



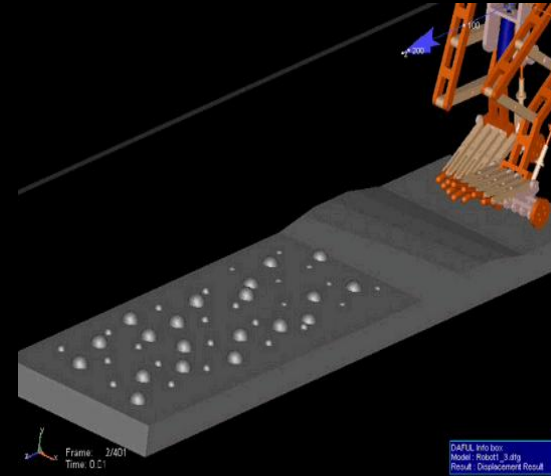
# Reducing the Sim2Real Gap for Industrial Robotics

Srinivasa Mohan, Distinguished Engineer and Scientist, Synopsys

Philip Sharos, Principal Engineer Edge AI, Analog Devices

# Introduction

- Training robots
  - Rule based hand crafted control
  - Learning and data-based training
- Modern robotics training
  - High-throughput simulation environment
  - Optimized for speed over accuracy
- The Sim2Real challenge
  - Policy trained may not work effectively in real world
- Overcoming the challenge
  - Domain Randomization (DR)
  - System Identification (SysID) or calibration
- Use high-fidelity simulations



