A DMD Based, Multi-Modal Imaging System for Tracking of Biological Processes

Elliot Steele, Ashley Cadby
University of Sheffield
Hicks Building, 226 Hounsfield Rd, Sheffield
S3 7RH, United Kingdom
Email: emsteele1@sheffield.ac.uk

KEY WORDS: Multi-Modal, DMD, Super-Resolution, Confocal, ISM, STORM

Super-resolution (SR) techniques represent a major advance in light microscopy (LM), allowing the resolution of structures previously only visible with electron or atomic force microscopy, whilst retaining the significant advantages associated with LM, e.g., selective labelling of target structures, non-invasive imaging of dynamic intracellular processes, etc. However, these techniques often require high illumination intensities (STED, STORM/PALM), long acquisition times (SMLM) or multiple images per super-resolved image (SIM). These drawbacks often limit the usefulness of these techniques in live cell imaging applications, due to phototoxic effects and speed limitations. Often, however, the higher resolution offered by these techniques is not required throughout the entire experiment or even the entire sample. This work presents a DMD based imaging system capable of performing multiple imaging modalities. By placing the DMD in an image plane in both the excitation and emission paths, the system can swap from widefield to confocal[1, 2] to SR techniques such as ISM and STORM[3, 4] by changing the image displayed on the DMD. The placement of the DMD in an image plane even allows multiple techniques to be applied simultaneously to different parts of the sample. The high refresh rates of DMDs allow the imaging modality to switch in less than a tenth of a millisecond, resulting in minimal information loss between switches and allowing SR to be applied only when advantageous.

References

[1] Verveer, Hanley, Verbeek, V. Vliet, and Jovin, "Theory of confocal fluorescence imaging in the programmable array microscope (pam)," *Journal of Microscopy*, vol. 189, no. 3, pp. 192–198, 1998.

[2] M. Thomas, "Improved optical arrangement for digital micromirror device," 2013.

[3] L. V. Peedikakkal, V. Steventon, A. Furley, and A. J. Cadby, "Development of targeted storm for super resolution imaging of biological samples using digital micro-mirror device," *Optics Communications*, vol. 404, pp. 18 – 22, 2017.

[4] L. Valiya Peedikakkal, A. Furley, and A. J. Cadby, "A multimodal adaptive super-resolution and confocal microscope," *bioRxiv*, 2018.