POLITECNICO
MILANO 1863

Data analysis for mechanical system identification

Order tracking

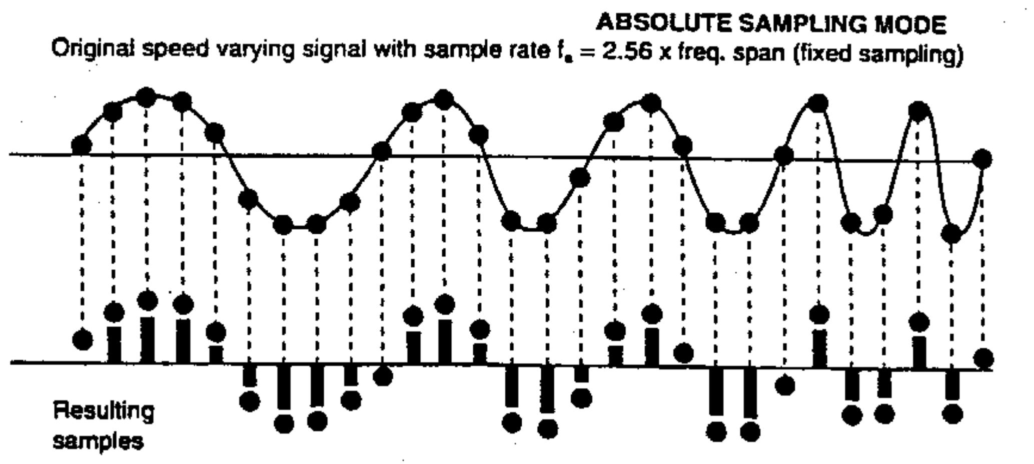
F. Lucà – francescantonio.luca@polimi.it

Asynchronous sampling: the samples are recorded at constant time intervals. If we call Δt the time elapsed between two subsequent samplings, the sampling frequency can be defined as $f_c = \frac{1}{\Delta t}$.

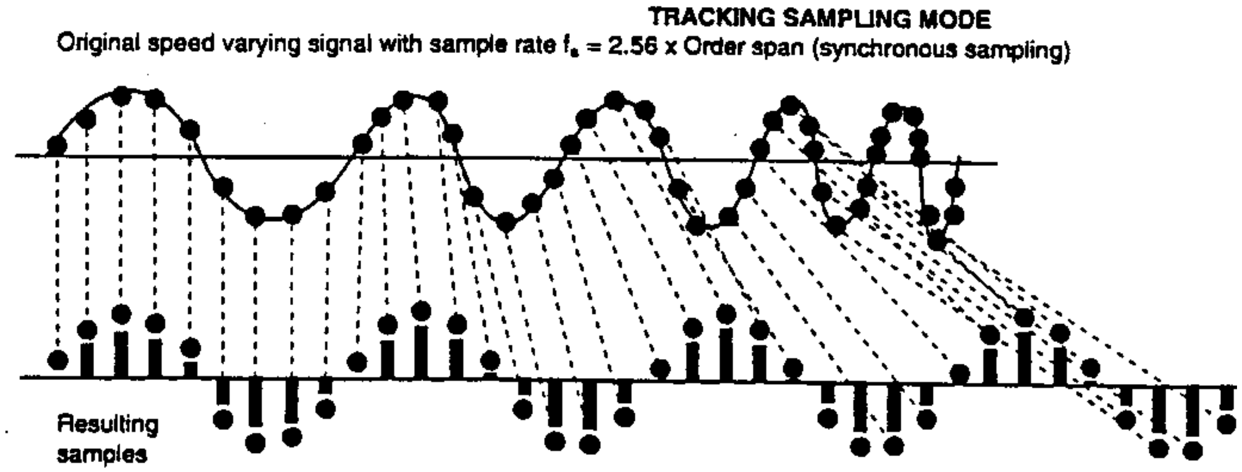
Synchronous sampling (order tracking): the samples are acquired in a way that is synchronized with a given phenomenon. Generally speaking the synchronous sampling is useful when a periodic phenomenon strictly related to the signal to acquire exists.

