MAS513-Advanced Robotics project:

Online health status detection of a motor

PROBLEM: Is it possible to determine the health status of the motor continuously using non-contact sensors and non-destructive testing?

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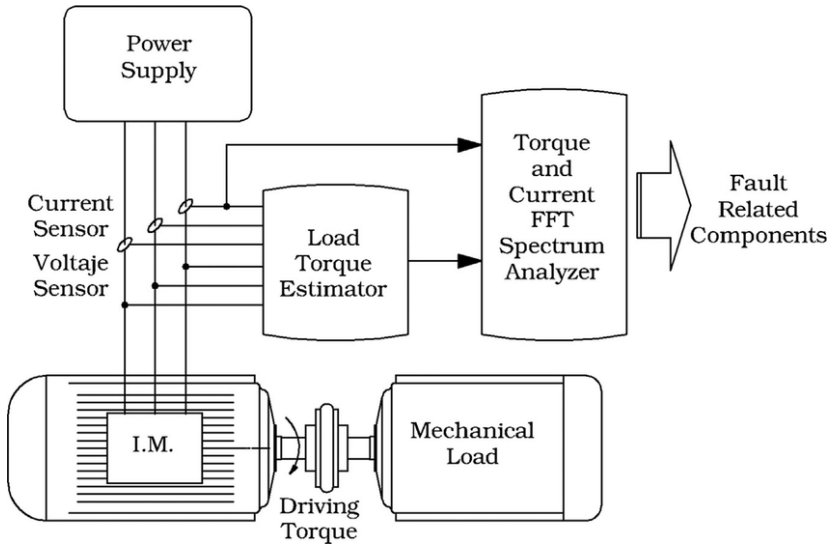
State of art:

The most common technique for the detection of the health status use contact sensor like as

- Vibrometer/accelerometer
- Voltmeter and ammeters

All of them are base on the key concept that:

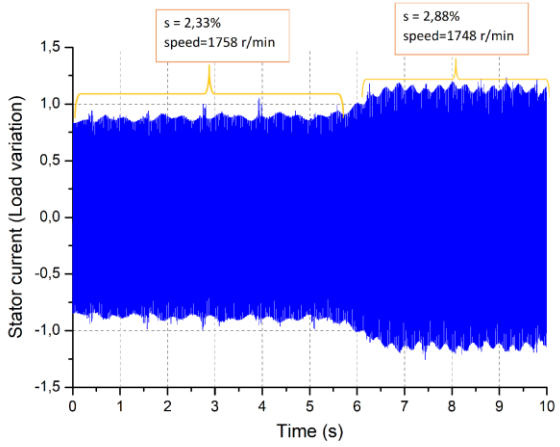
Each fault is related to a precise harmonic in the spectrum



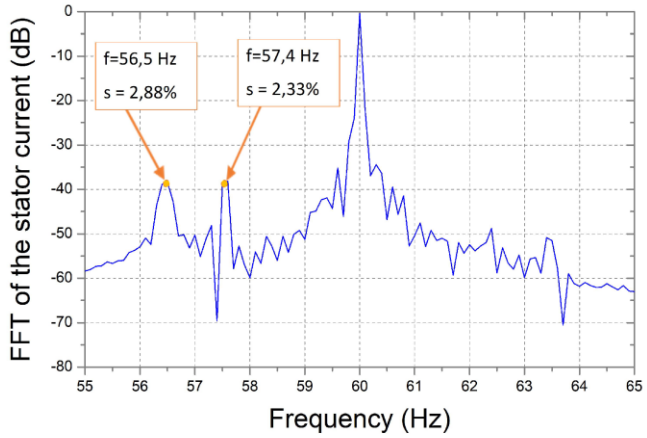
1) MCSA(motor current signature analysis)

This method require to measure the variation of the absorbed current from the motor.
From the current spectra is able to identify motor's fault thanks to a specific relationship.
For example, the frequency related to an air gap(eccentricity):

$$f_{ecc} = \left\{ (R \pm n_d) \left(\frac{1-s}{p} \right) \pm n_{\omega s} \right\} f_0$$



(a) Stator current variation



(b) Motor Current Signature Analysis (MCSA)

State of art:

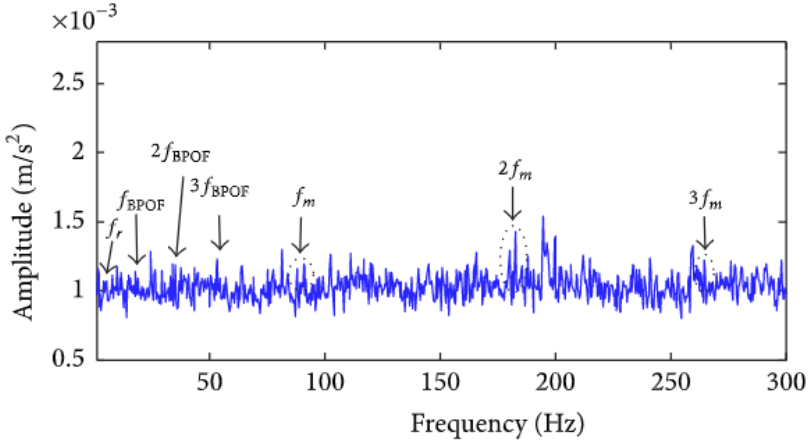
2) Vibration analysis

Usually It is based on 3-axis MEMS accelerometers that measure the vibration of the shaft. Also in this case is possible to find fault analysing the spectrum of the displacement of the shaft.

