SiliconMotion

WHITE PAPER

Revolutionizing AI Robotics: Ferri Solutions for Real-Time Data and Durability

Ferri Embedded Storage

Robots in the Real World

The robot population of planet Earth is growing, and the avant-garde – service robots, mobile robots, collaborative robots (cobots), and now humanoid robots – are mixing with humans. In industry, homes, and public spaces, people going about their daily routines are increasingly likely to encounter robots doing the same. Humanoid robots represent a rapidly advancing area of robotics, designed to perform tasks in human environments by mimicking human motion, dexterity, and behavior. These robots are positioned to enhance productivity, assist with laborious tasks, and interact seamlessly with humans, reflecting the next step in robot-human interaction.

Historically, robots have operated in controlled environments mostly devoid of humans. Unexpected events or objects were excluded, and any necessary visual markers or beacons defining routes or stop positions were clear and consistent. As robots now emerge from these restricted areas into broader environments, they face dynamic and unpredictable situations. To manage these challenges, robots must be capable of adapting to unexpected, uncontrolled circumstances and make decisions based on incomplete or noisy datasets. For humanoid robots, this ability is particularly important, given their aim to function autonomously in human-oriented settings.

Behind the sensors – image sensors, inertial sensors, LiDAR, environmental sensors, microphones – flexible, fast, and power-efficient computing is essential to handle functions such as machine vision, navigation, safety and protection systems, and interaction with humans. Deploying AI models can enhance the robot's ability to perceive, plan, and navigate, bringing advantages like faster responses, greater computing efficiency, and the ability to engage with people and their surroundings. Machine-learning algorithms, in particular, allow robots, including humanoid ones, to adapt to changing conditions, improving performance, and efficiency as they interact more naturally and autonomously in real-world environments.

Intelligence and Interactivity

Autonomous skills powered by AI include dynamic obstacle avoidance, enabling robots to adjust their movements in real-time when new obstacles like moving objects or people are detected. AI can also aid in long-term route planning, with pathfinding algorithms like A* and Dijkstra's that can help mobile robots plan optimal paths in known and unknown environments. Moreover, algorithms like object classification and anomaly detection can enhance sensing and perception, enabling robots to identify objects, obstacles, and people in real-time.

AI powers autonomous mobile robots for smart manufacturing.

Benefiting from these advanced capabilities, a mobile robot in a factory can learn to optimise its movements to reduce energy consumption based on feedback from previous routes and energy usage. Warehouse robots can optimise their battery usage by planning efficient paths and managing power-hungry sensors and actuators. Autonomous vacuum cleaners can plan efficient cleaning paths and navigate around furniture and unexpected obstacles. Surgical robots can leverage AI to distinguish tumours from healthy tissue, apply trajectory corrections, and assist decision-making during surgery. And service robots in hotels can use AI-powered speech recognition to interact with guests, providing information or delivering items to rooms.

Data-Hungry Learning

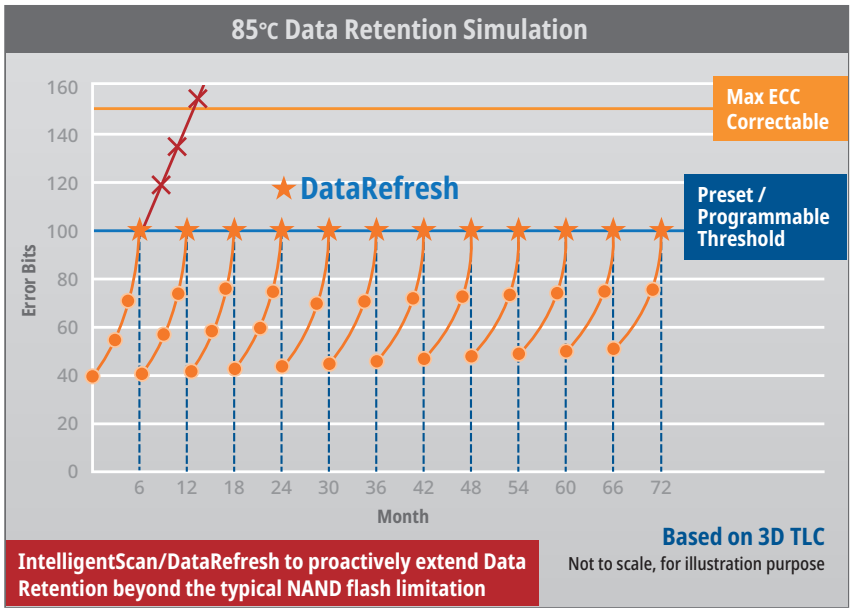
Machine-learning models are a defining aspect of modern AI and rely on large datasets to continue improving performance and accuracy. To accommodate this, memory subsystems must combine high storage density and fast performance with high reliability, low power consumption, and efficient management of memory space ensure fast retrieval of large datasets and to preserve longevity. Low power is important to extend battery life and minimise heat generation during extended periods of use. On the other hand, AI robots often handle sensitive data, which calls for advanced encryption and firmware protection to prevent unauthorised access and cyber-attacks.

