

Research News

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Optical wireless communication (LiFi) for medical imaging devices

Wireless Endoscope Transmits Data via Light

Medical imaging devices such as endoscopes transmit their data via cables to monitors and hospital information systems. In collaboration with partners, Fraunhofer researchers in the OWIMED project are working to make data cables superfluous in the operating room of the future. The project team has developed a prototype for an endoscope that uses light to transmit the images from a laparoscopic procedure in the abdominal cavity.

Without cables lying around, operations can proceed more efficiently, medical devices can be more easily cleaned and disinfected. However, the radio systems commonly used today do not meet the medical technology requirements for reliability, security and latency. "Instead of radio waves, we use modulated LED light for wireless communication. Due to the locally limited propagation of light, wireless transmission with light (LiFi) is ideal for medical technology. We can already meet the requirements for high data rates over short distances," says Anagnostis Paraskevopoulos, a research scientist at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI, who leads the project. In the OWIMED project (Optical Wireless Communication for Medical Imaging Devices, see below), researchers are exploring ways to enable LiFi technology in the OR. Working in close collaboration with IT Concepts GmbH and St. Joseph Krankenhaus in Berlin-Tempelhof, they are developing a wireless endoscope that can be used in laparoscopic procedures. The researchers are integrating the LiFi technology in surgical lights and use their optimal line-of-sight connection to receive the data from the endoscope and transmit it to the monitor, where the images from the abdominal cavity are displayed in 4K quality.

Taming the cable spaghetti

Commercially available endoscopy systems require two cable connections. One, a fiber-optic cable, is for lighting, while the other is for the power supply and the data connection that enable the camera images or video stream to be displayed on the monitor. These cable connections are not hygienic. They must be isolated with a sleeve and are draped over the patient or across the floor. This significantly disturbs work in the OR. "Our wireless endoscope eliminates this problem. We integrate the optical light source in the form of an LED directly in the endoscope, which is battery-operated. We also include a battery-operated LiFi module in the endoscope, which transmits the data optically to the OR-environment and to the monitor. This only requires a few additional LiFi modules on the surgical light above the operating table," Paraskevopoulos explains. A modulator switches the LED on and off at a rate that is too fast to be perceptible to the human eye. A photodiode detects these light pulses and converts them to electrical signals. The optical wireless connection is bidirectional, also enabling changes to the endoscope camera settings from the monitor.

The LiFi modules were designed to be compact, providing homogeneous hemispherical signal propagation over a 180-degree radius and thereby ensuring a robust high-speed data connection. The integrated camera chip and its microprocessor ensure low-latency data compression, enabling data transmission with low power consumption.

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The surgical team at St. Joseph Krankenhaus in Berlin-Tempelhof played a key role with continuous consulting in technical development throughout the project. They finally tested the wireless endoscope prototype and the associated LiFi infrastructure in an actual OR environment using a surgical simulator in the form of a medical phantom. "We were able to demonstrate with the tests that our LiFi solution functions very well with regard to latency, i.e., data lag, as well as reliability, data rates, light quality and ergonomics. The feedback from the surgical team was entirely positive. Once our system is fully developed, the doctors would prefer it over the cabled variant," says Paraskevopoulos.

The OWIMED project

Optical Wireless Communication for Medical Imaging Devices

Duration:

02/2023 – 04/2026

Project funded by:

German Federal Ministry of Research, Technology and Space (BMFTR) as part of its innovation program for SMEs (KMU-innovativ)

Project partners:

- Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI, Berlin (specialist for LiFi technology, coordinator)
- IT Concepts GmbH, Lahnau/Wetzlar (endoscope development, providing imaging expertise)
- St. Joseph Krankenhaus Berlin-Tempelhof GmbH, Berlin



Fig. 1 The medical staff of St. Joseph Krankenhaus use an OR simulator to test the wireless endoscope prototype in an operating room.
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Fig. 2 Optical wireless communication (LiFi) ensures robust data transfer from the endoscope to the monitor even under adverse conditions.
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