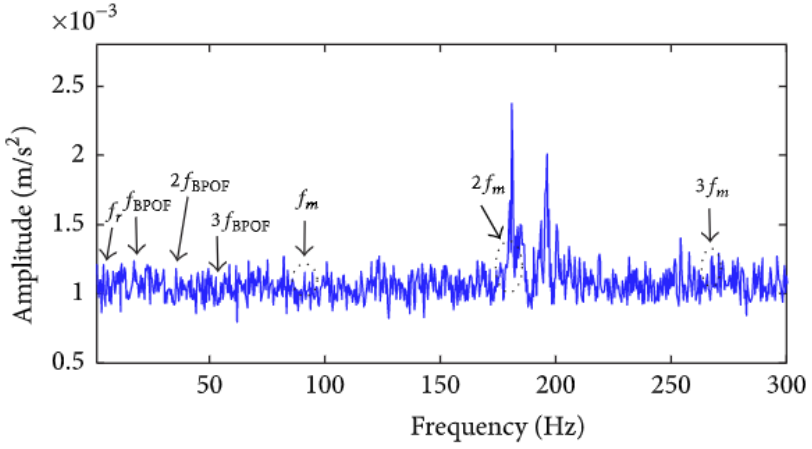
An outer race bearing defect is related a to the characteristic frequency:

$$f_{\mathrm{oD}} = \frac{n}{2} f_{rm} \left(1 - \frac{\mathrm{BD}}{\mathrm{PD}} \cos \phi\right)$$

Requires bearing's geometry



(a) Healthy condition



(b) Bearing defect

State of art:

MCSA	***Vibration analysis***
non-invasive	independent of the type of motor power supply
Easy to implement	low power consumption
low signal-to-noise ratio	Lower realiability
contact-sensors	contact-sensors

Project's aim

The aim is to determine the continous health status of the motor using a Lidar that measure the vibration of the shaft.

PROS:

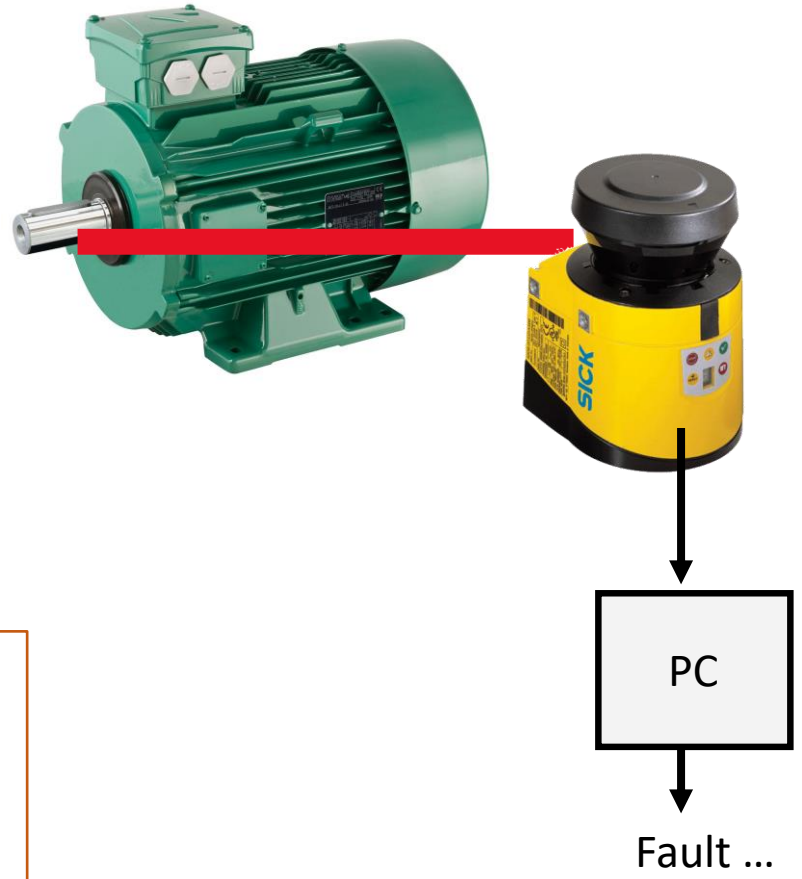
- Non intrusive monitoring system
- Mostly independent from enviroment condition
- Retrace the fault

CONS:

- Exspensive
- More complex

Assumptions:

