Laser Speckle-Contrast Imaging: Bloodflow Mapping

Fomin, Vsevolod

Medical problems such as tissue plasty, eye fundus examination, require obtaining the spatial distribution pattern of blood flow at the level of arterioles and venules. To do this, we have used and developed a method based on measuring the contrast of the speckle pattern in the area of biological tissue. We have created a laboratory setup, in which laser source illuminates the specified area generating the speckle pattern that is recorded by CCD matrix and transferred to the computer. Software code has been developed allowing image processing to detect moving scatterers against the background of immovable ones. A model medium was used for the experiment in the form of two identical diffusive tubes attached to the substrate and containing a solution of PVA emulsion in water that could flow in one of them at various velocities. Illumination of this model by incoherent light gives the identical images of the tubes while in coherent light they differ in brightness after processing. A model experiment was performed for tubes of different diameters (0.25 mm to 1 mm) and different liquid flow rates (0.5 to 5 mm/sec.) A number of optical arrangements were tested, as well as light sources of different wavelengths (532 to 808 nm) and spectral width (coherence length of 0.2 mm to 5 mm) were applied. Image quality was estimated as good for the signal-to-noise ratio greater than 2. On the basis of the performed experiments we have created a prototype of portable device that uses NIR laser diode, which enables reception of blood flow maps in about 4 mm2 area with spatial resolution of 20 microns. The device can be used to visualize blood flow during surgical procedures and to diagnose blood supply disturbances accompanying various diseases.