# How Can High-fidelity Physics Help With The Sim2real Challenge?



Inject high-fidelity physics for specific events and dynamics



Contact rich, high precision, safety constrained tasks



Real time ML models that surrogate data from high-fidelity simulations

# Challenges for Dexterous Manipulation

Philip Sharos

# Humanoids hit a dexterity wall

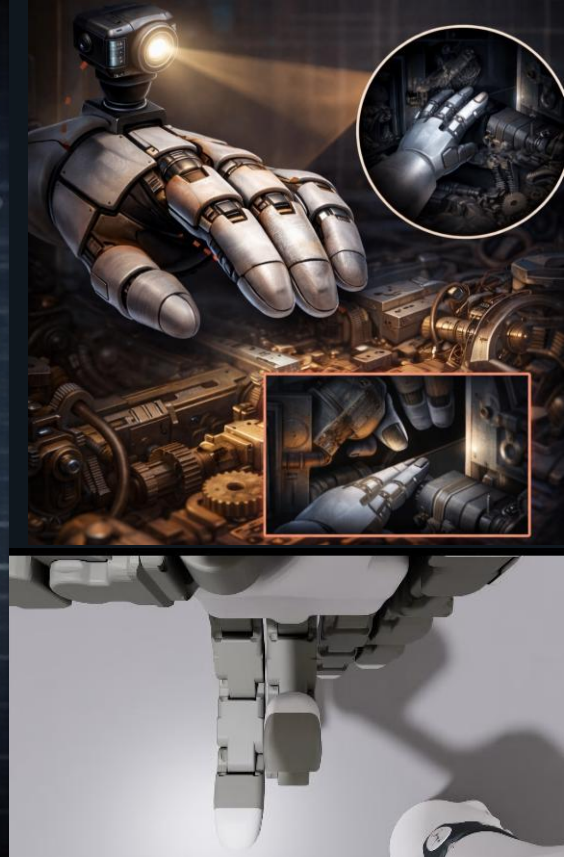
Moravec's paradox still holds



Data desert



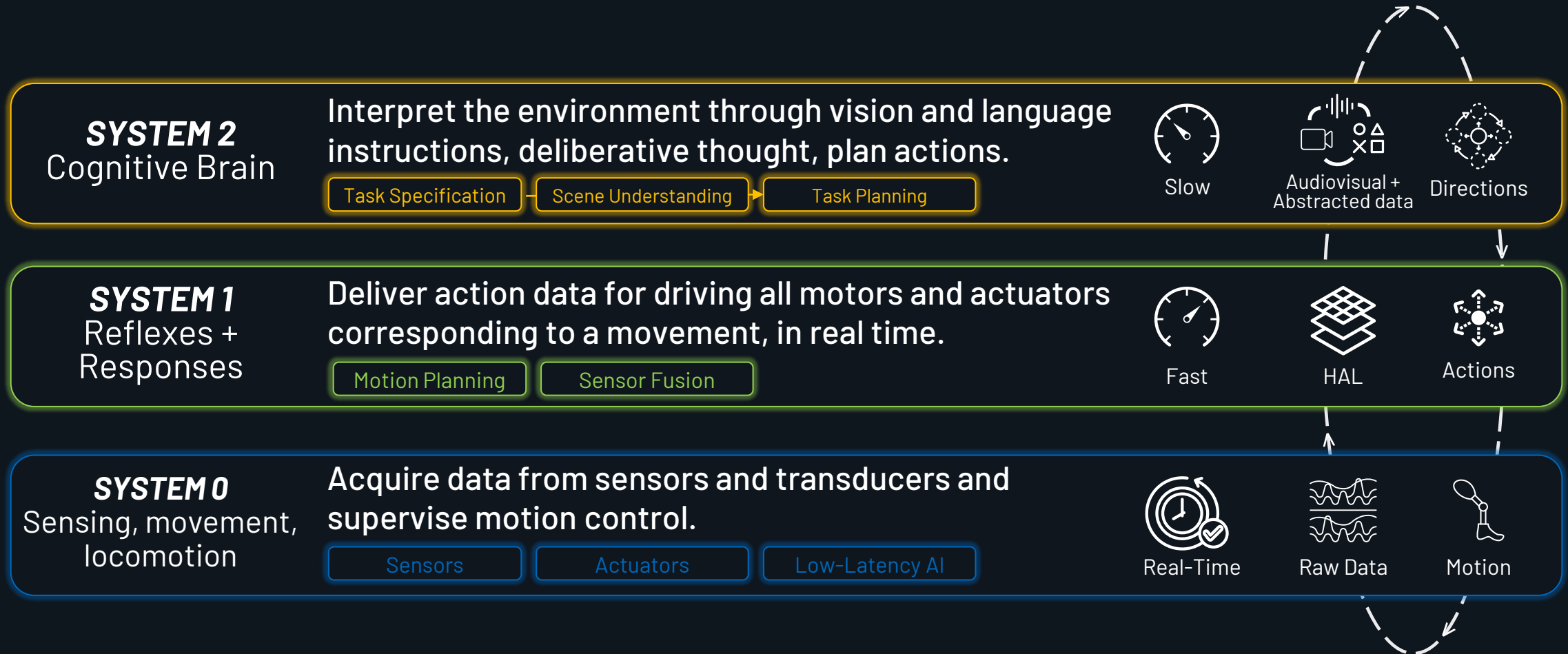
Actuation density



Sensing blindness

# System 0 + (System 1 + System 2)

Structured flexible blueprint for dexterous robotic pipelines



# Better dexterity with new modalities

Use case- and data-driven approach

## WHAT WE ARE SOLVING

Automotive Cable Harness Installation



Data Center Cable Management and GPU Upgrade



## NEW MODALITIES

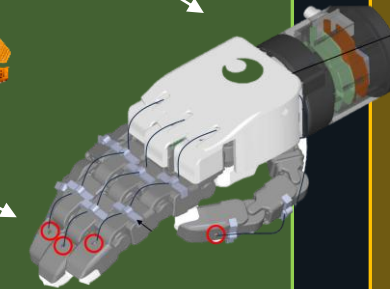
Time of Flight



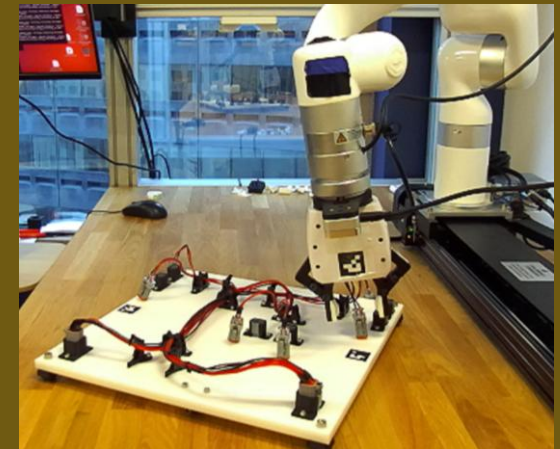
Tactile



Proprioception



## MEASUREMENT AND BENCHMARKING

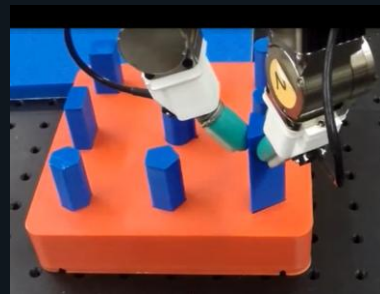


