Solution Brief

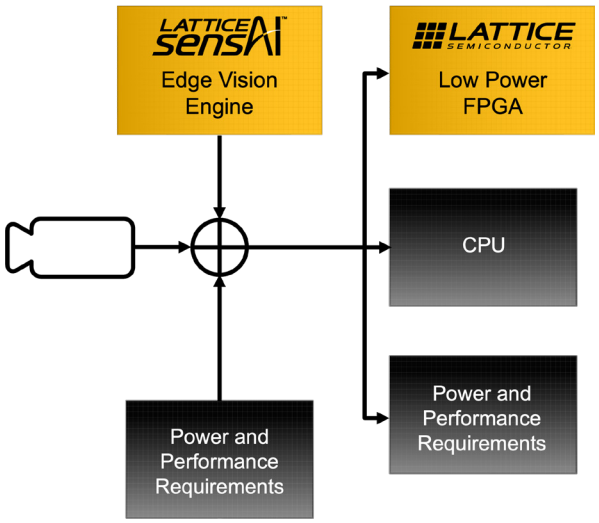
HUMAN-MACHINE INTERFACE APPLICATIONS ENABLED BY LATTICE SENSAI EDGE VISION ENGINE

Enhancing Human-Machine Interaction with Low Power, Flexible AI Vision Solutions

Overview

The Lattice sensAI™ Edge Vision Engine is a powerful tool that enables developers to create next-generation Human-Machine Interface (HMI) applications with advanced computer vision capabilities. It supports applications across various segments, including industrial, automotive, consumer, and client computing. Users and end-customers expect intuitive and easy-to-use interfaces, which not only enhance user experience but also increase efficiency and deliver better results. The Lattice sensAI Edge Vision Engine enables seamless integration of AI-driven features to achieve these benefits. Designed for Lattice FPGAs, x86 and Arm CPUs, this powerful software development kit (SDK) accelerates the development of intuitive, touchless, and intelligent interfaces. See Figure 1.

Figure 1: Hardware Optimized Algorithms



The computer vision models in this tool are built to perform at extreme low power in Lattice FPGAs, but they are also optimized for devices with more resources, such as x86 or Arm CPUs. This provides a cost-effective, efficient, and flexible solution for developers seeking to integrate gesture control, facial recognition, gaze tracking, object detection, and other advanced features into their products. All computer vision AI models provided in the Lattice sensAI Edge Vision Engine have an F1 score of 0.95 or higher. These pre-trained models are purpose-built for real-world applications, helping accelerate deployment and reduce time to market. See Figure 2.

