Electronic Design

By MURRAY SLOVICK, Contributing Editor

Creating Smarter, More Efficient Solutions Through Edge AI

Sponsored by Texas Instruments: Integrating AI into devices on the edge can be simplified with NPU-enhanced MCUs and having the right tools at your fingertips.

Connected devices aren't necessarily intelligent devices. However, by integrating artificial intelligence (AI) with edge computing, data can be processed and analyzed directly on devices at the "edge" of a network—at the point where a device connects to the internet, such as sensors.

In this way, edge AI brings computational power closer to the data source. Decisions can be made on the periphery of the device instead of in the cloud, enabling faster real-time decision-making, lower latency, higher power efficiency, and improved robustness and data security.

Engineers today are challenged to design systems that can make accurate, intelligent decisions in real-time. One example is the smart-home security camera. To detect whether an object in your backyard is a dog or a stranger using cloud AI may require sending the data up to the cloud, processing it, and then sending it back down so that a decision can be made. This would not only take too long, but it would require a great deal of power to accomplish.

When making decisions at the edge, highly integrated embedded devices run neural networks locally, requiring less power and allowing for improved security and privacy.

Higher-Precision Fault Detection

Lots of data can be utilized by edge AI. For instance, an OEM building a car will have a large amount of sensor-obtained data on how the car will behave. Edge AI allows you to take this data and create a function that will detect a potential fault or do preemptive maintenance. It can boost fault-detection precision by processing this data locally and in real-time, reducing latency and increasing responsiveness.

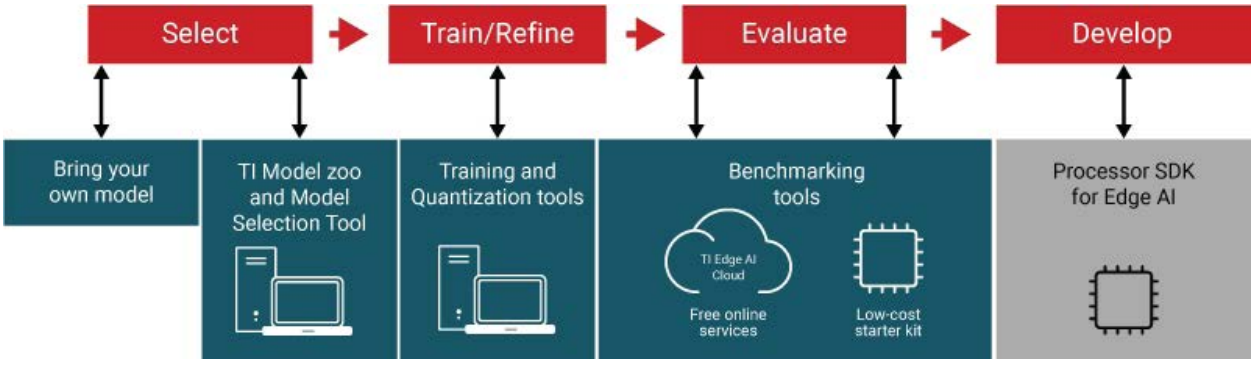
In applications such as motor drives and solar-energy systems, real-time fault detection ensures both operational safety and long-term reliability.

Edge AI-enabled MCUs can monitor two types of faults:

A **motor-bearing fault** occurs when there are abnormal conditions or deterioration in the bearings of an electric motor. Detecting these faults is vital to prevent unexpected failures, reduce downtime, and reduce maintenance costs.

An **arc fault** is a discharge that occurs when electricity

1. New TI MCUs such as the TMS320F28P55x series enable edge AI and industry-leading real-time control. (Source: TI)



2. Shown is an edge AI application development workflow. (Source: TI)

flows through an unintended path. These are often caused by insulation breakdowns, loose connections, or other faults in the system. The discharge can generate intense heat, leading to fires or damage to the electrical system. Arc-fault detection will prevent fires and ensure safety.

Embedded Processors Increase Intelligence at the Edge

Texas Instruments offers a range of processors with varying processing capabilities, enabling developers to choose the right level of AI performance for their application while maintaining low power consumption. Integrated edge-AI based fault detection in a real-time MCU such as the TI TMS320F28P550SJ can help avoid false alarms while providing better predictive maintenance *(Fig. 1)*.

With edge AI, these systems can learn and adapt to their environment to optimize real-time control, increasing overall system reliability, safety, and efficiency while reducing downtime.

Integrating NPUs into MCUs

TI has devoted decades to developing digital-signal-processing (DSP) products and investing in neural processing units (NPUs) and software that are now being used to optimize edge computing.

For instance, TI's TMS320F28P55x series of C2000 MCUs represents the industry's first portfolio of real-time microcontrollers with an integrated NPU, enabling fault detection with up to 99% accuracy and low latency. The on-chip NPU provides 5X to 10X faster AI model processing time than software implementations. It also allows for motor control, multichannel arc-fault detection, and power-conversion control to be performed by the same MCU.

Gaining an Edge with Edge AI Studio

A good way to get started on your embedded neural-network application is with TI's Edge AI Studio. The GUI and command-line-based tools are designed to accelerate the development of edge AI applications on TI MCUs and processors.

It includes low-code tools to help engineers new to AI quickly train, optimize, compile, deploy, and evaluate models from the TI model collection. It also includes command-line tools, giving expert users full control over deployment of their models.

Edge AI Studio includes Model Composer, a fully integrated solution for collecting and annotating data, training and compiling models for deployment on a live development platform. Model Composer supports Bring-Your-Own-Data (BYOD), enabling the re-training of models from the TI Model Zoo with custom data to improve accuracy and performance *(Fig. 2)*. It's available as a cloud-based application for vision-based tasks and as both a cloud and desktop application for real-time control tasks.

Fast, Secure AI at the Edge

Experience fast, secure AI at the edge with TI's sensing, processing, and control products. Backed by decades of expertise in DSP, the company's technology enables powerful algorithms that transform data to solve complex problems for perception, real-time monitoring and control, and audio AI applications.

Specifically, TI's edge AI technology can be integrated into applications ranging from industrial automation, smart home devices, and wearable electronics to robotics and automotive systems.

The company also offers low-latency, efficient real-time performance across processors, MCUs, and wireless and radar-based devices with integrated hardware accelerators tailored for myriad design needs. In short, TI provides a robust solution for integrating AI into embedded systems with minimal complexity.