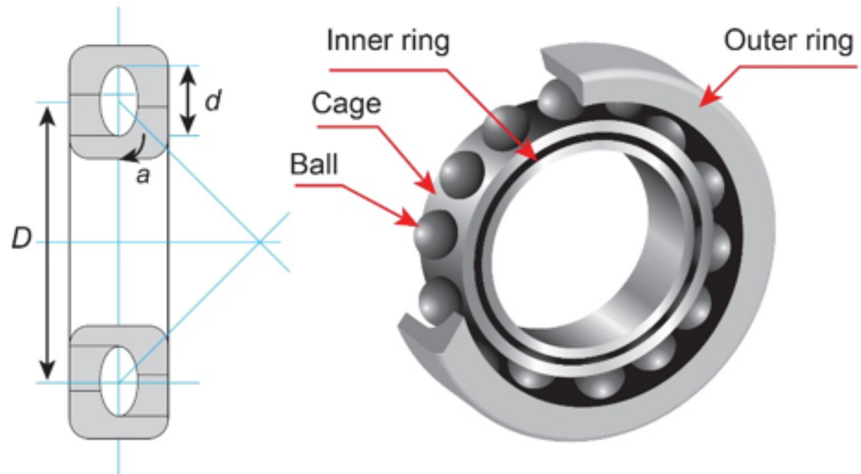






Vibrational frequencies associated with defective bearings have been discussed in many works.

Traditional methods of detecting these faults, based on actual frequencies, requires extensive electronics and an analyzer. This is an expensive method and computations can only be done locally.



Cage Fault Frequency: $f_c = \frac{f_r}{2}\left(1-\frac{d}{D_m}\cos a\right) = \frac{f_{bi}}{N_b}$

Outer Raceway Fault Frequency: $f_{be} = \frac{f_r}{2} N_b \left(1-\frac{d}{D_m}\cos a\right)$

Inner Raceway Fault Frequency: $f_{bi} = \frac{f_r}{2} N_b \left(1+\frac{d}{D_m}\cos a\right)$

Ball Fault Frequency: $f_b = \frac{f_r N_b}{2.d}\left(1-\left(\frac{d}{D_m}\cos a\right)^2\right)$

MachineSense has developed a patented sub-sampling method in a time domain which can detect bearing faults with high reliability in the cloud using transmission of a low volume of data over a period of time. This helps to reduce the cost down to an affordable level. As it is well known, these additional fault frequencies will create a cluster in the phase space of the vibrational vector. Patented **MachineSense** algorithms detect those angular clusters and decide which faults are traditionally done in FFT (Fast Fourier Transform) domain.

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Faults are detected from additional frequency components

The **MachineSense** sub-sampling time domain method has a couple of technical advantages over traditional FFT-based methods in addition to being cost effective and lighter in bandwidth. In traditional frequency domain analysis as described above, faults are detected from additional frequency components generated in the vibrational spectrum. Whereas in the **MachineSense** method, we track nearly 150+ different statistical features of vibration and at least 30+ features respond to bearing condition change.

Fig. 1: MachineSense Sensor mounted on a blower.

Fig. 2: How Component Analyzer works in the MachineSense Predictive Maintenance IoT system.

MachineSense sensors are placed directly on your machines or components to automatically monitor condition. The sensor data transmits to an easy-to-install gateway and is then sent to cloud-based servers running powerful analytic software. Results are transmitted from the server to a user-friendly app, where you will view real time machine condition and maintenance advice.

Fig. 3: The Blower Bearing Gauge is a real time indicator of the blower bearing status. Status is indicated by green/yellow/red.

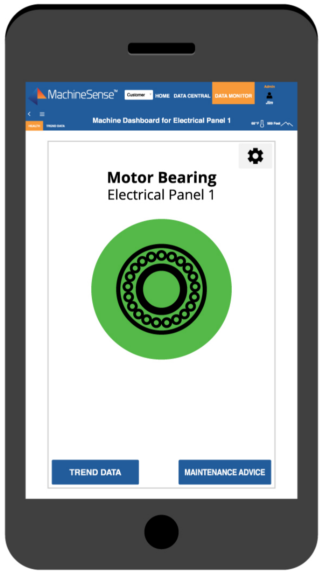
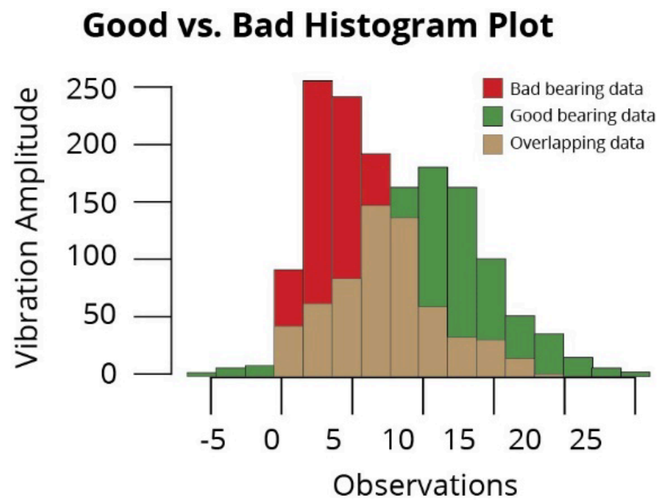


