Applications for spherical robots include hazardous and remote environments, and various methods of locomotion have been developed. REVO is a unique modular spherical robot platform employing 12 grounded force-output actuators with which one can implement a wide variety of locomotion strategies.

In order to ensure successful actuation, a motor with the appropriate speed and torque performance had to be selected. Calculations based on an estimate of the robot’s mass and the lead screw mechanics were carried out in the effort to characterize the drive train before components were purchased. Lead screw efficiency, screw and nut interface friction properties, and thread geometry were considered to provide an accurate engineering estimate of appropriate motor specifications. The calculations not only permitted the selection of motor performance, but also allowed the appropriate thread pitch for a pre-selected diameter. A visualization of the system requirements and existing motors’ performance is shown below.

The internal propulsion system is a custom linear actuator consisting of a high-powered brushless direct-current motor, a modified lead screw, and a custom leadscrew nut. The force of the moving nut is transmitted to the ground through a machined aluminum web that is fastened to a carbon-fiber disk. The aluminum web’s alignment is maintained by three guide rods which ride in raised bushing columns. The bushing columns provide a suitable bearing ratio to ensure binding-free operation. This elegant and simple drivetrain is a rigid, non-back drivable system. The geometric requirements revealed the need for a powerful, low-profile motor in order to achieve not only effective, but simple actuation. The immediate benefits of this lean configuration include additional space for electronics in the center of the robot, fewer parts to manufacture, and ease of assembly.

The modular architecture of REVO simplifies assembly and access. Care was taken to ensure that the structure could be assembled from the outside. A rigid frame consisting of a pod plate, three support struts, and a pentagonal shell plate is fitted with the drivetrain to form a “pod.” Twelve plates are fixed together to form a dodecahedron, which encases the battery pack and computer to form the “nucleus.” The nucleus can be fastened shut with the use of 3D printed brackets and the pods are installed by vertical access to three fasteners through the web to the pod plate.

Attached to each pod is a custom-designed printed circuit board. This circuit performs two tasks; the first is to receive commands from a central computer, and the second is to control the speed and direction of a DC brushless motor. Modules are then serially connected together via five wires that carry power and communications. The pods communicate on a Prox I2C (Inter Integrated Circuit) compatible protocol.