ADLINK



From Concept to Capability:

How ADLINK's COM-HPC & SMARC Platforms Powered the Next Leap in Humanoid Robotics

Janunary 2026

TECHNICAL CASE STUDY

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Compact Intelligence for Complex Robotics — Built for Rapid Innovation

Building a humanoid robot means orchestrating intelligence, movement, and responsiveness within a single, tightly integrated system. Developers must create four tightly coupled layers: a computing "brain" that understands voice commands and perceives the environment, a dedicated perception layer that processes vision and AI workloads, a control layer that plans motion and optimizes paths, and a hardware foundation that drives precise, coordinated movements — all in real time.

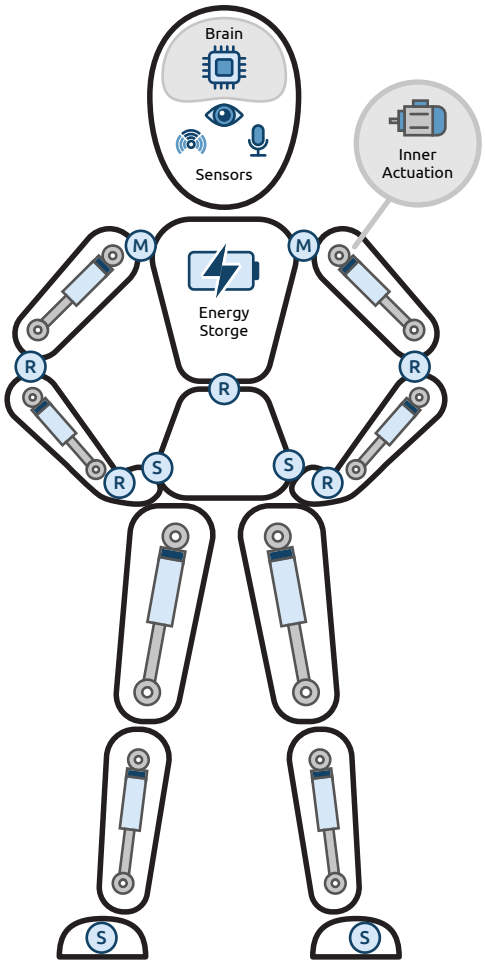


Figure 1: Generalized humanoid diagram

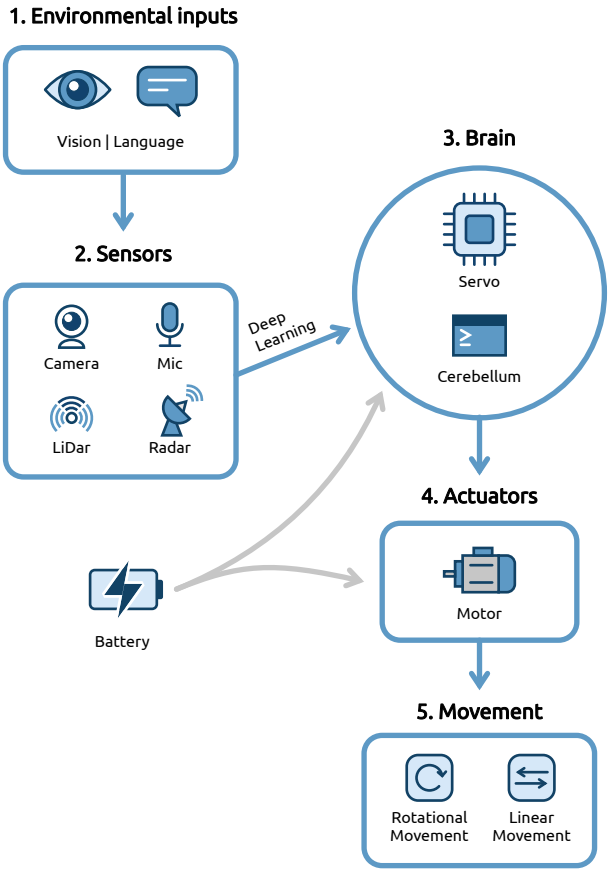


Figure 2: Flow of Vision/Language to Humanoid Actuation

At the heart of this system are the CPU, GPU, and NPU, enabling complex algorithms and rapid decision-making that bring intelligent behavior to life. For developers, the challenge goes beyond raw performance. It's about integrating this intelligence quickly and reliably, while staying within strict mechanical, thermal, and power constraints.

