

## Abstract

The operation of robotic manipulators reveals unwanted vibrations. On one hand, these vibrations occur due to several factors, such as, backlash, flexibilities, friction, non-linearities and other effects. On the other hand, the robots, interacting with the environment, generate often impacts that produce vibrations which are propagated through the mechanical structure. In this perspective, in order to adopt adequate strategies for reducing or eliminating the effect of vibrations and impacts, it is important to study the involved variables.

Bearing these ideas in mind, this work studies and develops analysis methodologies for applying to mechanical manipulators structures subject to impacts and vibrations.

Several experiments are performed with the developed robotic system in the presence of impacts, vibrations, or when carrying liquid containers. Some of the captured signals reveal a fractional order behavior. The windowed Fourier transform is applied in the study of the robotic signals and reveals to be an adequate tool to deal with this type of non stationary signals.

The robots use a multiplicity of sensors necessary to deal with the perturbations or with unexpected changes in its work space. Therefore, the data obtained can be redundant because the same type of information can be obtained by two or more sensors. In this context, is established the study of the signal spectra. A sensor classification scheme is developed that can help in the design optimization of the robotic instrumentation.

Several experiments are performed for analyzing the robotic signals, based on the information theory, and implemented through the pseudo phase space. An experimental relationship is determined between the slopes of the trendlines spectra, with the fractal dimension of the pseudo phase space and the corresponding time lag. Additionally, two indices are proposed to detect the backlash effect on mechanical systems with periodic oscillations. Finally, a new method based on the mutual information, for tuning the windowed Fourier transform, is presented.

**Keywords:** Pseudo Phase Space, Windowed Fourier Transform, Wavelets, Backlash, Impacts, Vibrations, Fractal Dimension, Fractional Calculus, Robotics.