# Industrial Dexterity Benchmarks

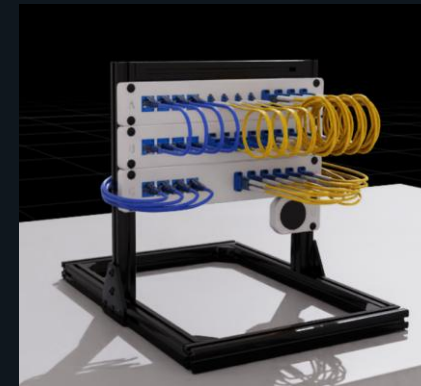
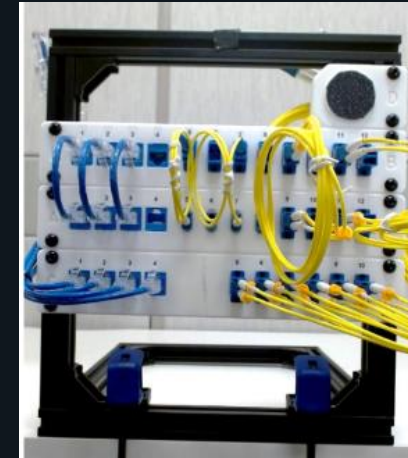
Connecting Unsolved Dexterity Problems and AI Research & System Development through Benchmark Tests



ADI Customer Problems



Existing Academic Benchmarks

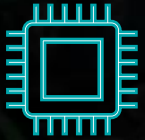


Industrial Dexterity Benchmarks

# Simulation framework for dexterous manipulation

Srinivasa Mohan

# High-Fidelity Simulation: Overcoming The Sim-to-Real Gap



ADI  
Sensor modalities

- Real-world and simulated sensing modalities
  - iTOF & Tactile
- Dexterity benchmark definition



Ansys  
Mechanical



Ansys  
AVxcelerate

- High-fidelity solver data for structural mechanicals and optics
- Calibrating high-throughput physics solvers for integration into Isaac Sim



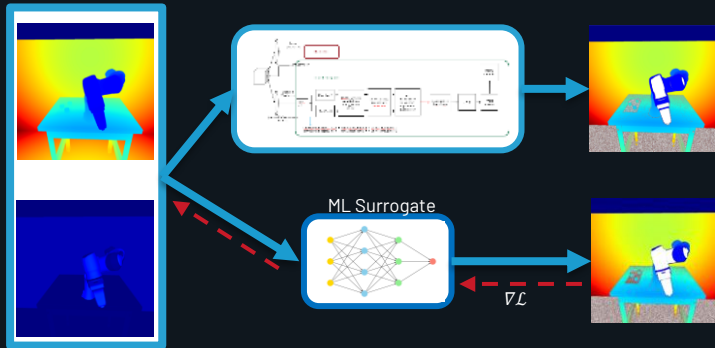
NVIDIA  
Isaac Sim / Lab

- Robotics simulation platform for policy training & validation
- Scalable solutions for reinforcement learning and synthetic data generation

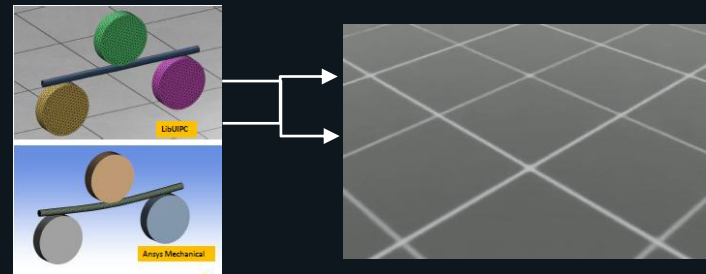
# High-Fidelity Simulation: Overcoming the Sim-to-Real Gap

