

Fault Diagnosis in Turning Operation with Neural Network Approach

FDD Course Project

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Introduction

- Fault detection and diagnosis (FDD) is a key component of many operations management automation systems.
- Fault monitoring is important for machining operations.
- Fault monitoring is very important for machining operations as it improves system reliability, safety and efficiency.

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Turning Operations

Turning is a machining processes in which the part is rotated while a single point cutting tool is moved parallel to the axis of rotation.

- Turning is the simplest machining operations.
- Turning is among the most stationary of all cutting processes.

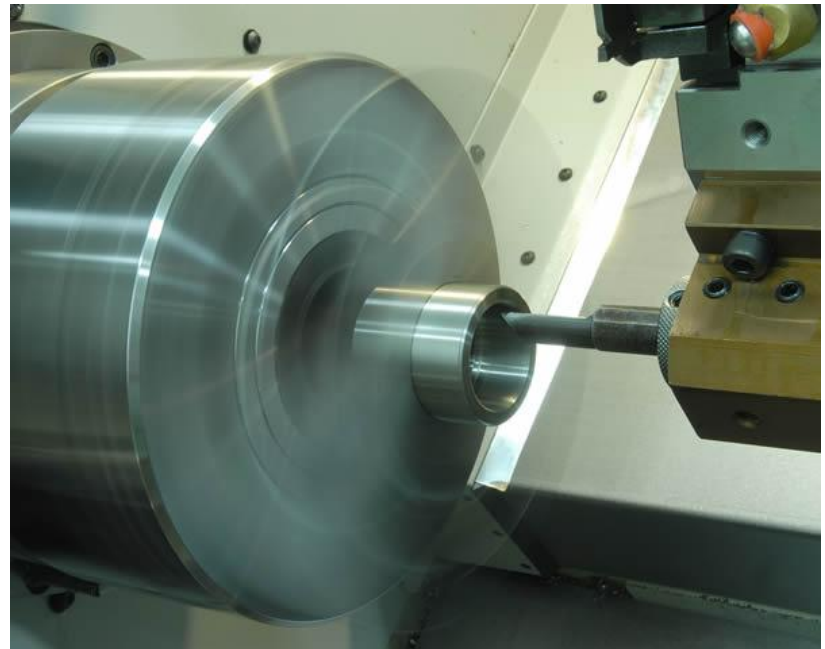


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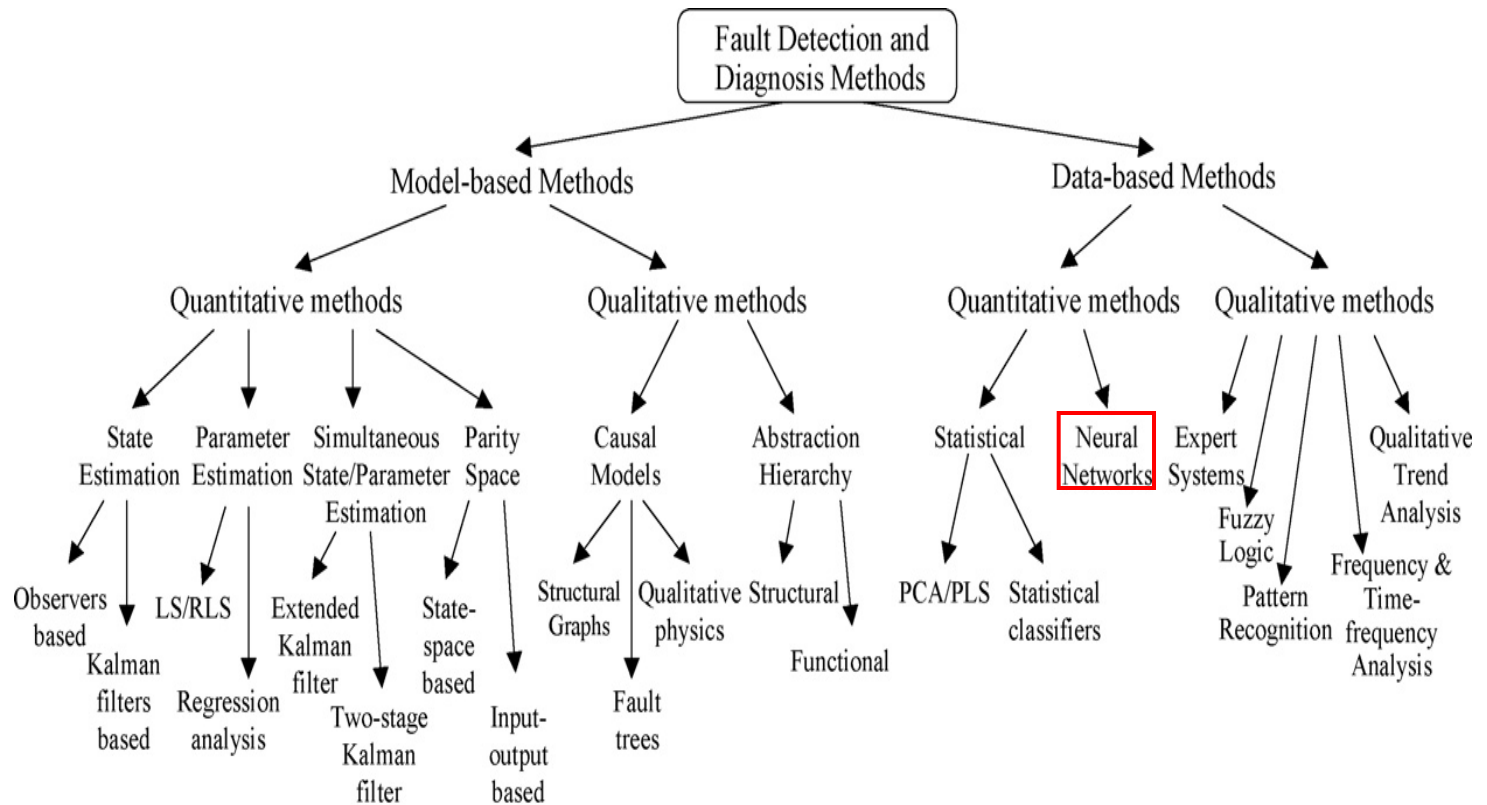
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Fault Detection and Diagnosis (FDD) and its Methods