For a humanoid robotics developer, these pressures were amplified by aggressive timelines and intensifying competition. The team needed a computing platform that could accelerate development, scale with future requirements, and remain stable throughout the product lifecycle.

By partnering with ADLINK and adopting its **COM-HPC** and **SMARC** platforms, together with an ADLINK **MXM GPU** module, the developer gained a compact, high-performance compute foundation that reduced integration effort, supported advanced AI and motion control, and helped bring next-generation humanoid robots to market faster — for both household and industrial use cases.

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The Robotics Pivot Point: Performance, TDP, and Time-to-Market

As the developer advanced toward its next-generation humanoid prototype, four mission-critical challenges emerged:

- Thermal constraints: Intensive AI workloads packed into a confined robotic torso risked overheating, throttling, or system instability.
- Escalating compute and I/O requirements: Their previous COM Express platform could no longer handle next-level vision, sensor fusion, or high-speed actuation demands, making COM-HPC migration essential.
- Relentless market pressure: In a space defined by rapid iteration and aggressive competition, even minor delays could result in lost market footing.
- Industrial-grade reliability expectations: Robots in real-world environments require 24/7 stability and long-term availability, ensuring the compute platform remains available and serviceable throughout the robot's lifecycle — with no exception.

ADLINK: A Development Partner Driving Speed, Reliability, and Scale

ADLINK emerged as an ideal partner that more than addresses the above mentioned challenges.

Built for 24/7 Demands

With Up to 10-Year Longevity You Can Count On

ADLINK's COM-HPC, SMARC, and MXM GPU modules are engineered with rugged industrial-grade components designed to run nonstop, even in demanding field environments. With up to 10 years of longevity (5 years for GPU), your compute platform stays available, serviceable, and consistent throughout the entire product lifecycle — minimizing downtime, simplifying maintenance planning, and keeping long-term costs firmly under control.

Designed to Adapt

Modular Flexibility That Protects Your Roadmap

ADLINK's modular architecture gives system integrators the freedom to build exactly what their application requires. The platform supports deep customization, including:

- Custom BIOS and firmware optimization
- MXM GPU module integration optimized for AI and vision processing
- Tailored carrier board designs
- High-speed I/O mapping for advanced sensors and peripherals
- Thermal tuning matched to unique mechanical constraints

This flexibility future-proofs your design. As compute demands grow, or sensors evolve, you can upgrade CPUs, expand I/O, or scale GPU performance independently — all without redesigning the entire system.

Engineering Expertise

That Shrinks Your Schedule

ADLINK doesn't just ship hardware — they become part of your development team. Their engineering team provides hands-on support from concept to deployment, including:

- Early schematic and PCB layout reviews
- On-site troubleshooting and rapid iteration
- Custom BIOS and firmware development
- Reference designs and off-the-shelf development kits that shorten integration time
- System-level validation of CPU, MXM GPU, and thermal performance under real-world AI workloads

This collaborative approach removes common integration bottlenecks and keeps ambitious deadlines on track. The result: faster prototyping, shorter validation cycles, and a smoother path to market

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Cost-Effective Today, Scalable for Tomorrow

By building on ADLINK's off-the-shelf COM-HPC and SMARC modules, robotics innovators avoid the complexity and expense of developing a custom CPU board from scratch. Combined with competitive pricing and flexible business terms, ADLINK delivers:

- Reduced engineering overhead
- Lower development and lifecycle risk
- Faster time-to-production
- A scalable compute foundation for future generations

It's a solution that delivers high-end performance now while preserving long-term design flexibility.

High-Performance Computing Where Every Gram Matters

In humanoid robots, every gram and watt count — making compact, modular computing essential.

ADLINK's COM-HPC module delivers server-class performance in a condensed form factor. With up to 128GB DDR5 memory, PCIe Gen5, dual 2.5GbE, and extensive high-bandwidth I/O, it enables the simultaneous execution of vision, planning, and actuation algorithms.

Paired with ADLINK's MXM GPU module, the platform accelerates AI inference and vision workloads without compromising power efficiency or mechanical constraints.

