INTELLIGENCE AT THE EDGE

HUMANOID ROBOTICS

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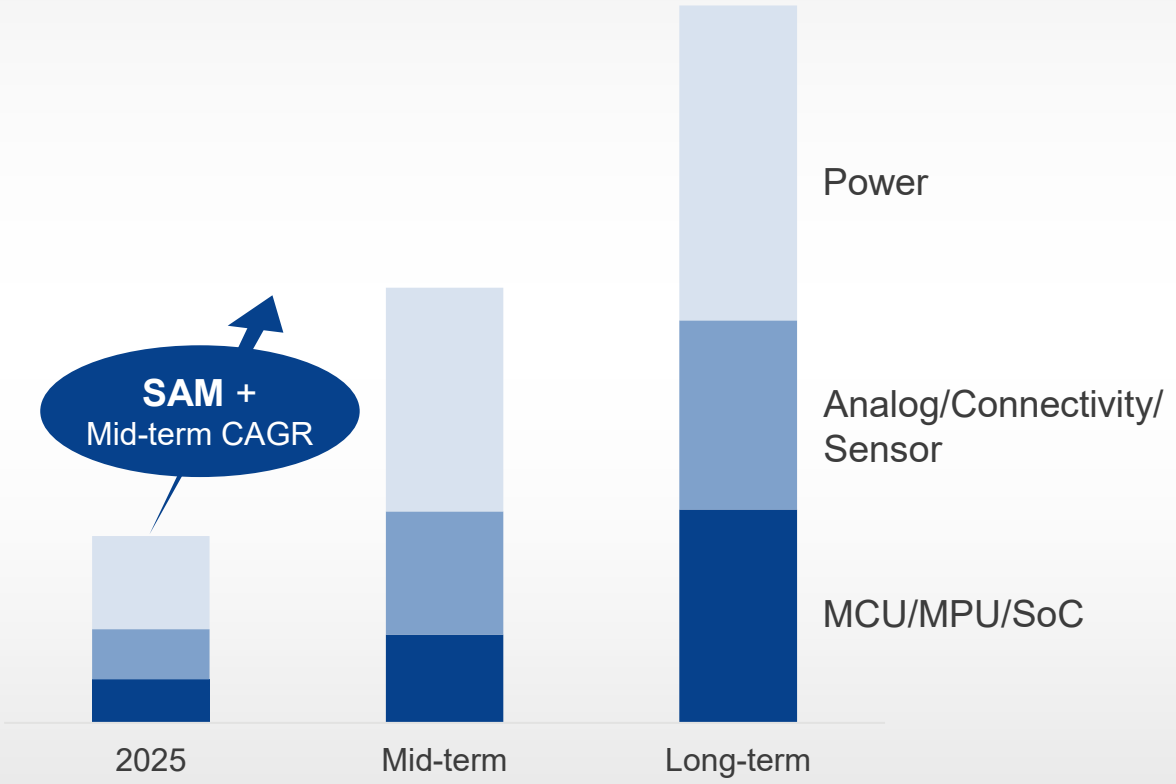
RENESAS ELECTRONICS CORPORATION

GROWTH DRIVERS
INTELLIGENCE AT THE EDGE AND PHYSICAL AI

Revenue



Foundational growth drivers

- Increased demand for processor solutions, including MCU, MPU, and SoC
- System intelligence drives higher content in analog, connectivity, and sensors
- Power and energy management is expanding across Physical AI and IoT devices
- Platform execution: reference designs, software frameworks, and scalable quality systems

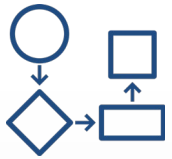
EMERGENCE OF PHYSICAL AI

INCREASING COMPLEXITY OPENS OPPORTUNITIES FOR RENESAS

- Evolution that adds complexity, involving Sensing, Compute, Memory, Power Management, Safety and Reliability
- Robotics applications are the embodiment of Physical AI and a great opportunity for Renesas growth

