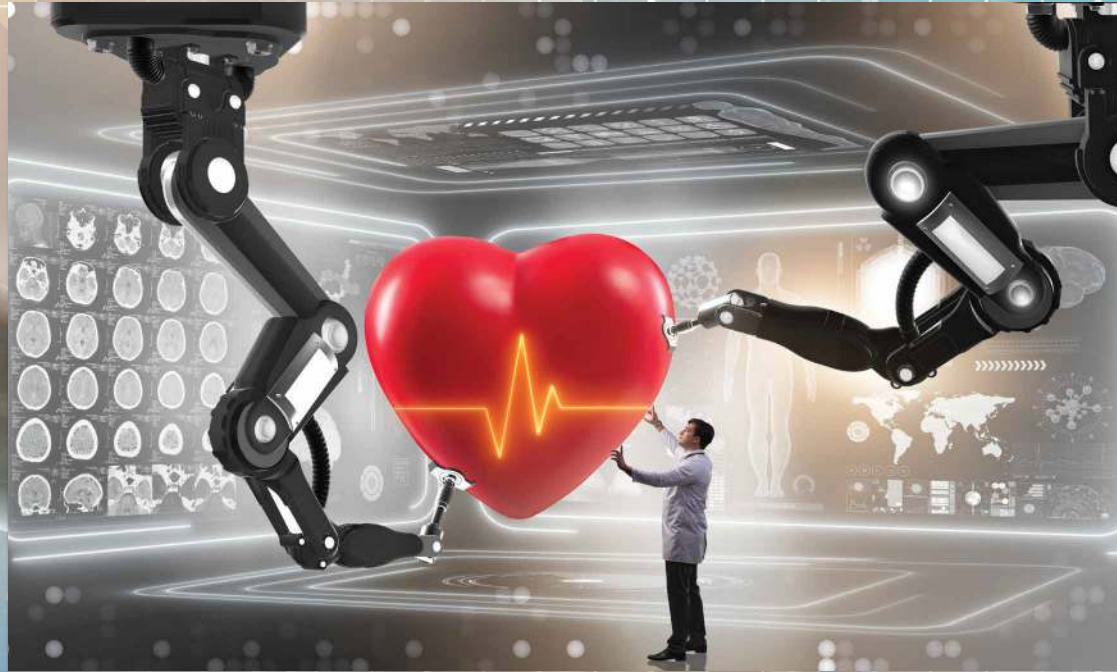


# Design Keys for Next Generation Surgical Robots



Advanced Motion Control Solutions  
for Medical Robots

**Allied Motion**  
*Motion Solutions That Change the Game*

# Gain the Cutting Edge in Surgical Robotics

Tomorrow's surgical robots will be more compact, more precise, more maneuverable than ever before – and they won't be built with off-the-shelf motion technology. To develop advanced, differentiated robotics, you need high-performance, custom motion control products and the engineering expertise to optimize them for your application.



## Experience + Vision in Surgical Robotics

Allied Motion's decades of experience developing innovative medical motion control, drive, motor, and feedback solutions gives us a unique perspective and level of experience not found in other suppliers. The result for you is quicker development cycles and higher performing medical robot systems.

## Design Collaboration for Innovation and Speed-to-Market

We tailor our engineering process to ensure we fully mesh with your team on the motion control aspects of your robot. What's more, Allied Motion is known in the industry for our willingness to develop customized solutions to help ensure our customers' objectives are met.