Sampling strategies

Asynchronous Sampling

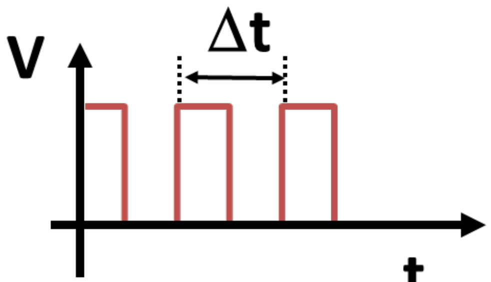


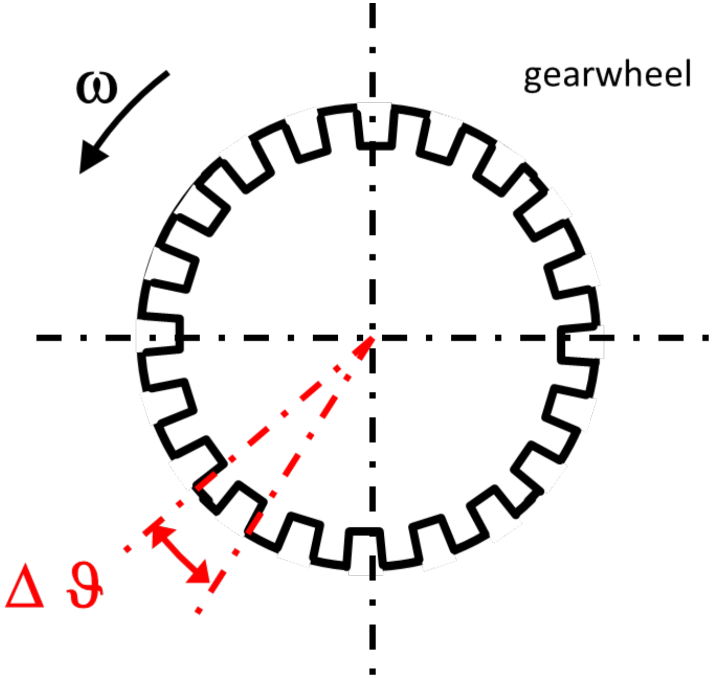
Synchronous Sampling – Order Tracking



Synchronous Sampling

- The time in which each sample is acquired is determined by the n impulses per revolution given by the encoder
- This results in an acquisition strategy at constant angle interval $\Delta\vartheta$
- In case of change of angular velocity the number of samples acquired per revolution remains the same

