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SENSOR-CONTROLLED MAGNETIC LOCOMOTION IN WIRELESS ENDOSCOPY: THE VECTOR PLATFORM

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Introduction

Wireless capsule endoscopy has become the gold standard for the diagnostic examination of the small intestine and the esophagus. Efforts have been made to adapt the technology for investigation of the colon for colorectal cancer screening, which is of fundamentally higher clinical and socio-economic importance compared to small bowel diagnosis. The use of passive capsule endoscopes in the colon led to lower sensitivity and specificity than examinations with conventional endoscopes. This is due to the large caliber of the colon lumen, in which the capsule is not stabilized. Within the scope of the VECTOR project, we have been working on an implementation of active control in wireless endoscopes, in order to facilitate a fast, painless and effective colorectal cancer screening.

System description

The VECTOR locomotion concept is based on a paraxial permanent magnet incorporated into the wireless endoscope, and an extra-corporeal permanent magnet (weight 4 kg) controlled by a robotic arm. The endoscope is further equipped with an inertial sensor that allows for a closed sensor feedback cycle that stabilizes the endoscope position and enables localization. The endoscope prototype is equipped with a camera and telemetry system providing approx. 2 frames per second in real-time.

Experimental results

The active locomotion system has been tested in-vivo in an underwater setting. The endoscope has been introduced through the anus. The closed loop control scheme of the system allows for a very controlled maneouvering of the wireless endoscope inside the colon. Artifact movements such as patient movements or peristaltic waves were compensated by the robotic system.

Discussion

The system concept developed during the VECTOR project offers a subjectively very robust and effective control modality of an active wireless endoscope in an underwater colonoscopy. The localization feature promises to be a valuable method to support recognition of suspicious lesions. However, the procedure can be difficult in certain anatomical situations.

Furthermore, the underwater modality can impede vision if the colon is not properly cleaned. Further development efforts and application research is required to make this system fully applicable in clinical reality.