Instantaneous Frequency Division Multiplexing (IFDM): An Approach for Wireless *In Vivo* High Definition Video

Samuel A. Ford
Tennessee Technological University

Background

In modern minimally invasive surgery, doctors are able to perform an entire surgical procedure through a single incision. This procedure is much less traumatic on the body and can leave the patient with no scarring. To perform this surgery a single endoscopic cameras is inserted through the abdominal wall to give the surgeon an *in vivo* view. This technique makes it difficult for surgeons as multiple surgical tools all occupy the same incision.

Purpose

Since the surgeon has only one small incision to work with, there is a need to provide more space in the opening. A few ways to make this procedure more efficient are to make the endoscopes wireless and to make the video high-definition as surgeons are accustomed to with current procedures. This project will present a new analog modulation and multiplexing technique for wirelessly transmitting high-definition video using hardware which is smaller in size and less expensive than a comparable digital system. In addition to the RF front end, a digital system for transmitting high definition video requires numerous digital components including processors, encoders, and analog-to-digital converters. For applications such as surgical endoscopy, the cost and size of these digital components is prohibitive. Large and expensive digital components can be avoided entirely by keeping the signals analog.

Design/Method

High-definition video components can be transmitted wirelessly using a new analog modulation scheme which will be referred to as instantaneous frequency division multiplexing (IFDM). Each video component is frequency modulated and then transmitted. The receiver will utilize a hybrid phase-locked loop to track the orthogonal instantaneous frequencies. Unlike frequency division multiplexing (FDM) which requires each signal to occupy separate frequency bands, the use of orthogonal instantaneous frequencies allows the video components to occupy the same bandwidth and benefit from the modulation gain of FM.

Results

The IFDM technique will be demonstrated through simulation and a prototype hardware implementation. It is expected that the performance of this system will be comparable to digital modulation schemes, but with fewer cost and size requirements. The signal to noise ratio, bandwidth, range and fidelity of the system will be determined and compared to a similar, wired, digital system.

Conclusions

Our solution to this problem is a novel approach to modulate the individual video signals. They will stay analog, which eliminates the need for an overwhelming amount of electronics. To the best of our knowledge this will be the first time such a system has been developed for wireless high-definition video transmission. Finally, possible applications and topics for future research will be proposed.