**Deep learning massively accelerates super-resolution localization microscopy**

**深度学习极大地加速了超分辨率定位显微镜**

1.在Direct determination中哪里提到该文章

In microscopy, ANNs are beginning to find use in both indirect[23–25] and direct aberration sensing methods[26–28].

2.该文章逻辑是什么

第一段提出荧光显微镜好，但是特性决定分析的细胞数量较少

第二段目前的改进办法和缺点

第三段我们的办法ANNA-PALM.

RESULTS

A deep-learning approach to super-resolution image reconstruction

第一段存在图像冗余，因此有提升的空间

第二段神经网络结构，仅需要少量帧。包含训练图像，重建分辨率。几个ANN训练不同的内容

Neural net architecture and learning strategy

神经网络架构

改进了复杂的架构

引入四层CNN

会生成误差图

Validating ANNA-PALM on simulated images

生成测试训练图像

进一步提炼出图像，介绍整个过滤恒

获取时间与重建质量间需要权衡

可用定位数据替代无定位数据

新的模型可以大大减少显微镜采样时间，同时保证一定的图谱质量

ANNA-PALM reconstructions of immunostained microtubules

另外一种重建

与普通PALM比可大大提升时间

ANNA-PALM enables high-throughput super-resolution imaging

ANNA-PALM可以从比PALM成像的典型时间短得多的采集时间恢复超分辨率图像的高质量近似值，并且可以预测最有可能出现重建错误的地方。

ANNA-PALM is robust to experimental perturbations

有鲁棒性

有背躁时不受较大影响

ANNA-PALM adapts to different biological structures

ANNA-PALM在经过适当的重新训练后可以成功地分析非丝状结构，并且一个具有简单计算开关的ANN可以重建非常不同类型的结构。

综上所述，我们的结果说明了ANNA-PALM的多功能性及其对结构非常不同的图像的适用性。

DISCUSSION

ANNA-PALM不需要对现有的显微镜系统进行任何更改，而只需要训练一个或几个标准的PALM图像即可。

ONLINE METHODS

Training objectives and error map.

Experimental training images and data augmentation.

Image simulations.

Sample preparation.

Image acquisition in localization and high-throughput microscopy.

Localization microscopy image analysis.

Quality metrics and sampling resolution.

3.该文章核心是什么？

因为PALM及STROM类显微镜有大量图像冗余，因此由提升空间。这篇文章利用神经网络识别此类显微镜宽视场图像，可以大大减少显微镜采样时间，同时保证一定的图谱质量，并且可以预测最有可能出现重建错误的地方。而且，该神经网络仅凭广角图像可以直接进行判断，定位数据为辅助作用

4.英语表达该文章核心

As PALM and STROM microscopes have a lot of image redundancy, there is space for improvement. This article uses neural networks to identify such microscope wide-field images, which can greatly reduce the microscope sampling time, at the same time ensure a certain quality of the map, and can predict the most likely places for reconstruction errors. Moreover, the neural network can directly judge based on widefield images alone, though adding localization data improves image quality.

5.积累的问题

Strehl ratios

Strehl ratio：艾里斑内聚光强度比

RMS magnitude 在π情况下 均方差大小

<https://www.telescope-optics.net/aberrations.htm>

<http://www.astronomycorner.net/notes/strehl.html>

<https://www.telescope-optics.net/Strehl.htm>

<https://wenku.baidu.com/view/6eaca0fde43a580216fc700abb68a98270feac7f.html>

PSF

https://blog.csdn.net/weixin\_39750861/article/details/84556204

<https://blog.csdn.net/miscclp/article/details/7456470>

<https://blog.csdn.net/weixin_40300818/article/details/86794116>

<https://bitesizebio.com/22166/a-beginners-guide-to-the-point-spread-function-2/>

<http://web.ipac.caltech.edu/staff/fmasci/home/astro_refs/PSFtheory.pdf>

<https://wp.optics.arizona.edu/jcwyant/wp-content/uploads/sites/13/2016/08/psfandmtfcurves.pdf>

<https://www.mathworks.com/matlabcentral/answers/343558-point-spread-function-of-an-optical-system>

Zernike

<https://baike.baidu.com/item/Zernike%E5%A4%9A%E9%A1%B9%E5%BC%8F/2735195?fr=aladdin>

<https://en.wikipedia.org/wiki/Zernike_polynomials>

<http://www.dm.unibo.it/home/citti/html/AnalisiMM/Schwiegerlink-Slides-Zernike.pdf>

<https://www.opt.indiana.edu/vsg/library/vsia/vsia-2000_taskforce/tops4_2.html>

<https://wenku.baidu.com/view/f92e4346a8956bec0975e3d9.html>

<http://xuebao.jlu.edu.cn/gxb/article/2014/1671-5497-44-6-1860.html>

<https://blog.csdn.net/qq_26898461/article/details/47123009>

<https://blog.csdn.net/piaoxuezhong/article/details/65444605>

<https://www.cnblogs.com/chensheng-zhou/p/5054354.html>

<http://wyant.optics.arizona.edu/zernikes/Zernikes.pdf>

<https://wp.optics.arizona.edu/jsasian/wp-content/uploads/sites/33/2018/04/Schwiegerling-Zernike-2018.pdf>

<https://telescope-optics.net/zernike_aberrations.htm>

<http://jan.ucc.nau.edu/jmn3/students/zernike.pdf>

<http://paristech.institutoptique.fr/site.php?id=562&fileid=6769>

<https://www.gatinel.com/recherche-formation/wavefront-sensing/zernike-polynomials/>

<https://www.telescope-optics.net/zernike_aberrations.htm>

像差补偿aberration compensation

<https://www.edmundoptics.com/knowledge-center/application-notes/optics/an-in-depth-look-at-spherical-aberration-compensation-plates/>

<https://optics.org/news/10/8/6>

波前传感器- Shack-Hartmann型

<https://zhidao.baidu.com/question/102215035.html>

<https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=5287>

<http://www.astrosurf.com/cavadore/optique/shackHartmann/Shack-Hartmann.htm>

<http://www.optics.arizona.edu/sites/optics.arizona.edu/files/pdf/Historical-Development-Shack-Hartman-Wavefront-Sensor.pdf>

<https://www.rp-photonics.com/shack_hartmann_wavefront_sensors.html>

剪切干涉仪shearing interferometer

<https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=2970>