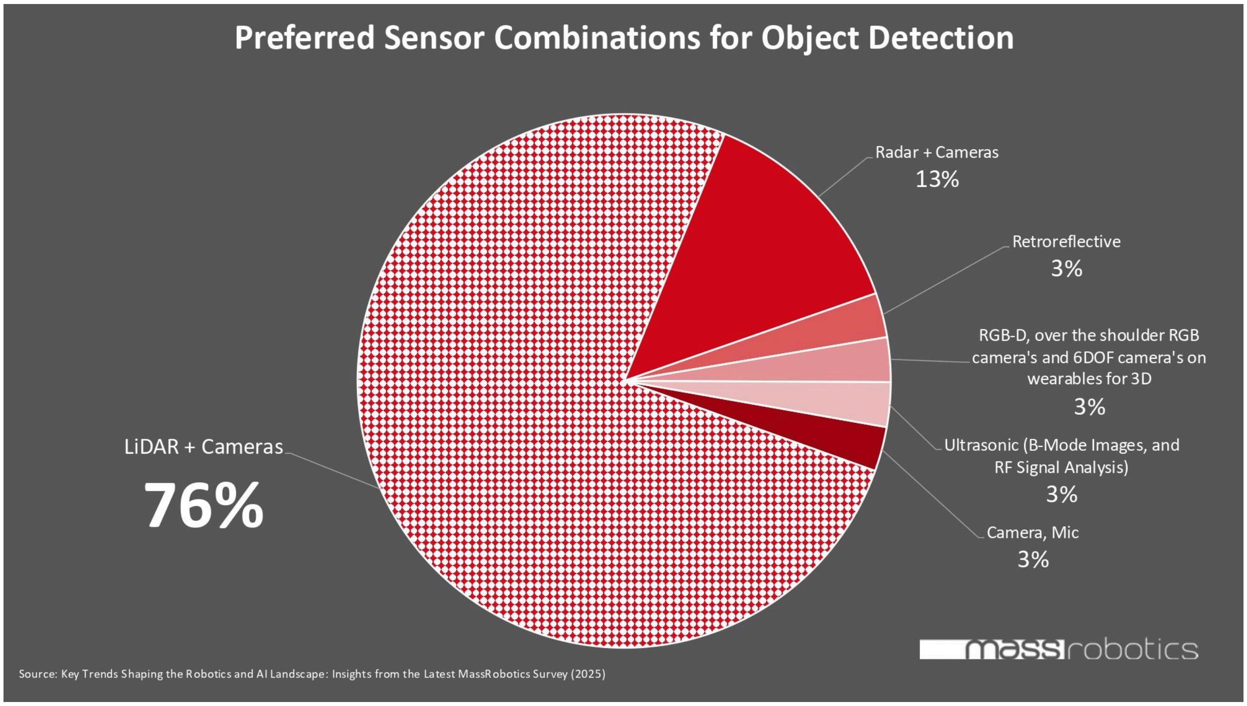
Key Trends Shaping the Robotics and AI Landscape: Insights from the Latest MassRobotics Survey

The fields of robotics and artificial intelligence are evolving at an unprecedented pace, driven by innovation and increasing demands for autonomy, efficiency, and safety. To better understand these shifts, MassRobotics conducted a comprehensive survey of professionals across the robotics and AI ecosystem. This market research was developed and deployed with the support and guidance of Lattice Semiconductor, for whom this report was originally prepared. This report summarizes key insights from 40 respondents from the innovation ecosystem, offering a snapshot of current practices, challenges, and future expectations in sensor fusion, AI integration, motor control, power consumption, and safety and security. Participants included a diverse range of professionals, from engineers and technical leads to product managers and executives, representing companies from startups to large multinational corporations, as well as academic institutions.

