2025

Embedded AI

CANopen

Machine-learning host controllers

Self-learning actuators

Deep-learning fusion sensors

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Embedded AI and CANopen

The next step: Embedded AI

Embedded AI involves integrating deep-learning capabilities into devices, allowing them to process data, make decisions, and learn locally without constant cloud reliance. Instead of sending sensor data to the cloud for processing, embedded AI devices analyze information directly, closer to where the data is generated. Such devices can be connected to embedded CANopen networks. With the embedded AI market projected to grow at a 22-percent CAGR (compound annual growth rate) through 2030, it is reshaping the future of automation.

Host controllers, actuators, and sensors

CANopen host controllers with embedded AI functionality are based on dedicated hardware and can collect data from networked sensors. These machine-learning devices also can configure and control actuators via CANopen. Even CANopen devices with smart sensor-fusion capability can implement embedded AI algorithms to unburden the host controller. Embedded AI is also suitable to be integrated into self-learning CANopen actuators, optimizing configuration and closed-loop algorithms by their own.

Smart CANopen networks

CANopen networks connecting devices with embedded AI functionality can use standardized profiles. A typical example is the CiA 462 profile for item-detection devices. These sensor systems can fuse several individual sensors and optimize the results by means of embedded AI algorithms. CiA is committed to extend other profiles for embedded AI usage. Smart CANopen networks are intended to support embedded AI applications.

Embedded AI CANopen applications

Autonomous driving

AI-powered vehicles rely on embedded AI to process real-time data from their surroundings, to navigate them and to avoid collisions. This applies to AGVs (automatic-guided vehicles), AMRs (autonomous modular robots), and drones. These vehicles can use embedded AI and neural networks to make split-second decisions based on datasets gathered from cameras, radars, and other sensors. Embedded AI allows AMRs to process data locally, adapt to real-time changes, and execute tasks such as quality control and assembly with minimal human intervention.

CAN and CANopen are the ideal networking technologies

Networked embedded AI devices require a robust physical layer, a reliable data link layer, a flexible application layer, and interoperable parameter specifications. The CAN-based (CC, FD, and XL) CANopen (CC and FD) approach fulfills these requirements and additionally offers high scalability regarding bit rates (50 kbit/s to 20 Mbit/s) and payload sizes (from 1 byte to 2048 byte). CAN hardware is available for reasonable prices, is appropriate for challenging outdoor environments (e.g., extended temperature range), and is well-suited for battery-powered devices.

Predictive maintenance

Detecting failures before they occur in industrial machinery is an increasing demand. Condition monitoring systems can be improved, implementing embedded AI functions. First predictive maintenance products with CANopen connectivity are under development, especially for mobile machinery, including agriculture implements, body application units for commercial road vehicles, and attachments for construction machines.

Healthcare diagnostics

Embedded AI is also suitable for monitoring patient health metrics in operating rooms, intensive care, and medical devices. Embedded CANopen networks can be used to communicate between such devices. This applies also to medical service robots.

We shape the future

Embedded AI CANopen network benefits

We shape the future

Increases energy efficiency

By performing local computations on devices, embedded AI minimizes the need for data transmission to and from the cloud, resulting in reduced energy consumption. This is particularly important for battery-powered devices. Embedded AI can rely on already existing CANopen energy saving concepts, e.g., as specified in CiA 302-9 or CiA 320.

Improves privacy

With embedded AI, enterprises can keep up to 90 percent of sensitive data on-premise, minimizing exposure to external threats. Local AI processing is estimated to reduce the risk of data breaches by up to 50 percent compared to solutions dependent on cloud infrastructure, leading to higher compliance and stronger trust among users. This improves data privacy by keeping all data in the device.
For CAN-based communication, there are several cybersecurity measures available.

Boosts bandwidth efficiency

By processing data locally, businesses can reduce data transmission costs by 30 percent to 60 percent, resulting in reduced data transmission and lower bandwidth requirements. This is beneficial in scenarios with limited or expensive network connectivity because it optimizes the bandwidth usage and reduces costs. CAN further enhances these benefits: its event-driven broadcast communication minimizes bus load. Systems can be designed easily using low-cost, multi-vendor components, which further increases overall cost efficiency.

Reduces latency

Embedded AI enables immediate responses to events by eliminating the delays associated with cloud data transmission. By integrating AI directly into devices, it processes data up to 4 times faster. Embedded AI minimizes the latency associated with data transmission over networks by processing data locally on devices. This is important for time-sensitive applications, such as the collision avoidance of autonomous vehicles. The event-driven data transmission in CAN complements embedded AI. Nevertheless, in case more determinism is needed, there is the option to operate CAN as time-triggered system.

Eliminates reliance on cloud services

Embedded AI reduces the reliance on cloud connectivity, eliminating unnecessary cloud transfers and minimizing ongoing operational expenses. Embedded AI can make use of the resource management options already specified and harmonized in CiA 309-5.

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