

**ASSISTANT ROBOT FOR MAGNETIC FIELD CONTROL IN SURGERY AND ENDOSCOPY: CONCEPT AND APPLICATIONS.**

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Introduction

It has been recognized by a number of groups that the application of magnetic fields for control of instruments and devices in surgery or endoscopy holds great promise to allow for advanced manoeuvres and reduce invasiveness of procedures. Various concepts have been presented on experimental level, and some have entered first stages of commercial use. Different types of external magnetic field generators have been presented; from simple handheld permanent magnets to complex MRT-like gentries have been proposed. Considering both the demands of clinical applications as well as cost requirements, we have devised and realized a concept of an assistive robot for magnetic field control.

Concept description

We have designed a robot arm for magnetic field control in assistive procedures and to operate in direct interaction with the patient. The use of a robotic system to operate a Neodymium permanent magnet (weight 4 kg) has been chosen in order to facilitate the implementation of sophisticated control schemes that enable intuitive control even in complex manoeuvres. Particular attention has been paid to the safety aspects, as the robot operates in direct contact with the patient. The robot arm cannot exert critical forces on the patient's body, due to the special kinematic structure that allows the use of comparatively small motors in combination with other constructive safety implementations.

Applications

The assistive robot for magnetic field control is able to position and orientate a permanent magnet above the patient's body. In contrast to gentry systems able to generate gradient fields, only a pull-up force can be exerted on intra-corporeal objects. If intra-corporeal objects are equipped with permanent magnets, also torque can be applied by orientating the external magnet. We have used the robot in single port surgery for trocarless tissue retraction as well as in endoscopy for catheter tip steering and control of wireless endoscopes.

Discussion

The use of a robotic system for magnetic field control is beneficial for manoeuvrability and intuitiveness in surgical or endoscopic procedures. The goal of the implemented safety concept in our dedicated assistive robot is to

allow full-fetched master-slave system to be feasible within an acceptable price range.