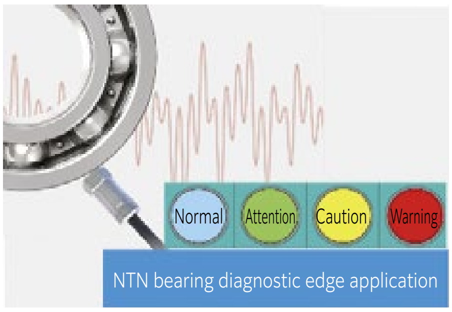
New Products

Bearing Diagnostic Edge Application for Industrial IoT Platforms



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In an effort to realize a smart and efficient factory, IoT-based condition monitoring systems are attracting attention in recent years. Rolling bearings are used to support the rotation of production equipment. We need to monitor bearing conditions to prevent unplanned downtime due to bearing damage.
NTN has developed a bearing diagnostic edge application for industrial IoT platforms to monitor bearing conditions using vibration data. In this article, we introduce the features and application examples of the bearing diagnostic edge application.

1. Introduction

There is a rising demand for predictive maintenance for production equipment, against the backdrop of manpower reduction and improved productivity at production equipment. Manufacturers are preferring to transition to condition-based maintenance from the conventional time-based maintenance implemented at production sites[1].

At the production site, it is necessary to minimize downtime that occurs due to equipment stoppages so that productivity can be improved. Therefore, we must apply monitoring technology that will allow us to quantitatively understand conditions such as equipment deterioration and failure, and quickly detect abnormalities that have occurred so that maintenance can be performed.

A method to achieve this is monitoring the condition of production equipment through the use of an industrial IoT (Internet of Things) platform.

NTN has developed an edge application for industrial IoT platforms that can diagnose production equipment bearings through the use of vibration data. This paper introduces the features of this edge application and examples of its application at production sites.

2. Condition monitoring at the production site

2.1 Industrial IoT platforms

Industrial IoT platforms refer to IoT system infrastructure in the industrial sector. In the manufacturing industry, various equipment at the production site is connected via a network, and the production process is monitored and controlled. This allows improvements to be made to productivity at each step of production.

Fig. 1 shows a schematic drawing of an industrial IoT platform. This schematic drawing shows how the industrial IoT platform, edge application and IT system are linked at the production site.

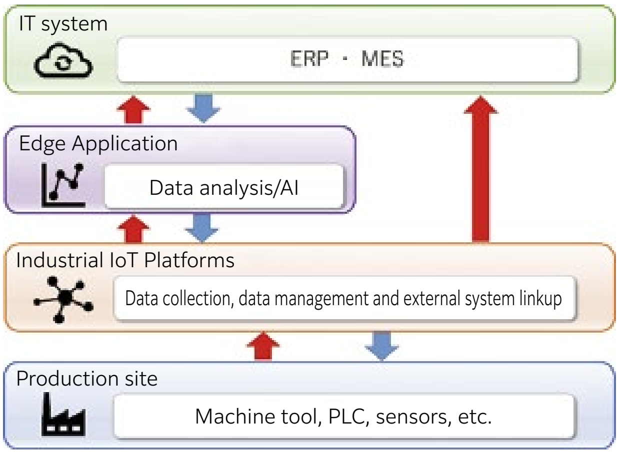

Fig. 1 Schematic drawing of industrial IoT platform

An industrial IoT platform connects to equipment at the production site and collects data relating to equipment operation. An edge application receives the data collected from the industrial IoT platform and analyzes it. The analysis results processed here are then sent to the production site equipment and host IT system. The IT system takes on the role of comprehensively managing the various information for the production site, and systems such as the Enterprise Resource Planning (ERP) system or Manufacturing Execution System (MES) can be used for this task.

Using this industrial IoT platform optimizes management tasks and provides visualization of the production site in terms of monitoring the operation

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and conditions of production equipment.

2.2 Monitoring the condition of bearings

Bearings are precision machine parts where high accuracy and quality are critical for proper function and long life. They are installed for use on several types of equipment to support the rotation of machinery.

If a bearing is damaged, the equipment must be stopped to perform inspection and repairs, which lowers productivity. Therefore, it is important to monitor bearing conditions to perform maintenance work at an appropriate time.

A method of diagnosing the bearing using vibration data is often used to monitor bearing conditions[2). **Table 1** shows the types of bearing diagnosis using this vibration method. Two types are available to diagnose bearings: simple diagnosis and precision diagnosis.