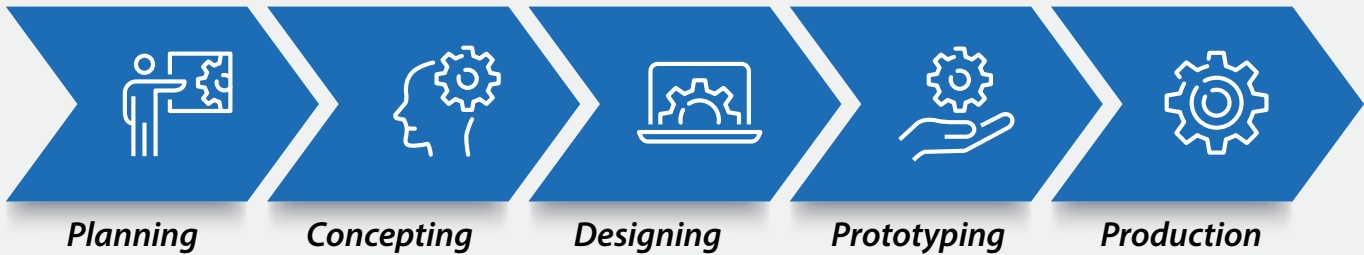
## We Are Committed to Your Success

Our team hits the ground running at our first meeting. We understand time-to-market is critical, so we streamline every step of the design process to fit your time constraints. Our engineers can travel to your facility, work side-by-side with your team, and quickly provide prototypes. And knowledgeable support is always just a phone call away.

**Let us help transform your ideas into the best next-gen surgical robot on the market!**



## Our Proven Process Works



*Development starts with requirements discovery, when our Class A team of design engineers works directly with your engineers to determine FIT and do a needs analysis. Your performance and mechanical requirements dictate our design approach and platform choices.*

*Leveraging our standard platform designs allows for quick-turn prototypes for 'proof of concept' while our team works in parallel to deliver production-intent designs that are fully tested to meet your specific application requirements. We use critical quality tools like Design, Validation, Plan, and Reporting (DVP&R) along with Pre-Production Parts Approval Process (PPAP) to ensure the highest quality standards are met with the goal of zero defects in delivered products. With ISO 13485 certified production facilities, we continue to provide medical devices and related services that consistently meet customer and applicable regulatory requirements.*

### Supply Chain Management for Maximum Efficiency

With design and prototyping underway our supply chain experts determine the best way to procure materials for your product in order to meet budget and on-time delivery.

Our established global supply chain enables us to engage top suppliers and ensure the component quality of the product we deliver to you.

# Experience Matters — Our People & Technology Make the Difference


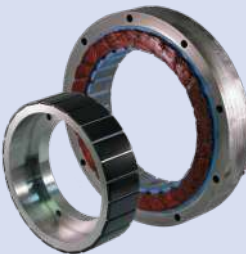



## Meet our Controlled Motion Specialists



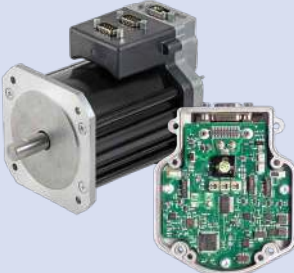

Allied Motion's engineers possess expertise in the key technologies critical to surgical robot motion control: advanced motion controls, drive electronics, frameless and housed brushless motors, and high precision feedback devices. Some technology examples are featured here.

Customized and even clean-sheet solutions are developed in over 80% of our engagements with medical industry customers. We won't offer our customers standard-only choices when a custom design is clearly needed.



