An Earthworm-Like Robotic Endoscope for the Human Intestine

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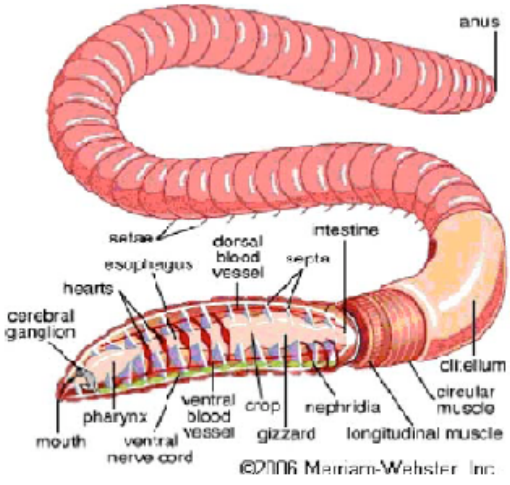
It is reported that 90% of malignant tumors of the colon develop from some benign intestinal polyps. In general, these polyps do not show remarkable clinical symptoms. The endoscope is an important procedure for gastrointestinal examination, but currently is an invasive inspection and as such, is only used for patients with a significant symptom. Because of this, most cancer of the colon is found in its late stages. If the endoscope could somehow be made less invasive and thus be included in ordinary health care, then the polyp could be cut away in its early stage, leading to a much lower death rate by gastrointestinal malignant tumors. That has been the goal of Kundong Wang and his team of engineers at Shanghai Jiaotong University as they have been developing an earthworm-like robotic endoscope system which boasts a wireless power supply, wireless communication system, and a sophisticated locomotion mechanism.



The dissection diagram of earthworm.

The existing endoscope is a device with a slim rigid shaft that is roughly 2-2.5 meters long. Patients often experience great discomfort as the doctor must exert force to insert it into the patient's gastro-intestine, causing the rigid rod to squeeze the intestinal wall. Additionally, the rigid shaft is restricted to only reaching about 1/3 of the small intestine, leaving the rest unexamined. Currently, to examine the rest of the intestine, an endoscope pill is ingested, but because this pill does not have a locomotion mechanism, it cannot reliably examine the intestine in its entirety. Kundong Wang's micro-robotic, earthworm-like endoscope is expected to replace the current endoscope rod and make the endoscope pill redundant. These seem like rather large boasts, but a brief examination of how their new robotic endoscope works, leaves no question about the future of the device.

The locomotion mechanism of the micro-robotic endoscope is composed of three liner-driving cells connected to each other through a two-freedom universal joint. Activating the three driving cells under some rhythm, allows the robot to creep forward and backward, much like a worm.

The wireless power supply subsystem is composed of a resonance transmit coil to transmit an alternating magnetic field, and a secondary coil to receive the power. This wireless technology is integral to allowing the robot to explore the full ten meters of intestine and the magnetic resonance technique, as opposed to a battery, allows the robot to operate as long as the doctor needs to examine the intestine in its entirety.

The wireless communication system of the robot can send real-time images of the intestine to a monitor, and send control commands to the locomotion mechanism. Again, the wireless attribute of this communication system is key.

Kundong Wang and his team at Shanghai University have created a prototype of this micro-robotic endoscope and ran some in-vitro experiments using a pig's intestine to test the efficiency and capability of energy transferring of the robot. The results of these experiments showed that the wireless power supply had enough power capacity. The results also demonstrated that the robot could navigate the pig's intestine easily and the locomotion mechanism proved to be very adaptive to the changing surface topology of the intestine. However, the robot's mechanism can still be optimized for smaller size and more reliability, and thus is not yet ready for use in clinics.

Reference:

Wang, K., Yan, G., Ma, G., Ye, D., An Earthworm-Like Robotic Endoscope System For Human Intestine: Design, Analysis, and Experiment; *Annals of Biomedical Engineering,* Vol. 37, No. 1, January 2009 (Copy write 2008)