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Whitepaper

Six Challenges of Integrating Edge AI into Industrial Vision Systems

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The Need for an Edge

Industrial manufacturers are increasingly turning to machine learning and AI-powered vision systems to improve both safety and quality. In sectors like pharmaceuticals, electronics, and automotive, AI-based inspection detects anomalies, ensures product consistency, and validates compliance with safety protocols such as Personal Protective Equipment (PPE) detection.

But to meet the strict latency, bandwidth and privacy requirements of these use cases, inference must happen at the edge. This is where development becomes complex. Edge AI is still maturing, and while interest is high, most companies are struggling to operationalize it. Manufacturers know they need to modernize, but many don't know where to begin.

This whitepaper, jointly developed by Synaptics and Arcturus, explores six common challenges facing industrial organizations as they seek to integrate Edge AI into their vision systems, and outlines how our partnership helps to uniquely address them.

1. Development Complexity: The Steep Learning Curve

For teams new to Edge AI, the ramp-up is steep. Building an effective AI vision pipeline requires:

- Curating high-quality datasets for model training
- Selecting the right neural network architecture (such as ResNet, MobileNet, or YOLO)
- Ensuring model layers are compatible with the chosen hardware and inference engine

Each step requires specialized expertise. And even when off-the-shelf models are used, tuning and adapting them for real-time industrial environments can be daunting.

Our solution: Synaptics and Arcturus offer a low-code/no-code development stack, built on open-source edge AI frameworks, and well-documented APIs. Together, these tools hide much of the complexity of machine learning, enabling teams to build, test, and deploy models more quickly—without requiring deep-learning expertise.

2. Dependency Risks: Managing Interrelated Software Components

The software environment for running Edge AI is complex. Each NPU vendor typically provides its own set of tools, compilers, and runtime libraries, many of which are tightly coupled to specific versions of the host operating system, runtime environment, and model frameworks. Updating just one component can break compatibility with others.

Our solution: We simplify dependency management through containerized architecture. Pre-integrated and validated software stacks remove the guesswork, accelerating time-to-value while reducing support burden.

3. Optimization Overload: Tuning Models for Edge Hardware

Even after a model is selected, it often needs to be optimized to run efficiently on constrained edge hardware. This involves:

- Quantizing the model (from FP32 to INT8, for example)
- Applying pruning and compression
- Tailoring the inference pipeline to leverage hardware acceleration (NPU, DSP, ISP)

Doing this manually requires experimentation to achieve the best balance of performance and accuracy. This not only requires deep knowledge of machine learning and hardware internals, but also time-consuming instrumentation and analysis.

Our solution: Synaptics and Arcturus provide automated and semi-automated model optimization workflows, including Human-in-the-Loop (HITL) model tuning. These workflows maximize inference performance and offer methods to improve inference accuracy, simplifying the creation of custom models that are edge-optimized and production-grade.

Additionally, the Synaptics SL1680 processor supports hardware-accelerated preprocessing functions via its NPU and ISP, offloading workloads that typically bottleneck the vision pipeline and improving end-to-end speed.

4. System Fragility: Maintaining and Monitoring AI Systems in Production

Once deployed, AI vision systems must be monitored continuously. Field devices require updates, performance tuning, and issue resolution. Many organizations need methods to integrate, manage, and orchestrate devices at scale.

Our solution: Our joint platform includes fleet management tools built atop a mature container ecosystem. These provide:

- Real-time analytics and events via a dashboard and APIs
- Visibility into device status, system health, firmware versions and configurations
- Compatibility with orchestration tools for Over the Air (OTA) updates
- Diagnostics for tracking inference accuracy, system health, and throughput

5. Deployment Risk: Future-Proofing in a Rapidly Evolving Ecosystem

The ML ecosystem is evolving rapidly. New model architectures, tool chains, and hardware emerge every year. Solutions tightly coupled to a specific stack become obsolete quickly, introducing risk and increasing long-term maintenance costs.

Our solution: Our architecture abstracts key ML subsystems from the underlying OS. This decoupling reduces validation requirements and increases system longevity. With our modular stack, teams can adopt new models, update components, and migrate hardware with minimal rework.

6. Data Privacy and Traceability: Complying with Industry Regulations

Many industrial customers operate under strict regulatory frameworks. They must ensure:

- Inspection data is traceable for audits and compliance
- Data stays on-premises to meet data sovereignty laws
- Edge devices resist tampering and unauthorized access

Our solution: Because inference happens on-device, our platform offers privacy-by-design. All image data and metadata remain under the control of the customer. Built-in tools ensure traceability across inspection events, software updates and device configurations.

Collaborating at the Edge

Synaptics and Arcturus offer a novel, effective pathway for integrating Edge AI into industrial vision systems. Synaptics brings industry-leading edge compute hardware and AI acceleration. Arcturus contributes deep domain expertise in embedded systems and industrial workflows. Together, we've built a solution stack purpose-built for industrial vision, one that simplifies integration, accelerates deployment, and protects your investment over time.

Ready to transform your vision systems with Edge AI?

Let Synaptics and Arcturus help you overcome complexity, cut development time, and deploy smarter, faster, and safer Edge AI solutions.

Visit Synaptics to learn more, or contact us to request a demo.