Physical AI / Robotics

Real-time interaction

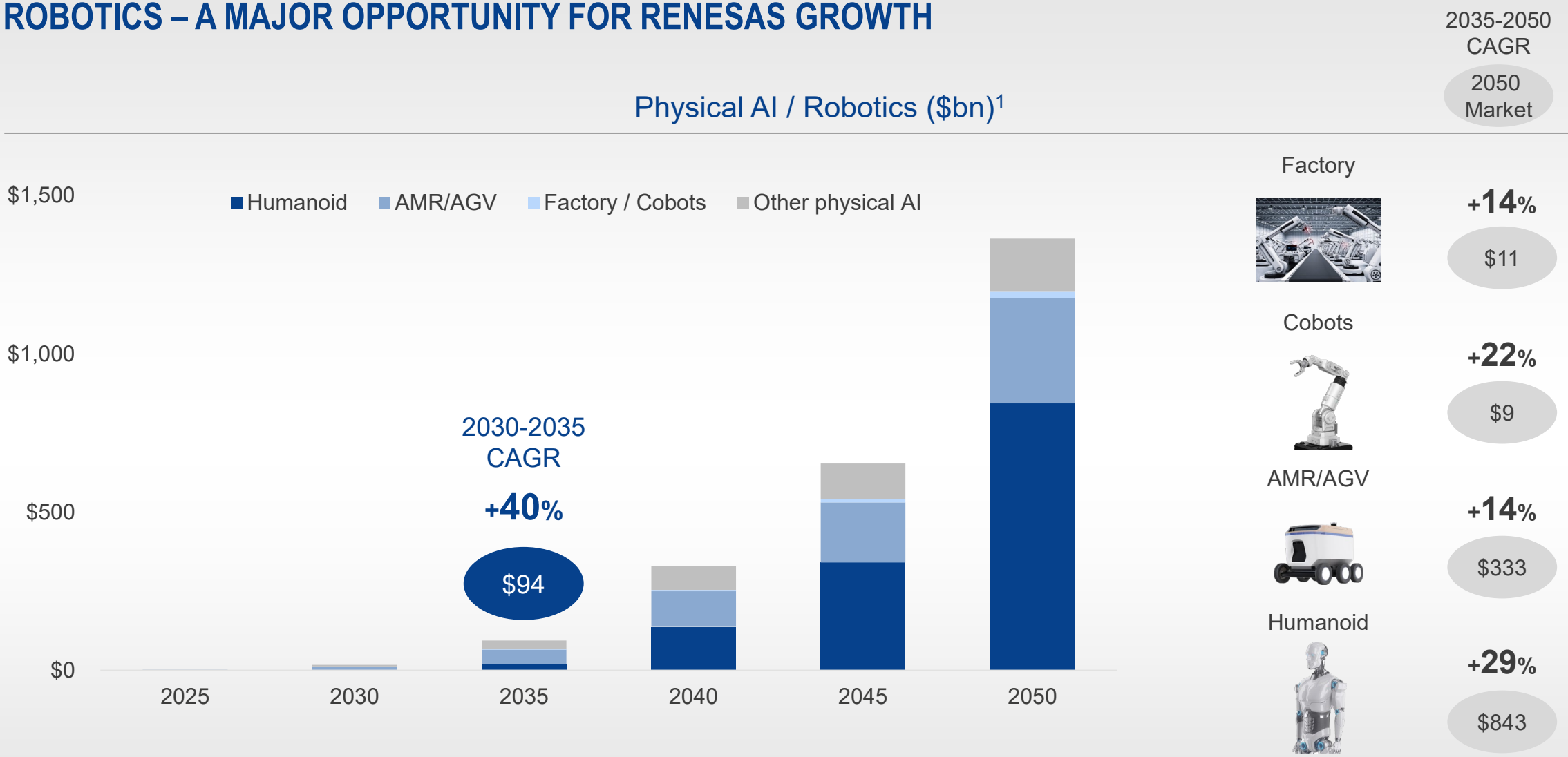


Deterministic behavior

Safety-critical control

MARKET OUTLOOK

ROBOTICS – A MAJOR OPPORTUNITY FOR RENESAS GROWTH



1. Semiconductor contents based on Renesas estimate. Autonomous Vehicle is excluded. AMR (Autonomous Mobile Robot) / AGV (Automated Guided Vehicle) includes Drones. Classified industrial robots into “factory robots” and “cobots”.

