

DYNAMICAL HOLOGRAM GENERATION ON THE GRAPHICS PROCESSING UNIT FOR HIGH SPEED OPTICAL TRAPPING

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Dynamical hologram generation can be realised in a number of different ways, in particular those that utilise twisted nematic or ferroelectric devices have been used in microscopy for aberration correction or holographic optical tweezers [1-2]. Furthermore, recently researchers have begun to realise the operational power of Graphics Processing Units (GPUs), which are typically used for 3D gaming to generate holograms up to 100 times faster than possible on the fastest CPU [3].

In a similar manner, we have worked on the development of a multiplexed optical tweezers system, which uses a ferroelectric spatial light modulator to project binary holograms on the pupil or back focal plane of a high numerical aperture lens (Figure 1).

To achieve this at high speed via the GPU (GE Force 8600GT nx86 512MB RAM, NVIDIA®) we have incorporated a Microsoft Foundation Classes (MFC) Visual C++ Dynamic Link Library (dll) into our *user friendly* LabView 8.2.1 interface (National Instruments). This has within it the OpenGL and OpenGL Shading Language (GLSL) programming language to communicate to the vertex and pixel shaders of the GPU, which are in turn used to render the hologram.

We intend to implement this technology in the future to perform real time 3D trapping and adaptive optics correction in microscopy and for the manipulation of the recently introduced Smart Droplet Microtools used for spatially selective proteomics [4].

REFERENCES:

- [1]. M.A.A. Neil, T. Wilson and R. Juškaitis. "A wavefront generator for complex pupil function synthesis and point spread function engineering". *J.Microsc.* **197**, 219-223 (2000).
- [2]. A. Lafong, W.J. Hossack *et al.* "Time-Multiplexed Laguerre-Gaussian holographic optical tweezers for biological applications". *Opt. Exp.* **14**, 7, 3065-3072 (2006).
- [3]. T. Haist, M. Reicherter *et al.* "Using graphics boards to compute holograms". *Comp. in Sci. & Eng.* **8**, 1, 8-13 (2006).
- [4]. P.M.P. Lanigan, T. Ninković *et al.* "A microfluidic platform for probing single cell plasma membranes using optical trapped Smart Droplet Microtools (SDMs)". *Lab on a Chip*, Accepted.

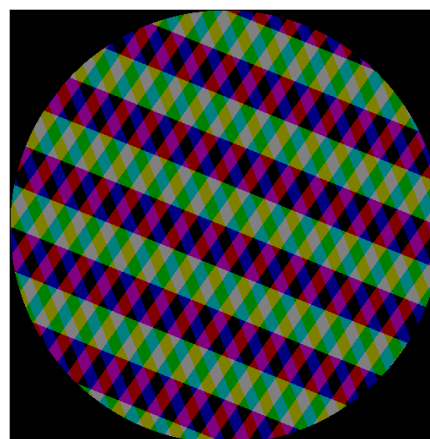


Figure 1. 512×512 pixels binary phase hologram showing three bit colour planes (red green and blue) used to assign the tip and tilt to the diffracted beam used for optical tweezers in the focal plane of the microscope objective.