Lightweight module that can pick up and move objects could lead to faster and more accurate automation

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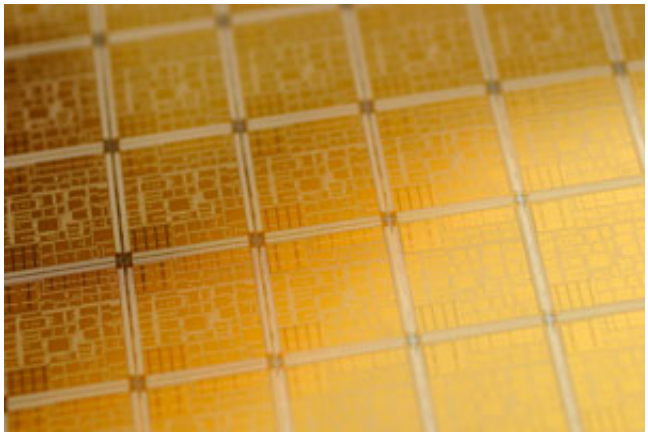

A*STAR SIMTech researchers have designed an actuator capable of the precise linear and rotational movements needed for fast and accurate positioning of semiconductor chips. Credit: StephanHoerold/E+/Getty

A module for rapid, accurate and versatile positioning of semiconductor chips has been developed by Singaporean researchers. It features a novel electromechanical actuator that can move objects both linearly and rotationally.

Actuators are transducers: they convert electrical energy into physical energy; mechanical motion or force. Electromagnetic motors can perform this task with a high-force output and highly accurate positioning—which makes them ideal for automated manufacturing systems in which objects must be picked up and moved quickly. But most actuators tend to move linearly in only one direction, or they offer a rotational motion.

"For surface-mount technology (SMT) assembly, it is important that an actuator can provide both linear and rotary motion concurrently so that assembly line can achieve high throughput and high accuracy ," says Daniel Tat Joo Teo and colleagues from the A*STAR Singapore Institute of Manufacturing Technology (A*STAR SIMTech) and National University of Singapore (SIMTech-NUS) Joint Lab.

"For example, when picking up a chip, the actuator can rotate it to compensate the angular misalignment based on the feedback from a camera before placing it on to the lead frame," says Teo. "How fast and how accurate the actuator can perform this task will determine the overall throughput and accuracy of the automated system."

Teo and co-workers designed, modeled and developed a novel type of actuator that delivers decoupled linear and rotary motions, which is both light and accurate. Their device comprised separate translational and rotary modules and included a cylindrical Halbach magnet array. This formed a closed-loop magnetic circuit that concentrated the magnetic field within an air-core coil rotator and reduced magnetic field leakage. These features made the actuator lighter and permitted a high-speed and dynamic response. Similarly, the translational module was made of two permanent magnets facing each other, which also focused the magnetic field on the active moving coil region.

The team built a prototype of their actuator design and demonstrated a linear movement range of ten millimeters and a rotational displacement of up to 90 degrees. The device could achieve a high throughput of 9000 unit-per-hour pick-and-place tasks with a linear and rotational accuracy of 20 micrometers and 0.66 degrees respectively.

The researchers propose that their actuator could be used in the semiconductor industry for SMT assembly and sorting silicon wafers. "We hope to make the design even more compact by reducing

the number of components and the size the electromagnetic modules," says Teo.

More information: Tat Joo Teo et al. Principle and Modeling of a Novel Moving Coil Linear-Rotary Electromagnetic Actuator, *IEEE Transactions on Industrial Electronics* (2016). DOI: 10.1109/TIE.2016.2585540

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