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Magnetic Control Platform for Wireless Endoscopic Capsules

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Abstract

This paper presents an active magnetic platform for guiding endoscopic capsules (EC) inside the human body. The system is composed by an external permanent magnet (EPM) made of neodymium Nd-Fe-B rare with a high-level of magnetization (N48) for allowing a maximum magnetic field of 1.5 T. Inside of a standard EC [1] (with dimensions of 26 mm of length and 11 mm in diameter) is placed a small internal permanent magnet (IPM) made of neodymium with cylindrical shape, diameter of 3 mm, length of 8 mm and magnetization of N48.
Remote control of ECs allows reliable diagnostic of the esophagus with the required time duration (not possible with the standard EC). The possibility to stop and to rotate the EC will provide detailed images of the esophagus, stomach and small bowel. Also, increasing the speed of the EC will save power battery that will allow the use of a battery with reduced dimensions and opening space for the placement of the IPM inside of the EC.

Keywords: Endoscopic capsules, magnetic control platform, permanent magnets.

1. Introduction

The developments in EC has been grown since they promise to perform diagnosis in a less invasive (no pain and bleeding) way in those areas accessible by traditional exams, such as gastroscopy and colonoscopy, and to access new areas of the GI (gastrointestinal) tract [1]. The propulsive force for the capsule is the natural motility of the intestine known as peristalsis. Unlike conventional endoscopy, no drugs are administered to the patient and air insufflation is not necessary. Furthermore the EC is a major

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up-full biomedical device for physiological measurements with imaging and optical biopsy, and immunologic cancer recognition [2].

2. Architecture

The magnetic approach, for EC locomotion, avoids mechanical parts and do not causes effects on capsule vision. The work done by Keller et al. [2] presents a modification of a standard Given Imaging company colon EC with dimensions of 31 mm of length and 11 mm of diameter, and the operator needs to support a heavy EPM to control the EC. A simple solution is presented in Fig. 1 with the EPM totally supported by an articulated arm and the operator can execute a long time duration clinical exams.

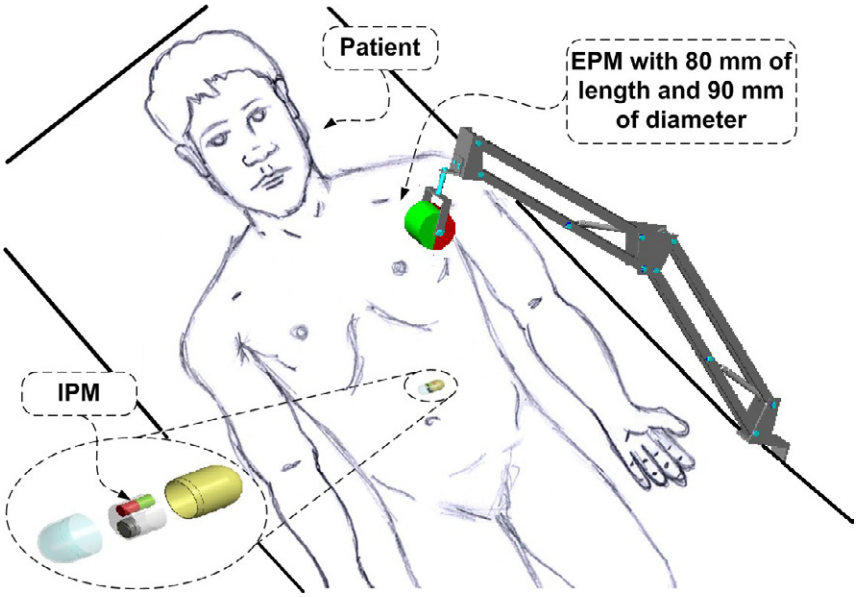

Fig. 1. Artist impression of the magnetic control platform for ECs.

In Fig. 2(a) and (b) is presented the fabricated part for supporting the IPM and the battery inside the EC. Fig. 2(c) presents the dimensions of the standard EC. The battery has a capacity of 16 mAh and the EC can work during 2.5 hours. A FEM simulation is presented in Fig. 2(d) for studying the magnetic field between the EPM and the IPM.

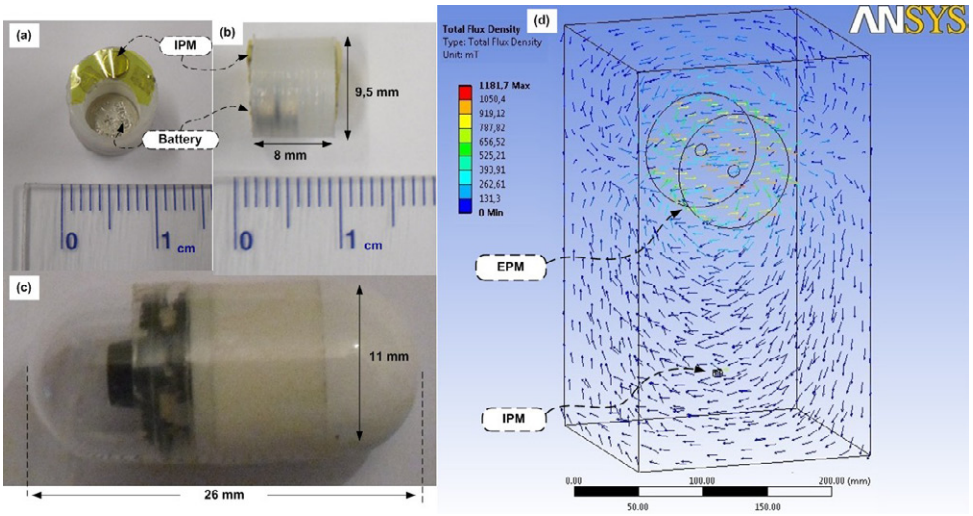

Fig. 2. IPM and battery inside of the EC (a) Topview; (b) Side view; (c) The modified EC (IPM and new battery inside) maintaining the standard size; (d) FEM simulations for study of the magnetic field between the EPM and IPM.

