Model based adaptive optics for single molecule localization microscopy

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The development of the scientific CMOS camera is a result of the need in biological sciences for imaging systems that can image at a larger field of view (FOV). When the thickness of a biological sample increases, the depth induced aberrations increase as well, which can be counterbalanced by using adaptive optics (AO). Unfortunately, AO can only be used to correct nominal aberrations leaving those that vary within the FOV unchanged.

We have developed a method that allows us to quantify the impact of correcting the nominal aberration by calculating the best possible localization precision, based on the aberrations retrieved at that particular point in the FOV. Our algorithm estimates magnitude as well as phase aberrations for a high numerical aperture (NA) microscope using at least two images [1].

The time of computation required for our phase retrieval algorithm is lengthy compared to the response time for our adaptive optics hardware. Therefore, we also present an approximation that increases the computational efficiency of this method and makes it suitable for real-time adaptive optics applications [2].
