Event Camera Technology

A brain-inspired computing case study

Event cameras are inspired by the human eye and represent a fundamental departure from conventional imaging. Where a standard camera captures full frames at fixed intervals, an event camera operates pixel-by-pixel: each pixel fires independently and only when it detects a change in brightness. This architecture, inspired by the human retina, enables capabilities that traditional sensors cannot match.

How are event cameras different?

Ultra-low power: Event cameras consume far less energy than conventional sensors, extending operational life in field-deployed or energy-constrained systems such as satellite payloads.

High speed: Pixels respond in microseconds, capturing fast motion without blur and enabling reactions that normal cameras cannot practically achieve.

High dynamic range: Sensors can operate in very bright and very dark settings, even at the same time. This means there's no need for exposure tuning, no saturation and no missed events in complex lighting environments.

Faster decision making: Data is only captured at the level of individual pixels, instead of full images. This avoids collecting redundant data and means images can be processed faster whilst avoiding bandwidth bottlenecks.

Conventional camera **Event camera**

Image: Image compares a conventional and an event camera assessing movements on a busy street. The event camera does not capture multiple frames with redundant data, but instead pixels only respond when their intensity changes by a threshold percentage. Source: Alexandre Marcireau, Optera

Key applications

- Better quality assurance and productivity
- Safer vehicles
- Space debris tracking
- Protecting critical infrastructure

Want to know more?

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NeuroWare
THE UK INNOVATION & KNOWLEDGE CENTRE IN NEUROMORPHIC COMPUTING HARDWARE

UCL Policy Impact Unit

Application deep-dives

Industrial inspection[1]

High-speed production lines push conventional cameras to their limits. Fast-moving parts blur, exposure has to be tuned carefully, and the resulting huge video streams are costly to store and analyse in real time. That leads to missed defects, slower lines, or expensive high-speed camera setups.

Event cameras operate with microsecond timing and >120 dB dynamic range, so they keep working as production lines speed up or lighting conditions vary. For manufacturers, this translates into higher yield, better quality assurance, and lower energy and compute costs for visual inspection, simultaneously achieving improved productivity and lower carbon emissions.

Counter-drone & critical infrastructure protection[2]

Drones are challenging to detect reliably: they are physically small, move quickly, and can appear against bright skies or cluttered backgrounds where conventional cameras and radars generate high false-alarm rates.

Neuromorphic event cameras can detect quadcopters by identifying the characteristic frequency signature of their rotating blades and they can then localise the aircraft within the sensor's field of view. By pairing event cameras with spiking neural networks on a neuromorphic chip it is possible to create a 'virtual tripwire' around restricted zones. This could operate for over a year on battery power and uses several orders of magnitude less energy than an equivalent edge-GPU solution.

For Counter-Unmanned Aircraft Systems and civil aviation safety this gives practical options for protecting sensitive sites and monitoring airspace in locations with limited power and without the infrastructure burden of conventional sensor arrays.

Automotive safety[3]

Advanced driver assistance systems currently rely on image-based cameras, where reducing motion blur and improving reaction time requires capturing more frames per second, but doing so inflates data volumes and processing requirements. Conventional cameras also struggle with glare, night driving, tunnels, and other situations involving extreme light conditions.

Research has demonstrated that pairing a standard 20 fps camera with an event camera achieves the reaction-time equivalent of a 5,000-fps camera, whilst only needing the same amount of data transfer and compute power as a 45-fps camera.

This can make collision avoidance and emergency braking more responsive, particularly in edge cases such as sudden pedestrian crossings, high-speed overtakes, or rapidly changing light. For regulators, this allows for safety gains without prohibitive sensor cost or data burdens, and new options for certifiable vehicle perception under challenging conditions.

Space & debris tracking[4]

Earth orbit is becoming increasingly busy. Existing detection systems struggle with faint, fast-moving objects against noisy backgrounds, yet the consequences of tracking failures (collisions, loss of critical infrastructure, risk to crewed missions) are severe.

Event cameras can provide more frequent and robust measurements of resident space objects with similar accuracy and using lower power and bandwidth. Algorithms have also shown improved detection of faint debris compared to established baseline methods. Furthermore, as space debris tracking moves from ground-based observatories to satellite-mounted sensors, event cameras enable rapid local collision-avoidance decisions without the delays caused by downlinking data to Earth, a critical enabler of autonomous spacecraft operations.

[1] Posch, C. Machine Vision Breakthrough. Quality Magazine, January 6 2025

[2] Gehrig, D and Scaramuzza, D. "Low-latency automotive vision with event cameras," Nature 629 (2024): 1034-1040, https://doi.org/10.1038/s41586-024-07409-w

[3] Lundin, A et al. "Drone Detection Using a Low-Power Neuromorphic Virtual Tripwire," arxiv, 2025, arXiv:2509.12997v1 and Stewart T et al. "Using neuromorphic cameras to track quadcopters" (paper presented at ICONS, August 2023), 7, 1-5, https://doi.org/10.1145/3589737.3605987

[4] Ralph, N et al. "Real-Time Event-Based Unsupervised Feature Consolidation and Tracking for Space Situational Awareness," Frontiers in Neuroscience 16 (2022), https://doi.org/10.3389/fnins.2022.821157 and Cohen, G et al. "Event-based Sensing for Space Situational Awareness," The Journal of the Astronautical Sciences 66 (2019): 124-141, https://doi.org/10.1007/s40295-018-00140-5

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