# **VARIABLE STIFFNESS ROTARY JOINT**

## **Goals**

Improve a rotary joint allowing it to change the value of system stiffness. This leads to a different natural frequency.

Our goals:

* Have a joint which connects rotary components
* Allow a changing in joint stiffness during working conditions
* Stay away from resonance: different stiffness cause different natural frequency
* Create QFD for requirements (forse più facile per chiarire gli obiettivi)
* Unlimited rotation range, able to allow continuous motions. Or limited rotation range to be defined in accordance to the motor used.
* Stiffness adjustment that occurs with reduced energy consumption
* Decoupling of equilibrium position and stiffness adjustment

## **Introduction**

Torsional vibrations are present in almost every rotating system and some machines are inherently prone to them. These vibrations produce cyclic stresses, which can make the machine elements susceptible to fatigue damage. The vibrations can manifest heavily due to resonance if the excitation frequency of the system coincides with torsional natural frequencies of the system.

We can define the value of the excitation frequency of the system starting from the system stiffness.

### Real cases to improve.

Usually to change the frequency of the system the machine must be stopped and some components are substituted with others more or less stiff depending on the new frequency range I want.

In our work we want to improve this operation by allowing the system to adapt the natural frequency of the system by changing the stiffness without stopping the machine. In addition, an automatic device will control the value of stiffness to reach for the frequency range wanted in each istant. (Decide if electronic and how to implement automatic control).

### Applications

1. One application is related to the robotic field. In fact, in robotics we often need joints with variable stiffness to implement different operations. A robot arm, for example, must be able to satisfy a lot of operations that could request precision, velocity, high forces/torques or other properties.

The main differences in high or soft joints are: high stiffness will provide better results in a precise positioning task. On the contrary, a soft preset will be the best choice for gentle manipulation in a sensitive environment.

1. Rotational motor-to-rotor systems which need to control stiffness to stay away from resonance. In addition, the stiffness control allows to reduce vibrations, energy dissipation and fatigue damage.

Concept

1. Pistons which move a flange that is linked to the rotary beam though some rollers or other. Stiffness changes if the flange position is changed.
2. Elastic components which give different stiffness with radial locking.
3. Pressure system: oleodynamic (easy) system which give different pressure to the coupling and this change the whole stiffness
4. Electromagnetic coupling.
5. System to change the shape of internal configuration of metal dust. (simil fluid)

## COSE CHE VUOLE PER IL 22/11/2021

## decide which concept to use for changing stiffness: works on geometry or it is a smart material?

## Bibliography

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<https://www.researchgate.net/publication/342126298_Design_Dynamics_Analysis_and_Real-Time_Stiffness_Control_of_a_Variable_Stiffness_Joint/fulltext/5ef1759c458515814a7741a6/Design-Dynamics-Analysis-and-Real-Time-Stiffness-Control-of-a-Variable-Stiffness-Joint.pdf>