Problem description

The resonant magnetic actuator is often applied in the power toothbrush. This actuator has many advantages above a drive train consisting of a permanent-magnet motor with eccentric. It is much easier to realise a silent high-frequency driver, with a higher lifetime. Further the resonant drive can be seen as a direct-drive system, which operates close to the final load. By this a high efficiency can be achieved.

However, the problem is that the resonant actuator gives a stroke which is dependent on the load. The motor with eccentric provides a constant stroke. One could think of various approaches to obtain a more stable stroke. A solution is currently often sought in the choice of the operating point: a driving frequency at a greater distance from the resonance does increase stability, but also leads to lower efficiency. A substantial technical solution is to add a control loop. Stable and efficient designs become possible, however, the drivetrain also become more costly, because of the stroke sensors needed.

Relevance

The central idea behind this assignment is to investigate a system in which the actuator itself functions as a sensor. From the actuator voltage and current, the instantaneous stroke is reconstructed using an algorithm. Around this system, a measurement and control system is then proposed with which the stroke can be stabilized.

Aimed output

- What will the student need to do?
    - Examining a suitable stroke reconstruction algorithm. Because the nature of the actuator used is of great importance, the different actuator properties are mapped out.
    - Testing the mentioned sensor function, both in simulations and in practice.
    - Investigating the sensor quality sensitivity, as a result of variations in the actuator properties.
    - Designing a control loop that uses the sensor method to stabilize the stroke.
    - Testing the controlled system, in simulation and in practice. Load variations must be considered.
    - Writing a report in which all the findings are described.

- Main topics the student will work on
    - Stroke quality and efficiency of the toothbrush drivetrain
    - Efficient sampling techniques
    - Non-linear resonant actuators
    - Stable control loops for resonant drivetrain with a highly varying load

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Type of assignment: Graduation project
Desirable duration: 6 months

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