1. Sensor Fusion for Enhanced Object Detection: A Double-Edged Sword

Object detection is foundational to robotic autonomy, and the survey highlights a strong reliance on sophisticated sensor combinations. Over two-thirds of respondents (67.5%) utilize LiDAR in conjunction with cameras (85% use cameras in general), which 75.7% of respondents deemed the "most effective" combination. Other sensor types commonly used include Time-of-Flight (50%) and IMUs (62.5%).

Despite the effectiveness of these multi-sensor approaches, significant challenges persist. Cost and integration complexity were the most frequently cited barriers for professionals. Additionally, accuracy and calibration/maintenance needs regularly surfaced as concerns. This underscores a clear industry need for more streamlined, cost-effective solutions for integrating multiple sensor modalities.



2. The Growing Momentum of Edge AI

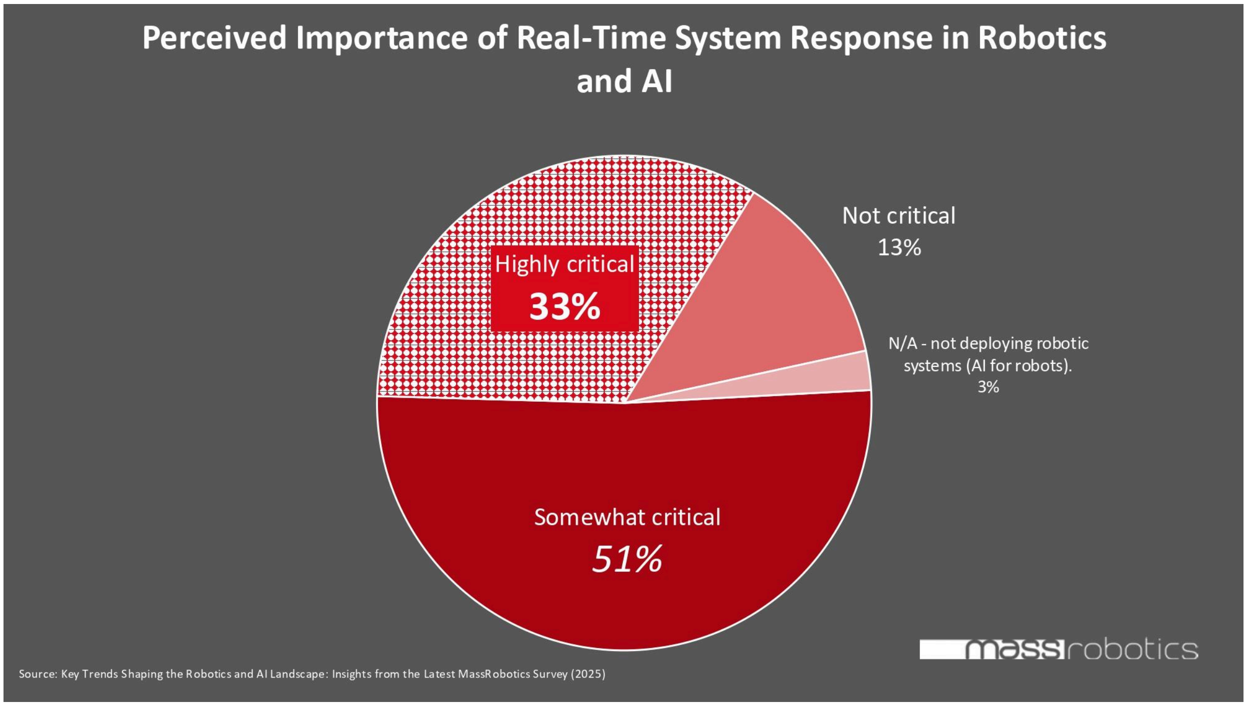
A significant trend emerging from the survey is the increasing adoption of AI at the sensor or "edge" level. Currently, half of the respondents (50%) are already implementing AI at the sensor level. Of these, 72.7% apply some form of machine learning model, 54.5% specifically use "Edge AI," and 40.9% incorporate "Neural Networks".

