PREDICTIVE MAINTENANCE

TINY AI APPLICATION EXAMPLE

POLYN TECHNOLOGY
NEUROMORPHIC ANALOG SIGNAL PROCESSING

For Industry 4.0 health monitoring of machines is vital, and neural networks are ideal for that purpose.

Predictive Maintenance is performed by placing sensors on equipment, vehicles, and other assets, making it possible to discover and resolve maintenance issues before they cause real problems.

If sensor data indicates deteriorating performance, repairs can be taken care of immediately. Vibration-based condition monitoring is one of the basic Predictive Maintenance options detecting machine failure.

Different types of vibrations help to measure displacement, velocity and acceleration, with different measuring technologies, such as piezoelectric sensors, microelectromechanical sensors and many others. Today it is the most popular solution implemented by most sensor-node makers.

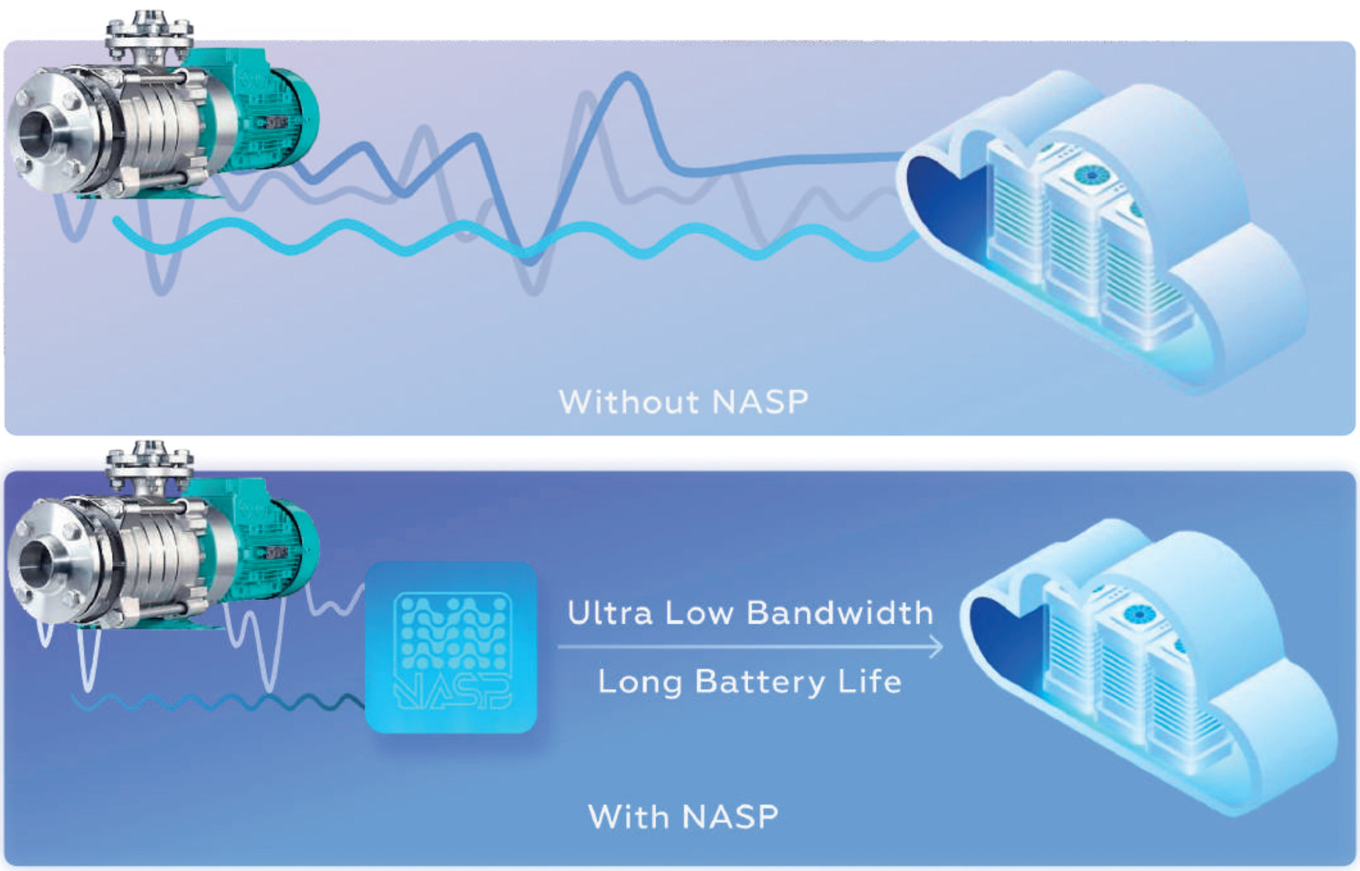
Benefits of Neural Networks for PdM

- Superior modeling with nonlinear data with a large number of inputs for sound and vibration.
- Once trained, a neural network does not fail, providing superior function for resilient solutions.
- Neural networks trained with more layers offer better prediction and stable pattern detection.

PROBLEM AND SOLUTION

The power-hungry sensor node collects a lot of data for further analytics by Machine Learning (ML) algorithms. To send all this data to a center for analysis, the data communication would be more trouble than it worth. Data reduction can significantly decrease the volume of data sent to the cloud, saving OPEX and improving latency.

