BLIND STRUCTURED ILLUMINATION MICROSCOPY WITH DISTORTED LIGHT GRIDS

R. Ayuk 1, E. Mudry 1, K. Belkebir 1, J. Girard 1, A. Sentenac 1, J. Savatier 1, E. Le Moal 1,
C. Nicoletti 2, M. Allain 1, N. Sandeau 1, H. Giovannini 1
1 Institut Fresnel, Aix-Marseille Université/CNRS, Campus de St Jérôme
13397 Marseille cedex 20, France
2 ISM2, Aix-Marseille Université/CNRS, Campus de St Jérôme
13397 Marseille cedex 20, France
E-mail: hugues.giovannini@fresnel.fr

KEY WORDS: structured illumination microscopy, fluorescence, blind reconstruction, inverse problem

1. ABSTRACT
In Structured Illumination Microscopy (SIM) the fluorescent samples are illuminated with periodic light patterns in order to obtain an improvement of the resolution beyond the diffraction-limited detection band pass [1-3]. The distribution of fluorophores is determined with a reconstruction process that assumes a precise knowledge of the illumination grid. For this reason, SIM is sensitive to aberrations, to mechanical and thermal drifts of the setup.

Recently, a technique called blind-SIM [4] has shown, both theoretically and experimentally, that the image reconstruction can be performed even when the samples are illuminated with random unknown light patterns, provided that their average is almost homogeneous over the sample. Results have been presented when the samples are illuminated by a set of speckle patterns and when an iterative algorithm of reconstruction based on the resolution of an inverse problem is used for retrieving the distribution of fluorophores.

We will show that the method of reconstruction developed for the blind-SIM can be modified and adapted in order to recover the distribution of fluorophores from the data given by standard SIM setups. The advantage in this case is that the reconstructions are insensitive to the distortions of the light grid produced by lens aberrations, misalignements or phase shifting errors.

We present numerical and experimental results obtained when deformed light grids are projected on the samples. We analyze the robustness of the technique against aberrations, phase shifting errors and noise.

2. REFERENCES