亮点报道：高频增强超快压缩成像技术 (H-CAP) 让微观超快影像纤毫毕现

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超快压缩成像技术与计算成像相结合是实现单次曝光大帧数超快成像最具前景的技术途径。但在超快压缩图像的重现中，图像空间分辨率会随着帧数的增加而降低。这给复杂多变的超快过程观测带来了巨大的挑战。

西安交通大学陈烽教授课题组提出了一种高频增强超快压缩成像 (H-CAP) 方法。该方法在空间域中将微观超快现象投影到特制的编码上，巧妙地提取了微观超快现象的高频信息，解决了传统超快压缩成像引起的高频信息模糊的问题，可以让微观超快影像纤毫毕现。具体的实现方法是，通过对传统使用的随机编码的结构分布进行重新排列，消除黑色像素和白色像素的聚类，得到可以在傅里叶变换域中抑制低频噪声的高频增强随机编码。该编码拥有更均匀的结构分布，满足压缩感知的精确重建特性，在前端采集超快现象时更多保留了高频成分，可以在大帧采集的情况下提高信噪比。

这项研究工作提供了一种在大帧数下观测高时空复杂度超快过程的新方法，标志着超快压缩成像的一项重要进展，有望成为超快激光与物质相互作用、超快光场测量或超快退磁等不可重复动态过程的全新手段。

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Highlights: High-frequency enhanced ultrafast compressed photography technology (H-CAP) allows microscopic ultrafast movie to appear at a glance

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The combination of ultrafast compressed imaging technology and computational imaging is the most promising technical approach. However, the spatial resolution of the image will decrease with the increase of the number of frames in the reconstruction of ultrafast events. This brings great challenges to the observation with both high spatial complexity and high time complexity.

Prof. Feng Chen's research group from Xi'an Jiaotong University has proposed a high-frequency enhanced ultrafast compressed photography (H-CAP) method. This method projects the microscopic ultrafast phenomenon onto a special coding in the spatial domain, and skillfully extracts the high-frequency information of the microscopic ultrafast phenomenon, which solves the problem of high-frequency information blurring caused by traditional ultrafast compressed imaging. The specific implementation method is to eliminate the cluster of black pixels and white pixels by rearranging the structural distribution of the traditional random coding, and obtain a high-frequency enhanced random coding that can suppress low-frequency noise in the Fourier transform domain.

This research provides a new method to observe the ultrafast process with high space-time complexity under a large number of frames, which marks a significant progress in ultrafast compressed imaging.

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