SOLUTION OF THE INVERSE LIGHT-SCATTERING PROBLEM FOR CHARACTERIZATION OF RED BLOOD CELLS

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Motivation and Aim: Hematological analyzers, that are widely used in clinical diagnostics, measure volume of red blood cells and hemoglobin concentration. Determination of red blood cells shapes and index of sphericity can be used in detailed analysis of human blood for diagnosis of various diseases.

Methods and Algorithms: Scanning Flow Cytometer (SFC) is a novel device measuring light scattering patterns (LSP) of single particles in flow [1]:

$$I(0) = \frac{1}{2\pi}\int_0^{2\pi} \left(S_{11}(\theta,\varphi) + S_{14}(0,\varphi)\right)\mathrm{d}\varphi,$$

where S – the Mueller matrix, θ and φ – polar and azimuthal scattering angles, $\theta \in [10°, 70°]$. Using this approach blood sample can be analyzed apiece with independent analysis of every particle.

We consider an inverse problem consisting in determination of shape parameters of red blood cells from measured LSP. We model a red blood cell as biconcave disc described by 5 parameters (volume V, surface area S, spontaneous curvature C_0, orientation angle β, refractive index n). The particular shape of red blood cell is determined from the minimization of deformation energy with fixed V, S, and C_0 [2].

We used Discrete Diploe Approximation (DDA) method for solution of the direct light-scattering problem [3].

Results: In the experiment we measure 10^2–10^3 cells per second. Due to the fact that solution of direct light-scattering problem takes about 1 minute at personal workstation, direct fitting is not feasible. Instead the inverse solution is realized by nearest-neighbor interpolation on the preliminary calculated database with $2 \cdot 10^6$ records.

References:

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