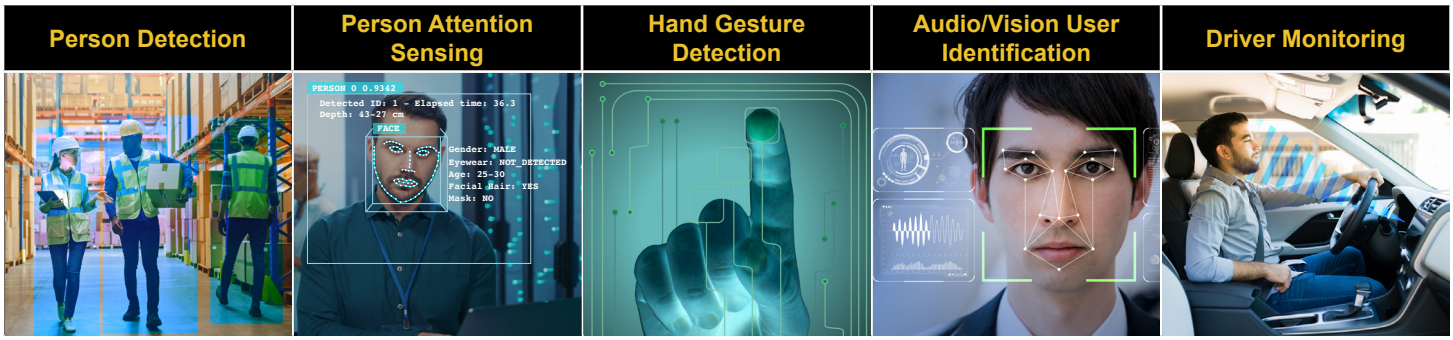
KEY CHALLENGES

- High Power Consumption: Many AI-driven HMI solutions need a lot of power, making them unsuitable for low power devices.
- Latency and Real-time Performance: Smooth, real-time interactions are crucial.
- Cross-platform Compatibility: HMI solutions must work across multiple platforms.
- Security and Privacy: Protecting user identity and preventing unauthorized access is vital.
- Complex Development: Implementing AI-driven HMI requires expertise in computer vision, AI optimization, and hardware acceleration.

LATTICE SOLUTION

- Lattice's computer vision models balance power and performance, optimizing solutions to run at the lowest possible power on FPGAs, CPUs, NPUs, or GPUs.
- Lattice sensAI Edge Vision Engine supports FPGA, x86, and Arm, enabling deployment on diverse hardware platforms.
- Features like face identification, speaker recognition, and privacy alerts enhance security and authentication.
- Lattice provides pre-trained AI models, tools, and documentation, reducing development complexity and accelerating time to market.

Figure 2: Purpose-Built Pre-Trained Models



Trained models with high F1 score, low power, low latency, and shipping in high volume currently available from Lattice Semiconductor.

Key Capabilities of the Lattice Edge sensAI Vision Engine SDK

The Lattice sensAI Edge Vision Engine SDK delivers cutting-edge computer vision features optimized for real-time performance:

- Body Detection & Tracking – Accurately identifies and tracks human bodies for interactive applications.
- Face Detection & Tracking – Enables facial recognition, user authentication, and expression analysis.
- Face Identification – Recognizes and verifies individuals for security and personalization.
- Speaker Identification – Identifies individuals based on voice patterns for secure and hands-free authentication.
- Gesture Detection & Tracking – Supports touchless interactions using hand and body gestures.
- Gaze Tracking – Accurately detects and interprets user eye movements, enabling intuitive, precise, hands-free interactions for accessibility or safety applications.
- Object Detection – Recognizes and tracks objects in real-time for enhanced situational awareness.

The Lattice sensAI Edge Vision Engine addresses challenges by providing low power, high performance AI models, cross-platform support, enhanced security features, and an optimized development framework that accelerates time to market. See Table 1.

Flexible Deployment Options

The SDK supports multiple computing platforms, offering scalability and flexibility for different application needs:

- Runs on Lattice FPGAs, x86, or Arm SoCs – Choose the ideal hardware for performance, power efficiency, and cost.
- Optimized AI/ML Models – Pre-trained models intelligently leverage the best available hardware for inference, whether it is an FPGA, CPU, NPU, or GPU, ensuring optimal performance for real-time edge applications.
- Cross-platform Compatibility – Seamless integration into existing applications across various operating systems.

Development Capabilities:

- Full-stack Support: Covers everything from user experience development to machine learning on ultra-low power (ML-on-ULP).
- Cohesive Development: Focuses on designing machine learning algorithms tailored to the desired user experience, and vice versa.

Table 1: Key Challenges in Human-Machine Interfaces

DEVELOPER CHALLENGES	LATTICE FPGA SOLUTION
High Power Consumption – Many AI-driven HMI solutions require significant computational power, making them impractical for low power edge devices.	Lattice's computer vision models are designed to balance power and performance, optimizing solutions by running at the lowest possible power for the selected device, whether it be an FPGA, CPU, NPU, or GPU.
Latency and Real-time Performance – Ensuring smooth, real-time interactions with minimal lag is critical for an intuitive user experience.	Lattice sensAI Edge Vision Engine includes highly optimized AI models that run efficiently on FPGAs, CPUs, NPUs, and GPUs, ensuring low-latency responses.
Cross-platform Compatibility – HMI solutions need to work seamlessly across multiple platforms and hardware architectures.	Lattice sensAI Edge Vision Engine supports FPGA, x86, and Arm, allowing developers to deploy applications on diverse hardware platforms.
Security and Privacy Concerns – Protecting user identity and preventing unauthorized access is essential for sensitive applications like banking and security systems.	Features such as face identification, speaker recognition, and privacy alerts enhance security by preventing unauthorized access and improving authentication methods.
Complex Development and Integration – Implementing AI-driven HMI requires expertise in computer vision, AI model optimization, and hardware acceleration.	Lattice provides pre-trained AI models, optimized tools, and documentation, reducing development complexity and accelerating time to market.

