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Robotic Crystal Harvesting: The Final Frontier in Automated High Throughput Crystallography.

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High throughput crystallography has reached a level of automation, where complete computer-assisted robotic crystallization pipelines are capable of cocktail preparation, crystallization plate setup, and inspection and interpretation of results. Mounting of crystal pins, data collection and structure solution are also highly automated. The remaining challenge towards full automation is crystal harvesting and cryo-cooling. These critical operations occur late in the crystallization process and are a major source of loss of valuable crystals.

To address the final frontier in achieving fully automated high throughput crystallography, we have designed and tested an anthropomorphic, 6-axis Universal Micromanipulation Robot (UMR) capable of reliably harvesting and cryo-quenching protein crystals as small as 10 μ m from a variety of 96 well plates. The UMR arm is equipped with a versatile tool exchanger. Tape cutters, harvesting pins with MiTeGen MicroLoops, cryo-liquid exchange and custom tools provide additional operational flexibility. The current user interface is a simple game-style keyboard layout allowing intuitive manual control. Semi-automated process steps such as tool location, loop approach to crystals, as well as fully automated tape cutting and quenching have been implemented in the prototype. Integrated machine vision and object tracking are in development to achieve minimally supervised, automated crystal harvesting.

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