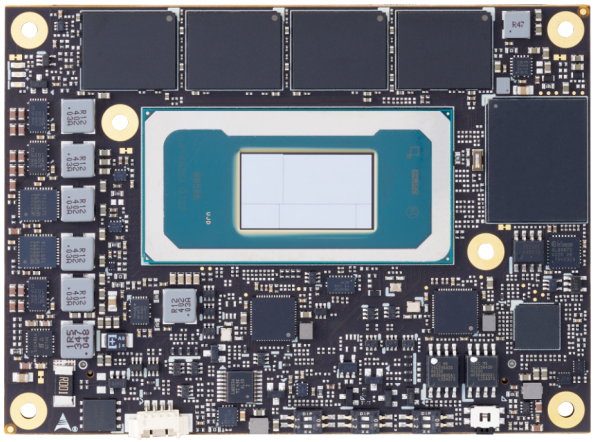
Complementing the main compute hub, ADLINK's SMARC modules handle distributed sensor management and auxiliary control with extremely low power consumption — a crucial advantage for battery-powered mobility and system efficiency.

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Why the Modular Design Approach is Your Key to Long-Term Success

Modular design starts with simplicity. By using standardized Computer-on-Modules (COMs) such as COM-HPC and SMARC, developers avoid the complexity of designing a full computing system from scratch. Core components—including CPU, memory, high-speed I/O, graphics, and optional AI acceleration—are integrated into an application-ready module, allowing teams to focus on what truly differentiates their robots: autonomy, perception, and motion control.

COM-HPC



COM-HPC-mPTL

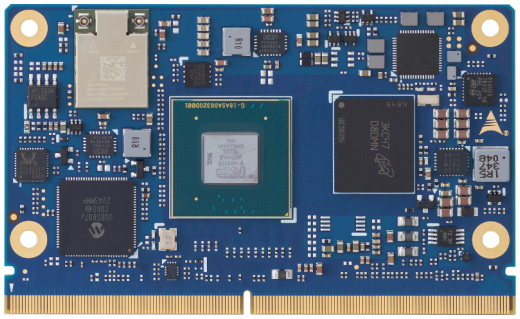
That simplicity accelerates time-to-market. With ready-made computing power in place, development can move quickly into integration and testing. Only application-specific functions and interfaces are implemented on a custom carrier board, reducing design risk and shortening validation cycles.

Modularity also enables straightforward upgrades. As AI models evolve or sensor demands increase, performance can be scaled by swapping modules rather than redesigning the system. Because COM standards scale across processor generations—and even manufacturers—systems remain upgradeable long after deployment.

This future-proof approach extends system lifespan while lowering total cost of ownership (TCO). Reduced redesign effort, faster development, and predictable long-term maintenance minimize risk and protect engineering investment.

These benefits extend well beyond humanoid robotics. The same modular strategy supports autonomous mobile robots, industrial automation, medical systems, smart manufacturing, and edge AI platforms—any application where performance evolves, uptime matters, and long product lifecycles are critical.

SMARC module



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A Blueprint for Robotics Innovators Everywhere

This collaboration shows how forward-thinking teams — across humanoid robotics, mobile autonomy, and industrial AI — can leverage ADLINK's compute platforms to stay ahead of surging performance demands and tightening market windows.

Core advantages include:

- High-performance AI compute for real-time autonomy
- Scalable CPU + MXM GPU acceleration for vision and AI workloads
- Ruggedized 24/7 reliability for harsh environments
- Up to 10 years of longevity support (5 for GPU) for predictable lifecycle planning
- Modular architecture that scales with future requirements
- Faster development enabled by hands-on engineering support
- Reduced cost and risk through off-the-shelf compute solutions

From Prototype to Production — With a Partner Built for Robotics Innovation

Whether building humanoid robots, autonomous mobile systems, or next-generation industrial AI platforms, ADLINK's COM-HPC, SMARC, and MXM GPU modules offer the performance, stability, and scalability needed to move from concept to market with confidence.

With ADLINK's engineering collaboration, thermal optimization expertise, design flexibility, and long-term product availability, innovators can focus on creating intelligent robotic systems that redefine what machines can do.

Accelerate your next breakthrough with ADLINK's COM-HPC, SMARC and MXM solutions.

ADLINK
LEADING EDGE AI COMPUTING

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