How to Build Better Robotics with Integrated Actuators

by Reese Abouelnasr

Motion is a critical function of any robotic system and actuators play a key role in supporting accurate and repeatable torque, force, etc. As robotic systems evolve, thanks to trends in miniaturization and humanization, requirements for actuators are changing too.

Reese Abouelnasr, a Mechatronics Engineer with Harmonic Drive, answers a few questions about the latest developments in actuators and the design or engineering challenges these devices can help solve in robotics. Harmonic Drive develops and manufactures precision servo actuators, gearheads, and gear components and is known for commercializing the strain wave gear, a three-part precision reducer design invented by C. Walton Musser. One of Harmonic Drive's offerings is the integrated actuator, which incorporates a Harmonic Drive® gear, brushless servo motor, encoder and a servo drive into the device.

1 What are the benefits to using an integrated actuator?

Abouelnasr: The robotics industry has been undergoing a trend in miniaturization and compact designs. To meet these demands without sacrificing system functionality, roboticists and engineers require actuators with high torque density, or a high actuator torque per unit volume. Conventional actuators require the use of an often bulky external servo drive for each actuator in use, which comes with additional cable management and space concerns. With an integrated actuator, the servo drive is built right in, and we have managed to do so without compromising on the actuator size. So, a 6DOF robotic arm that used to require six actuators and six servo drives now only requires six integrated actuators, which offers a lower cost solution with less cabling and installation time required. The reduction in cabling also means a reduction in the number of failure points. This can be fairly significant, as we have found that the most frequent potential failure point for our actuators is damage to the external cables due to improper routing.

2 What types of integrated actuators does Harmonic Drive offer?

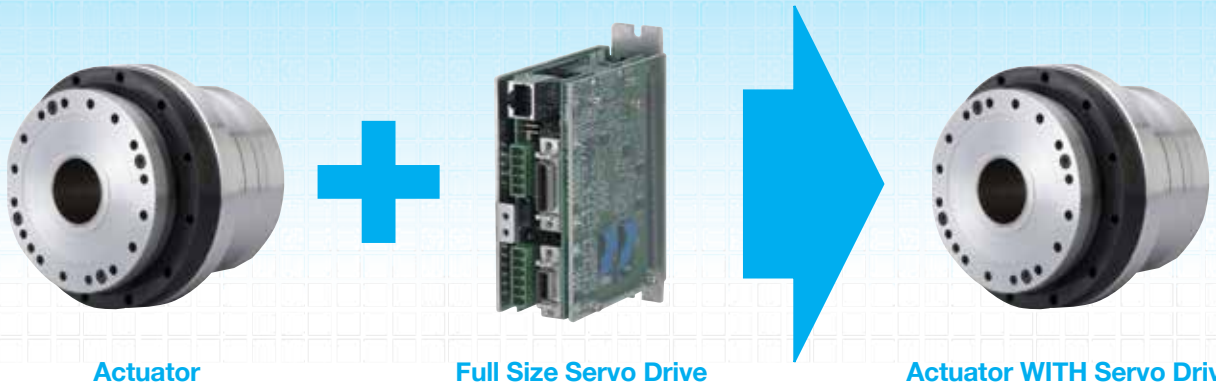
Abouelnasr: Many of our actuators, ranging broadly in mass, volume, and form factor, now have integrated drive options. We offer our SHA-20, 25, and 32 actuators with integrated drives, as well as our low-profile LPA- 20 actuator, and extremely compact FHA mini, RSA-8, and RSF-5 units. It is again worth noting that these versions come with almost no increase volume nor any change in form factor, so no difficult decisions need to be made by roboticists.

3 Are there any current design or engineering challenges that these actuators can help solve in the fields of robotics, aerospace, medical equipment, or other industries?

Abouelnasr: Mass and volume optimization is often the biggest challenge in robot design, particularly with mobile robots that don't have the luxury of an external cabinet. In eliminating the need for an external servo drive, we have given engineers the freedom to pursue even more compact, torque-dense designs, or to incorporate additional features within the same volume.

One of the biggest bottlenecks in the development of humanoid robots, for example, is the current actuation technology on the market that roboticists are using in an attempt to replicate human muscle. These actuators must be compact enough to fit within small, bio-inspired joints, while still providing a high torque that can emulate fluid human motion. In continuing to deliver actuator designs with a greater torque density, Harmonic Drive is giving roboticists greater freedom to pursue novel robotic concepts that were once only possible in nature.

Rotary Actuator with Integrated Servo Drive



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4 Are there any changes in actuator function or communication?

Abouelnasr: An additional feature we are adding to our integrated units, that we are excited about, is communication over EtherCAT. The EtherCAT fieldbus allows for a 100X increase in communication speed, as well as, a 10X greater maximum distance between units when compared with CANopen.

EtherCAT also allows for flexible topology (line, star, tree, ring), which pairs well with the easily scalable functionality of actuators with integrated drives. We are in the process of releasing EtherCAT for our SHA-20, 25, and 32 actuators, as well as our low-profile LPA-20 actuator.

5 How would these changes benefit engineering projects?

Abouelnasr: Our line of integrated actuators allows engineers to pursue highly modular and compact designs. Different sized actuators can be smoothly mixed and swapped into your system and since integrated actuators can be chained together without the need to connect each to a central controller, scalability and expansion are now made much easier.

6 Are there any changing use or environmental conditions that would influence the selection and design of an actuator?

Abouelnasr: One of the biggest concerns when considering the operating temperature of our actuators is the Harmonic Grease® used in the strain wave gear, however we do manufacture grease for a range of extreme temperatures. When considering ingress protection, sealing and connector selection are particularly important. Our SHA, RSA, and RSF-5 integrated actuators have an IP54 rating, and we also offer FHA servo series actuators with IP65 protection. As a company, we have extensive experience designing products for harsh environments, and anyone with a specific need can contact our sales engineers who will work with our engineering department to create a custom solution.

7 Can Harmonic Drive help engineers with customization requests? If so, how would that work?

Abouelnasr: Absolutely! Our low-profile LPA-20 and extremely compact RSA-8 actuators both began as special customer requests and our engineering design service is provided free of charge, in most cases. We provide many highly-customized solutions to customers for many applications. Anyone who is interested can contact one of our sales engineers for more information.

Reese Abouelnasr is a Mechatronics Engineer with Harmonic Drive, has a bachelor's degree in mechanical engineering from Georgia Institute of Technology and a master's degree in mechanical engineering from Tufts University.

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