DEMO: Short-Term Fault Vibrodiagnostics in a Production Machinery Unit Based on Neural Network Analysis

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***Abstract*—The demo is part of a system for multi-parameter monitoring of production machinery (technical state, operating conditions, personnel actions). The use of machine learning can increase the machinery productivity when possible faults are detected and appropriate service maintenance is started in advance. In this DEMO, we show a solution to analyze the sensed vibrating data from a machinery unit. A neural network is used to detect possible faults as deviations from the normal state. Our early experiments show that faults can be detected with short-term prediction in time.**

The proposed solution applies recurrent neural networks (Long Short-Term Memory in this case) to detect faults (as deviations from the normal technical state). The application scheme is shown in Fig. 1. Consider the example of a bearing vibration sensor. During training, the network receives the data vector of the healthful bearing as input. Its purpose is to restore the incoming signal if the actual readings differ from the reconstructed ones, then we can assume that the bearing is broken.

For detecting a possible fault, the mean absolute error (MAE) metric is used.

$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n} |y_i - x_i| \,,$$

where y_i is predicted values and x_i is actual (true) values. That is, MAE evaluates the deviation from the normal state or conditions.

The Keras framework is used to create such a neural network [1]. The neural network is trained. Nvidia Jetson Nano device can be used for data analysis, as Fig. 2 shows.

To detect a fault, the error metric is analyzed. If the predicted vibration signal differs essentially from the actual one then a possible fault is detected. The difference begins to increase sharply, showing the existence of a malfunction. An example for bearing is shown in Fig. 3.

Nvidia Jetson Nano is one of the mainstream devices of integrated GPUs on the market [2]. Computing board, featured with 128-core Nvidia GPU in Maxwell architecture, is a small developer kit for processing neural network model inference at the edge [3]. The Jetson Nano is a complete device for computing using GPU, i.e., we do not need to use motherboards, processors, etc.

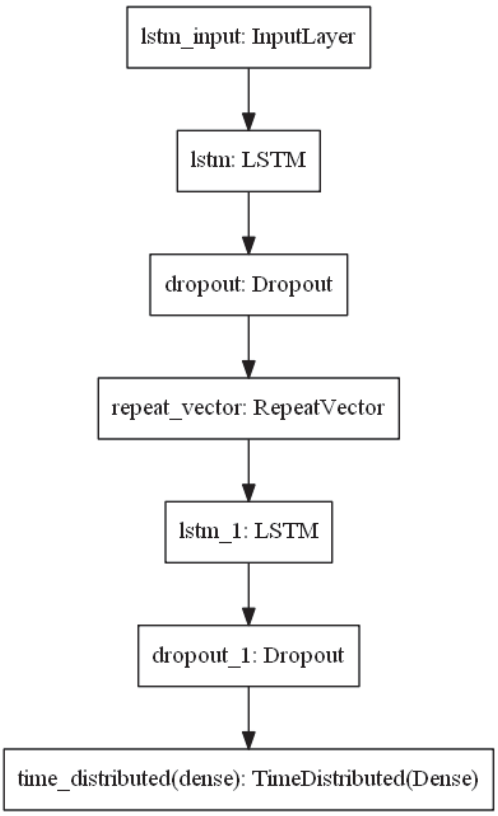

Fig. 1. Version of model LSTM autoencoder

A special feature of hardware that supports CUDA (Compute Unified Device Architecture) technology is the ability to provide an order of magnitude higher bandwidth when working with memory. Nvidia graphics accelerators, starting with the eighth series, implement the CUDA parallel computing architecture, which provides a specialized software interface for non-graphical computing. The CUDA platform is designed to work with programming languages such as C or C++. This accessibility makes it easier to use GPU resources [4].

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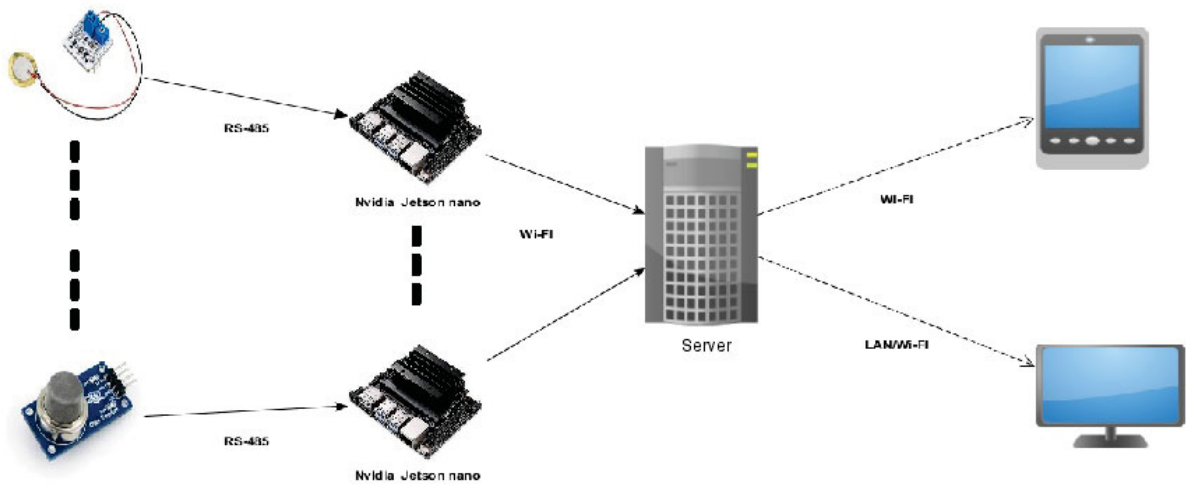

Fig. 2. Fault detection service: architecture

Fig. 3. Broken bearing experiment: actual sensed data and prediction

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