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An Optimized Method for 3D Magnetic Navigation of Nanoparticles inside Human Arteries

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Abstract : In the present work, a numerical method for the estimation of the appropriate gradient magnetic fields for optimum driving of the particles into the desired area inside the human body is presented. The proposed method combines Computational Fluid Dynamics (CFD), Discrete Element Method (DEM) and Covariance Matrix Adaptation (CMA) evolution strategy for the magnetic navigation of nanoparticles. It is based on an iteration procedure that intents to eliminate the deviation of the nanoparticles from a desired path. Hence, the gradient magnetic field is constantly adjusted in a suitable way so that the particles’ follow as close as possible to a desired trajectory. Using the proposed method, it is obvious that the diameter of particles is crucial parameter for an efficient navigation. In addition, increase of particles' diameter decreases their deviation from the desired path. Moreover, the navigation method can navigate nanoparticles into the desired areas with efficiency approximately 99%.

Keywords : computational fluid dynamics, CFD, covariance matrix adaptation evolution strategy, discrete element method, DEM, magnetic navigation, spherical particles
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