More and better synthetic data

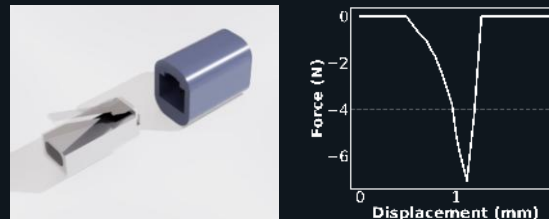
Ansyes Avx + ADI Physics Based iToF:  
**Sim Accelerated with ML surrogates**



NVIDIA Isaac Sim: Bespoke Cable models tuned from  
Ansyes simulations with ADI Tactile Sensors



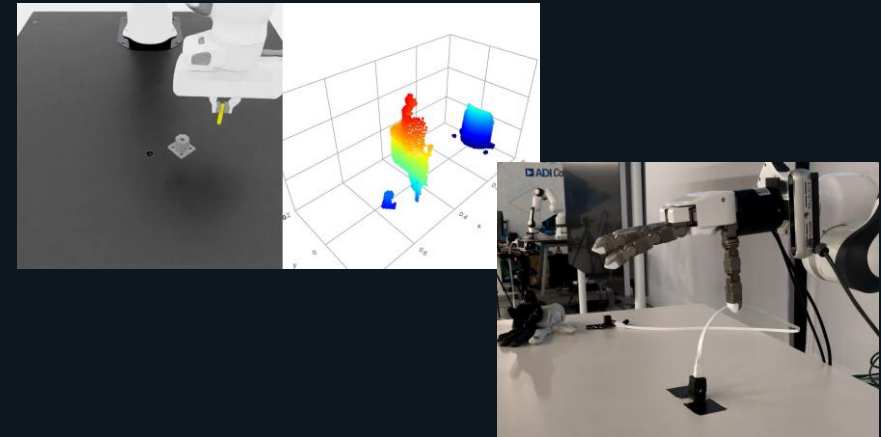
Realistic Connector Behaviour & Forces



Real-world Test Bench and Digital Twin



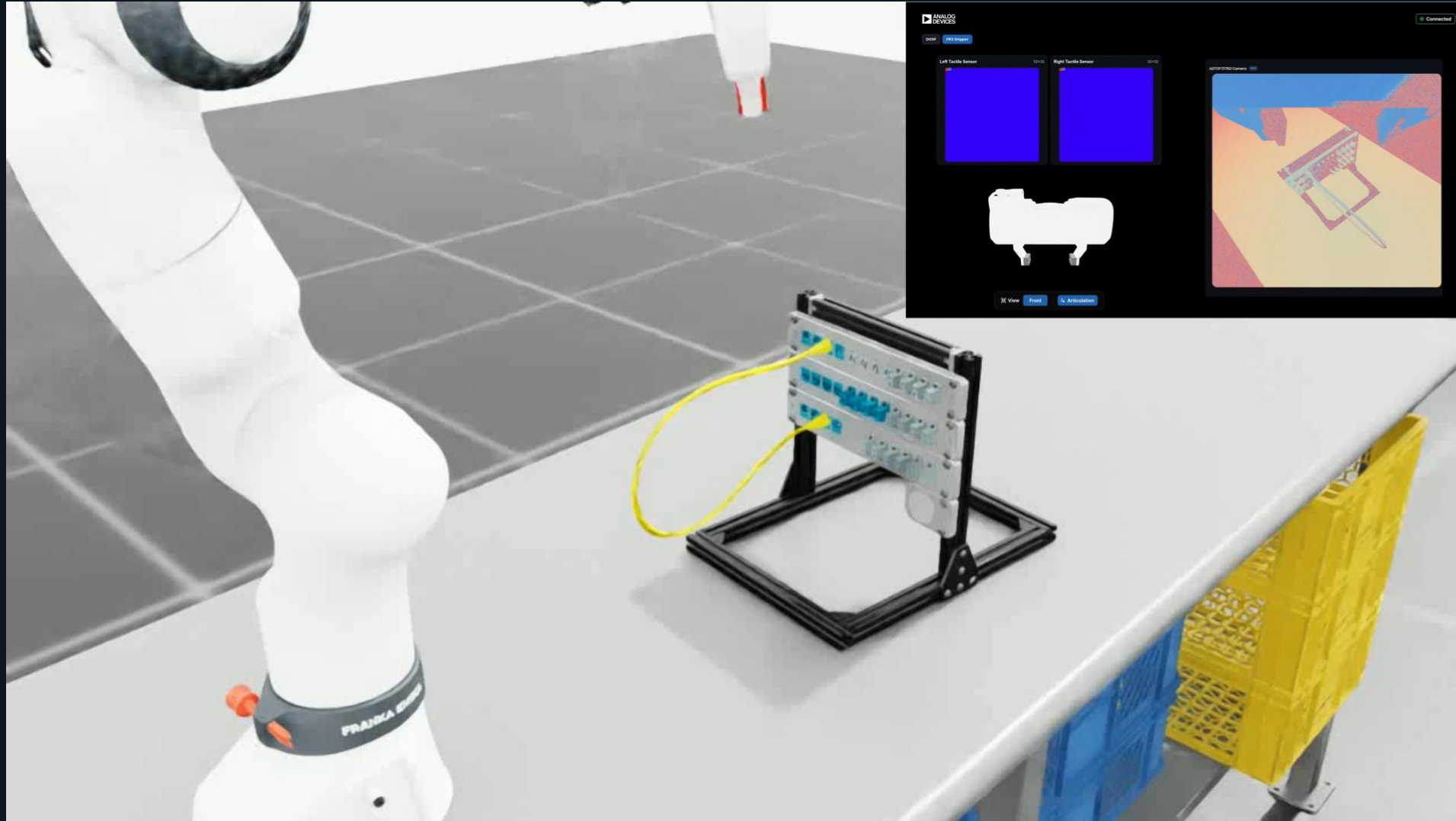
Simulation-driven AI



**Slip Prevention:** Reactive behavior



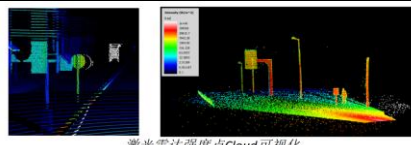