- Fault Detection and Diagnosis (FDD) is a process (or technique) to detect faults and to determine their locations and significance in a system being monitored.
- Existing FDD approaches are classified in two important categories: model-based methods and data-based methods.

FDD Methods



Note: LS/RLS: Least Squares/Recursive Least Squares; PCA: Principal Component Analysis; PLS: Partial Least Squares.

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Neural Network Approach

- Artificial neural networks (ANNs) may be defined as structures comprised of densely interconnected adaptive simple processing elements (neurons) that are capable of performing massively parallel computations for data processing and knowledge representation.

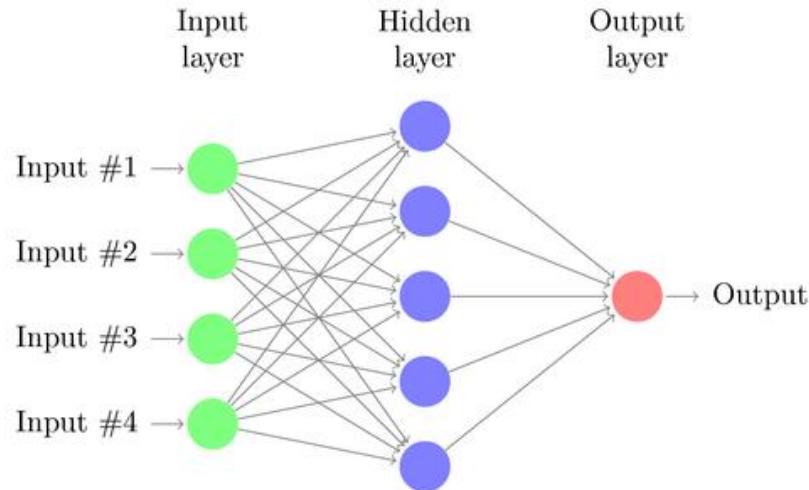


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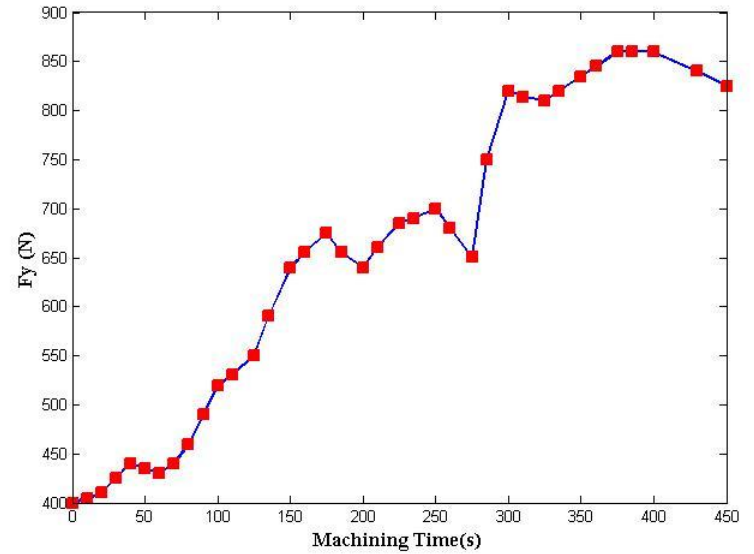
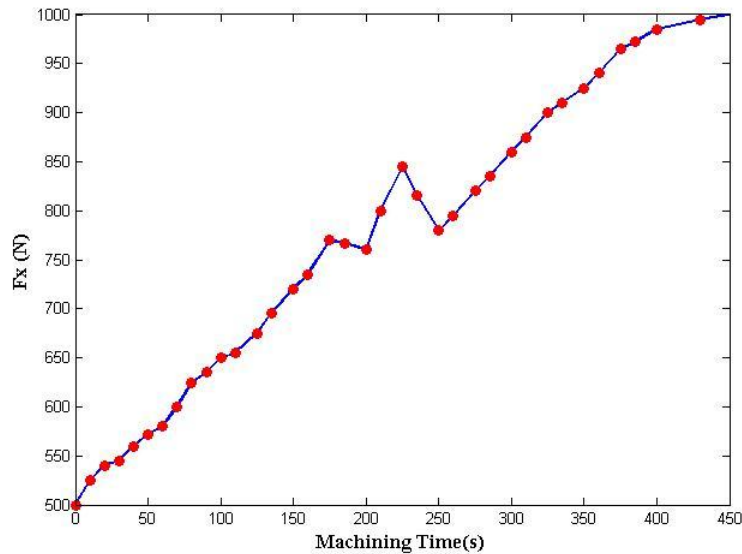
Calculations and Results

- Cutting forces and vibrations are good indicators for turning operation then feature vectors are considered as a combination of them:

$$\begin{bmatrix} F_x \\ F_y \\ F_z \\ \text{Vibration} \end{bmatrix}$$

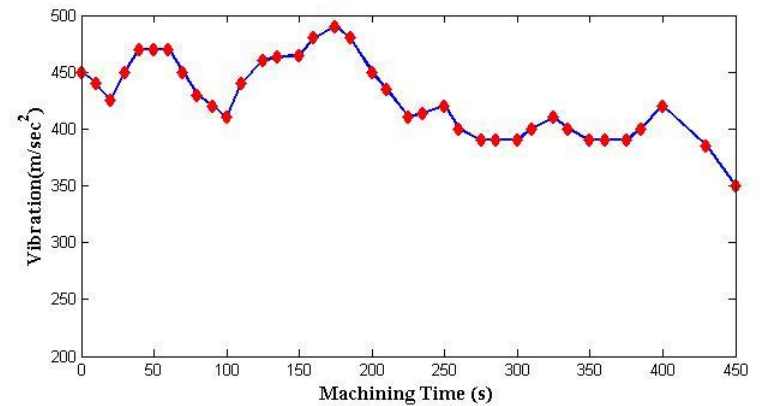
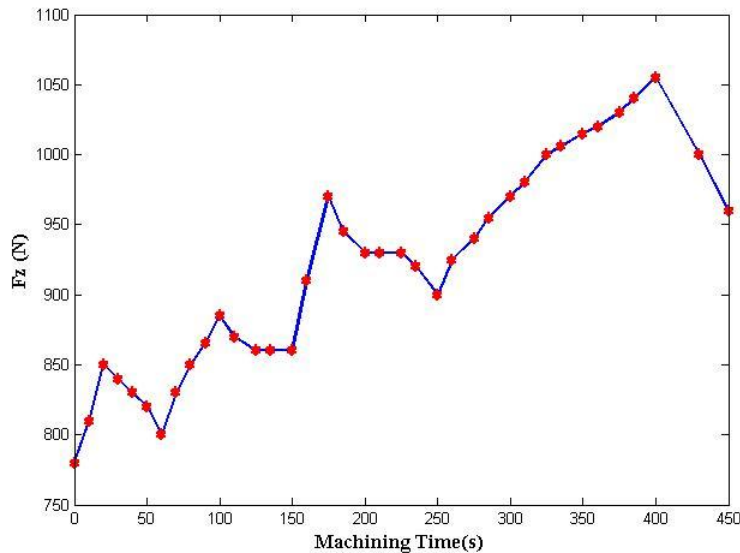
Calculations and Results