		
<b>Slotless Motors</b>	<b>Brushless Direct Drive Torque Motors and Part Sets</b>	<b>Brushed &amp; Brushless DC Gearmotors</b>
<p>Patented design slotless motors for medical applications. Ideal for surgical hand tools, robotic arm end-effectors, surgeon controls, and surgical robot systems.</p>	<p>High performance housed and frameless brushless torque motors. Ideal for surgical robot base, shoulder and joint axes.</p>	<p>Exceptionally designed integrated geared solutions. Ideal for positioning control on exam tables, patient beds, and surgeon console seating.</p>
<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• Patented winding design enabling double the performance vs competitive motors</li> <li>• Zero-cogging torque for smooth operation with minimal vibration rated for 1000+ autoclavable cycles</li> <li>• High-speed capability of up to 100,000 RPM</li> <li>• Equipped with Rare Earth magnets to maximize torque output</li> <li>• Special bearing and gearbox lubrication, along with high-performance laminations and high-speed ball bearings for extended life</li> <li>• 20% cooler running, 20% longer life</li> <li>• Gearheads in multiple ratios to boost torque</li> </ul>	<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• High output torque at low speed eliminates mechanical backlash and lost motion</li> <li>• Low cogging torque for smooth precise 360-degree rotation</li> <li>• Large clear hollow shaft, enabling the passage material through the motor center</li> <li>• Available with integrated electronics, including hall sensors, hollow shaft encoders and mated drives</li> <li>• Feature distributed or concentrated single-tooth windings &amp; laminated stators</li> </ul>	<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• Offer Right Angle, Planetary (epicyclic) and Parallel Shaft PMDC Gear Motors</li> <li>• Designed for lifetime lubrication</li> <li>• Choice of helical or spur designs for optimized noise and torque transfer</li> <li>• In-house analysis tools to optimize geartrain and bearings per application.</li> </ul>



			
<b>Brushless Servo Motors</b>	<b>Powered Wheel Drives and Transaxles</b>	<b>Brushless DC Motors with Integrated Smart Electronics</b>	<b>Motor Drives</b>
<p>Housed (NEMA) and frameless brushless servo motors. Ideal for robot base, shoulder and joint axes, along with multi-axis positioning systems.</p>	<p>Electric powered traction units ideal for medical mobility equipment such as patient beds and base carts for consoles.</p>	<p>Brushless DC motors with integrated controllers. Ideal for torque, speed and/or position control applications, including patient beds, tables, arm tower and seat adjustment.</p>	<p>Offer AC Servo, Brushless Servo, and Sensorless Brushless motor drives. Ideal for high performance plug-and-play solutions.</p>
<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• Optimization of windings and rotor designs for high efficiency, and extremely low cogging and torque ripple (&lt;2%)</li> <li>• Up to a 35% shorter motor compared to other servo motors on market</li> <li>• Optimized bearing system for low noise and long life, even at elevated temperatures</li> <li>• Multiple feedback options able to meet virtually any positioning requirement, including resolver (standard), incremental encoder, SSI absolute encoder (up to 32-bit), Hiperface®, or Hiperface® DSL</li> </ul>	<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• Choice of either PMDC brush or brushless DC motors – with or without integrated drive electronics</li> <li>• Epicyclic gearing for high gear reduction and space savings</li> <li>• Optimized gear geometry maximizes life and minimizes noise and vibration</li> <li>• Alternate gearing materials for Noise, Vibration and Harshness applications</li> <li>• Modular mounting of motor and wheels for flexibility in design</li> <li>• Capable of zero turning radius for precise maneuvering</li> <li>• Hardened steel gears for exceptional durability</li> <li>• Lifetime lubrication to reduce maintenance</li> <li>• Rated for platform weights up to 1000 lbs.</li> </ul>	<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• Patented sensorless brushless technology</li> <li>• Integrated controllers eliminate the wiring/cabling between these two elements as is normal in traditional, separate motor and drive combinations</li> <li>• Torque and power density up to 40% better than brush DC motors</li> <li>• Control networks like CAN can be directly integrated into the motor</li> <li>• High power density for performance</li> <li>• Minimum size and lighter weight</li> <li>• Eliminates need for brush maintenance and no commutator wear for longer motor life</li> </ul>	<p><b>Allied Advantages:</b></p> <ul style="list-style-type: none"> <li>• Robust, patented sensorless speed control of brushless motors provides performance exceeding even conventional Hall commutated drives</li> <li>• Designed to mate perfectly with our servo motors and torque motors, creating high performance plug-and-play servo solutions</li> <li>• Available in both standard and custom-designed drive assemblies, which are integrated into our motor-drive series.</li> <li>• Communication and command interfaces offered ranging from Ethernet to EtherCAT, CANopen over CAN, Modbus RTU, USB UART, to traditional <math>\pm 10V</math></li> </ul>

# Breakthrough Surgical Robotic Arm Systems

## Surgical Robotic Arms

The articulated arm joints found on many surgical robots, such as shoulders, elbows, wrists and fingers/tools, must be precisely moved and positioned. Allied Motion is the leading supplier of high torque density, direct-drive joint motors and actuators (drive-integrated motor and autoclavable gearing), bestowing precision of motion on surgical robots.



