Empowering Cryo-EM Research: Introducing a Customizable, Modular Freezing System with High-Precision Robotics
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Cryo-electron microscopy (Cryo-EM) is widely used to study complex structures of biological macromolecules. However, traditional freezing methods suffer from issues with reproducibility, flexibility, and affordability. Our modular freezing system solves these issues by integrating high-precision robotics at a lower cost compared to similar systems.

Our system enhances reproducibility through multiple features. It maintains a consistent environment for sample preparation with self-regulating humidifiers. The robot's precise movement control reduces the need for manual dexterity when handling grids. A high-speed camera allows for the evaluation of the specimen immediately prior to vitrification, reducing the use of microscope time. Triggers with defined timings can be added to optimize the grid preparation process.

It is built on an open-source platform allowing users to customize functions to fit experimental needs. For instance, it can perform not only traditional blot and plunge freezing but also employing acoustic transducers for sample dispensing, mixing, and blotless liquid thinning experiments. Here we show high resolution structures obtained with this system as well as successful mixing of different complexes using an acoustic transducer.

The system is constructed of off the shelf parts, 3D printed components, and a commercially available SCARA robot. The cost of this system, at least an order of magnitude lower than comparable systems, making it accessible to a wide range of research groups.