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Unmanned Marine Vehicles Motor Fault Classifier Based on Nonlinear Autoregressive with Exogenous

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Outline

- Aim of Fault diagnosis and condition monitoring Task
- Major Faults in electrical Machines
- Fault diagnosis process
- Dynamic Neural Network for fault Diagnosis
- Conclusions

Tasks of Fault Diagnosis

The system performs the following tasks:

- Fault detection – to indicate if a fault occurred or not in the system
- Fault isolation – to determine the location of the fault
- Fault identification – to estimate the size and nature of the fault

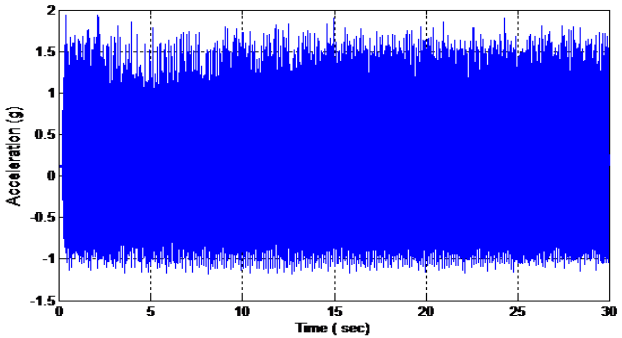
The first two tasks of the system - fault detection and isolation - are considered the most important. Fault diagnosis is then very often considered as fault detection and isolation (FDI).

What Would A Condition Monitoring System Do?

- The need to improve accuracy in failure prediction.
- The need for an overall view of equipment condition.
- The need to reduce the cost of condition monitoring.
- The need to improve system reliability.

Experimental Set-up

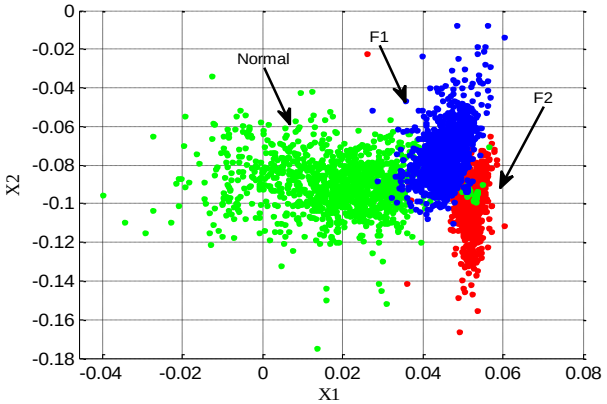
Propellers in the trolling motors are durable but not indestructible. Hard surfaces can damage blades partly or fully and can imbalance the operation of a trolling motor causing significant damage to the internal parts. The diagnoses of these faults are thus necessary for the healthy operation of the trolling motors and critical for USV operations.



The orthogonal fuzzy neighborhood discriminative analysis (OFNDA) for Features Reduction

To reduce additional computational time for fault classification, an accurate dimensionality reduction tool is needed to select the most informative features from the wavelet feature set

OFNDA as a new approach for feature reduction , it works to maximize the distance between features belong to different classes (S_b) whilst minimize the distance between features in the same class (S_w) while taking into account the contribution of the samples to the different classes



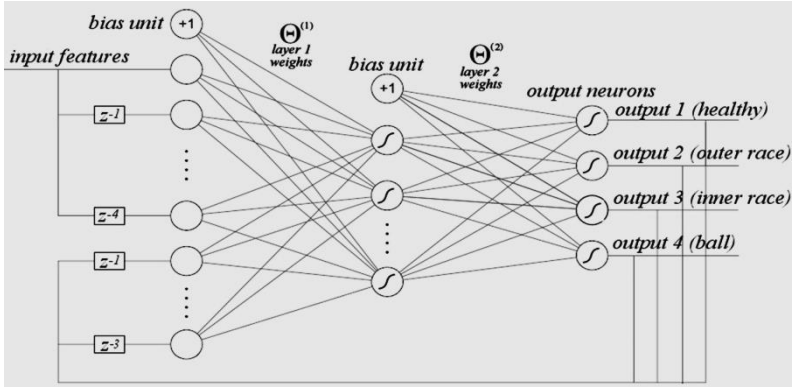
OFNDA features

Dynamic Neural Network for fault Diagnosis

NN network is an information processing system that has certain performance characteristics in common with biological NN

NN can be used for fault isolation due to its stability and parallel processing

- The solution time for calculating machine circuit parameters using NN model has been dramatically reduced, while sufficient accuracy has been maintained
- excellent pattern recognition can be effectively employed for the fault classification

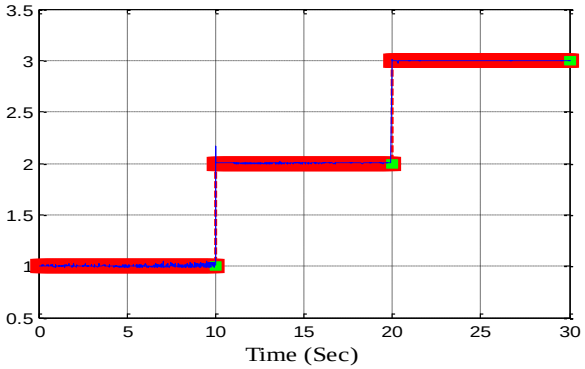


DYNAMIC NEURAL STRUCTURE

Supervised learning with Levenberg marquardt propagation was used to train the NN with a training data set. The process consists of initially assigning some random weights to each of the connections. Forward propagation is then used to obtain the predicted output for each training set sample.

NARX performance for fault classification

Input-output Time delay	Test accuracy	Validation
	MSE	
2	9.52e-10	8.44e-9
4	2.84-6	6.45e-8
10	4.89e-5	3.60e-3



Conclusions

- A DWT was used as a feature extraction tool to obtain a better resolution of the signal in time and frequency domains and then
- feature reduction based on OFNDA was applied to obtain the best features for fault classification.
- These features were then fed into a NARX for classifying the faults and results showed that better classification accuracy was obtained with OFNDA techniques. Further tests simulating the real operating behavior of the trolling motor under normal and faulty conditions also confirmed the superiority of the proposed method which can easily be applied to real time fault detection and classification on board the *Springer* UUV. The proposed technology is portable to other types of autonomous vehicle