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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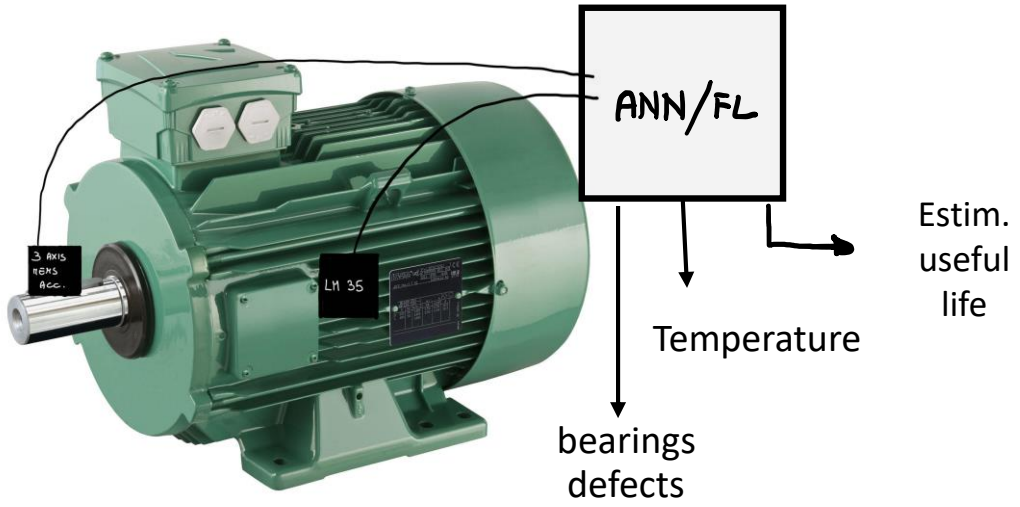
State of art:

Detection of the health status of the motor using **contact sensor** such as:

- Temperature sensor
- Vibrometer/accelerometer
- Voltmeter and ammeters.

The vibration of the shaft is related to defects of the inner components of the motor, i.e. bearings. Each harmonics is associated to a specific fault.



Project’s aim

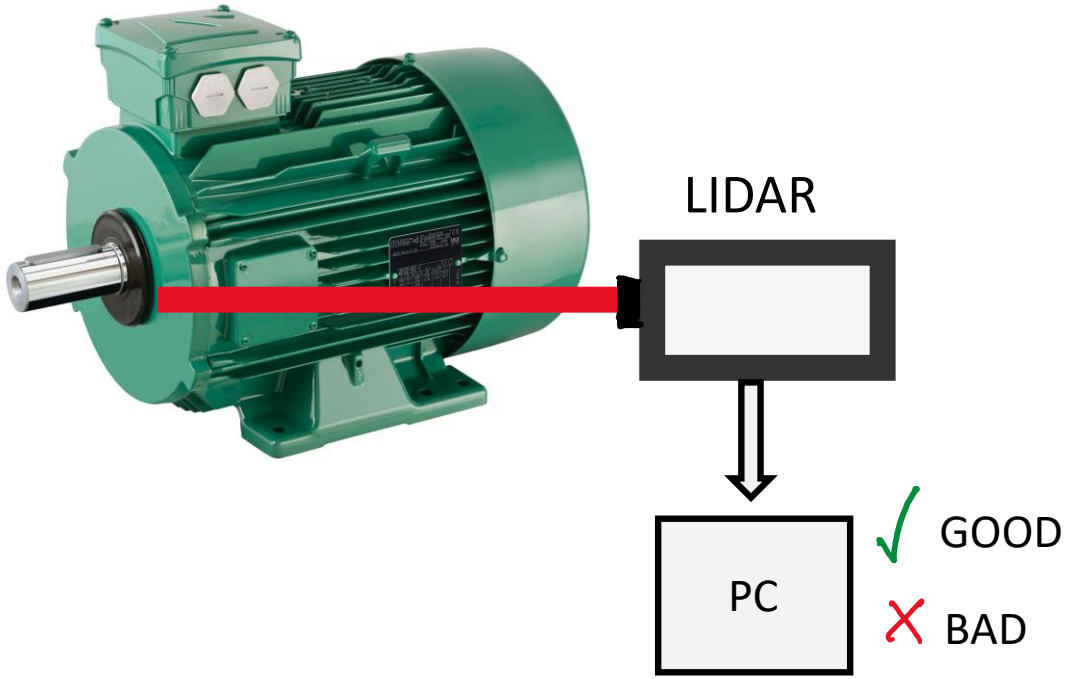
The aim is to determine the continous health status of the motor using a non-contact sensors that measure the vibration of the shaft.

