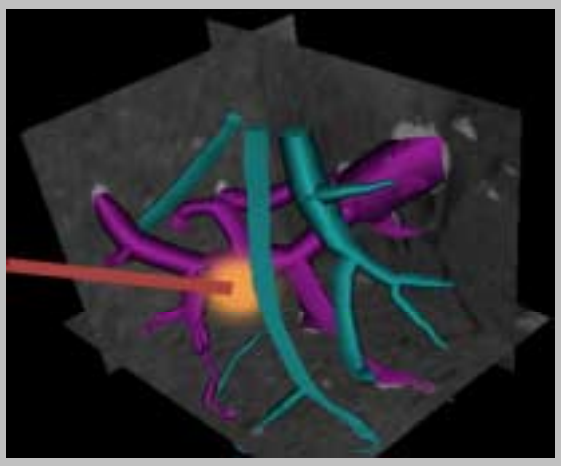
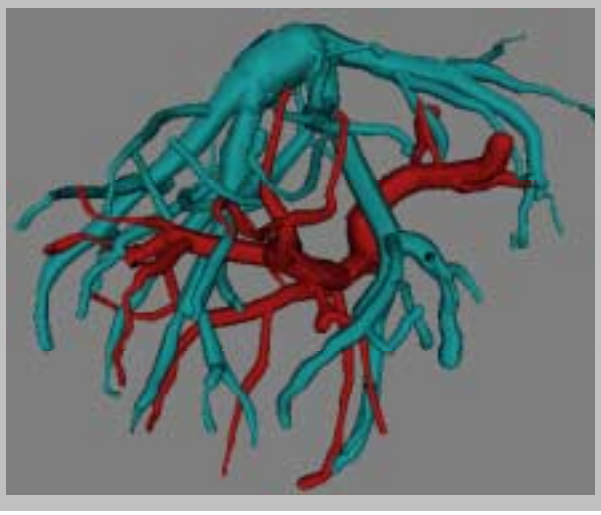
Computer-Aided Diagnosis and Display Lab
Department of Radiology, UNC @ Chapel Hill

Augmenting intra-operative 3D ultrasound with pre-operative CT and MR data



Above: A visualization of liver vessels extracted from 3D ultrasound data. Inserted into this image is a simulated lesion (to be derived from pre-operative CT data) and a rendering of radio-frequency treatment probe. This is the type of visualization that will be presented to clinicians during the treatment of liver lesions.

Below: The complex and complete set of vessels that can be extracted from liver CT data. The density of this network ensures that they will surround a lesion, and if these vessels are well localized on the ultrasound data, then liver lesions in the CT data can be accurately co-registered with the ultrasound data.



The primary goal of this project is to significantly increase the number of lesions that can be percutaneously biopsied and treated. However, the methods being developed are even more broadly applicable: any information localized on pre-operative images can be overlaid onto intra-operative ultrasound images. Potential overlays include tumor margins, surgical cutting paths, and the outlines of critical sub-surface organs and nerves.

Our initial application will focus on the percutaneous localization of liver cancers for radio-frequency ablation treatment. Most liver lesions are detected on CT and MR data. If these lesions can also be seen on ultrasound, they can be treated quickly and inexpensively and with minimal risk to the patient via percutaneous access. Regretfully, nearly 60% of liver lesions cannot be seen using ultrasound; consequently expensive and risky open-surgical procedures must be employed.

We have developed a method for rapidly and accurately registering 3D ultrasound data with pre-operative CT and MR data. The method performs this alignment using the vessels that are visible in these data. Once the vessels are aligned, features in the CT and MR data can be accurately superimposed onto the ultrasound data.

Using this method, we can overlay tumors visible in CT or MR data onto real-time ultrasound data. Using these fused visualizations, a needle can be percutaneously guided to a lesion even if the lesion is not directly seen in the ultrasound data — the number of liver lesions requiring open-surgical procedures can be significantly reduced.

This project is being lead by Drs. Sue Weeks and Stephen Aylward. Significant technical contributions are being made by research assistants Julien Jomier and Jean-Philippe Guyon. For more information, please see the CADDLab web pages at:

http://caddlab.rad.unc.edu

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