# Xiao Hu

**2018 Xiao Hu--****A dynamic ultrasound simulation of a pulsating three-layered CCA for validation of two-dimensional wall motion and blood velocity estimation algorithms**

**Purpose:**A dynamic ultrasound simulation model for the common carotid artery (CCA)(颈总动脉) with three arterial layers for validation of two-dimensional wall motion(壁室移动) and blood velocity estimation algorithms is proposed in the present study.This model describes layers with not only characteristics of echo distributions conforming to clinical ones but also varying thicknesses,axial,and radial displacements with pulsatile blood pressure during a cardiac cycle（心动周期）.

**Methods:** The modeling process is as follows: first, a geometrical model according with the clinical structure size of a CCA is built based on the preset layer thicknesses and the diameter of lumen.Second,a three-dimensional scatterer model is constructed by a mapping with a Hilbert space-filling curve from the one-dimensional scatterer distribution with the position and amplitude following Gamma and Gaussian distributions, respectively. The characteristics of three layers and blood are depicted by smoothly adjusting the scatterer density, the scale, and shape parameters of the Gamma distribution as well as the mean and standard deviation of the Gaussian distribution. To obtain the values of parameters of scatterer distributions, including the shape parameter, density, and intensity, for arterial layers and blood, the envelope signals simulated from different configurations of scatterer distribution are compared with those from different kinds of tissue of CCAs in vivo through a statistic analysis. Finally, the dynamic scatterer model is realized based on the blood pressure, elasticity modulus of intima-media (IM) and adventitia, varying IM thickness, axial displacement of IM as well as blood flow velocity at central axis during a cardiac cycle. Then, the corresponding radiofrequency (RF) signals, envelope signals, and Bmode images of the pulsatile CCA are generated in a dynamic scanning mode using Field II platform.

**Results:** The three arterial layers, blood, and surrounding tissue in simulated B-mode ultrasound images are clearly legible. The results based on a statistical analysis for the envelope signals from 30 simulations indicate that the echo characteristics of blood, intima, media, and adventitia are in accordant with clinical ones. The maximum relative errors between the preset geometrical sizes and the measured ones from the simulated images for the diameter of the lumen and the thicknesses of the intima, media, and adventitia are 0.13%, 3.89%, 1.35%, and 0.06%, respectively. For the dynamic parameters, the variation in IM thickness, the radial displacements of lumen and adventitia as well as the axial displacement of IM and blood flow velocity are measured with the mean relative errors of 68.03%, 9.27%, 2.10%, 4.93%, and 17.34%, respectively.

**Conclusion:** The simulated results present static sizes and dynamical variations according with preset values; echo distributions conforming to clinical versions. Therefore, the presented simulation model could be useful as a data source to evaluate the performance of studies on measurements of ultrasound-based tissue structures and dynamic parameters for the CCA layers.

**2017 Xiao Hu--Assessment of Homodyned K Distribution Modeling Ultrasonic Speckles from Scatterers with Varying Spatial Organizations**

**Purpose:** This paper presents an assessment of physical meanings of parameter and goodness of fit(参数和拟合度估计) for homodyned K (HK) distribution modeling ultrasonic speckles(超声斑点) from scatterer distributions with wide-varying spatial organizations.

**Methods:** A set of 3D scatterer phantoms based on gamma distributions is built to be implemented from the clustered to random to uniform scatterer distributions continuously.(散射模型基于伽马分布)The model parameters are obtained by maximum likelihood estimation (MLE) from statistical histograms of the ultrasonic envelope data (通过来超声膜数据地直方图的最大似然估计)and then compared with those by the optimally fitting models chosen from three single distributions. Results show that the parameters of the HK distribution still present their respective physical meanings of independent contributions in the scatterer distributions(零差分布的参数表现他们各自的在散射分布中独立一致性的物理含义). Moreover, the HK distribution presents better goodness of fit with a maximum relative MLE difference of 6.23% for random or clustered scatterers with a well-organized periodic structure. Experiments based on ultrasonic envelope data from common carotid arterial B-mode images of human subjectsvalidate the modeling performance of HK distribution.

