Graph Theory Report – Modeling Acoustic Waves in Nonhomogeneous Mediums Project

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After learning a little about Graph Theory in the ultrasound research territory, I better understand my errors with my Machine Learning report. I think this is a great opportunity to comment on machine learning because after looking into Graph Theory I learned that there is a wide use of Machine Learning in conjunction with Graph Theory. Graph Theory is very common in Ultrasound mainly for the uses of segmentation algorithms or colorization. I do not want to claim that all use for Graph Theory are for those two purposes, but I do not find the trend surprising because those are very strong functions that make ultrasound have better resolution and make software help with interpreting data. In my previous report on Machine Learning, I was inaccurate by saying that Machine Learning is a new thing to ultrasound research and researchers were only just starting to think about what Machine Learning can offer. After reading my articles on Graph Theory, I think I might be confusing Graph Theory and Machine Learning with the language they use in papers on this subject by heavily emphasizing one over the other when their research might in fact be using both. I am looking into the information more, but I am still confused why segmentation is written to sound like there exist algorithms that are either Machine Learning or Graph Theory depending on which paper I read. [1]

The other function used commonly in ultrasound is using Graph Theory to colorize in any way to communicate data. The common one would be to colorize based on just groups that are defined for different tissues, such as to differentiate cardiac muscles for normal muscles. In Yatchenko, color was used to illustrate not just segments, but also movement [2][1]. Flow itself can be color coded to illustrate the direction of blood flow, for example.

An interesting case that I found that uses Graph Theory for accomplishing a task that was not for coloring or segmentation purposes was in a paper by Musada [3]. That paper details how they used graph theory for image reconstruction of the blood vessel system in ultrasound. I found this really intriguing because ultrasound has serious problems with noise when trying to image something that is on a scale as individual blood vessels. With so many objects of interest in a give amount of space, I personally thought that ultrasound was not a great option for blood vessel imagery; however, in the paper, the idea was to use graph theory to construct its own image from data found by ultrasound. Ultrasound would find points where vessels would branch off and basically treat those as a set of points of graphic nodes and use graph theory algorithms to reconstruct the rest of the data from the given data.

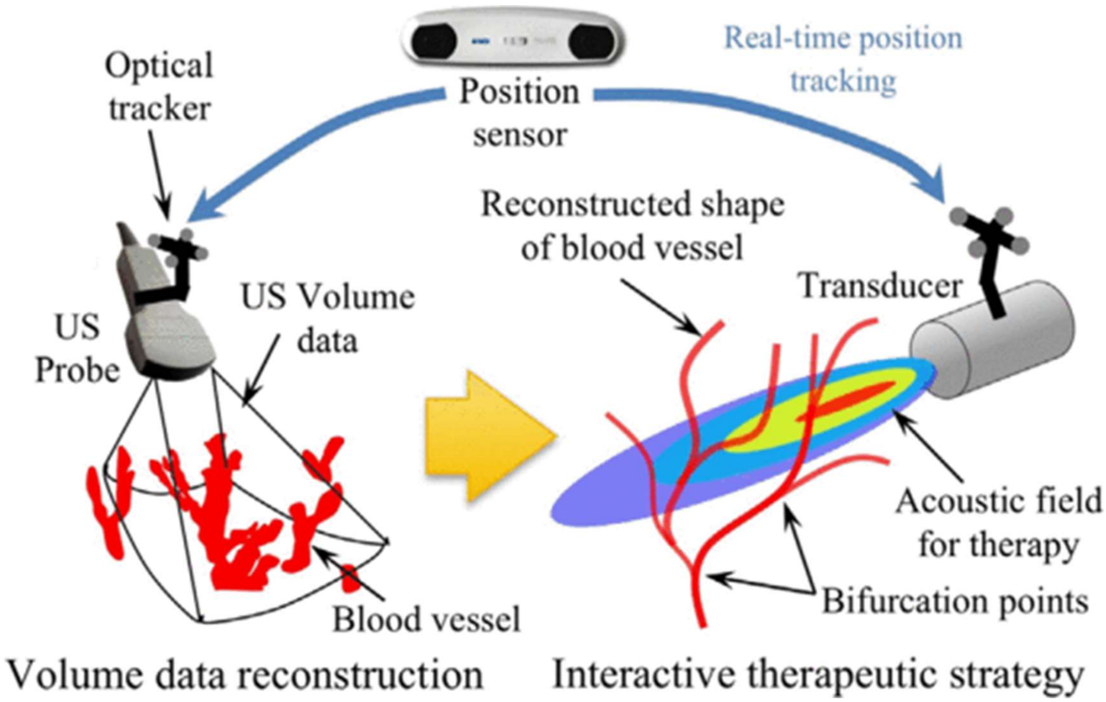

Figure 1: How the Node Points are Recorded [2]

Figure 2: How Algorithms Interpret Node Points [2]

References

[1] H. Q. B. X. L. Y. J. L. L. X, "Optimized graph-based segmentation for ultrasound images," *Neurocomputing,* vol. 129, pp. 216-224, 2014.

[2] Y. A. K. A. G. A. A. I, "Graph-cut based antialiasing for Doppler ultrasound color flow medical imaging," *Visual Communications and Image Processing (VCIP),* pp. 1-4, 2011.

[3] M. K. B. A. S. Y. K. T. O. S, "Reconstruction and error detection of blood vessel network from ultrasound volume data," *Proceedings of the 26th IEEE International Symposium on Computer-Based Medical Systems,* pp. 497-501, 2013.