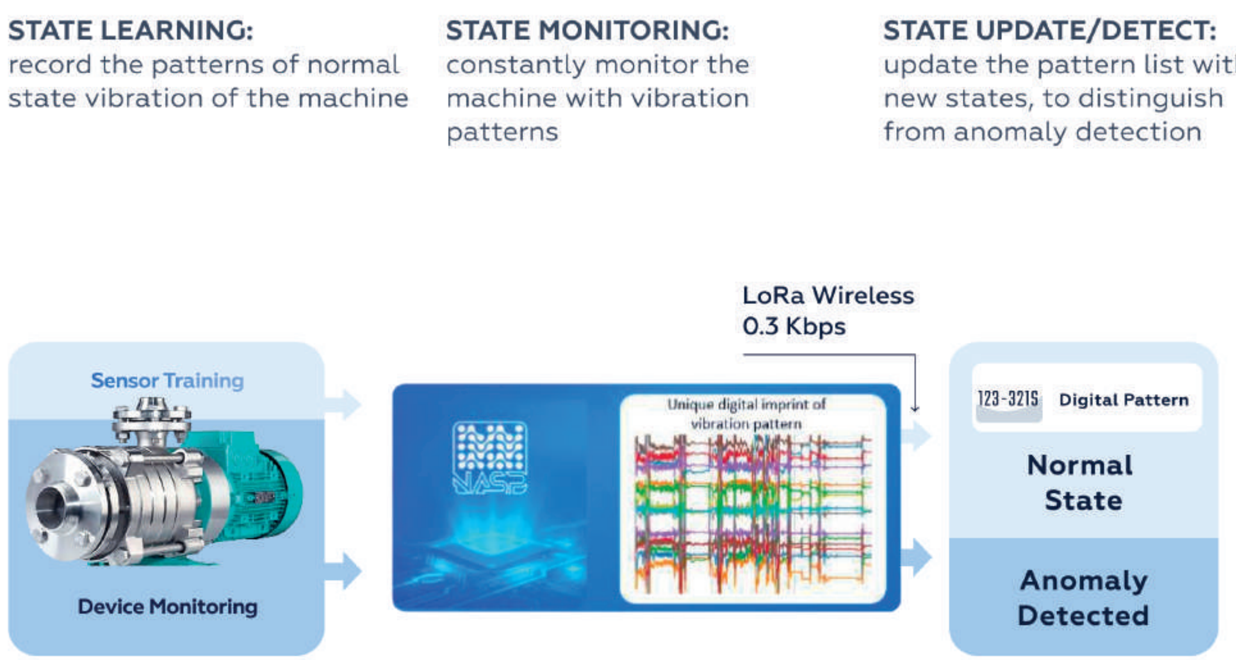
For devices such as sensor nodes performing always-on measurements, Neuromorphic Analog Signal Processing (NASP) is an ideal solution with ultra-low 100μW power consumption and ability to process the raw data on-device with high accuracy. This increased accuracy also enables simplification of the entire system and reduction of related costs.



HOW IT WORKS

The huge data flow generated by vibrational sensors typically must be transferred wirelessly to analytics in the cloud. This shortens the battery life of operating sensor nodes. A NASP solution reduces that data flow by 1000 times, using neural network modeling, and transmitting through LoRa (or another wireless technology) only the embeddings extracted from the initial data. The solution will create new classes, describing new signals of vibration sensors, if they were not initially trained to recognize these types of signal patterns.

Thus, by applying a neural network, in this case rigidly built-in NASP, we can obtain the whole range of patterns of vibration signals from various vibration sensors. These can then be analyzed by a digital system to recognize machine malfunctions. Use of embeddings reduces data sent to the cloud, solving the fundamental problem of low bandwidth required by IoT systems.



The standard practice of a vibration sensor installation requires in many cases dedicated training cycles for a specific machine, since the same signal generated, for example, from bearings could differ within the same machine under different conditions.

So, it is necessary to learn about the character of the vibration. During this training period, signals could be recorded entirely together with the short digital signature (pattern). Later at the monitoring stage only the detected patterns would be propagated toward the analytics point.

The idea is to generate those patterns with a high level of confidence. POLYN's VibroSense solution, based on NASP technology, achieves that.

THE IMPORTANCE OF NASP FOR PDM

NASP technology provides the optimal answer to power consumption and computing latency challenges through a hybrid analog and digital solution.

It combines the advantages of the fixed weights part of the NASP chip and flexible weights in a digital co-processor, with smart optimization (pre-processing) of raw data directly on-sensor. Applications such as predictive maintenance highlight the potential of NASP technology for IIoT sensory systems to optimize the system power consumption by drastically reducing data transfer.

This not only saves bandwidth but enables solutions based on energy harvesting to save OPEX during exploitation. All that is possible because the use of deep learning neural networks enables a high accuracy of pattern detection and extraction from the vibration signals.

WHY POLYN?

Our unique NASP technology has a brain-mimicking architecture for handling raw sensor data of various types of signals. Moreover, POLYN offers a novel approach to analog integrated circuits aiming to imitate the human brain processing in a truly neuromorphic solution. The NASP solution is hybrid; it includes a fixed neural network that doesn't change after a certain number of training epochs along with a flexible one capable of changing the last few layers according to the transfer learning approach.

POLYN supports the fast and cost-effective development of tailored solutions that perform deep learning computations on mass-market devices targeted for always-on, low power, and fast inference. POLYN's additional services cover neural network selection, optimization (pruning), and generation of the SW simulation (D-MVP) for the resulting neural network prior to the silicon production, guaranteeing 100% fit of the resulting analog chip.