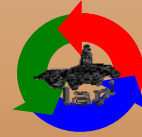# Digital Acquisition and Remote Investigation of Film Radiographies of Total Hip Prostheses

Laura Florea, Constantin Vertan, Corneliu Florea, Alina Oprea

**Politehnica University of Bucharest**
**Image Processing and Analysis Laboratory**

**Abstract** X-ray film images still are the main medical diagnosis tool in the investigation of the bone system. The implementation of a remote computer-aided diagnosis system requires several operations, including the digitization of the analogue-film radiography, the enhancement of the digital image, the transmission of the recorded data to a diagnosis center and the automatic diagnosis aid. This contribution presents the use of a consumer-grade digital still camera as a digital acquisition tool for hip prosthesis X-ray images, enhanced via a log-bracketing approach.
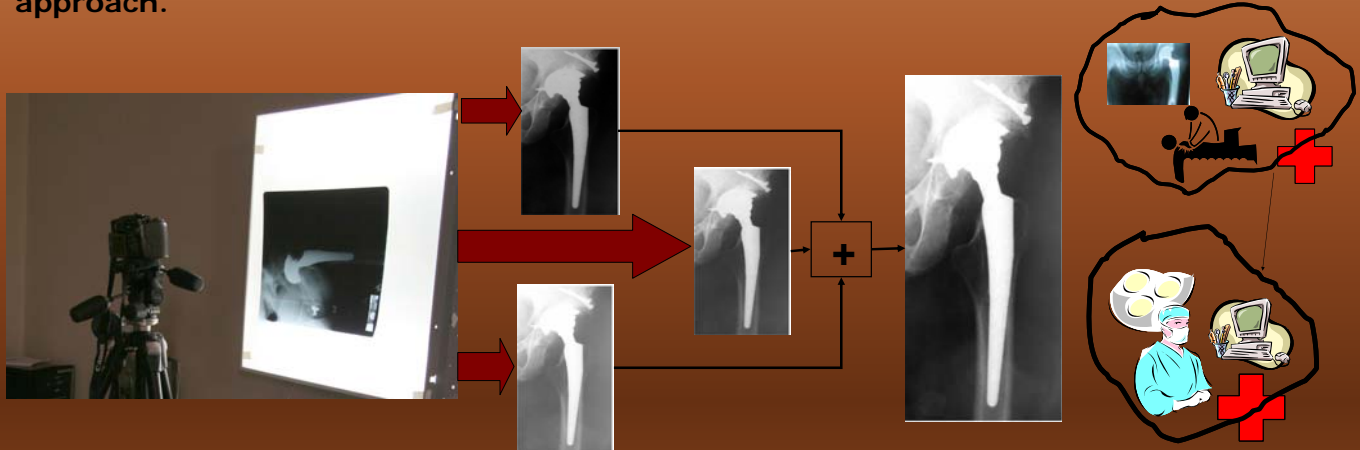
**Image Acquisition and Enhancement** - Log-bracketing: Convex combination of different exposed images implemented in a logarithmic space:

$$f_{HDR}(l,m) = \frac{\sum_{i=1}^{N}\left(\mu(EV(i),f_i(l,m))\cdot 2^{EV(i)}\right)\otimes f_i(l,m)}{\left(\sum_{i=1}^{N}\mu(EV(i),f_i(l,m))\right)}$$

$$v_1 \oplus v_2 = v_1 + v_2 - \frac{v_1 v_2}{D}$$

$$\lambda \otimes v = D - D\left(1-\frac{v}{D}\right)^{\lambda}$$
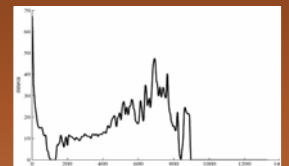
**Classical Logarithmic Image Space**

**Image Analysis for Diagnosis Aid** - Prosthesis segmentation and Bone-Prosthesis distance estimation for Gruen areas:



**Defuzzification result**

**FCM segmentation**

**Typical distance variation around the prosthesis for Gruen areas 5, 6 and 7**

## Results for Image Enhancement



**Original**    **Real-space**    **Classical LIP**

**Conclusions** We described a system architecture consisting out of two parts: the digitization wizard and the diagnostic aid. The digitization wizard ensures the acquisition of the best available digital X-ray image, due to implementation of the logarithmic bracketing of different exposed images acquired with **tripod-mounted consumer digital cameras**. This is a local PC-based component.

The diagnosis aid runs on the server machine. The server stores the prosthesis image database and run the image analysis application to obtain the prosthesis descriptors for adding meta-data to the database content.

The diagnosis module can be used either as local diagnosis aid for a general practitioner, case in which server and client machine are the same, or within a tele-radiology screening/ diagnosis framework.