**Object-independent image-based wavefront sensing approach using phase diversity images and deep learning**

**使用相位分集图像和深度学习的基于独立对象的图像的波前感测方法**

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

Introduction

非相干成像系统受到限制，因为相位畸变一起，可通过自适应光学来改进

基于波前的探测较为适用

如果需要扩展，需要有一定的评估扩展场景的能力

人工神经网络好

目前的神经网络没有较好地扩展性，需要大量数据训练进行扩展

提取与相差相关但与原始对象无关

LSTM的优势

Object-independent feature extraction

波前相位差与焦平面间非线性映射

利用傅里叶关系，去除扩展对象信息

Object-independent wavefront sensing approach using deep LSTMs

Introduction of LSTM network

LSTM是递归神经网络变体

简要介绍

Object-independent wavefront sensing approach using deep LSTMs

输入有区别

无需任何模拟或真实扩展场景就可以训练深度LSTM网络。 实际上，用于训练深度LSTM网络的特征图像是从根据傅立叶光学系统生成的模拟PSF图像中提取的。 另一方面，经过训练有素的深度LSTM网络可以应用于从真实扩展场景中提取的特征图像，并恢复波前相位像差。 根本原因是特征图像与对象无关。

Simulations and experiment

Simulations

数据集建立

对硬件要求低

训练准确性较好

可从不同相差提取图像

Experiment

以孔为例做实验

器具

检测方法

恢复的较为准确

再次强调无关

Other discussions

比较两个神经网络能力

Comparison between deep LSTM network and Resnet 18 as deep learning tool

LSTM好

原因是卷积耗时，LSTM把图片拆成序列放入

Influence of the incoherency of incident light on wavefront sensing accuracy

预测遇到的问题

Conclusion

Note that the proposed approach needs a pair of images with a roughly known phase diversity between them, while it seems that some other existing deep learning methods only need one image [11,12]. However, we should point out that the mathematical mapping from the set of all possible pupil phase screens to the set of all possible intensity distributions is a many-to-one mapping. Therefore, to invert this mapping and guarantee the uniqueness of the solution for wavefront phase, simultaneous collection of multiple intensity images with certain phase diversities are usually needed [24,25]. This is the underlying reason for why we need two images with a phase diversity between them.

3.该文章核心是什么？

本文介绍的LSTM神经网络（a variant of recurrent neural network）由于将图片利用傅里叶变换后拆成多个序列，因此训练的特征图像与相位差有关，与原图片无关。这赋予了该神经网络很大的扩展性，无需大量扩展数据进行训练，而且对硬件要求低

4.英语表达该文章核心

In this article, the LSTM neural network (a variant of recurrent neural network) uses Fourier transform to split the picture into multiple sequences, so the training feature image is related to the phase aberrations, not the original picture. This feature gives the neural network a great scalability, does not require a large amount of extended data for training, and has low hardware requirements