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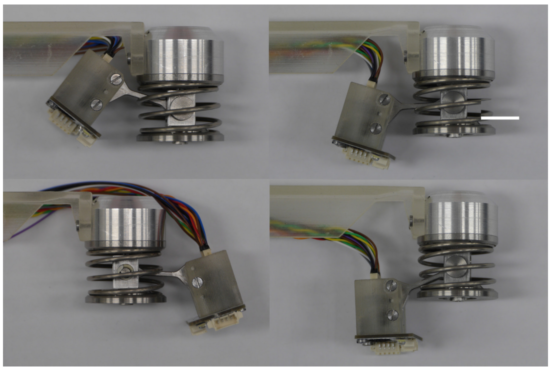
Topic	Innovation in Products, Processes and Materials

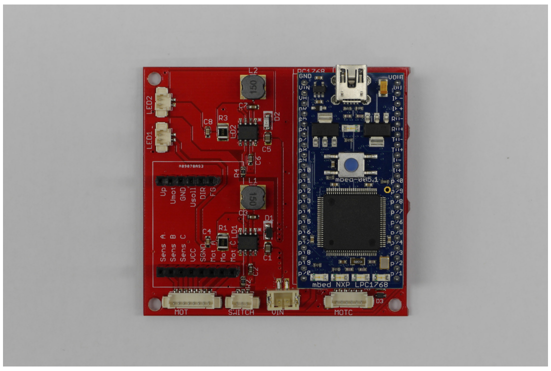
Design of mechanisms for aerial manipulation

Two different use cases, a gripper for aerial transportation and an end-effector for tree cavity inspection.

Gripper with electronics and camera mounted on the baseplate.



End-effector for tree cavity inspection in four positions through the scan process.



Electronics for the end-effector with mounted microcontroller and embedded driver for the LED's.

Introduction: Aerial robots gain attention thanks to their ability to reach areas inaccessible for humans and the possibility to work in hazardous environments. In this thesis, two mechanisms for aerial manipulation with a hexacopter Micro-Aerial-Vehicle (MAV) are addressed. The first mechanism is a gripper to manipulate ferromagnetic objects and the second is an end-effector for tree cavity inspection.The gripper is primarily used in the Mohamed Bin Zayed International Robotics Challenge. The challenge is to autonomously search and relocate ferromagnetic objects distributed on the ground with a mass up to 1kg. Some objects need to be carried by two MAV's cooperatively.Tree cavities are used by a wide range of different species such as birds, mammals and beetles. To gather detailed data from the inside of such cavities, a camera needs to be inserted. With a MAV that can insert an end-effector with a camera, the inspection process can be simplified and the data quality can be increased.

Approach/Technologies: The gripper consists of a vertical slider joint for retraction and expansion and a ball joint mounted below to allow roll, pitch and yaw movement. As the grabbing mechanism an electropermanent magnet is used. Hall effect sensors which measure the magnetic field near the magnet are used to detect objects grabbed by the gripper.The end-effector for cavity inspection consists of a stereoscopic camera mounted on a lever that is guided by a spring in a screw-like movement. The lever moves in the guidance of the spring and pivots vertically as it is rotated by the motor. This leads to a very small construction that pivots the camera around two axes with only one motor.

Result: The gripper reaches a holding force of up to 15kg when attached to a steel plate. This is enough to hold smaller objects even when the distance between the magnet and the object through paint or dust is increased. Four hall effect sensors are placed near the edges of the magnet which gives a reliable response if something is attached to the magnet or not. A microcontroller is used to control the magnet and read the sensors.The end-effector has a total scan coverage of about 80% of the cavity. This is sufficient, as the bottom is the interesting part of the cavity. For illumination, LED's are used. They have a very high light output and can be dimmed to reach optimal illumination for the camera. The LED's and the motor are controlled with a microcontroller located on a main board with driver electronics below the MAV.