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Live-cell mAIcroscopy - Cracking the challenge to image living cells with real-time event attention

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Abstract

Microfluidic live-cell imaging (MLCI) unlocks unique insights into living cells, their development over time, and their response to environmental cues. Exploiting high-throughput lab-on-chip devices in connection with modern automated microscopes provides unprecedented detail on the single-cell level while capturing natural biological variations by large amounts of observations. So far, the technology's focus has been on observing microbial life within an experiment through first recording microscope images, which are only subsequently analyzed to gain quantitative insights. Now, emerging AI-driven real-time image analysis empowers us to obtain such insights in real-time, for instance, to detect specific events during the experiment. This bears the opportunity to shift our position in MLCI from being retrospective analyzers to becoming AI-assisted drivers, facilitating a wide range of opportunities to exert control on microbial life in the running experiment.

In this talk, we present our event-driven ultrahigh-throughput MLCI platform that we develop within the Helmholtz imaging project EMSIG. We show that software-based microscope control, real-time event detection, and response scheduling fundamentally change the opportunities in MLCI experimentation. The new platform accelerates MLCI experiments, leads to ultrahigh-throughput and large-scale data acquisition, standardizes experimental procedures using software, introduces real-time insights using fast AI image processing, and enables us to perform event-driven experimentation, widening control on microbial populations during the conduction of the experiment.

With our contribution, we showcase that the tight interconnection of imaging hardware and real-time AI image analysis into a closed feedback loop bears the opportunity to introduce a paradigm shift in MLCI experimentation that heralds a new era in live-cell analysis.

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Session Classification: Thematic Session: Image Analysis - part II

Track Classification: Image Analysis (focus on representation learning and foundation models): Thematic focus: Image Analysis