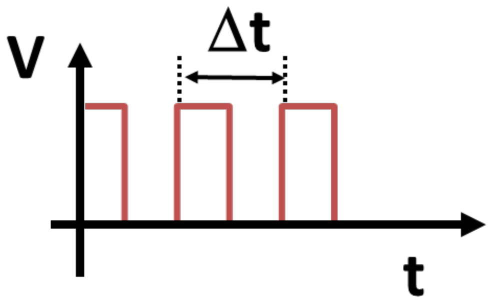


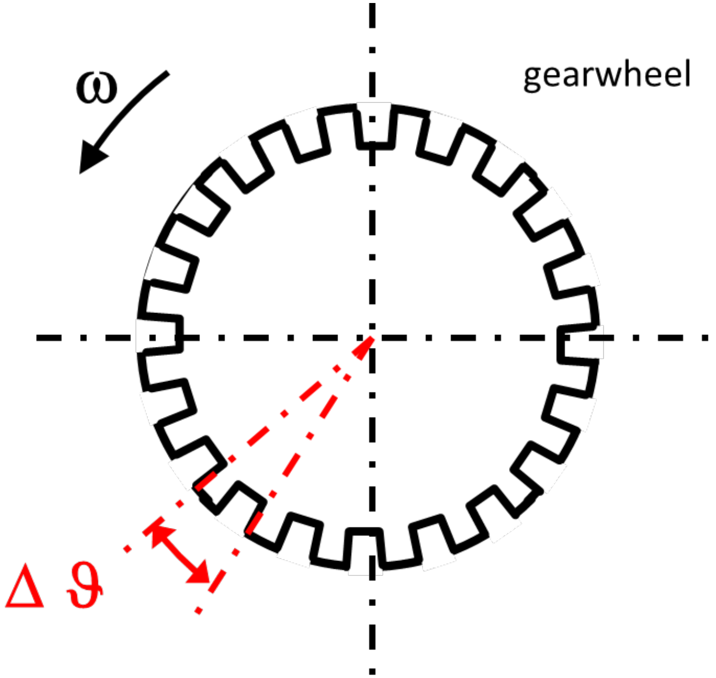


Synchronous Sampling

With this sampling strategy we can compensate possible variation of the angular velocity ω.
Also with synchronous sampling strategy we face some questions: how many points for each revolution should be recorded in order to sample the signal in a correct way? What should I pay attention at?

