Multi-fault diagnosis for wind turbines based on SCADA data

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Poster

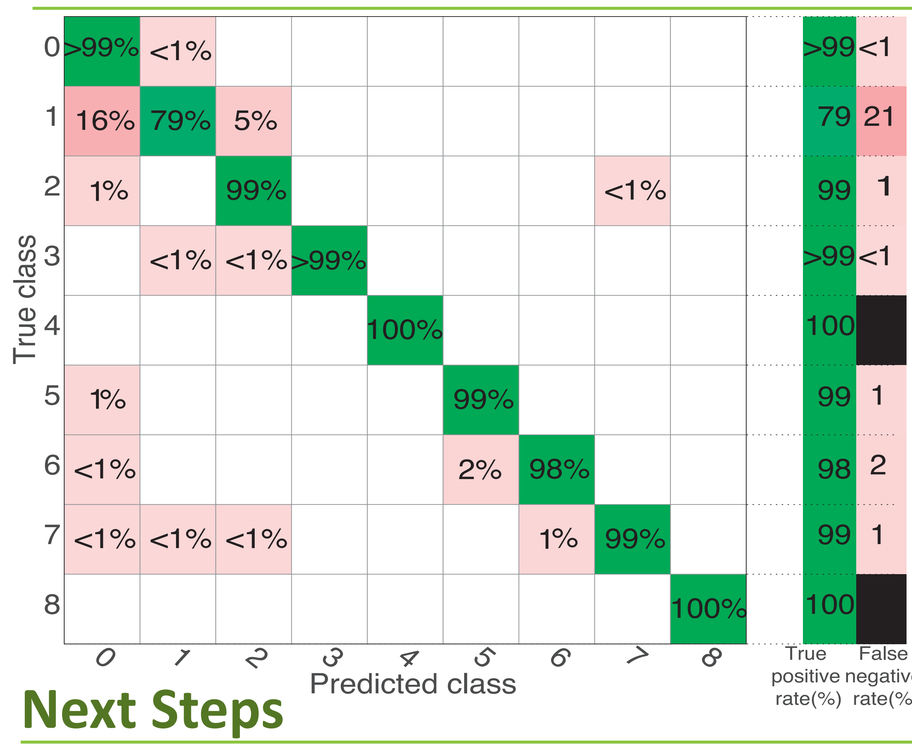
Research Objective

With wind turbines (WT) becoming larger and their operating conditions becoming more extreme (e.g. offshore), a major issue is the relatively high cost of maintenance. Therefore, the implementation of fault diagnosis systems is crucial. This work contributes a strategy to **classify different types of faults** in the main components of a WT through the analysis of its SCADA data. The proposed technique is validated using an enhanced **benchmark challenge for WT fault detection [1] that makes use of FAST [2]**.

Expected Contributions

- The SCADA data sets are already collected by the WT control system and, therefore, **no new installation of specific sensors is required**.
- The strategy is based on **PCA** and **SVM** through *k*-fold cross validation.
- **Overall accuracies of 98%** are obtained.

State of Research



Confusion matrix results

Next Steps

As an accurate **prognosis of the WT subsystems is essential for reducing operation and maintenance costs** in wind farms, the next future work will study the contribution of an **effective predictive maintenance strategy (prognosis)** based on this same principle.

