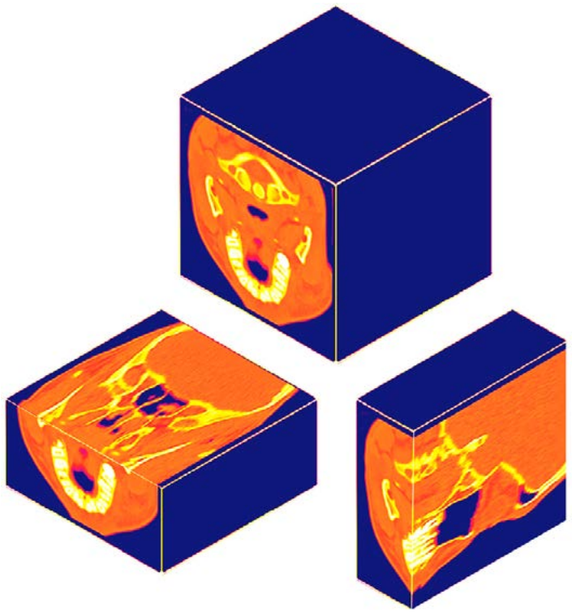
UDICMI

Ultra High Definition Image Communication for Medical Imaging

This project aims to investigate new communication technologies for medical environments, namely the use of more efficient medical imaging compression methods, which can reduce significantly the amount of data to be transmitted and stored, as well as transmission technologies for real-time Ultra High-Definition (UHD) video and images using 60GHz radio systems.



PROJECT WEBPAGE URL
http://www.co.it.pt/~comuvi/udicmi/

Main Project Team

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Funding Agencies

QREN (+Centro - Centro-SCT-2011-01	**58,823€**
Start Date	01/01/2013
Ending Date	30/03/2015

Indicators

Journal Papers	1
Conference Papers	2
Concluded MSc	3

Two Main Publications

N. Leonor, R. F. S. Caldeirinha, T. Fernandes, N. Gaddam, **60 GHz Channel Characterisation and Key Performance Evaluation of HD Video Transmission**, IET Microwaves Antennas & Propagation, Vol. 99, Nº N/A, pp. N/A - N/A, 2016

S. M. M. Faria, J. M. P. S.S. Santos, A. G. Guarda, N. M. M. Rodrigues, **Contributions to Lossless Coding of Medical Images using Minimum Rate Predictors**, IEEE International Conference on Image Processing - ICIP, Quebec City, Canada, Vol., pp. 2935 - 2939, September, 2015

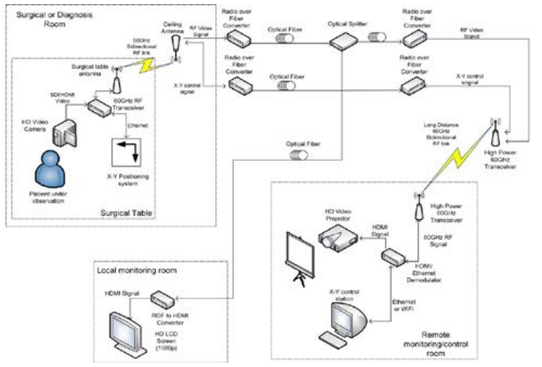

Fig. 1 Broadband transport framework at 60GHz.

	H.264	HEVC REx1	MMP	JPEG 2000	JPEG LS	CALIC	MRP
Original (Z)	2,545	1,471	2,446	2,473	2,290	2,183	1,821
X	2,162	1,664	2,087	1,958	1,773	1,872	1,350
Y	2,168	1,642	2,110	1,972	1,788	1,880	1,402

Fig. 2 Performance comparison using various encoders, in bits per pixel (bpp).

GENERAL MOTIVATION AND OBJECTIVES

The demand for easier and more accurate medical diagnosis implies the evolving of medical imaging technology and applications, resulting in their increasing spatial and temporal resolutions. However, this demands a growing amount of data to be stored and transmitted. Despite the high compression efficiency achieved by the most recent image and video coding standards in lossy compression, they are not well suited for quality-critical medical image compression where either near-lossless or lossless coding is required. Medical image volumes such as Magnetic Resonance (MR) and Computed Tomography (CT) consist of many similar slices, presenting a great amount of redundancy, which can be exploited with more efficient prediction techniques, and thus allowing a better compression.

In order to propose an efficient communication system for the next generation of telemedicine and tele-health systems, namely for real-time Ultra High-Definition (UHD) video and image transmission, the feasibility of developing a broadband transport framework at 60GHz will be exploited, as shown in Figure 1.

CHALLENGE

The requirement of lossless compression severely limits the performance of the video encoding standard HEVC. Furthermore, most state-of-the-art lossless encoders only perform compression of single images, and as such do not exploit the redundancy between slices of MR and CT volumetric medical images.

On the other hand, a feasibility of real-time high-definition video and image and transmission using 60GHz radio systems will be demonstrated through a proof-of-concept test, which will allow one to perfectly understand the system limitations, and consequently the range of applications that might be developed.

WORK DESCRIPTION AND ACHIEVEMENTS

Several approaches were developed in order to improve the lossless compression efficiency of medical images, including:

· Use of image processing techniques, such as inter-slice prediction and directional approaches, as in Figure 1.

· Geometric Transformations for motion estimation between slices in the standard HEVC.

· Implementation of pixel-wise prediction techniques in HEVC, such as Least-Squares Prediction extended to 3D sequences (MR and CT), to take advantage of the inter-slice redundancy.

· Extension of the image encoder Minimum Rate Predictors (MRP) for 3D medical images, using inter-slice prediction.

The best results were obtained for the extension of MRP, which allowed an average bitrate reduction of 44% over the standard HEVC and 30% over original MRP, as shown in Figure 2.

An extensive measurement campaign and a detailed analysis of the 60 GHz channel for the transmission of HD video streaming demonstrated that constructive and destructive behaviour due to multipath, directly influences the measurement results when using an omnidirectional antenna at the receiver end. Results show strong correlation between the KPI of video transmission and propagation environment. Ray based and IEEE TG3c radiowave propagation models seem to be sufficient for the channel prediction for LOS applications in indoor environments.

Additionally, implementation of a realistic Matlab/Simulink simulation tool for mmWave systems employing SC-FDE and OFDM transmission schemes, have been proposed. SC-FDE clearly outperforms OFDM under the PA effect and the signal degradation is reduced for low PA IBO.

The produced the following outputs:

· Construction of a working codec of MRP with all the extensions described fully functional;

· A simple raytracing tool for radio coverage simulation of surgical room environment;

· A framework for SDI transmission over addictive white Gaussian noise (AWGN) channels;

· A simulink based framework to simulate uncompressed video transmission of AWGN and multipath environments, including OFDM based transmission schemes and RF impairments;

· Specification/extension of the existing radio channel sounder for uncompressed HD video transmission over radio channels.