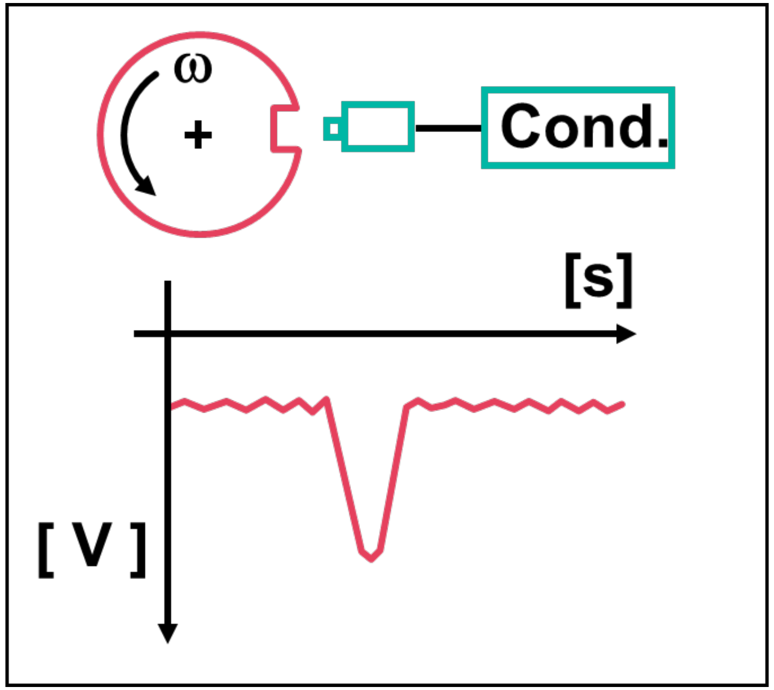
1. Aliasing
2. Leakage

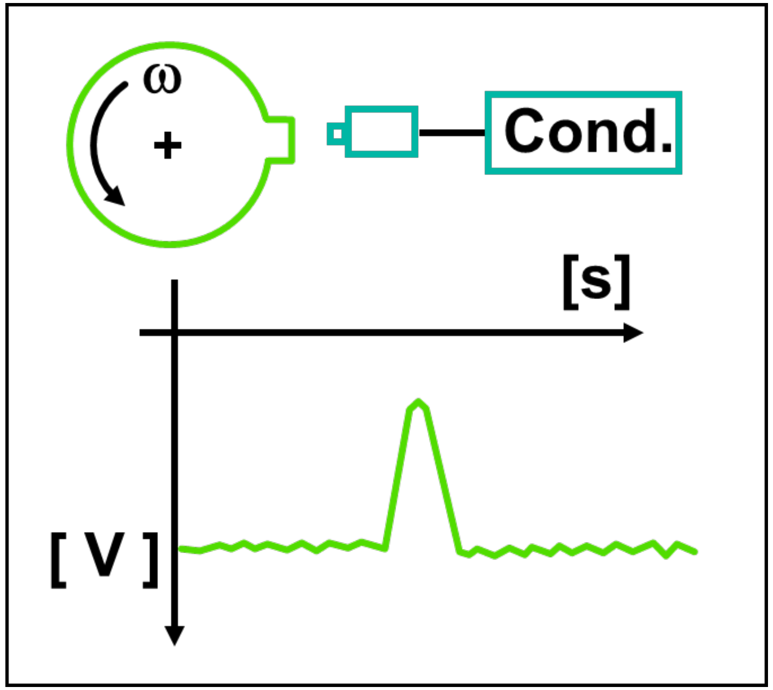




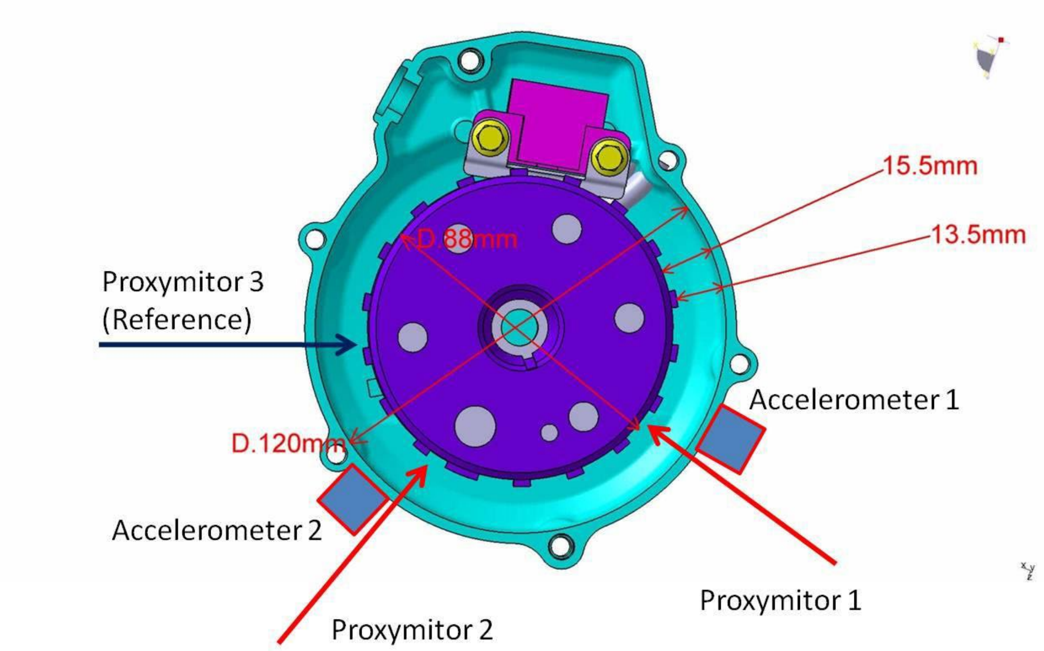
Order tracking technique: 1*rev reference

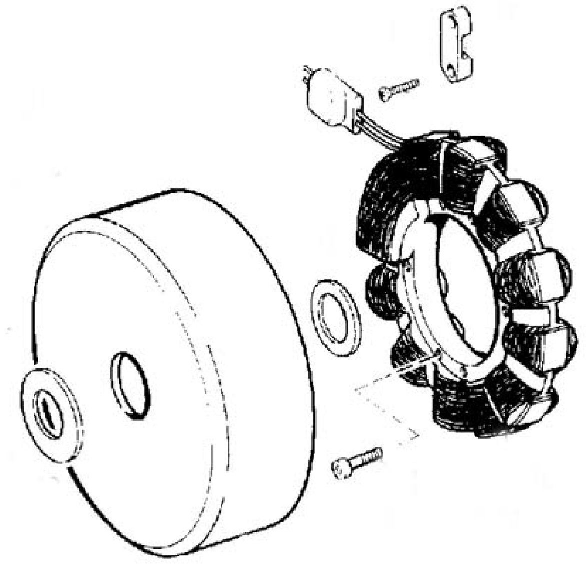
- One reference per revolution: the acquisition starts always in the same angular position.
- The sampling frequency is constant on the single rotor revolution (no compensation for possible changes of the rotational speed w within each revolution).