RENESAS RUNS DEEP & WIDE

ENGAGED WITH 100+ ROBOTICS AND HUMANOID CUSTOMERS GLOBALLY

Brain and motion

AI computing	Motion controller	Safety companion	BLE/WiFi

Sensing

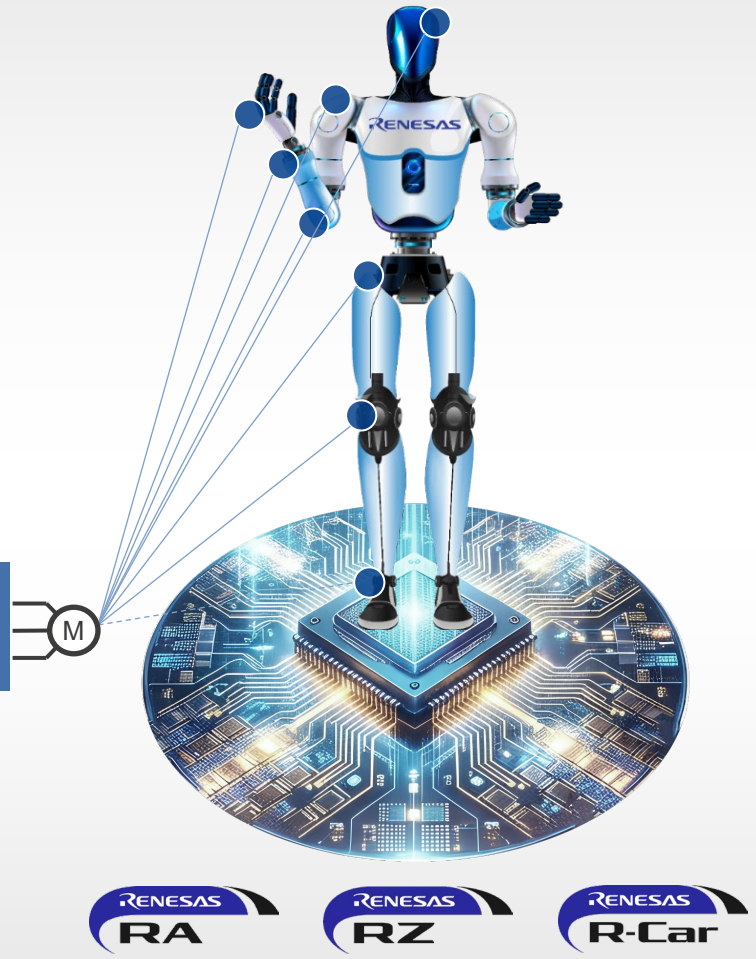
Impedance touch	Coherent lidar	Pressure sensors	Force/Torque sensors

Actuation and Motor control

Force/Torque sensors	HVPAK	Motor control MCU	Current sensors	Position sensors

Power management

Current Sensors	Battery Management	Gate driver	MOS/GaN FET



Today Renesas is:

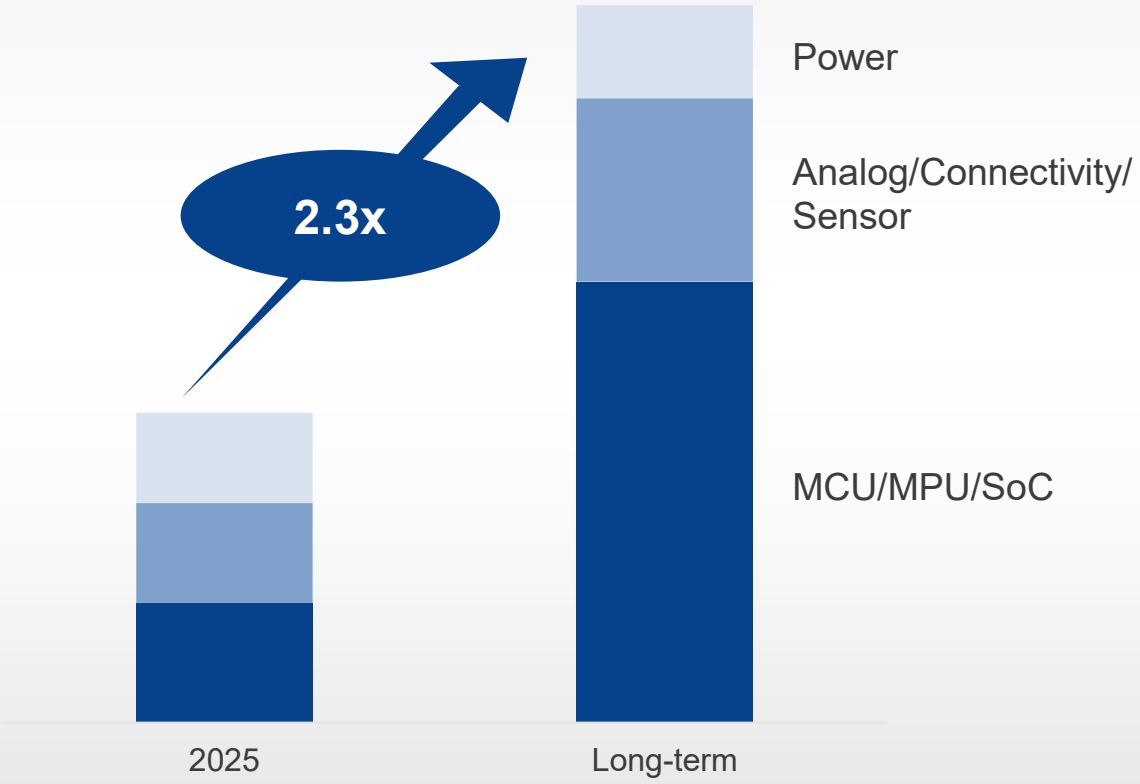
- Enabling physical AI at the edge (**~ 30%** BOM coverage[1])
- Providing **safe and accurate control systems** leveraging decades of expertise in Automotive
- Delivering **system-level solutions** that simplify integration across the humanoid stack

1. Dollarized content

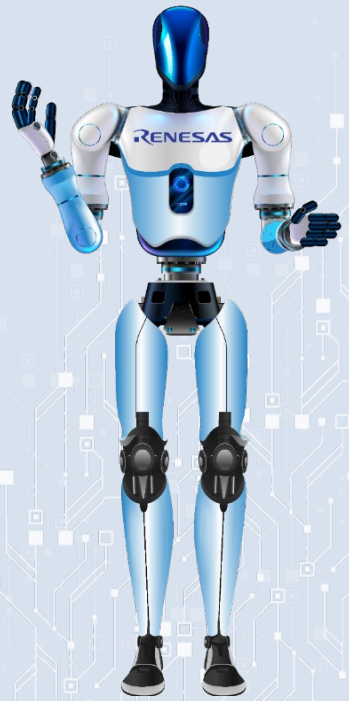
RENESAS HUMANOID ROBOTICS SILICON PLAY

SAM EXPANSION THROUGH COMPUTE AND SENSING

Renesas Humanoid BOM[1]



- **BOM[2] SAM expansion from 30% → 70%**
- **2x** coverage vs most competitors
- **Wide variety** across Motor Control, Actuator, Networks, Safety