3. Results

Through a magnetic link between the EPM and the IPM the operator control the EC locomotion as desire movements shown in Fig. 3.

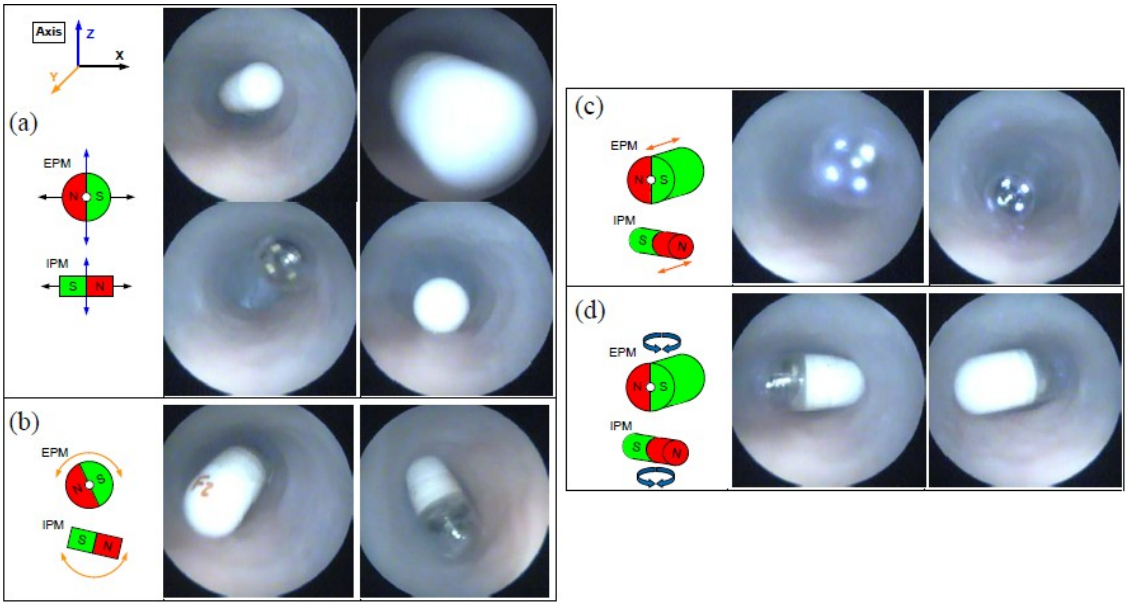

Fig. 3. EC movements when actuated by the EPM; (a) Forward and backward, lifted and lowered; (b) Tilt up and down; (c) Left and right translation; (d) Tilt left and right.

Fig. 4(c) and (d) show a 40 cm of porcine intestine and a fiber colonscope for acquiring images of the capsule movements. The capsule vision is simultaneously recorded and transmitted onto a screen Fig. 4(b) so the operator can easily control the locomotion of the capsule. The magnetic control platform has no interference with the wireless EC communications.

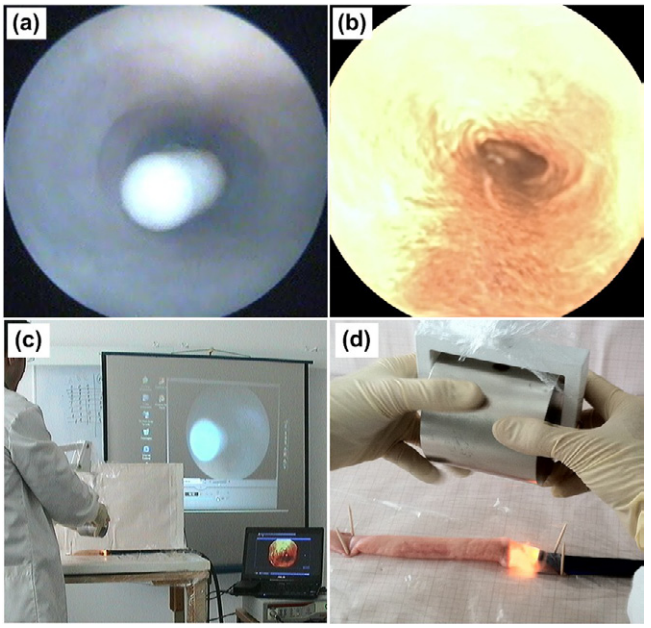

Fig. 4. Clinical tests in porcine intestine; (a) Fiber colonscope image; (b) EC image; (c) Remote control of the EC by a technician; (d) Manipulation in detail of the EPM.

Acknowledgements

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