Internship in Image Processing for Super Resolution Microscopy (*M*2, 6 months)

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BioAxial establishes a new super-resolution imaging modality. Our technology is based on a powerful beam shaper, generating controlled and localized light patterns used to scan biological samples with very low photo-toxicity and negligible photo-bleaching.

The principle being to scan a sample by a laser, we produce a large number of micro-images corresponding to local illumations on the entire sample, the laser having different shapes to allow us to retrieve high frequencies in the object.

From these images we have to find a way to restore the original object, which correspond to the concentration map of fluorophores.

The Maximum A Posteriori (MAP) approach is a very relevant choice because:

- It allows to merge the information from all the micro-images from all the distributions (i.e. the different laser shapes);
- It takes into account the Poisson Noise which affects these data;
- It takes into account the Point Spread Function (PSF) which blurs the image;
- It allows us to introduce a prior (or constraint) to regularize the problem which is ill-posed due to the low SNR and the blur effect;
- It takes into account the shape of the laser, which is a way to introduce Super Resolution by increasing high frequencies content.

This approach is a paradigm which needs to choose:

- Which prior do we use? it exists a wide family of priors and the choice has to be chosen according to different criterions;
- Which method do we use to optimize the MAP criterion? The optimization methods in regularized problems have received much attention recently in scientists work, especially in split methods which are typically our case.

The current method implemented in BioAxial algorithms uses positivity constraint and band-limited approach. This one leads to very good result, but it's a soft prior which can have some artifacts we want to correct.

The intern work will be to:

- Review the state of the art of recent works in regularized method in microscopy (and astronomy, which has similar features) imaging;
- With the help of algorithm manager, to choose new method to implement and test with BioAxial data;
- Code in Matlab and/or C /C++;
- Produce an internship report and presentation report;

Profile and skills:

- Good knowledge in applied mathematics, algorithms and/or signal and image processing;
- Experience in Matlab and/or C/C++;
- Remarkable communication skills and attention to detail;
- communication skills in English.