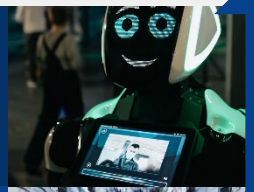
1. Renesas estimate 2. Dollarized content

RENESAS SENSING EVOLUTION

Growth vectors in sensing

Robotics / CNC[1]

- Humanoids & Consumer robots
- Industrial robots



Industry AI

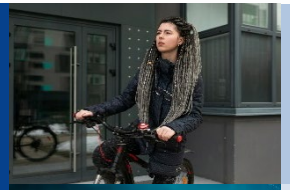
- Factory automation
- Predictive maintenance
- AGV[3]

Advanced mobility

- X-By-Wire
- Electro mobility
- Micro-mobility

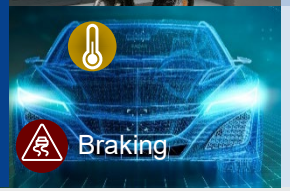
Traditional consumer

- E-bikes
- Power tools
- Smart homes
- White goods



Heritage automotive

- FUSA[2]
- Braking
- EV heat pump & Thermal management
- Motor commutation
- Pedal position

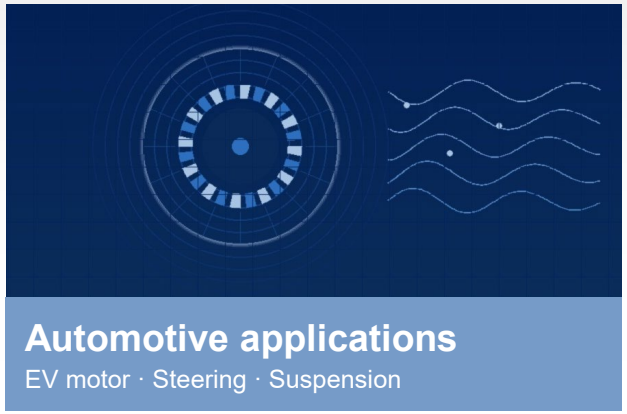


Core business

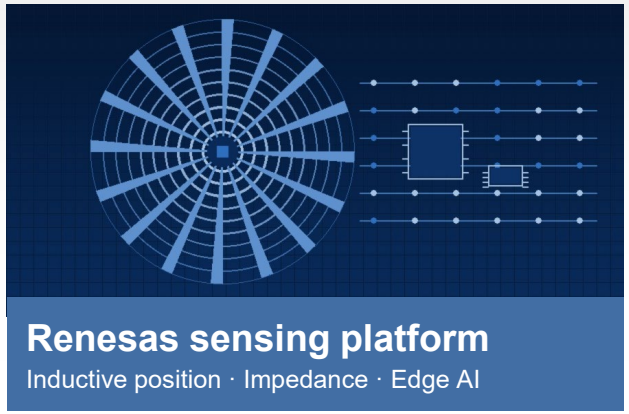
1. Computer Numerical Control 2. Functional Safety 3. Automatic Guided Vehicle

PROVEN IN AUTOMOTIVE, DESIGNED FOR WHAT'S NEXT

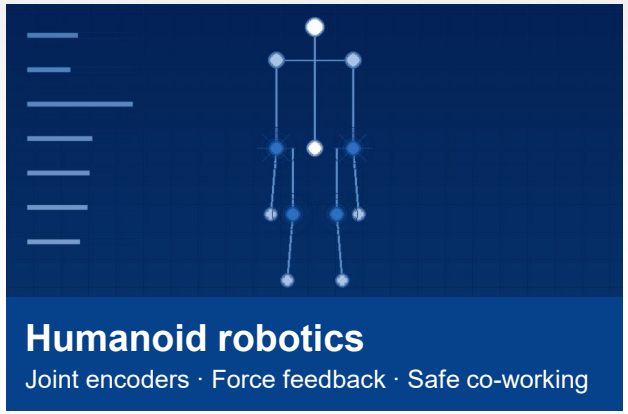
- The same inductive position and impedance sensing qualified in automotive is the foundation for humanoid robotics