Table 1 Types of bearing diagnosis

Type	Diagnosis method
Simple diagnosis	• Absolute value determination (Evaluated in line with standards/ standard values) • Same type comparison (Evaluated by comparing with the same type of equipment/machines under the same conditions) • Trend management (Determine abnormalities by constantly observing trends)
Precision diagnosis	• Estimates damage positions on bearing and extent of damage with frequency analysis (FFT, etc.) *Requires various bearing information

Simple diagnosis monitors changes in the condition over time and the degree of deviation from healthy conditions. Methods include absolute value determination in line with predetermined criteria and standards, compariative analysis that involves comparing the same type of equipment and machines, and trend management in which constant observation is implemented. Simple diagnosis is used to properly understand the bearing condition and create maintenance plans for equipment based on diagnosis results, which can prevent such things as unscheduled equipment stoppages due to bearing damage.

Meanwhile, precision diagnosis is performed when further analysis is required based on the results of simple diagnosis. Fast Fourier transform (FFT) and similar can be used to analyze the vibration spectrum to estimate where the bearing is damaged and the extent of the damage. However, to analyze the relationship between the spectrum and the position of damage, various bearing factors such as the rolling element raceway diameter, rolling element diameter, number of rolling elements, and the contact angle, as well as information about the shaft rotational speed are required.

3. Bearing diagnostic edge application

As a bearing manufacturer, **NTN** has developed a condition monitoring system (CMS) for wind turbines using our knowledge about bearing damage along with sensing technology and diagnosis technology developed over many years and released this for sale as “WindDoctor™”[3). Currently, we are providing a condition monitoring service using this system on over 250 wind turbines throughout Japan. This technology was used to develop a bearing diagnostic edge application using real-time processing functions from Edgecross[4), which is an industrial IoT platform (hereafter, bearing diagnostic application).

3.1 Features

The main features of the bearing diagnostic application are shown below.

(1) Realtime diagnosis

The application includes **NTN** proprietary diagnosis algorithms to automatically collect vibration data for analysis and diagnosis purposes. Up to 16 locations are diagnosed within at least 3 seconds using a single bearing diagnostic application license. This enables users to know any changes in the bearing condition that may appear in a short amount of time and can detect abnormalities early on.

(2) Automatic threshold generation

Thresholds are automatically generated to identify the bearing conditions based on learned data. This eliminates work to configure thresholds that require an experienced operator.

(3) Provides diagnosis not limited to certain bearing numbers

It is not necessary to configure such things as bearing factors and rotational speed. Therefore, the application can be used even if you do not know the number of the bearing installed on the equipment or the rotational speed.

(4) Rating scale for bearing health condition

Diagnosis results display 4 ratings (Normal, Attention, Caution, and Warning) in text and color on the display screen of the bearing diagnostic application. Therefore, it is possible to easily know the bearing condition without the operator performing detailed analysis.