Looking ahead, many anticipate a greater shift of intelligence to the edge over the next few years. The primary drivers for this distributed intelligence are the desire to reduce latency, enhance real-time performance, and decrease data transfer overhead. This shift signals a rising demand for low-power AI hardware that can handle inference directly on-device.

3. Motor Control: Criticality of Real-Time Response and Efficiency

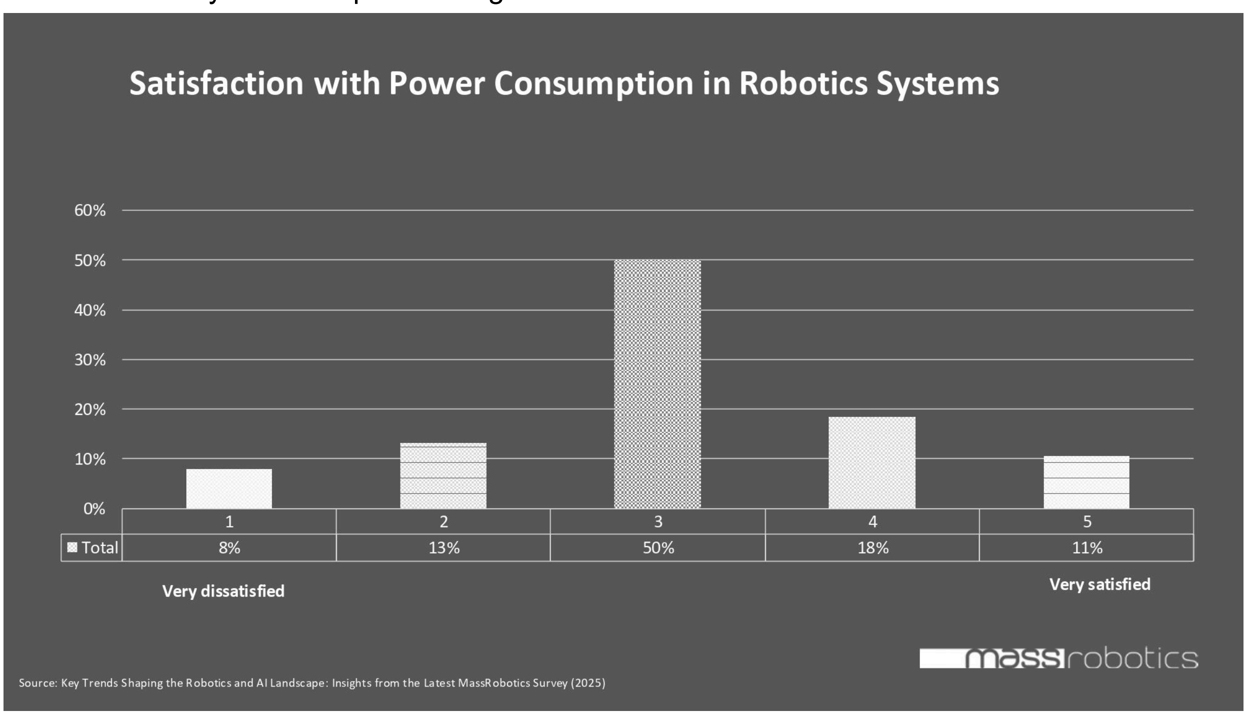
Motor control remains a core component of robotics systems, with servo motors (55.3%), DC motors (44.7%), and stepper motors (31.6%) being the most common types used. The survey revealed that real-time response is "highly critical" for 51.3% of respondents, and "somewhat critical" for another 33.3%.

Key challenges in motor control include the demand for real-time control (43.6%), power efficiency (41%), and precision (28.2%). This emphasis on immediate responsiveness and energy conservation points to an industry need for advanced control loops and motor drive solutions that minimize latency and optimize power usage.



