Second-Order Finite-Volume Numerical Scheme for Blood Flow PDEs With Stenosis At The Boundary

Overview: In this MATLAB code we check the Lyapunov stability conditions for the boundary terms (related to $a(t)$ and $b(t)$) and $R(x,t)$ matrix for different levels of stenosis. Specifically, equations (33) and (35) of the article.

Description of the MATLAB File: LyapunovConditions_BloodFlow_ErrorSystem.m

Step 1. First define the positive definite matrix $\mathcal{P}(x)$

Step 2. Using the MATLAB functions calculate the values of the matrices $\Lambda(x,t)$ and $\Gamma(x,t)$ for all x and t. Note that this MATLAB code requires the solutions vector $[A Q]$ and the corresponding Riemann variables vector $[u v]$, which are computed in the BloodFlow_Van_Leer.m file. The reason for doing this is to reduce the computational power required.

Step 3. Compute the $R(x,t)$ matrix based on the Lyapunov condition in the paper.

Step 4. Compute the eigenvalues of $R(x,t)$ matrix.

Step 5. Compute the Lyapunov condition at the boundary $x=L$. Condition at $x=0$ is always satisfied as $p_1\mathcal{P}_{11}(0)=1$ and $p_2\mathcal{P}_{22}(0)=0.7$ or $p_2\mathcal{P}_{22}(0)=0.8$ based on the stenosis level.

Step 6. Plot the eigenvalues of $R(x,t)$ matrix and the Lyapunov boundary condition (33) (of the article) at $x=L$ over time.

The folder also contains function file needed to calculate Riemann variables and their spatial derivatives, also the functions files for calculating individual elements of the $Gamma(x,t)$ matrix. I guess these are the files with which you solve the nonlinear hyperbolic system, right?