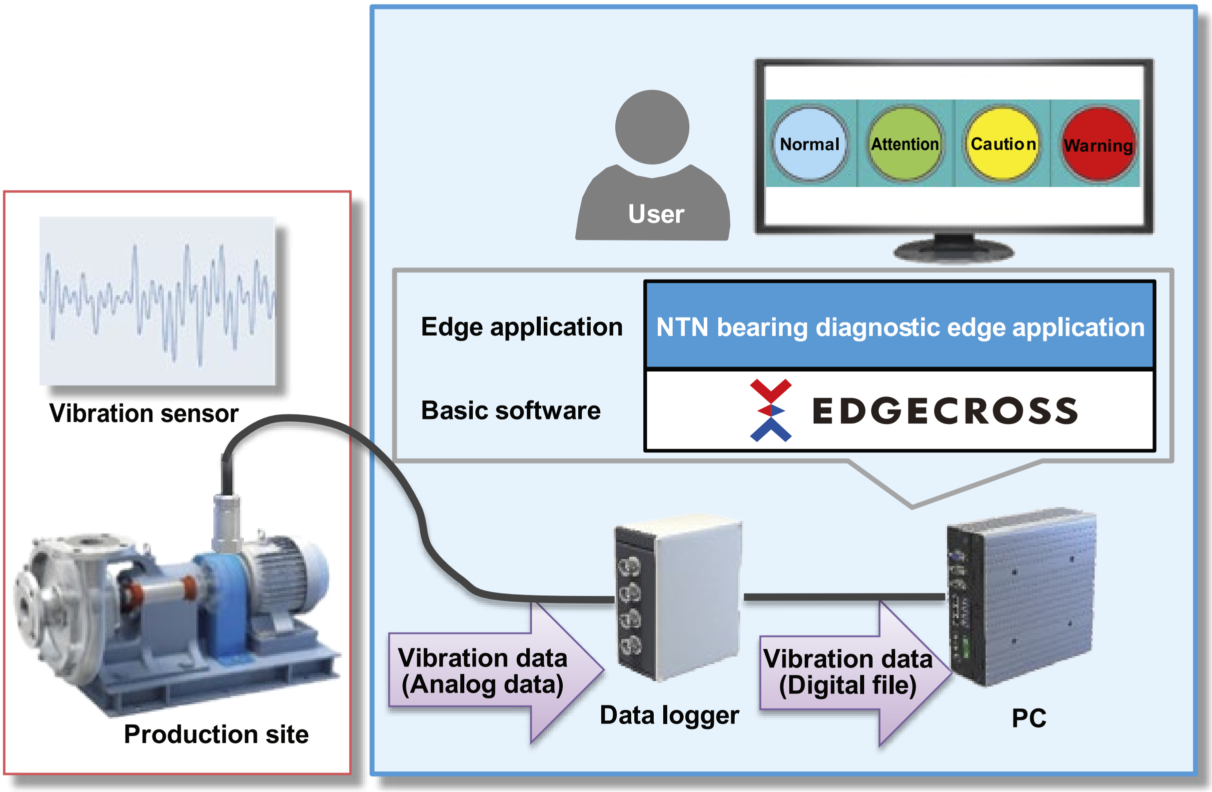

Fig. 2 Device configuration for bearing diagnostic application

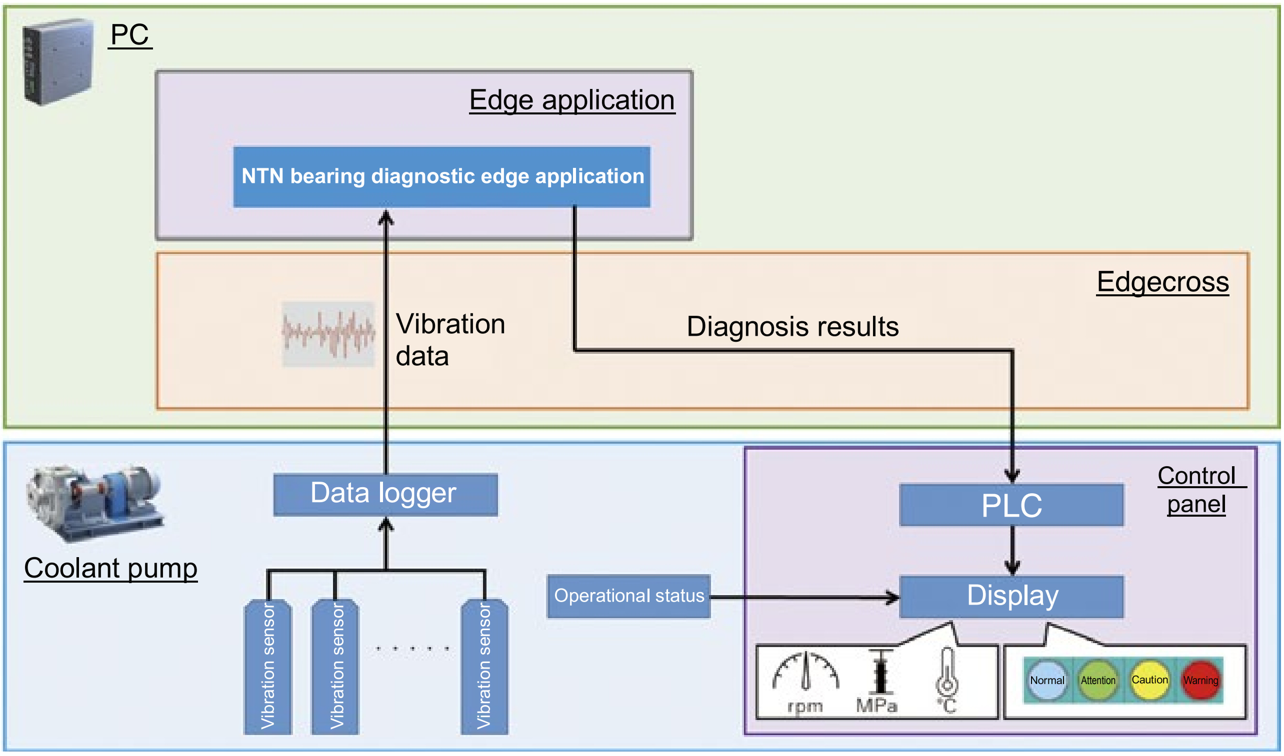

Fig. 3 Coolant pump diagnosis process

3.2 Usage configuration

The devices required to use the bearing diagnostic application are a PC installed with Windows operating system, a vibration sensor, and a data logger. Edgecross basic software and the bearing diagnostic application can be used after installing them onto the PC **(Fig. 2)**.