**Conclusion:** We conclude that the HK model for ultrasonic speckles is a better choice for characterizing tissue with a wide variety of spatial organizations, especially the emphasis on the goodness of fit for the tissue in practical applications.

**2015.11 胡晓--三层膜管壁结构的颈动脉超声仿真**

**不足**：模型在仿真真实颈动脉管壁时存在局限性 ～ 没有细分血管壁的分层结构， 也没考虑各层组织回声图像的统计特性差异。

**方法**：为了更准确精细的建立颈动脉管壁超声仿真模型，本文提出基于位置伽马随机分布组织散射点模型的三层膜管壁结构颈动脉超声仿真方法。研究了组织散射点分布的形状和密度参数与超声回声斑点分布的变化规律，为产生与临床超声特征一致的回波信号，对临床采集的颈动脉血管各组织回声斑点进行**统计分析**，确定对应组织散射点随机分布参数、密度及强度等**特征参数**，使用三维希尔伯特曲线映射散射点到血管空间，进而利用FIELDII产生超声射频回波信号并得到B超图像

**目的**：方法仿真的 B超图像能够准确刻画颈动脉血管壁三层膜及血流组织的斑点回声统计特征及几何尺寸，获得与临床超声回声分布相致的三层膜管壁颈动脉超声图像，为相关超声异常病变组织测量，信号处理和特征提取及可视化研究提供仿真试验手段。

**展望**：首先，没有考虑随心脏脉动周期颈动脉三层膜结构厚度及管腔直径的变化；其次，没有考虑在血液流动及心脏脉动时三层膜结构间的运动差异。

**观点：**

**2015 Xiao Hu--Ultrasound Simulation for 3D Model of Carotid Artery with Three Membranes**

**Purpose:** This paper presents a simulation method for the 3D model of the carotid artery with a three-membrane wall structure (CA3M) basing on their scatterer models with different statistical characteristics.

**Methods:** The 3D-Hilbert space-filling curves(3D希伯尔空间填充曲线) are used to map spatial distribution of tissue scatterers in the CA3M model. Each region is acoustically(声学的) characterized using FIELD II, which produces the radio frequency echo signals. To produce echo signals which are consistent with the clinical ultrasonic ones,the B-Mode ultrasound images of common carotid arteries collected from clinic are segmented and statistically analyzed.

**Conclusion:** The results indicate that the distributions of intimae（内膜）, mediae, adventitias and lumens(腔) are consistent with the clinical B-Mode ultrasound images.

**2014 Xiao Hu--An ultrasound simulation method for carotid arteries with a wall structure of three membranes**

**Purpose:** Ultrasound simulation for carotid arteries is helpful to the performance assessments of vessel wall detection and signal processing methods by using ultrasound techniques. An ultrasound simulation method of carotid artery wall with a three-membrane structure is proposed in present study.

**Methods:**According to the ultrasound speckle distributions varying with the shapes and densities of scatterer distributions, as well as the statistic results of the clinical images, the parameters of distributions, densities and intensities of scatterers for different kinds of tissues in the carotid artery phantoms are determined. Each region is acoustically(声学上) characterized using FIELD II software to produce the radio frequency echo signals, from which ultrasound images are derived.

**Conclusion:** The results based on 30 simulations show that the echo distributions of the intimae, mediae, adventitias and blood are consistent with the clinical ones. Moreover, compared with the results from the central frequency of 8 MHz, the mean measurements for thicknesses of the intima, media and adventitia membranes, as well as the lumen diameter from the simulation images based on 12 MHz are the same as the preset（预先设置） ones, and the maximum relative errors are the 4.01%, 1.25%, 0.04% and 0.15%, respectively. The simulation under this condition is more realistic.