Design of inverted F antenna for capsule endoscope

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Capsule endoscopy is a painless and more pleasant experience alternative to the usual endoscopic examination of the small intestine. A capsule endoscope consists of a subminiature camera, a lens, a light emitting diode, an instrument for recording pictures, a wireless transmitter, and a battery. The capsule endoscope captures images while moving through the digestive tract, and the image is transmitted to the outside of the human body through an antenna.

In this paper, the inverted F antenna is printed on a loop-shaped substrate for simplification of the fabrication and to avoid interference with recording; in addition, it is designed to prevent the electronic coupling with the other components of the capsule endoscope.

The antenna is located on the same side as the camera and LEDs. The radiation characteristic of the antenna is affected by the dielectric constants of the LEDs and camera. Therefore, the radiation characteristics of the antenna are simulated after the modeled LEDs are placed on the first layer of the substrate and the modeled camera was placed at the center of the antenna. Furthermore, the electronic components are placed nearby the antenna to analyze effect of the electronic components. And the proposed antenna is simulated in a human phantom environment using saline solution. For comparison, the performance of a fabricated antenna is measured under the same conditions.

The height and diameter of proposed antenna are 0.614 mm and 10.5 mm, respectively. The center frequency of the proposed antenna is 2.419 GHz and the return loss is -38.14 dB. This result shows an input impedance close to 50 Ohm. The bandwidth of the antenna is 40 MHz in ISM (2.42-2.48 GHz) band. When the distance between the transmitting antenna and receiving electrode is 100 mm distance, the gain measured on the receiver is more than -20dB, despite the effects of the human phantom model and electronic components. The radiation pattern of the antenna is found to be isotropic. Therefore, the proposed antenna could be developed to have high radiation efficiency, despite the challenge of limited space of the capsule endoscope. The proposed antenna is also designed to have an electric shield to prevent coupling with other electronic components at both sides of the capsule endoscope. Therefore, accurate disease diagnosis in the digestive tract with a capsule endoscope using the proposed antenna is possible at wide viewing angles.

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