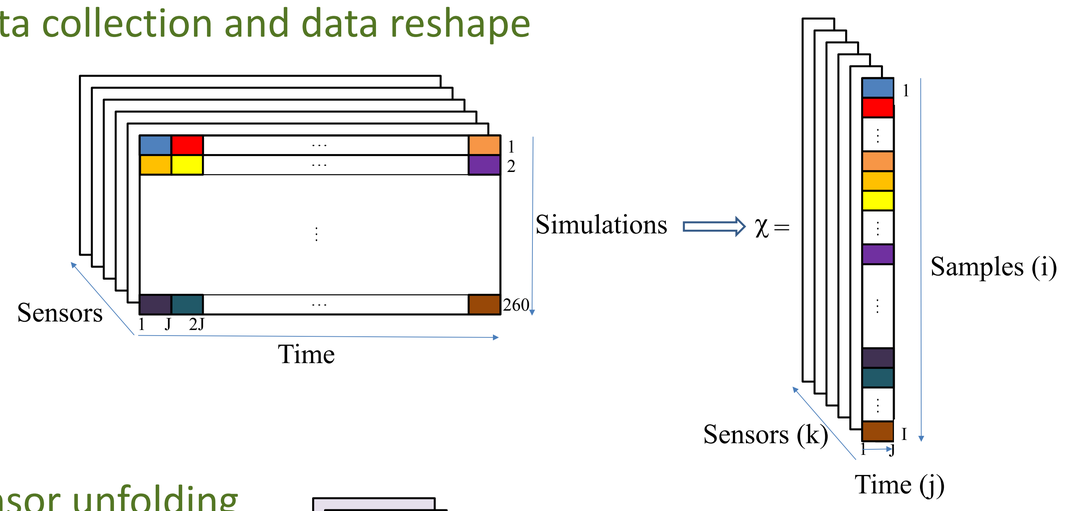
Research Details

1 FAST Benchmark model

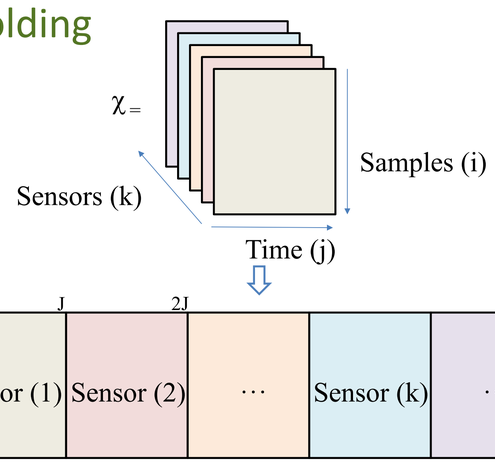
Number	Sensor type	Unit	Noise power
S1	Generated electrical power	W	10
S2	Rotor speed	rad/s	10^{-4}
S3	Generator speed	rad/s	$2{\cdot}10^{-4}$
S4	Generator torque	Nm	0.9
S5	Pitch angle of first blade	deg	$1.5{\cdot}10^{-3}$
S6	Pitch angle of second blade	deg	$1.5{\cdot}10^{-3}$
S7	Pitch angle of third blade	deg	$1.5{\cdot}10^{-3}$
S8	Tower top fore-aft acceleration	m/s^2	$5{\cdot}10^{-4}$
S9	Tower top side-to-side acceleration	m/s^2	$5{\cdot}10^{-4}$

Number	Fault	Type
F1	Pitch actuator - High air content in oil	Change in system dynamics
F2	Pitch actuator - Pump wear	Change in system dynamics
F3	Pitch actuator - Hydraulic leakage	Change in system dynamics
F4	Generated speed sensor	Gain factor (1.2)
F5	Pitch sensor	Stuck value (5 deg)
F6	Pitch sensor	Stuck value (10 deg)
F7	Pitch sensor	Gain factor (1.2)
F8	Torque actuator	Offset value (2000 Nm)

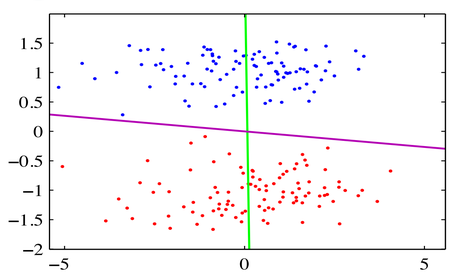
2 Data collection and data reshape



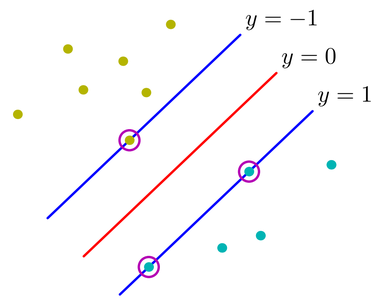
3 Tensor unfolding



3 Multiway PCA + SVM



With PCA, 99,98% of the variance is kept



The one-vs-all SVM approach is used

Acknowledgments and References

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[1] P. Odgaard, K. Johnson, WT fault diagnosis and fault tolerant control - an enhanced benchmark challenge. *The American Control Conference*, 2013.
[2] NWTC Information Portal (FAST). https://nwtc.nrel.gov/FAST. Last modified 04-January-2018 ; Accessed 14-June-2018.