Automotive applications
EV motor · Steering · Suspension



Renesas sensing platform
Inductive position · Impedance · Edge AI



Humanoid robotics
Joint encoders · Force feedback · Safe co-working

Inductive position sensing

From EV Motor control to joint encoders

Automotive today

- Rotor position in EV drive motors
- Steering angle & throttle position
- Suspension travel & pedal mapping

Humanoid tomorrow

- >30 joint encoders per humanoid
- Immune to dust and vibration
- Ultra compact for tight assemblies

Impedance sensing

From drive-by-wire to safe human contact

Automotive today

- Force feedback in steer-by-wire
- Active suspension compliance
- Haptic response in drive controls

Humanoid tomorrow

- Calibrated grip from object to hand
- Real-time contact force detection
- Safe co-working in any environment

HUMAN-LEVEL TACTILITY: SUB-1% SSC PRECISION IN DEXTEROUS HANDS

SUCCESS @ INSPIRE ROBOTS: LEADER IN DEXTEROUS HANDS

Each 6° of freedom: **12 Joints**

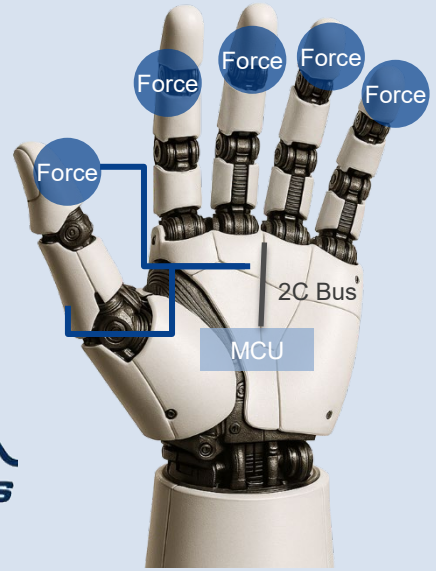
(6 Force sensors, 12 Tactile sensors)

Sub-millimeter repeatability

Similar size with real hand

Load capacity of several kilograms

因时机器人 INSPIRE-ROBOTS



Leader in dexterous hands

RAAS2S4251 innovation advantage

- Measurement range, 100N/200N/400N
- Linearity error, ±1%FS, Repeatability error, ±0.1%FS
- Size 11x13mm, Resistance 1KΩ
- Sensitivity 1mV/V

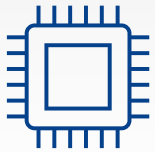
Why we won @ system level

- De-risked the force sensor with proven design + test/validation expertise (plan/fixtures/characterization)
- Improved beyond ~3% baseline via multi-point calibration in firmware
- Unified calibration to single-step (no pre/post-assembly)