Human-Machine Interface Target Applications and Benefits

The HMI applications powered by the Lattice sensAI Edge Vision Engine are ideal for a wide range of applications:

Industrial Automation

- Hands-free control of machinery and interfaces using gestures, allowing operators to be more efficient and reducing the need for physical interaction.
- Worker safety monitoring via body detection, which minimizes the risk of injury and ensures a safer working environment.
- Smart surveillance with real-time object tracking, increasing accountability and providing valuable data insights for process improvement.
- Better HMI simplifies interfaces, improves operator response time, and reduces errors and mistakes.
- Intuitive HMI allows tools to be accessible and usable by everyone, making industrial automation more inclusive and efficient.

Client Computing and Edge AI

- Touchless control interfaces for laptops, tablets, and enterprise devices, enabling more natural and efficient interactions.
- Enhanced accessibility features for hands-free computing, making technology more inclusive for users with mobility impairments.
- AR/VR applications using real-time object detection and tracking, enhancing immersive experiences.
- Increased battery life by tracking user awareness and adjusting power consumption accordingly.
- Increased privacy by tracking user identity and detecting unauthorized individuals peeking at the screen.

Automated Teller Machine (ATM) Privacy and Security

- Human Presence Detection – Ensures ATM activation only when a legitimate user is present, enhancing security and preventing unauthorized access.
- Continuous Face Identification – Verifies the user throughout the transaction to prevent identity fraud and unauthorized withdrawals, providing peace of mind for customers. See Figure 3.

Figure 3: ATM Privacy and Security - Continuous Face Identification

- Privacy/Intruder Alert – Detects unauthorized individuals near the ATM and triggers alerts to enhance security and user privacy, protecting sensitive financial transactions.
- Faster and Safer Transactions – Reduces the need for manual PIN entry by leveraging biometric authentication, making ATM interactions quicker and more secure.
- Increased User Confidence – Provides an added layer of protection, reassuring users that their transactions are safe from fraud and prying eyes.

Automotive and Transportation

- Driver monitoring systems (DMS) using gaze tracking and face recognition to enhance safety by detecting driver drowsiness, distraction, or inattention.
- Gesture-based infotainment control for safer in-vehicle interactions, allowing drivers to adjust settings without taking their hands off the wheel.
- Occupant detection for adaptive seat positioning and safety measures, improving passenger comfort and enabling smart airbag deployment.
- Enhanced security with face identification for personalized vehicle settings and anti-theft measures.

Consumer Electronics and Smart Home

- AI-powered smart displays with gaze and gesture control, allowing users to interact seamlessly without touch, improving accessibility and convenience.
- Personalized user experiences through facial recognition, enabling customized settings for individual users in smart home ecosystems.
- Hands-free control for smart home devices, improving usability for individuals with disabilities and making daily tasks more efficient.
- Enhanced security through face identification and presence detection, preventing unauthorized access to personal devices and home automation systems.

Why Choose Lattice for Your HMI Solution

Developers looking to build efficient, scalable, and high-performance Human-Machine Interfaces need a solution that balances power efficiency, ease of integration, security, and flexibility. The Lattice Edge sensAI Vision Engine is the ideal solution for edge AI applications, offering:

- **Low Power and High Performance** – Optimized AI/ML models deliver efficient power usage without compromising accuracy or real-time responsiveness, making them perfect for edge devices.
- **Flexibility and Scalability** – Compatible with multiple platforms, including Lattice FPGAs, x86 and Arm CPUs, giving developers the freedom to choose the best hardware for their needs.
- **Security and Reliability** – Built-in features like face identification, speaker recognition, and privacy protection enhance security and help prevent unauthorized access.
- **Faster Time to Market** – Purpose-built, pre-trained AI models streamline development, reduce complexity, and accelerate deployment.