Fig. 4: Shows two histograms of vibration frequency - good vs. bad bearing showing how symmetry in the pattern is broken. (The red color depicts the bad bearing and the green color depicts the good bearing. The brown shows the intersection of the two regions.)



Visualization of diagnosis and fault data 24x7 is done via several applications that run on the web, as well as in the **MachineSense** Mobile app. *(Fig. 3, 4, 5 & 6).* Visualization delivers both a real time gauge *(Fig. 3)*, trending of the fault for up to the last 6 months *(Fig. 5)* and a summary of faults of all the machines in a dashboard format. *(Fig. 6)*

Fig. 5: Trend line showing how a blower fault is being monitored over the last seven days. The system will track up to the six months.

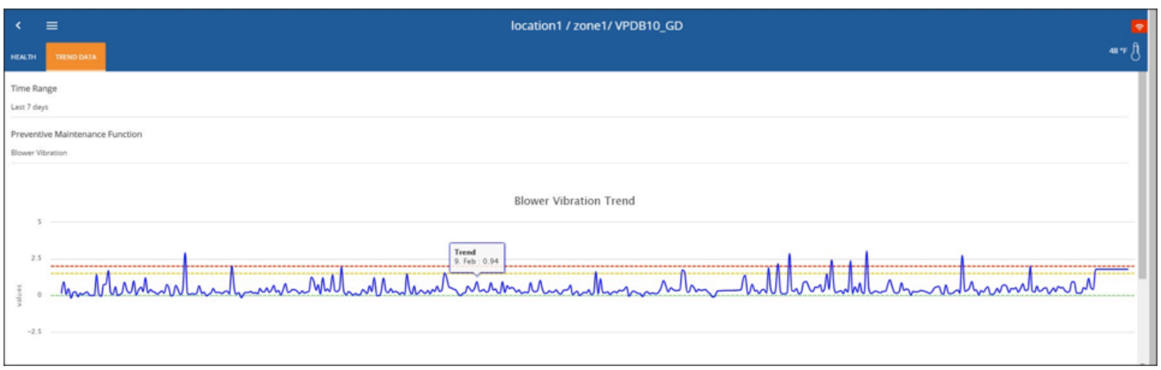
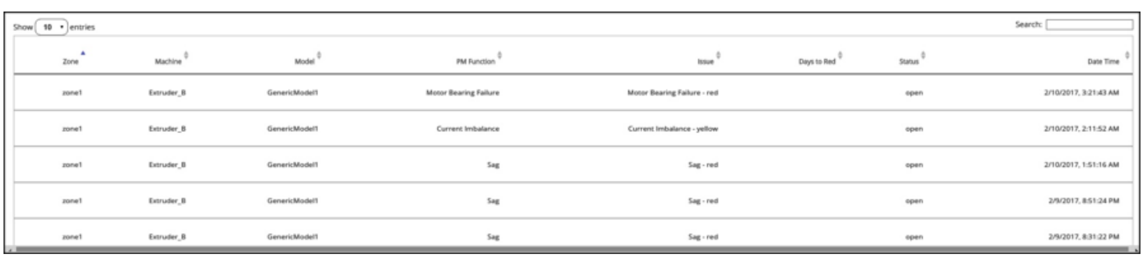


Fig. 6: Alarms are sent via email/SMS if a blower bearing fault is detected. All of such alarms can be read from MRO (Maintenance Repair Operation) logs of the MachineSense Data Viewer and maintenance advice will be sent by text and email.



Show 10 entries   Search:

Zone	Machine	Model	PM Function	Issue	Days to Red	Status	Date Time
zone1	Extruder_B	GenericModel1	Motor Bearing Failure	Motor Bearing Failure - red		open	2/10/2017, 3:21:43 AM
zone1	Extruder_B	GenericModel1	Current Imbalance	Current Imbalance - yellow		open	2/10/2017, 2:11:52 AM
zone1	Extruder_B	GenericModel1	Sag	Sag - red		open	2/10/2017, 1:51:16 AM
zone1	Extruder_B	GenericModel1	Sag	Sag - red		open	2/9/2017, 8:51:24 PM
zone1	Extruder_B	GenericModel1	Sag	Sag - red		open	2/9/2017, 8:31:22 PM