RENESAS

FROM HARDWARE TO RENESAS 365

GATEWAY TO THE DIGITALIZATION FUTURE



ICs

Analog runs deep

SW & Tools

Core technologies:
Innovative, Low power

Renesas 365
Powered by Altium

Gateway to the Digitalization Future
Enabled by Renesas 365

RENESAS ROBOTICS ECOSYSTEM – TRAIN, TEST AND DEPLOY

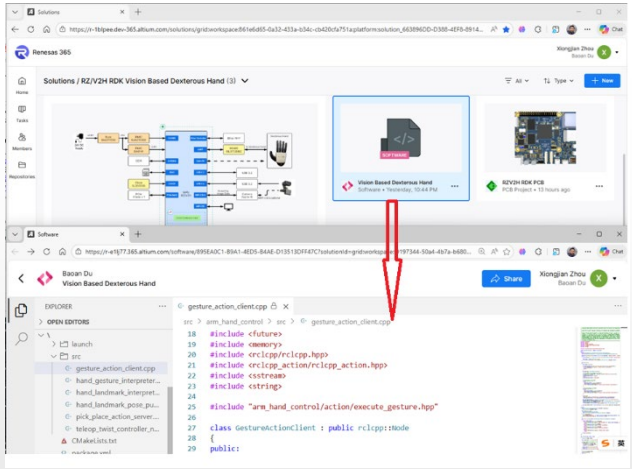
FROM VIRTUAL DESIGN TO REAL-TIME DEPLOYMENT – FASTER, SMARTER, CONNECTED

AI-Assisted **Ideation**

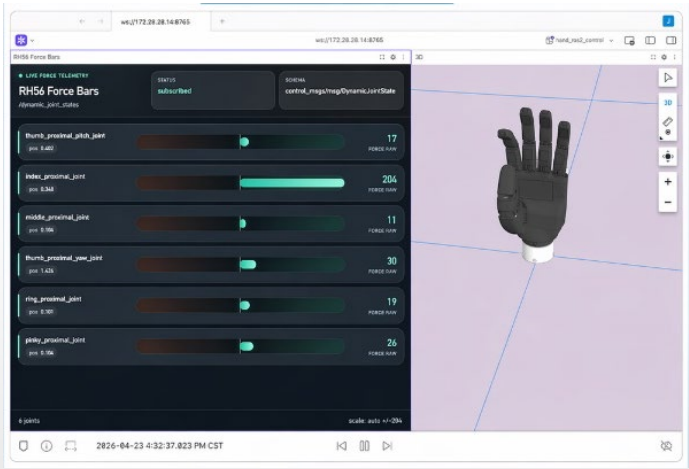
Model-Based **Realization**

Cloud-Based **Utilization**

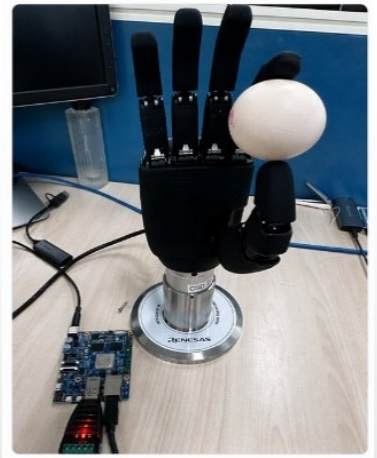
Renesas 365
Powered by Altium



Optimize virtually



Visualize everything

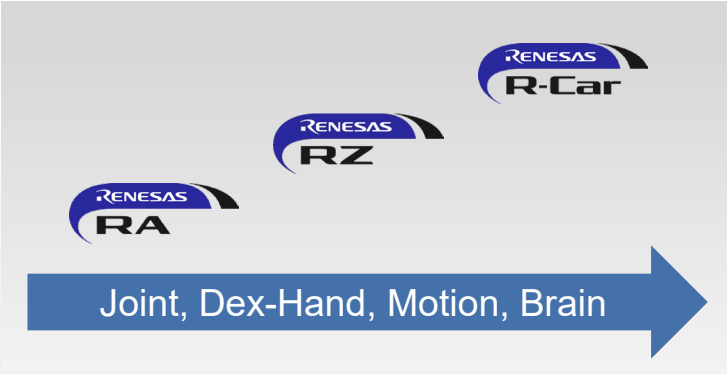


Deploy instantly

FORWARD STRATEGY AND GO TO MARKET

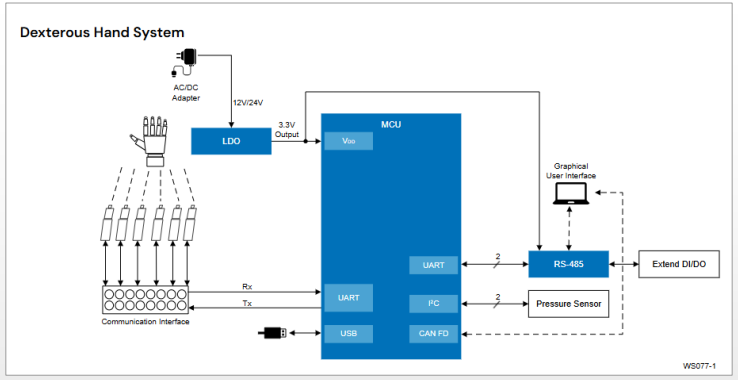
Robot development kit expansion

Model conversion tool chain,
