The objective of this project is the research and development of quantitative tomography based on scattered ultrasound. Conventional B-mode ultrasound, used in most clinics, is basically qualitative, in the sense that it measures relative local difference of acoustic impedances. On the other hand, diffracted tomography is able to estimate material properties such as velocity of propagation and density that may characterize the local tissue.

Specific objectives are:

- Development of a framework for realistic simulation of ultrasound fields in order to investigate resolution, precision, accuracy and robustness of hardware and software approaches;
- Research, development and implementation of efficient hardware and reconstruction algorithms (2D and 3D) for diffracted tomography, aiming the reduction of image acquisition time and processing time;

Team: S S Furuie, D A C Cardenas, PME (R Lima and colleagues) and PMR
Elastography using ultrasound images

In this project we investigate the elasticity of structures (elastography) and their components using dynamic ultrasound images. Conventional elastography is based on images obtained by sampling echo signals (RF) at high spatial resolution. We intend to explore the richness of spatial and temporal information present in B-mode images to characterize them objectively.

The project consists of: a) detailed numerical simulations of 2D and 3D dynamic images with deformation and realistic image noise; b) estimation of displacements and deformation based only on B-mode images; c) estimation of the elasticity.

(For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuie, F M Cardoso, M C Moraes
Framework for contraction analysis (IVUS and regular US)

The objective is the development of a framework for analysis of dynamic 3D contraction of coronaries. In this sense we have implemented: a) realistic simulation of dynamic 3D IVUS, including coronary contraction and heart motion; b) ultrasound images with speckle noise; c) artery contraction using finite element method considering isomorphism of scatterers; d) realistic positioning of guide-wire for pullback of sensor. Others tools have also been developed such as filtering, segmentation and elastography estimation. A framework for general structure deformation and analysis using ultrasound is in progress. *(For details, please see related papers in our CV in the tab “members”)*.

Team: S S Furue, F M Cardoso
*(see available tools and projects on main page)*
Neo-intima segmentation in IVOCT images

The stent implantation is one of the most common methods for coronary obstruction treatment, but this can trigger a neo-intima re-stenosis, and cause again narrowing of the vessel wall, resulting in heart-irrigation problems. Modalities such as Intravascular Optical Coherent Tomography (IVOCT) can be important for this kind of investigations, because it provides coronary cross section images for in vivo detection; it is an important support for monitoring atherosclerotic plaque progression. Additionally, computational methods applied to IVOCT images, can render objective structure information, such as areas, perimeters, etc., allowing for more accurate diagnosis. We investigate methods for neo-intima re-stenosis quantification after stent implantation. *(For details, please see related papers in our CV in the tab “members”)*.
Model identification and analysis in dynamic PET

Analysis in dynamic PET (Positron Emission Tomography) deals with estimation and quantification of parameters for compartmental and non-compartmental models. The main topics are related to: input curves estimation; image filtering; tomographic reconstruction; segmentation of regions of interest; and myocardial metabolic rates of Glucosis estimation. In a specific approach, an alternative way to estimate a noninvasive input function using image derived input functions are considered. (For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuie, J E M Silva, E F Pacheco
Analysis and quantification of Intravascular Ultrasound images (IVUS)

The objective of this project is to characterize coronary lesions based on analysis of intravascular ultrasound (IVUS) images. It involves 3D segmentation of lesions, texture analysis and classification.

Intravascular structure characterization is the process of plaque composition inference. An approach using invariant features has been investigated. As the atherosclerotic plaque is a three-dimensional object, consecutive frame information are used in the plaque composition identification process. Current techniques are based only in-plane frame attributes. (For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuie, F J R Sales, P Lemos Neto (InCor)
Coronary contraction analysis based on 4D-IVUS

The aim of this project is the analysis of coronary contraction. Conventional IVUS (intravascular ultrasound) with continuous pullback provide 4D data, but without correct spatial localization. We propose to reconstruct tomographic IVUS image without heart movement artifact for different phases. Moreover, the time synchronization will depend only on the images, and will preserve 4D information. Thus it involves: a) determining images (3D structures) from IVUS sequence that belong to the same phase within the cardiac cycle; b) spatial registration of 3D coronaries; c) 3D interpolation; d) contraction analysis. (For details, please see related papers in our CV in the tab “members”.)

(For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuie, M M S Matsumoto, M Haddad, P Lemos Neto (InCor)
Algorithms for tomographic reconstruction: optimization, restoration, quantification and clinical application

The main objective of this project is the investigation of methods for quantitative tomographic reconstructions in Nuclear Medicine. The investigations basically include: a) practical and optimized tomographic reconstruction algorithms; b) alternative image restoration algorithms; c) robust volume quantification and segmentation processes; and d) clinical applications.

Specific objectives are:

- Research, development and implementation of efficient reconstruction algorithms (2D and 3D) for Nuclear Medicine, aiming the reduction of absorbed doses as well as the image acquisition and processing time;
- Research of methods for quantitative tomographic reconstructions in Nuclear Medicine dealing with correction/compensation and restoration of images;
- Research on truly 4D reconstruction algorithms for dynamic structures;
- Research, development and evaluation of the whole reconstruction process, including restoration and quantification, through physical and numerical simulation in 2D, 3D and 4D;

(For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuiie, F H Palladino, A R De Pierro (Unicamp), N D A Mascarenhas (UFSCar), J C Meneghetti (InCor)
Visualization and segmentation of coronary arteries in microbubble contrasted 3D Echocardiographic images

The improvement in micro bubble contrasted images in three-dimensional Echocardiography has created new opportunities for non-invasive and relatively inexpensive exams. This objective of this project is the visualization of the 3D coronary tree in a simpler and non-invasive form. There are several challenges such as: a) high noise and natural degradation of the images; b) dynamic nature of the structures; c) poor contrast. The main approach is based on modified version of fuzzy connectedness algorithm.

(For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuie, D M Lage, J M Tsutsui (InCor)
Medical image categorization based on wavelet transform and self-organizing map

Images are fundamental data source in modern medicine. These can support doctors and students in diagnostic decisions and provide research and didactic material. The images stored in a database according with categories are an important step for data mining and content-based image retrieval (CBIR). This work addresses a CBIR methodology involving: a) discrete wavelet transform to characterize images; b) Self-Organizing Map (SOM) neural networks to cluster the classes; c) and SOM classification of medical images. This datamining methodology can be used in categorization and diagnostic decision aid.

(For details, please see related papers in our CV in the tab “members”.)

Team: S S Furuie, L A Silva, R A Moreno (InCor), E Del-Moral-Hernandez (EPUSP).