**Artificial neural network for the determination of Hubble Space Telescope aberration from stellar images**

**用人工神经网络判断哈勃望远镜行星照片的像差**

1.在Direct determination中哪里提到该文章

In adaptive optics, deep learning was initially applied to astronomical telescopes [18–20]

The ANN considered here is modelled on a multi-layer perceptron network previously investigated for the determination of Zernike coeﬃcients [19].

The use of two PSF images enables axially symmetric aberrations such as defocus to be determined [19].

Where the image path cannot be accessed or modified, training on single PSF images using the default CCD camera is certainly possible although such ANNs cannot lean the sign of axially symmetric aberrations such as defocus [19].

2.该文章逻辑是什么

Introduction

第一段简单介绍神经网络优点+简要介绍训练方法+大致工作

第二段Iterative method与neural network对比，显示神经网络优点

Neural networks for the recovery of phase

第一段对比人判别与神经网络判别，突出神经网络对于复杂情况判断的优势

第二段给出简单PSF公式，简要介绍。介绍神经网络处理非线性问题优势

第三段强调完全均匀的光瞳功能不存在

第四段提到一张图片会导致出现pathological behavior，原因是since the network must be trained to distinguish between two solutions that are quite different but that correspond to nearly identical input data.所以采取on opposite sides of the best focus of the telescope

第五段讲述了其优点及相应的应用场景

第六段区分大气系统和HST系统的区别，因为HST主要为低频失真，因此用低阶Zernike即可，及初步公式

第七段神经网络无需高分辨率即可恢复低空间失真

Neural network architecture

第一段就是人工神经网络结构

第二段反向传播的监督架构，训练数据

第三段权重更新，误差函数定义，学习速率

第四段需要大量迭代，因为二维FFT耗时生成较小网络，训练集数量一定要足够，发现4000-6000个足够

Result for HST

第一段对神经网络准确性的评估，1.在STScI模拟很多星图2.自己生成模拟图像

第二段对于图片获取方式及格式的介绍

第三段对于图片预处理，同时不同尺寸图片关注内容不同

第四段模拟数据的实验结果

第五段实际实验中参数

第五段实验结果及实验中问题

第六段实验总结

第七段说明单输入的性能

第八段单输入与双输入的对比

Conclusion

第一段阐述实验结果，显示较为吻合

第二段阐述精确的光学建模对于实验精确性的影响

第三段额外的测试

第四段感谢

3.该文章核心是什么？

本文使用多层感知器网络来预测Zernike系数，该网络在望远镜最佳焦点的相对两侧具有两个PSF图像。 在只有一个PSF图像的情况下，也可以使用默认的CCD相机对单个PSF图像进行训练，但不会预测出像散焦之类的轴对称像差。

4.英语表达该文章核心

This article uses a multi-layer perceptron network, which has two PSF images on opposite sides of the best focus of the telescope, to predict Zernike coefficients. Where there is only one PSF image, training on single PSF images using the default CCD camera is certainly possible but will not lean the sign of axially symmetric aberrations such as defocus.

5.积累的问题

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>