Graph Theory Report – Modeling Acoustic Waves in Nonhomogeneous Mediums Project

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Agent-based model's strength lies in understanding macro level behavior of any system by modeling the behavior of many objects which have the ability to make their own choices from given data. My research in modeling sound vibrations through material has a interesting situation because although it does have potential macro view approach to data by looking at movement traveling through space with is modeled currently with ordinary differential equations. Agent-Based models can be used to model ordinary different equations, but the problem is that for imaging the human body, you are looking at a large amount of data that is difficult to portray as many entities with agency because if the waves can travel through, reflect, or scatter in the medium then they do and can not choose which situation occurs. There is research on using Agent-Based models to simulate the behavior of cell growth and travel that is used to understand the growth and spread of cancer cells [1][2]. Ultrasound imagery can be used at a cellular level, so potentially both can be used together to understand the topic better. However, that does not mean the ultrasound imaging itself will use an Agent-Based model which is why writing this report is weird because my project could assist research that uses an Agent-Based model, but never uses the model itself. [3]

The most direct application might be using Agent-Based modeling to create artificial data sets for machine learning that can be used to create better ultrasound segmentation of captured images or by creating an artificial dataset you could maybe use that to assist in image editing to cut down on the effects of noise. This would probably be used for any situation were there is specific cell growth so the Agent-Based model can model the progression of the cell growth or spread so the ultrasound program or the specialist interpreting the image can have a model to compare the image to. Basic situations that

could use this might be looking for the spread of cancer, the growth of a fetus in the womb, or tissue growing from injury. Also, the model could model the movement of tissue such as the movement of the heart muscles to help predict possible noise in the imagery from the movement of the heart.

[1]   J. Tang *et al.*, "Phenotypic transition maps of 3D breast acini obtained by imaging-guided agent-based modeling," *Integr. Biol.*, vol. 3, no. 4, p. 408, 2011.

[2]   R. Mukhopadhyay, S. V Costes, A. V Bazarov, W. C. Hines, M. H. Barcellos-Hoff, and P. Yaswen, "Promotion of variant human mammary epithelial cell outgrowth by ionizing radiation: an agent-based model supported by in vitro studies," *Breast Cancer Res.*, vol. 12, no. 1, p. R11, Feb. 2010.

[3]   P. P. Maglio and P. L. Mabry, "Agent-based models and systems science approaches to public health," *American Journal of Preventive Medicine*, vol. 40, no. 3. pp. 392–394, Mar-2011.