INEMA: Design and analysis of a 2-DoF actuator for robotic applications
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Objectives

To analyze and optimize actuators, fast and accurate analytical models are essential. Conventional analytical modeling techniques for permanent magnet actuators describe mainly 2D geometries. Therefore, existing 2D models are extended to calculate magnetic fields in 3D cylindrical structures.

Fourier modelling\[^{[1,2,3,4]}\]

Modeling technique based on Fourier series description of sources and fields

- Extension of existing 2D models
- Based on magnetic scalar potential
- Slotless and slotted structures can be modeled
- High accuracy
- Fast compared to numerical (FE) methods
- Ideal for optimization and parametric analyses

Research

Application

Objectives

The technical requirements of the actuator are defined by the leading application, pick and place of surface mounted components on printed circuit boards:

- Stroke Z-Θ 45 mm - unlimited rotation
- High acceleration (axial direction) 150 m/s\(^2\)
- High accuracy (rotational) 50 000 inc/rev
- Controllable placement force (0.3-40 N)
- High force reproducibility
- Low mass 1.2 kg (including vision and optics)
- Gravity over compensation

Development of new position sensor

- Integrated 2D sensor grid on moving magnet translator
- Two off-the-shelf optical encoder heads to measure Z and Θ

Development of coils

- Innovative coil to obtain compact design

New integrated actuator design\[^{[5]}\]

Magnetization patterns for 2-DoF actuators

- Stator
- Magnetization

Publications


Realization of an experimental setup including system integration

- Coil assembly
- Translator
- Realized actuator
- Assembleon pick and place robot

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