# High-Fidelity Simulation: Overcoming the Sim-to-Real Gap



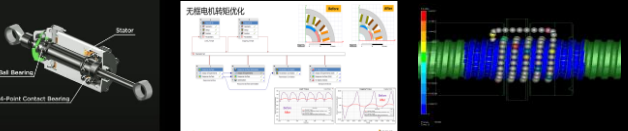
# Conclusion

Srinivasa Mohan

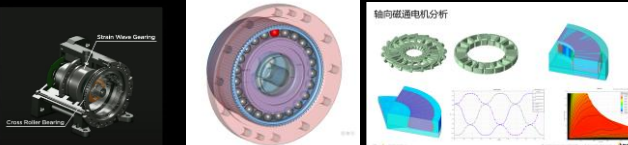
# Synopsys Solution for (Humanoid) Robot



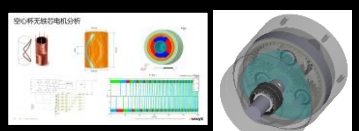
**Perception Systems**  
Camera Visual Sensing Solution  
AVX Automatic Scene Recognition Solution  
LIDAR/Millimeter Wave Radar  
Magnetic sensors for proprioception



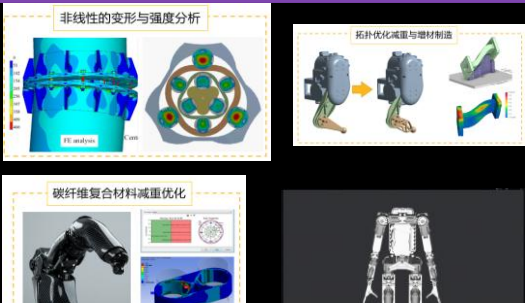
**Linear Actuator**  
Internal Rotary Motor Analysis  
Ball Screw Dynamics solution  
eMotor drivetrain NVH solution



