Expanding infrared microspectroscopy with Lucy-Richardson-Rosen computational reconstruction method

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Computational imaging technologies have substantially reduced the costs of imaging systems and at the same time significantly improved their performances such as three-dimensional imaging capability, multispectral imaging with a monochrome sensor, etc., However, computational imaging methods are not free of challenges.
The research group of Prof. Saulius Juodkazis from the Swinburne University of Technology and a team of scientists from the infrared beamline of the Australian synchrotron have developed a novel computational holography method by combining two well-known deconvolution methods namely the maximum likelihood algorithm developed by Lucy and Richardson and non-linear correlation developed by Rosen. This Lucy-Richardson-Rosen algorithm is capable of deconvolving intensity distributions obtained from direct imagers such as Cassegrain objective lenses. When the imaging condition is satisfied, a direct image of the object is formed and when the imaging condition is disturbed, the computational reconstruction method is applied. The new method was applied to image chemical samples at the infrared microspectroscopy system of the Australian synchrotron. From a single camera shot of the chemical sample and the known three-dimensional point spread functions of the Cassegrain objective lenses, a complete three-dimensional image of the chemical sample is generated by the Lucy-Richardson-Rosen algorithm.

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LRR 计算重建方法显著提升红外显微光谱的成像性能

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计算成像技术不仅能大幅降低成像系统成本，还能显著改善其性能，如三维成像能力、单色传感器多光谱成像等。然而，计算成像方法依然存在一些挑战。

澳大利亚斯威本科技大学 Saulius Juodkazis 教授的研究小组与澳大利亚同步加速器红外光束线科学家团队的 Jitraporn Vongsvivut 教授等合作，开发了一种新的计算全息技术方法，用于生化样品的快速成像。

红外显微光谱仪采用液氮冷却的汞-镉-碲单像素探测器，严格聚焦的 Cassegrain 物镜对，以及逐点扫描方法来记录样品的二维信息。这种扫描方法非常耗时，限制了同步加速器光束时间内的可研究样本数量。Saulius Juodkazis 教授等开发的新方法采用焦点阵列探测器代替单像素探测器，并采用较弱的卡塞格伦物镜增加样品平面内的光束直径。这种方法能够对样品进行单次二维成像。该项工作最重要的创新点是，提出了一种新的计算全息方法，能够显著提高成像质量。通过结合两种众所周知的反卷积方法，即 Lucy 和 Richardson 开发的最大似然算法以及 Rosen 开发的非线性相关方法，设计了一种新的计算全息方法。这种 Lucy-Richardson-Rosen (LRR) 算法能够对从直接成像器 (例如 Cassegrain 物镜) 获得的强度分布进行反卷积。

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