SW stack and OS



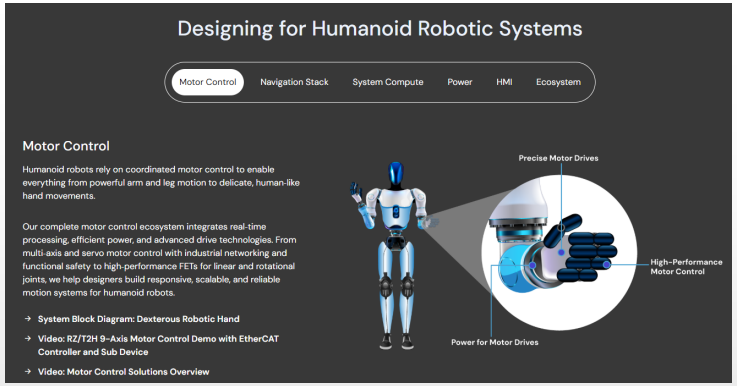
Digitalization and Renesas 365

Develop and test virtually
before physical deployment

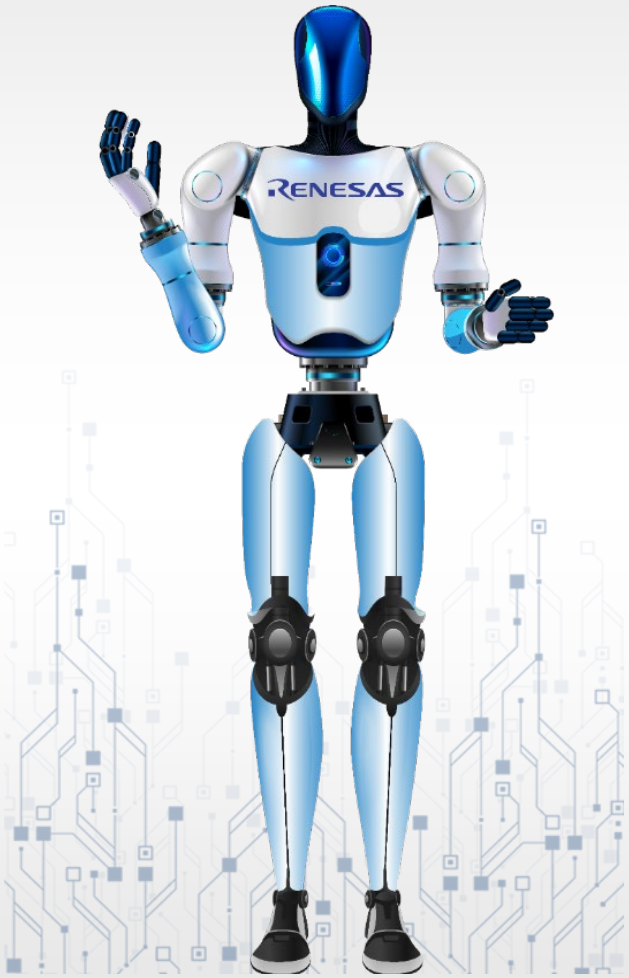


Mass market

Ready-to-go solutions,
rich digital content, distribution focus



SUMMARY
HUMANOID ROBOTICS



Broad MCU/MPU/SoC portfolio enables right-sized compute for robot brain and motion control at optimized cost

Differentiated sensing and power solutions improve precision, reduce size and weight, and extend battery life

Renesas 365 provides a scalable development platform with upgradeable software, motor-control algorithms, and safety-certified subsystems

Renesas is uniquely positioned to capture major opportunity growth in robotics humanoid over the next decades

THANK YOU

(FORWARD-LOOKING STATEMENTS)

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