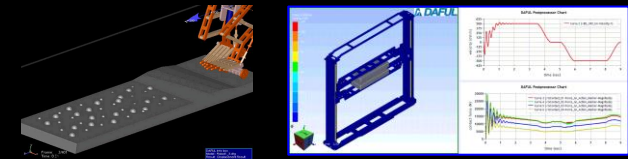
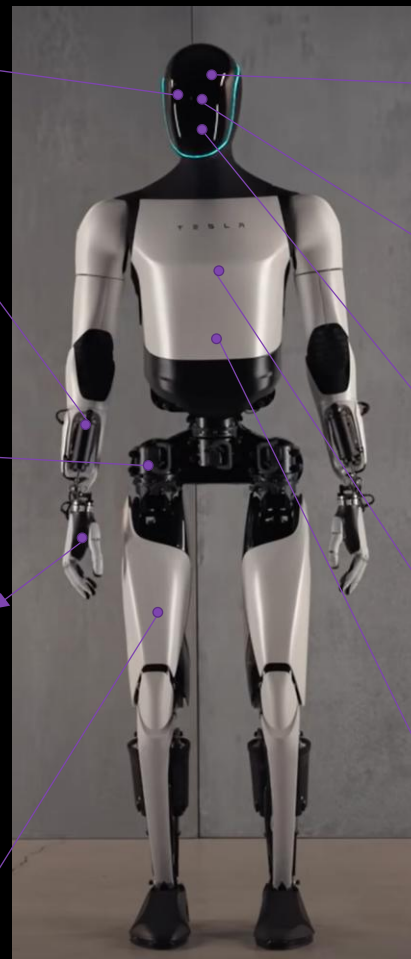
**Rotary actuator**  
Radial- /Axial-Flux Motor Solution  
Harmonic reducer dynamics solution  
Bearing dynamics, strength solution



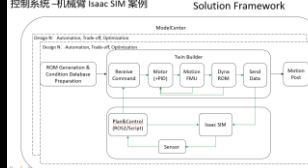
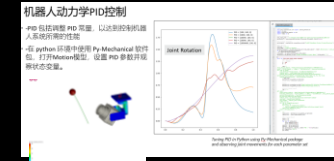
**Dexterous Hand**  
Hollow Cup Motor Analysis  
Planetary Gear Dynamics Analysis



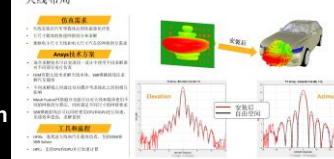
**Robot Overall Structure**  
Component Nonlinear Structural Strength Deformation Analysis  
Component Topology Optimization  
Structural Linear Dynamics  
Robot Fall Simulation  
Composite Material



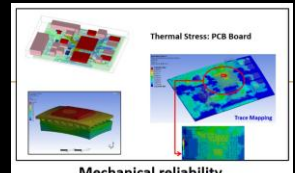
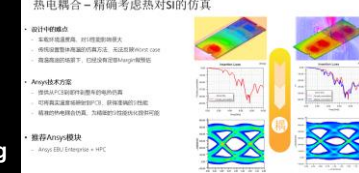
**Machine Dynamics**  
Robot System Operational Performance Analysis  
Rigid-Flexible Coupled System Dynamics Analysis  
Motion Vice Inverse Analysis  
Motor Torque/Force Analysis



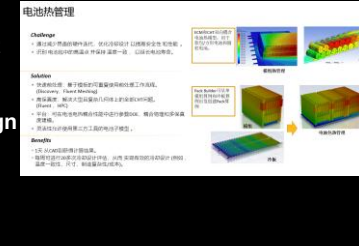
**Robot Control System**  
Dynamics PID control solution  
Motor Drive and Its Control  
Robotic arm Isaac SIM co-simulation control



**Comm. System**  
5G/WiFi/Bluetooth  
Antenna Layout Simulation  
High Speed Transmission  
Bus EMC/EMI Simulation



**Robot Control PCB**  
SI/PI  
Coupled EMI (capacitive/inductive)  
Structural Reliability  
Electro-Thermal Coupling



**Energy Systems**  
Battery Cooling and Heat Dissipation Simulation  
Power supply and distribution system design  
Power Device Electro-Thermal Coupling Simulation  
Battery Reliability Simulation

Booth #1135



Booth 3203  
[Grand  
Ballroom]



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Thank you