*Allied Motion is a leading supplier of torque motors for surgical robots.*

## Robotic Surgery End-Effectors, Instruments & Hand Tools

We offer autoclavable slotless motors and gearing used in surgical hand tools and the positioning system of the manipulators found on many robotic surgery programs. Extremely lightweight, high-torque and near-zero cogging, our motors are ideal for high-precision robotic surgery hand tools, end-effectors, and end-of-arm tooling.



*Near-Zero Cogging Slotless Motors with Autoclavable Gearboxes*



## Surgical Robotic Arm System Positioning

Our brushed and brushless DC motors, with integrated electronics and an optional integral holding brake, provide the motion control needed for quiet and smooth height adjustment and position holding of the surgical robot arm system.



*Brushless DC Motors with Integrated Drives & Electronics*

# Next Generation Surgical Robot Control Consoles

## Surgeon Console Adjustment & Positioning

Allied Motion's brushless integrated motor drives, gear motors, and brushed and brushless DC motors power the linear actuation devices used to adjust console height, depth, and tilt, allowing the surgeon to position themselves comfortably throughout an operation.



*Brushless DC Motors with Optional Autoclavable Gearing*



## Surgeon Console Controls

The surgeon's movements made via the surgeon console are carried through to the arms located on the tower. Our autoclavable slotless motors and gearboxes are low cogging in order to reduce hysteresis drag and reduce friction, thus improving haptic feedback between the surgeon's movements and the surgical robot's arms.



*High-Speed, Near-Zero Cogging Slotless Motors with Optional Autoclavable Gearing*



Our family of brushless integrated motor drives, wheel drives and transaxles provide the steering and traction capabilities needed to maneuver the control console with ease and precision.



*Powered Wheel Drives, Transaxles and Gearing for enhanced maneuverability*

# Leading-edge Patient Tables

## Patient Table Adjustment & Positioning

The table is often adjusted throughout surgery to allow optimal positioning of the patient for access to the target area. Recent innovations include the introduction of integrated motion tables (IMT) that enable surgeons to dynamically move the table in tandem with a surgical robot while they operate.



Table adjustments must avoid disturbing the patient, and positions must be held precisely while the surgeon works. Allied Motion low-cogging brushed and brushless DC-based motors and servo motors, available with integrated gearboxes and holding brake, enable smooth, quiet, and precise movement of operating tables and other patient handling equipment.



*Low-Cogging  
Brushless DC  
Motors with  
Integrated  
Electronics and  
Gearboxes*

## Patient Table Transporting

Maneuvering a heavy patient table into position alongside a surgical robot system can be a challenge given the limited space of many operating rooms. Our brushless integrated motor-drives, brushed DC-based gear motors, wheel drives, and transaxles provide the propulsion, steering and traction capabilities to allow staff to quietly position or transport the patient with minimal effort.



*Powered Wheel Drives capable of zero-turn radius*



*Power Differentiating Transaxles ideal for medical mobility equipment*



*Brush and Brushless AC & DC Gear Motors*

## Allied Motion Solution Centers

Allied Motion Solution Centers provide support to customers around the world from five geographically-strategic locations. Each facility is staffed by experienced application engineers and customer service teams to assist you with all aspects of your motion control needs. We also have a global network of factory-trained Allied Motion Sales Partners to serve you. For contact information on the location nearest you, please see below or visit our website.

## Global Presence and International Support



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