- Cutting force data as the input data:



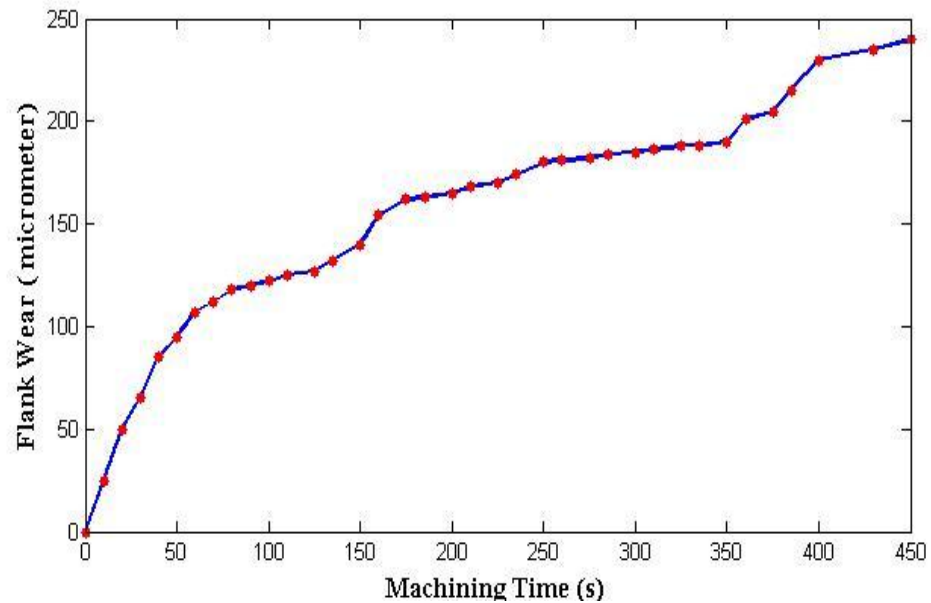
Calculations and Results

- Cutting forces and vibrations as the input data:



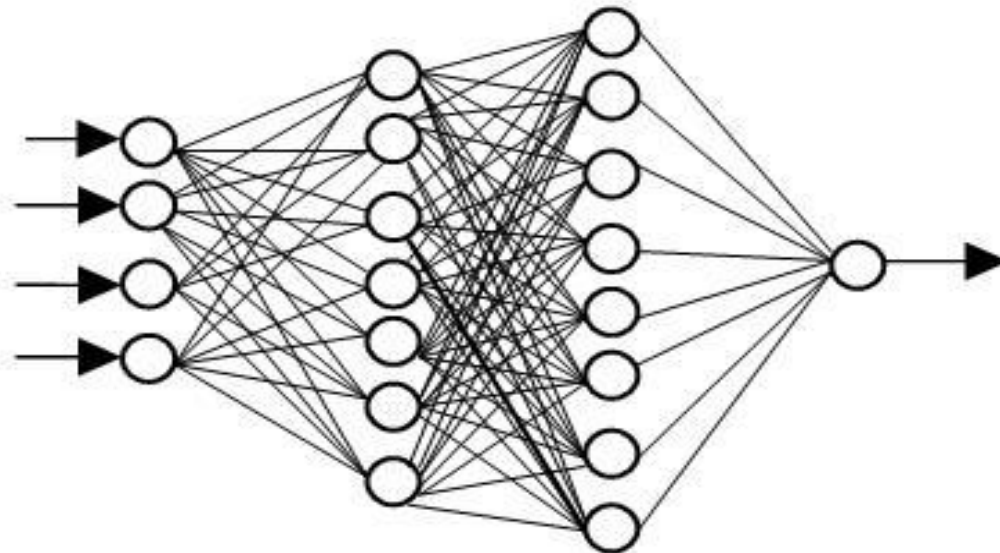
Calculations and Results

- Flank wear amount as the output data:



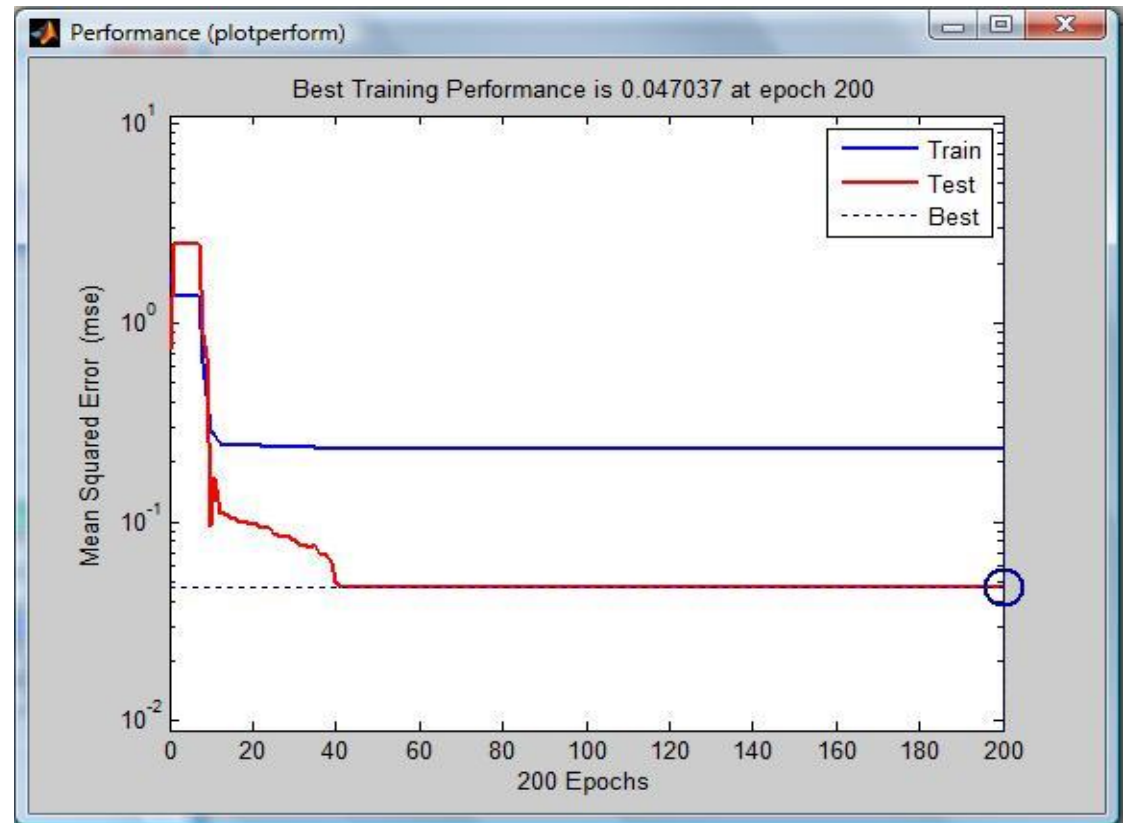
Calculations and Results

- A multi-layer neural network which has 2 hidden layers (with 7 and 8 neurons) is trained.



Calculations and Results

- Mean square error of network training is really close to zero and then it means that the network is trained accurately and the result will be reliable.



Calculations and Results

- Example 1:

$$A = \begin{bmatrix} Fx = 768 \\ Fy = 660 \\ Fz = 955 \\ Vib. = 485 \end{bmatrix}$$

Neural network will give $y = 1.0000$ which it means that the data is related to a sharp tool.

- Example 2:

$$A = \begin{bmatrix} Fx = 968 \\ Fy = 860 \\ Fz = 1035 \\ Vib. = 395 \end{bmatrix}$$

- Neural network will give $y = 0$ which it means that the data is related to a worn tool.

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Conclusion

- Neural network is a famous data base methods in fault detection and diagnosis.
- It has good result for turning data in this study.
- In this study cutting forces and vibrations are used as the input data and they are good indicator for turning tool status monitoring.
- In this study data are used directly and feature extraction methods are not used.
- Neural network is trained offline and it can be applied for online detection.

Thank you for your attention!
Questions?