4. Power Consumption: The Perpetual Quest for Efficiency

Achieving an optimal balance between performance and energy efficiency is a persistent challenge in robotics. Half of the respondents rated their current satisfaction with power consumption at a "3" on a 1-5 scale (with 5 being most satisfied), indicating moderate satisfaction. Only 10.5% expressed high satisfaction.



For many systems, 44.4% of respondents target a power threshold of 50-100 W, with others aiming for even lower thresholds (<10 W or 10-50 W). The need for more efficient on-board processing, reducing reliance on power-hungry GPUs, and improved battery technology were repeatedly cited as crucial advancements. This highlights a strong market demand for solutions that offer robust processing capabilities without compromising on energy efficiency.

5. Safety and Security: A Growing Urgency with AI Integration

As robotics systems become more autonomous and interconnected, safety and security concerns are escalating. A significant majority of respondents (64%) already implement redundant sensors and use safety-rated components. However, the integration of AI introduces new complexities.

Cybersecurity threats were highlighted by 48.6% of respondents as their biggest security challenge, followed by data protection (35.1%) and system integrity (35.1%). While many respondents acknowledged these concerns, a concrete plan for AI-focused security is often lacking, with only a few mentioning hardware isolation or encryption. This gap underscores the critical need for robust hardware-level security measures, such as secure boot, encryption, and tamper detection, especially as more AI processes migrate to the edge.

Overall Conclusions and Future Outlook

The survey data collectively confirms that robotics companies highly value integrated, low-power solutions capable of handling real-time demands. The strong interest in at-sensor AI points towards significant future growth in specialized processing. Key takeaways include:

- **Sensor Fusion Complexity:** While cameras and LiDAR dominate, their cost and calibration remain areas for improvement.
- **Distributed Intelligence:** The shift to Edge AI is well underway, with half of respondents already implementing AI at the sensor node, and this trend is set to accelerate.
- **Power & Performance Trade-Offs:** Users aim for the 50-100 W range but are actively seeking advancements in battery longevity and reduced thermal loads.
- **Safety & Security Gaps:** Robust, hardware-based security will be crucial as more AI processes move to the edge, addressing top security and integrity concerns.

In essence, the industry is witnessing a "massive shift into ML" and anticipating "physical AI" and "AI-powered robots becom[ing] the norm". Future advancements are expected in areas like "more autonomy in crowded spaces" and "task learning". The biggest current gaps include the lack of large datasets for physical tasks, sensor integration and fusion challenges, and the need for more accessible sensor fusion solutions.

These insights confirm that the robotics sector is actively embracing edge AI, navigating power constraints, and seeking robust security measures as systems become increasingly autonomous. The demand for advanced robotics solutions remains strong, driven by the need for sensor-rich platforms, efficient motor control, stringent power management, and fully integrated safety and security measures.

Addressing Key Trends

"**Random Bin Picking Based On Structured-Light 3D Scanning**", a white paper by Lattice Semiconductor, outlines an approach to address several challenges highlighted in the MassRobotics survey, particularly regarding object detection, sensor fusion complexity, and the demand for more cost-effective solutions. Lattice posits that their FPGA solutions can reduce system Bill of Materials (BOM) cost. They arrived at this finding by designing a system where the FPGA, located in the sensor module, partitions computing tasks by offloading processing from the main computing module. This involves the FPGA generating structured light sequences and synchronizing camera capture.

A key finding was that the FPGA can encode the captured images into a compact 10-bit coded image, rather than sending raw sequences, which significantly reduces the bandwidth required for Ethernet communication (e.g., a 16x data reduction for a 1080p scenario from 680 MB to 41 MB). Furthermore, Lattice identified that FPGAs can take over compute-intensive tasks like triangulation to generate depth images and can also perform aspects of machine learning-based object detection and segmentation, thereby reducing the processing demands on the main computing module (CPU/GPU). This approach supports the survey's observation on the need for more efficient on-board processing and reducing reliance on power-hungry GPUs. The low power consumption and small form factor of Lattice FPGAs also allow the sensor module to be designed without the need for additional heat dissipation components, contributing to a reduced BOM for the sensor module. A proof-of-concept (PoC) demo system was built utilizing a general-purpose projector, a CPNX VVML development board, an NVIDIA Jetson Orin Nano, and a UFACTORY LITE6 robot arm to verify these concepts.