1) Only one fault can occur for each run (NO multiple-fault diagnosis)
2) Only air between the Lidar and the target
3) Consider only one direction vibration



Process

CWFM Lidar generates a voltage signal

↓

Acquisition

↓

Filtration

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Fourier trasformaton o of the signal to obtain the range o the shaft

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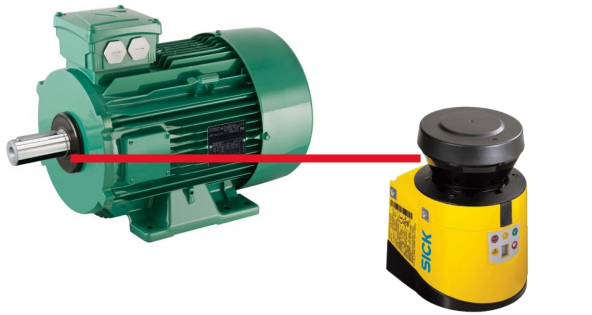
Analysing harmonics of the displacement to detect known fault

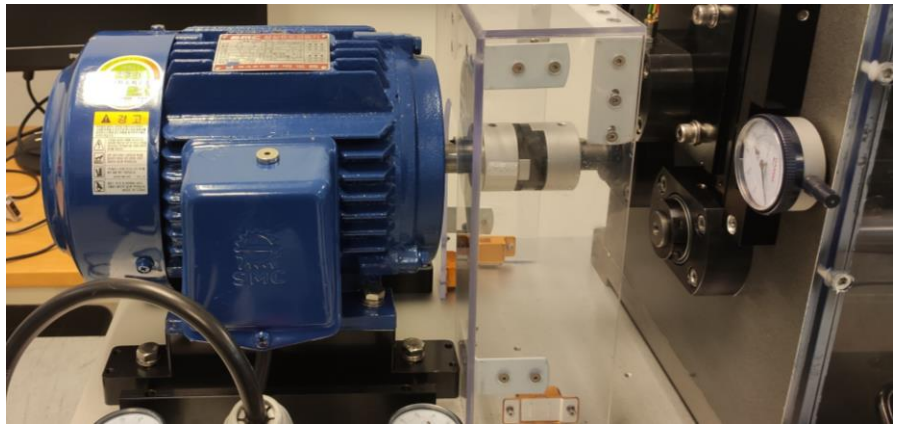
Validations of known equation injecting known fault



PC

Equipment

Induction motor with variable load



LIDAR LMS133 -10100

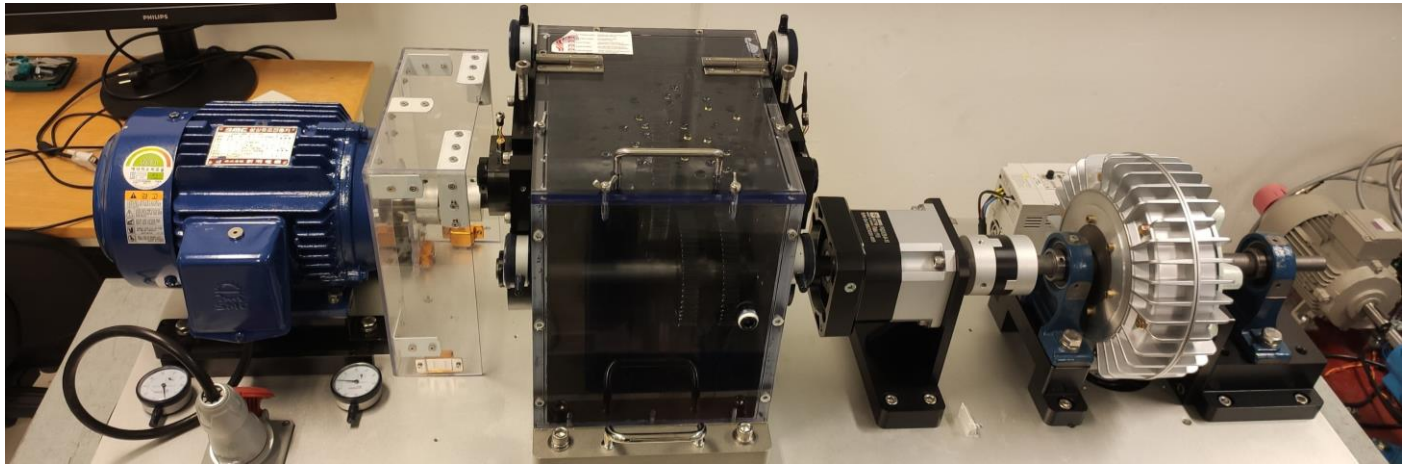
Datasheet: here

Future applications and developments

The project can be improved introducing multiple-fault diagnosis and multi axes measurements.

Condition monitoring without contact with the object can be very useful when the motor is placed in hostile or not very accesable enviroment.

The data from the sensing components can be used for the control system of the motor, improving efficiency.



Thanks for the attention!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