PROS:

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

CONS:

- Exspensive
- More complex



Process

CWFM Lidar generates a voltage signal

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

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Plotting istantenous range with time we obtain the displacement

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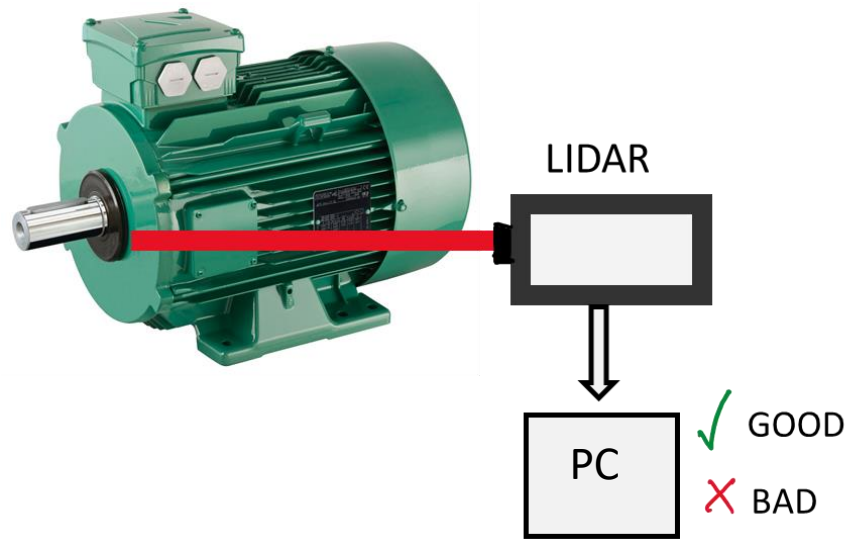
Analysing harmonics of the displacement to detect known fault



Future applications and developments

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.

The health of the motor can helps to develop new predictive maintenance technique, reducing the costs of industrial installations.

Continuous health status detection of a motor

1. Excellence

1.1. State of art, knowledge needs and projects objectives:

Determine the continuous health of a motor can be useful to predict a failure and to enable some procedures to put the motor into safety condition. This can also help the engineer to be aware of the type of the failure.

Actually, most technique use contact sensor. [1] demonstrate how it is possible to estimate remaining useful lifespan of a motor (applied to an EV motor) using temperature and speed sensor. It is also possible to determine the health of a motor, in particular of its bearings, analysing the vibration of the shaft, as described in [2]. However, this technique requires contact-sensor which can disturb the reading of the vibration of the motor. In fact, vibrations are a key factor to determine the health of a motor. Misalignments of the shaft or bearing defects can cause several vibrations, also destructive ones. For this reason, it is relevant to determine the health status of a motor without any contact-sensor, so they can not interfere with the readings. This project wants to determine the amplitude of the vibration of the shaft using a Lidar and analysing the presence of harmonics inside of the displacement is possible to retrace some known fault. McFadden and Smith [3] describe that every superficial defect of the mechanical components is related to a specific frequency that is proportional to the speed of the shaft. But also other defects, specific for induction motor (most common type of motor in the industry), have typical harmonics in the spectrum [4].

1.2. Research question and hypotheses, theoretical approach and methodology

The development of the project is based on different questions. Using a Lidar, it is necessary to determine the correct distance between the sensor and the shaft. Also, how it is possible to determine the amplitude of the displacement of the shaft while the motor is working. The presence of a load attached to the shaft can disturb the readings, if the load is unbalanced. The project is articulated in different phases: at first the Lidar must be properly adjusted and sets all its parameters. The voltage data coming from the lidar must be processed and doing the Fourier transformation of the signal is possible to determine the speed and the displacement of the vibration.

1.3. Novelty and Ambition:

A lidar is a non-contact sensor, that can be used to determine the speed of the motor, so to apply this technique the motor must not but modified. In fact, the actual technique requires to put a sensor on the motor, this could be very difficult if the motor is in hostile and uncomfortable places like for example on the wind turbine. The project wants to present how to determine the amplitude of displacement and speed of a motors shaft.

2. Impact

2.1. Potential for academic impact of the research project

The output of this project could raise new academic challenges. Determinate the continuous health status of a motor can helps to develop different type of predictive maintenance. For example, is possible to determine if some components inside of the motor are goint to fault and schedule a maintenance before the broke ; this helps reducing drastically the downtime of a machine.

2.2. The project's target audience is composed by all researcher whose need to implement different types of fault detection in motors, to improve their predictive maintenance scheme. But also, for who want to improve non-contact control of a motor, because it is allocated in a hostile environment for classic contact sensors.

2.3. This work will be published in specialized magazines because can be useful for who wants to improve this project including, for example the ability to recognized the precise fault.

3. Implementation

3.1. Project organisation and management

The project will be divided in different tasks: at the beginning we proceed with the setting of the Lidar and how to acquire its data. After the sensing part, we continue with the implementation of the code that must be able to execute the Fourier transform of the signal and determine the speed of the vibration and the displacement of it. In the end, everything must be fused in a project and test the project in laboratory.

[1] Health monitoring and prognosis of electric vehicle motor using intelligent-digital twin (wiley.com)

[2] Analyzing the Vibration Signals for Bearing Defects Diagnosis Using the Combination of SGWT Feature Extraction and SVM - ScienceDirect

[3] P. D. McFadden and J. D. Smith, "Model for the vibration produced by multiple points defects in a rolling element bearing", J. Sound Vib., vol. 98, no. 2, pp. 263-273, Jan. 1985

[4] A. Garcia-Perez, R. d. J. Romero-Troncoso, E. Cabal-Yepez and R. A. Osornio-Rios, "The Application of High-Resolution Spectral Analysis for Identifying Multiple Combined Faults in Induction Motors," in IEEE Transactions on Industrial Electronics, vol. 58, no. 5, pp. 2002-2010, May 2011, doi: 10.1109/TIE.2010.2051398

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