The bearing diagnostic application can also run in standalone mode for convenience of use at the production site.

4. Example of application on coolant pumps

This section introduces an example of using the bearing diagnostic application to monitor the conditions of a coolant pump at the production site.

4.1 Challenges of inspection work

If a coolant pump that supplies coolant to equipment fails, it will lead to production line stoppages. To mitigate this type of situation, operators either regularly perform inspection work on the equipment or perform such work depending on the situation. However, this inspection work relies on the experience of the operator so there are times when an operator may fail to notice a problem with the coolant pump. To prevent this type of situation, it is necessary to evaluate the bearing conditions automatically and quantitatively (whether damage has occurred and its extent, etc.) based on the operational status of the coolant pump expressed in a numerical format.

4.2 Introducing the bearing diagnostic application

Fig. 3 shows the device configuration and measurement/diagnosis procedure for this example. The bearing diagnostic application is organized such that it links to the coolant pump control PLC and the display via Edgecross. Operation information such as the rotational speed, pressure and temperature are displayed on the coolant pump control panel display in addition to diagnosis results from the bearing diagnostic application.

In this example, operators receive information about the coolant pump operational status at the same time the bearing conditions are checked, which reduces the amount of inspection work the operator must do. Furthermore, the bearing diagnostic application constantly monitors the bearing conditions, enabling any bearing abnormalities or development of damage to be quantitatively evaluated. If any signs of damage are discovered on the bearing, control is switched to lower the load on the coolant pump based on the diagnosis results, which is expected to delay the progress of damage on the bearing.

5. Proof of concept build support service

When introducing the system to the production site, proof of concept (PoC) is performed to validate the effectiveness of introducing the system in advance.

Sensors and equipment used for the PoC step are prepared by the user. However, when introducing the bearing diagnostic application, users were unable to prepare equipment such as vibration sensors and data loggers, and it was sometimes difficult to implement PoC. Due to this fact, **NTN** provides a "PoC build support service"[5] in collaboration with Edgecross Consortium[4], in which the user can borrow a set of the devices that need to be prepared. They are borrowed for a fixed period at no cost to the user.

Fig. 4 shows a flowchart up to the point of starting PoC operation for the PoC build support service. This service includes an interview concerning what equipment needs to be diagnosed and any issues to address, followed by a decision on the PoC implementation details and **NTN** work support details. For users who are concerned about how to set up the devices, **NTN** also helps set up peripheral devices and configure the bearing diagnostic application.

This service has been favorably received by users who have used it, describing how they were able to quickly start PoC and were able to understand how it operates. Even after the PoC build support service ended, many users continued to use the bearing diagnostic application.

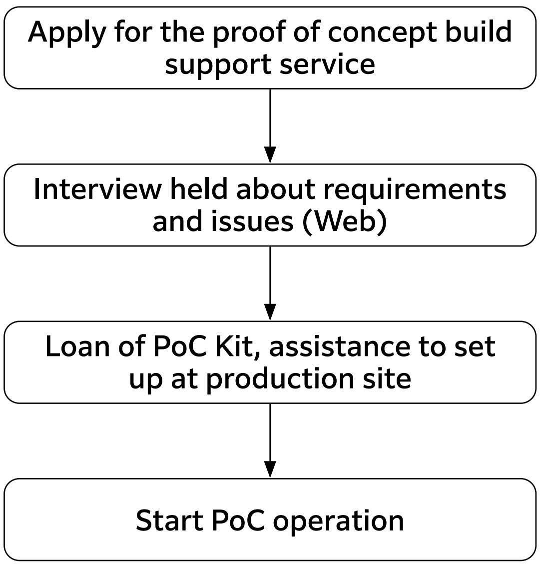

Fig. 4 PoC build support service flowchart

6. Summary

This paper introduced the bearing diagnostic edge application used for industrial IoT platforms. It also showed the introduction of the bearing diagnostic edge application at a production site using an example of application on cooling pumps. The bearing diagnostic edge application is not limited to the example shown in this paper and is used by a variety of users. We will continue to develop products with enhanced functionality in the future, provide service solutions that meet the needs of our users, and contribute towards improving productivity in each industry.

References

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