The Precision Motion Control Laboratory at MIT conducts research in the design of electromechanical systems for precise positioning applications such as semiconductor photolithography, high-speed machine tools, and scanned probe microscopy. Our group's strengths complement the more traditional mechanical engineering disciplines to allow us to develop novel machines, actuators, and sensors for advanced manufacturing processes.

Our Past and Ongoing Projects in PMC Lab

Hysteresis Self-Bearing Motor
- Multiple winding: 4 poles for levitation, 2 poles for rotation
- Single winding Segmented Stator: Higher filling factor, Easy/low-cost manufacturing
- Self-Bearing Motor: Using one magnetomotive force for both levitation and commutation
- Single Axis Self-Bearing Motor: Low-cost/Simple Controller, Commercial Power inverter, Reliability/Robustness

Non-operative Correction for Esophageal Atresia
Motivations and Goals:
- Every year, 100 newborn infants in USA have disconnected esophagus, esophageal atresia, which requires serious surgical procedure.
- Goal is to develop a medical device for non-surgical anastomosis by using permanent magnets and control techniques.

Design Approaches:
- Esophageal pouches are stretched by pressurized outer casing.
- Magnets guide the outer casing to the right direction for contact, thereby inducing non-operative anastomosis.

Nanometrology for Nanoscale Science and Engineering

High-accuracy AFM Control and Instrumentation System
- HAFM uses a self-sensing AFM probe in frequency-measuring mode to sense the tip sample gap.
- It uses a piezoelectric stack actuator with a range of 20 μm and three capacitive displacement sensors to measure z-motion of probe as it follows a sample.

HAFM installed on Sub-Atomic Measuring Machine and Results
- Image of a sawtooth grating with 30-nm amplitude and 200-nm pitch captured using HAFM and SAMM system.
- Scan speed of 195 nm/sec and elapsed time of 11 minutes.

Portable Controls Lab
- NI myDAQ based system that allows students to explore the use of different schemes on an analog plant, a single or double integrator.
- Noise or disturbance can be added to the control loop and the effects on performance can be directly observed and studied.