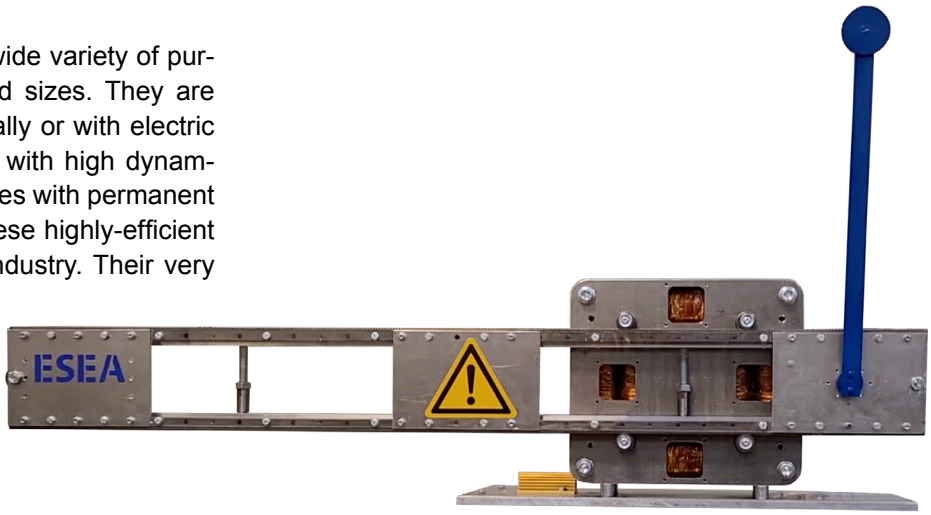
TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Institute of Energy Systems
and Electrical Drives
Gusshausstr. 25-29
1040 Vienna, Austria
www.ieam.tuwien.ac.at/EN

High-end Linear Actuator

Highly dynamic, space-saving and with integrated carriage bearing - via multirotor E-drive with planetary motor structure

Linear actuators are produced for a wide variety of purposes in many different systems and sizes. They are often driven hydraulically, pneumatically or with electric motors. When powerful linear drives with high dynamics are required, synchronous machines with permanent magnets (PMSM) are often used. These highly-efficient drive machines are widely used in industry. Their very high energy density makes them irreplaceable for applications with limited installation space.



Prototype of the novel linear actuator - holds a pendulum in the upright position via highly dynamic controls

Objective

Prof. Manfred Schrödl and his research group at TU Wien wanted to develop a particularly powerful, energy-efficient and space-saving linear drive. The drive needed to be operated with standard inverters. For special environmental conditions and requirements (corrosive, icing hazard, safety-critical), the drive had to function without mechanical encoders or sensors.

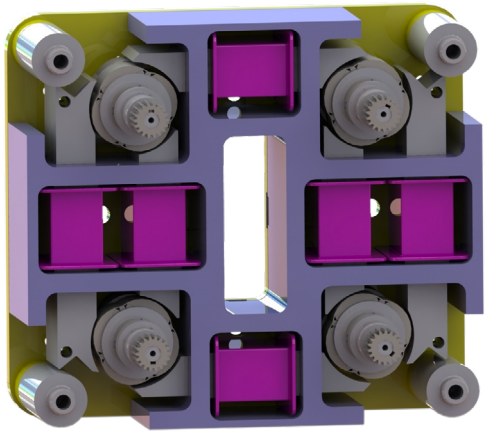
Approach

To obtain very high power density, the planetary motor is used, which Prof. Schrödl and his research group had developed. In the first step, the rotor of a classic PMSM is divided into several rotors - in this case, four. The individual rotors have half the diameter of the single-rotor solution and can therefore be operated at twice the speed - if they are not allowed to exceed the same maximum circumferential speed (depending on the rotor material - cost issue).

In this clever design, the four rotors (or more) can interact with a single stator that generates multiple synchronous rotating fields with a common three-phase winding system. This can save a considerable amount of copper and iron compared to the conventional motor with a single rotor.

Now, to implement a linear drive, two adjacent rotors must each rotate in the same direction and can transmit their drive power directly to a rack or toothed belt via drive pinions. The rotation of adjacent rotors in the same direction is possible with an adapted winding scheme. In the present case, the upper pair of rotors rotates in the opposite direction to the lower pair. This allows a linear carriage sliding horizontally between the two pairs of rotors to be positioned with high precision. Since the drive power is applied symmetrically at the top and bottom, there are no transverse forces, resulting in particularly smooth operation.

Due to the special electromagnetic design of the planetary motor, it acts at the terminals like a classic PM synchronous machine. This means that it can be operated via a commercially available inverter. This inverter can be integrated in the center of the drive, because it is not consumed by a central output shaft in the multirotor machine.



View into the multirotor structure of an energy- and cost-efficient drive motor

In order to achieve an even more cost-effective drive, the planetary motor can be controlled without sensors up to and including standstill using the INFORM® method, which has been tried and tested for years in thousands of industrially manufactured drives. This makes it possible to dispense with position sensors that are susceptible to interference and to further reduce the installation space. This results in a highly dynamic, robust and cost-effective drive.

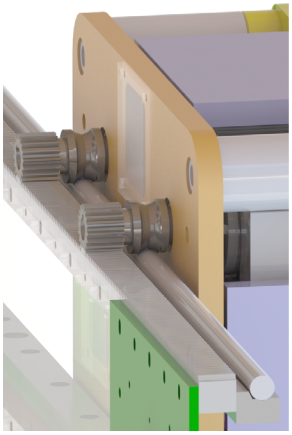
Notes

Your Advantages

With this innovative concept, you can produce a new linear actuator that offers the following advantages:

- high thrust with high dynamics and low overall volume
- high efficiency
- high short-term overload capacity
- bearing of the carriage by the rotors of the planetary motor
- low wear and tear
- power electronics integrated in the motor center to save costs and space
- sensorless and thus fail-safe control with the INFORM® method
- maintenance-free - without sensors and lubricants
- lubricant-free, no risk of leakage and contamination
- compared to conventional drives, very compact or flat design and considerably reduced costs

The TU Wien offers cooperation partners the opportunity to jointly design innovative high-end linear drives in the range from several hundred watts up to several kilowatts.



Design with a carriage bearing provided by the rotors of the multi-rotor motor

Contact

Prof. Dr. Manfred Schrödl
TU Wien – Research Unit Electrical Drives and Power Electronics
www.ieam.tuwien.ac.at/EN
+43 1 58801 370212
manfred.schroedl@tuwien.ac.at, rema@tuwien.ac.at