These capabilities are underpinned by Lattice’s sensAI solution stack, which provides pre-trained models, development tools, and reference designs to accelerate deployment.

Lattice's white paper on "**Sensor Hub For Near-Sensor Low-Latency Data Fusion In AI Systems**" directly addresses key trends from the MassRobotics survey, including the growing momentum of Edge AI, the criticality of real-time response, persistent power consumption challenges, and the increasing urgency of safety and security with AI integration. Lattice posits that FPGAs serve as a valuable hardware solution by acting as a "bridge" between sensors, actuators, and main processing units, supporting the shift of intelligence to the edge. They arrived at these findings by developing a proof-of-concept (PoC) demo system where a Lattice Avant™ FPGA simultaneously processes raw data from multiple sensor types: a camera, lidar, and radar.

Through this demonstration, Lattice observed that FPGAs offer flexible and customizable Input/Output (I/O) capabilities, enabling connectivity with a wide array of diverse sensors and actuators, which helps overcome the I/O limitations often found in high-performance computing modules. Lattice's findings indicate that performing hardware-based parallel processing near the sensors significantly reduces latency for critical tasks such as sensor fusion; for instance, they demonstrated processing VLP16 lidar data in 0.32 milliseconds, compared to the 1.32 milliseconds for packet transmission. This near-sensor processing also reduces overall system energy consumption by processing data locally before transmitting it to the main computing module, addressing the "perpetual quest for efficiency". The PoC further demonstrated effective sensor fusion by combining camera-based human detection bounding boxes with lidar point cloud data and radar object output, which enhanced the system's accuracy and decision-making, directly addressing the survey's noted "sensor integration and fusion challenges" and the need for "more accessible sensor fusion solutions".

This fusion capability enables applications that can reduce power consumption (e.g., radar triggering camera AI/ML only when motion is detected) or enhance safety (e.g., creating virtual safety fences by using AI/ML to define regions of interest for radar data). The small form factor, low power consumption, and lack of need for a cooling system for Lattice FPGAs also make them suitable for robotic applications. The development process for these solutions can integrate tools like High Level Synthesis (HLS) and Matlab/Simulink, supported by Lattice's sensAI Studio and Edge Vision Engine, which streamline AI model development and deployment for edge applications.

For more information on Lattice's edge AI and FPGA solutions, please visit Lattice Edge AI page.

Source: MassRobotics and Lattice Semiconductor

About MassRobotics: MassRobotics is the world's largest independent robotics hub dedicated to accelerating robotics innovation, commercialization and adoption.
Our mission is to help create and scale the next generation of successful robotics and Physical AI technology companies by providing entrepreneurs and startups with the workspace, resources, programming and connections they need to develop, prototype, test and commercialize their products and solutions.
While MassRobotics originated and is headquartered in Boston, we are reaching and supporting robotics acceleration and adoption globally and are working with startups, academia, industry and governments both domestically and internationally. Learn more about MassRobotics here

About Lattice Semiconductor:

Lattice Semiconductor (NASDAQ: LSCC) is the low power programmable leader. We solve customer problems across the network, from the Edge to the Cloud, in the growing Communications, Computing, Industrial, Automotive, and Consumer markets. Our technology, long-standing relationships, and commitment to world-class support let our customers quickly and easily unleash their innovation to create a smart, secure, and connected world.

For more information about Lattice, please visit www.latticesemi.com. You can also follow us via LinkedIn, Twitter, Facebook, YouTube, WeChat, or Weibo.