In addition, size constraints often apply in relatively small robots such as mobile and service-oriented robots. These demand space-efficient storage without sacrificing performance. Excellent reliability is also required, to ensure continuous uptime and thus provide consistent and uninterrupted access to data. This is especially important in healthcare and industrial applications.

AI-Ready Memory

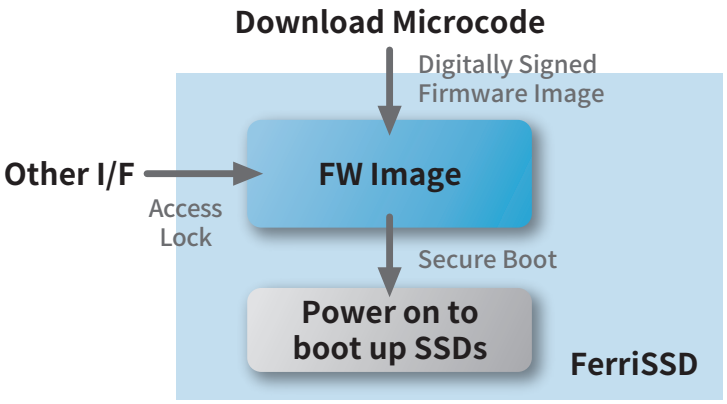
Suitably featured non-volatile memory can help robot designers achieve high targets for performance, energy efficiency, reliability, and security in AI-powered robots. Embedded multimedia card, solid-state disk, and universal Flash storage compliant memories such as Silicon Motion's FerriSSD, Ferri-eMMC, and Ferri-UFS integrate the memory and controller in a single module that is space-efficient and robust. Their compact form factor permits integration in AI robots with tight space constraints without compromising performance.

The built-in controller eases integration and relieves the host system of responsibility for memory management. Moreover, the controller can provide special features, specially developed by the vendor, to enhance the memory's performance. The Ferri Family has features such as IntelligentScan™ with DataRefresh, NANDXtend® ECC, IntelligentThermal™, and IntelligentShield™ enhance long-term durability and data integrity, which are essential for AI robots in extreme operating conditions.



IntelligentScan and DataRefresh ensure enhanced data-loss and error correction, extending SSD service life

In addition, carefully chosen storage with dynamic power management algorithms can significantly reduce power consumption thereby helping to prolong battery life in mobile AI robots. Also, end-to-end data path protection with AES 256-bit encryption and features like Ferri's IntelligentGuard™ keep stored data and firmware IP safe against potential cyber threats. These memory ICs also utilise IntelligentZones™, which optimally segments data into efficient blocks, ensuring AI robots can quickly access and manage large datasets. This helps maximise utilisation of the available capacity and boosts operational efficiency. There is also advanced protection against unstable power conditions and technologies to prevent data corruption in case of sudden power loss.



IntelligentGuard™ technology maintains boot security by enhancing authentication and protection mechanisms of the SSD's firmware

Conclusion

Growing reliance on AI holds the key to the future of robotics, as robots emerge from their traditional guarded-off, tightly controlled environments. Small and affordable robots, collaborative robots, mobile robots, and humanoid robots are now mixing with humans, bringing qualities such as speed, endurance, dexterity, and repeatability to activities ranging from complex industrial processes and service assistance to daily chores and human interaction. Humanoid robots, in particular, illustrate how AI and advanced memory solutions can empower machines to perform tasks in human-centric environments with increasing adaptability and sophistication.

AI-driven skills that utilize machine learning are data-intensive, placing heavy demands on the performance, energy efficiency, and durability of on-board system memory. To meet these demands in next-generation robots, memory solutions should not be seen as mere commodities. Differentiating features of products such as BGA SSD, eMMC and UFS chips, often driven by sophisticated controllers, can help designers create robots capable of performing better, for longer periods, while ensuring superior safety, security, and sustainability.

For more information about Ferri Family, please go to
www.siliconmotion.com or send email to **ferri@siliconmotion.com**

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