Computational imaging empowers laser material processing with snapshot compressive microscopy

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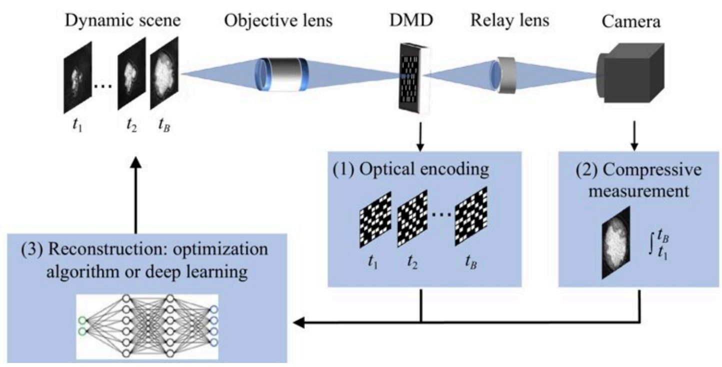

Principle of snapshot compressive imaging, which consists of optical encoding, compressive measurement, and reconstruction. Credit: *Light: Advanced Manufacturing* (2024). DOI: 10.37188/lam.2024.029

A team of researchers has developed a novel computational imaging system designed to address the challenges of real-time monitoring in ultrafast laser material processing. The new system, known as Dual-Path Snapshot Compressive Microscopy (DP-SCM), represents a significant advancement in the field, offering unprecedented capabilities for high-speed, high-resolution imaging. The team was led by Yuan Xin from Westlake University and Shi Liping from Xidian University.

The paper is published in the journal *Light: Advanced Manufacturing*.

Traditional microscopy techniques often struggle to meet the demands of real-time monitoring in laser processing due to their limited imaging speed, restricted field of view, and insufficient resolution. These limitations, coupled with the vast amount of data generated during high-speed imaging, have made it difficult to achieve precise monitoring in dynamic, fast-changing scenarios.

To overcome these challenges, the DP-SCM system employs a dual-path optical design that integrates both high-resolution and wide-field imaging capabilities. Each optical path uses snapshot compressive imaging technology, effectively breaking the bottleneck between imaging speed and data storage. This innovative approach allows the system to capture high-resolution images across a large field of view at unprecedented speeds.

The DP-SCM system also incorporates advanced deep learning algorithms for image reconstruction, enabling the dynamic observation of micro- and nanostructures as they evolve over time. In experimental applications, the system successfully monitored the laser material processing and growth of nanogratings, providing crucial insights into the mechanisms underlying new material formation.

More information: Xiaodong Wang et al, In-situ real-time monitoring of ultrafast laser processing using wide-field high-resolution snapshot compressive microscopy, *Light: Advanced Manufacturing* (2024). DOI: 10.37188/lam.2024.029

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