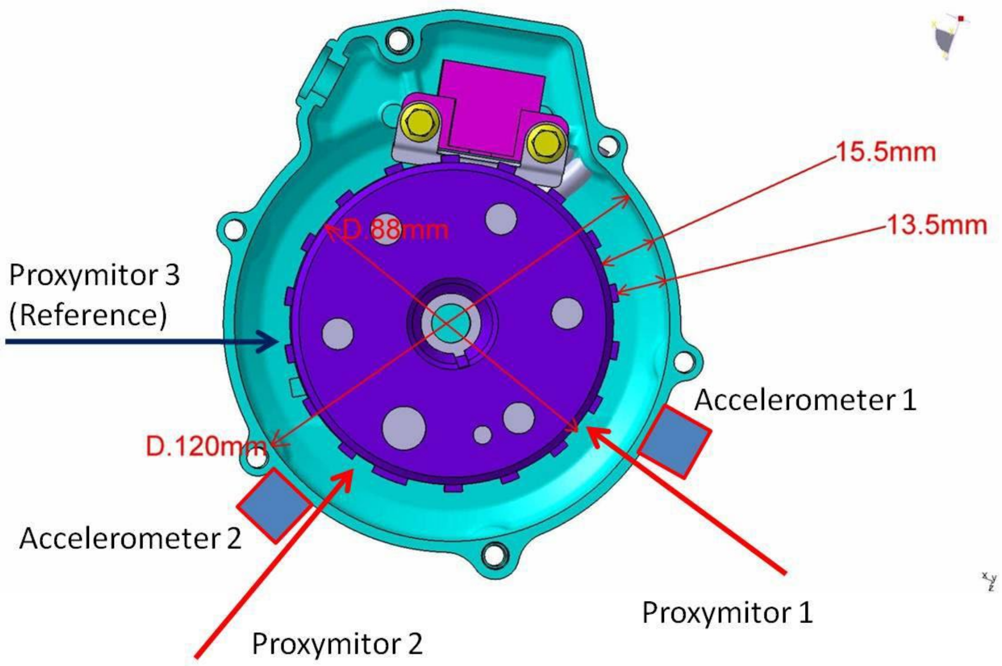
Test set-up





Sensor	Sensitivity	Range
Accelerometers PCB 356A02	10 mV/g	0-500 g
Proxymitor Bently Nevada 330900-50-00	8 V/mm	0-3 mm

Charachterization of the behaviour of a single-cylinder engine alternator



- The test was performed with increasing angular frequency
- Displacement signals were acquired with asynchronous sampling
- We would like to <u>decrease the uncorrelated noise level</u> in the acquired signal. How can we do?

Laboratory 2
To do list

1) Load the dataset and calibrate the displacement signal
2) Plot the displacement signal and the trigger signal
3) Calculate the angular speed as a function of time during the test
   – Use *findpeaks* on the trigger signal to find the indexes to cut each revolution
4) Carry out the time averaging procedure to reconstruct the displacement profile of the rotor during a complete revolution (<u>maximum 20*rev component</u>). To do so:
   – Implement an order tracking procedure.
   – Filter (*filter*) the signal of each revolution using a 4-th-order low-pass Butterworth filter (*butter)*.
   – Interpolare the signal of each revolution and resample it on a common grid (*spline*).
   – Save each resampled signal in a matrix to carry out averaging at the end.
5) Plot the signal after the averaging procedure as a function of the angular position.

Laboratory 2
Variables

Variables in *«Lab_02_data.mat»*

- *proxi_async*: displacement of the shaft (data acquired with asynchronous sampling)
- *sens*: sensitivity (in V/mm)
- *ref*: trigger signal
- *fsamp*: sampling frequency
- *Note*: measurement unit of the sensitivity