

Compact, Efficient Motion Powers a Submersible Robot for In-Service Inspection of Fuel Storage Tanks

Founded in 2016, Square Robot is an innovator in robotic inspection of above-ground tanks used to store diesel fuel, gasoline, kerosene, various oils and other products. Through ongoing development of robotic, data-acquisition and data-processing technologies, Square Robot is uniquely positioned to enable in-service inspections for ensuring tank integrity and safety.

Challenge

Storage tanks are often drained, opened and manually inspected for corrosion, weld defects and other potential problems. This process is expensive and potentially hazardous both for inspectors and the environment. Square Robot saw an opportunity to enable in-service tank inspection using a submersible robot with both video cameras and phased array ultrasonic testing.

The challenge was to design a submersible robot compact enough to fit into tight entryways originally designed to accommodate a single human, maneuverable enough to closely inspect the entire tank while avoiding columns and other obstructions, versatile enough to perform in fluids of widely varying weight and viscosity, and efficient enough to complete inspections lasting eight hours or more on a single battery charge.

“The integration of a frameless motor into Square Robot’s propulsion system was an incredible achievement for the team. We’ve been researching and developing technology to address the challenges that gasoline and other low-flashpoint materials bring, so it was great to collaborate with Kollmorgen and leverage their motor expertise during this successful SR-3 project.”

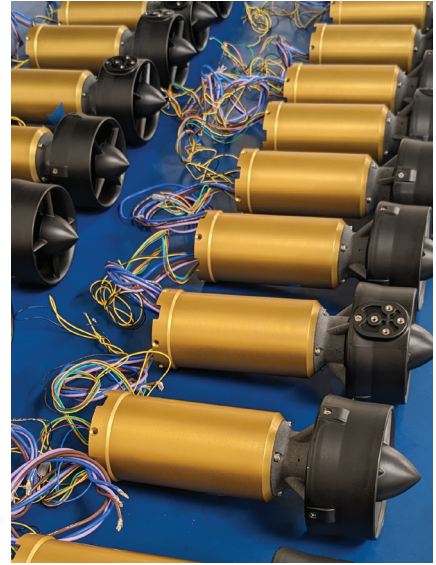
— Charles O’Connell, Director of Mechanical Engineering, Square Robot

Solution

Eight thrusters are required to give the submersible robot six degrees of freedom in navigation. When a commercially available thruster proved to be incompatible with gasoline and other petrochemicals due to the materials used, Square Robot's engineering team turned to a market leader trusted for its expertise in specialized motion applications: Kollmorgen.

A compact KBM frameless servo motor, housed in a nitrogen-filled pressure vessel with a dynamic seal, was selected to power the thrusters on Square Robot's next-generation SR-3 submersible. Kollmorgen modified the KBM windings to meet the application's exact performance requirements — including the ability to maintain relatively high torque at high rotational speeds. Kollmorgen's Frameless Motor Performance Curve Generator provided essential data for achieving the optimum winding design.

The pressure vessel isolates the KBM motor windings to prevent ferrous sediment buildup, unlike the previous design that bathed the encapsulated windings directly in the tank fluid. The KBM motor also incorporates integrated Hall sensors that allow thrusters to achieve velocity as low as zero when necessary.



Results

Highly modified, compact KBM motors deliver efficient thruster performance even in challenging lower-density and higher-viscosity fluids. Hall sensor feedback enables a full velocity range for total navigational control, even allowing the bottom scanner to be precisely positioned within ½ inch of the tank shell. The ruggedized design ensures reliability in challenging in-tank environments.

Working in concert with Square Robot's preferred drive, the motion system delivers efficient performance across the full range of speed/torque demands, maximizing the robot's battery life so that it can complete inspections lasting eight hours or more on a single charge.

Yet despite all the modifications, this custom level of performance is achieved using the commercial-off-the-shelf KBM servo motor platform — ensuring that Square Robot can count on long-term manufacturability, availability and affordability.

Efficient motor design
maximizes battery life for
8+ hours
of use on a single charge.

About Kollmorgen

Kollmorgen, a Regal Rexnord Brand, has more than 100 years of motion experience, proven in the industry's highest-performing, most reliable motors, drives, linear actuators, AGV control solutions and automation platforms. We deliver breakthrough solutions that are unmatched in performance, reliability and ease of use, giving machine builders an irrefutable marketplace advantage.