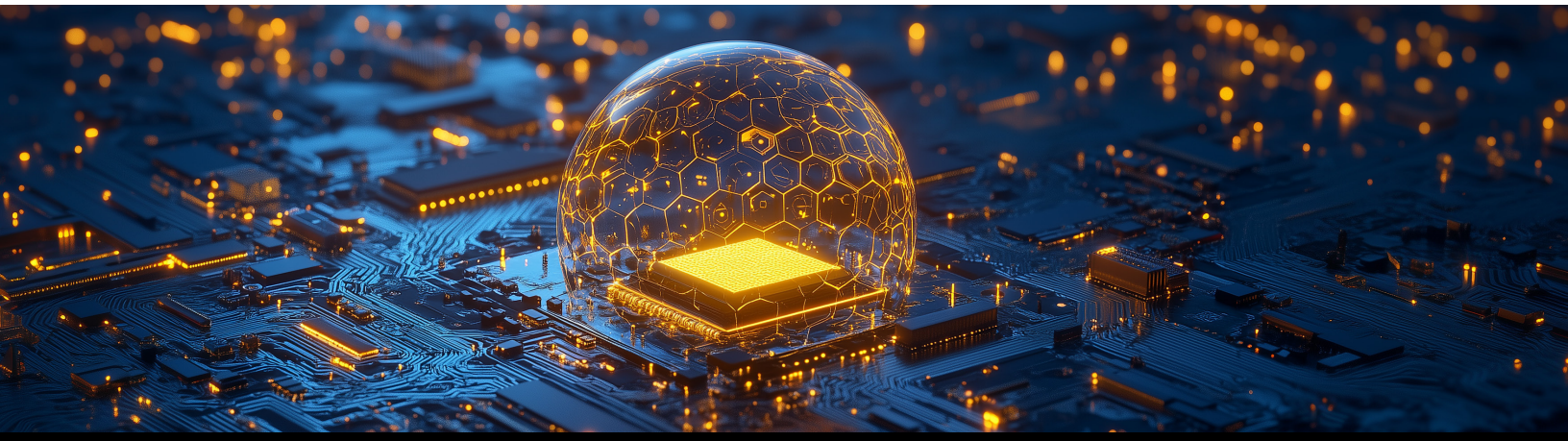
- **Seamless Integration** – The Lattice sensAI Edge Vision Engine is designed to work with existing infrastructure, enabling easy integration into both new and legacy systems with minimal modifications.
- **Enhanced User Experience** – AI-powered HMI solutions offer intuitive, user-friendly interfaces that improve efficiency, reduce errors, and deliver smoother interactions.

Empower your HMI applications with the Lattice sensAI Edge Vision Engine SDK.

Conclusion

The Lattice SensAI Edge Vision Engine SDK enables developers to transform Human-Machine Interface applications with low power, secure, and scalable AI solutions—featuring purpose-built, pre-trained models that deliver intuitive performance at the edge. By leveraging low power, high-performance AI models optimized for Lattice FPGAs, x86, and Arm platforms, the SDK addresses key challenges such as power consumption, real-time performance, and cross-platform compatibility. It enables innovative applications across industrial automation, automotive, and consumer electronics. See Figure 4. The SDK simplifies deployment and accelerates innovation at the edge. With Lattice, the future of HMI is not only more human-centric—but also more intelligent.

Figure 4: Human-Machine Interface Applications



Ready to Learn More?

To learn more about Lattice low power FPGA-based solutions for industrial, automotive, communications, computing, and consumer applications, visit **www.latticesemi.com** or contact us at **sales@latticesemi.com**.

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