WESTERN SYDNEY UNIVERSITY

INTERNATIONAL CENTRE FOR NEUROMORPHIC SYSTEMS (ICNS)

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The Astrosite™, a mobile space situational awareness (SSA) module, is a revolutionary and world-first approach to space imaging. Led by Western Sydney University's International Centre of Neuromorphic Systems (ICNS).

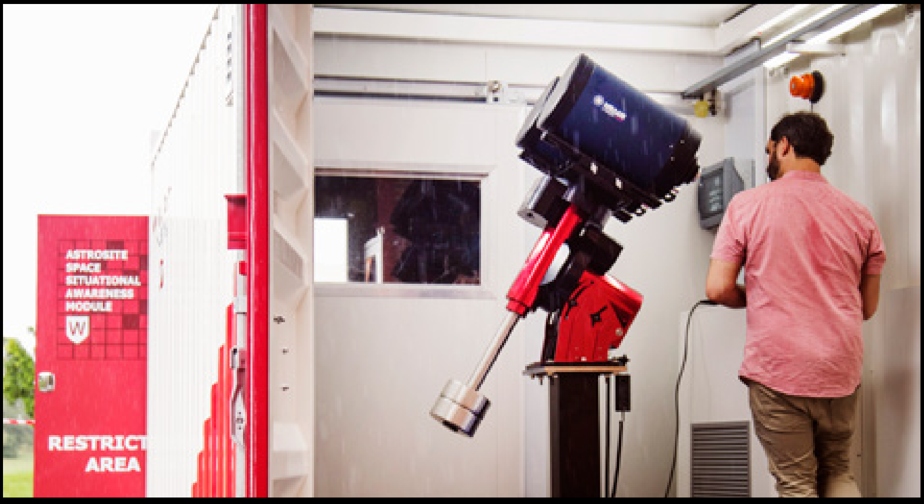
Using biologically-inspired event-based sensors – i.e. sensors that function like the eye and brain to overcome limitations of cameras exposure times and saturation – the Astrosite™ can capture objects in space with unprecedented temporal resolution, and during the day in real time.

Defence application of this technology has sparked interest, with the RAAF's Plan Jericho supporting the design and development of the Astrosite™. The potential of this technology is game-changing with uses including: the observation of high-speed phenomena such as satellites; the provision of early warnings for potential collisions; allowance of the daytime recording of objects in low earth orbit; facilitating imaging in low-visibility environments; monitoring space debris and the high-speed tracking of objects.

Our world has been shaped by the development of microscale electronics and the waves of innovation and disruption that these technologies have delivered. The growth of smarter, more efficient, and inexpensive devices has affected almost every aspect of our lives. However, the pace of this rapid change and accompanying benefit is at risk, as we come to the physical limitations of transistor size and density. Alternative means of acquiring signals, processing data, and ultimately understanding data is required to usher in the next wave of smaller, smarter, and more dynamic systems.

We need to look to another set of technology principles, and one such technology is Neuromorphic Engineering. With a biologically-inspired approach, Neuromorphic Engineering seeks to achieve the same level of robustness and efficiency as biological systems when it comes to perceiving, interacting, and making decisions on the world. With a focus on practicality over biological plausibility, the benefits of a Neuromorphic Engineering approach are already evident in nature.

Western Sydney University is home to a world-leading research centre undertaking ground-breaking research and development in Neuromorphic Engineering – including the Astrosite. ICNS distinguishes itself through a fundamental and core focus on real world applications for neuromorphic technology.



ICNS, in partnership with other leading researchers and corporations, is tackling pressing global problems and exploring innovative solutions to escalating world-wide issues. Through Neuromorphic Engineering, Western Sydney University aims to enable and embrace the next wave of electronic based innovations.

One area of ICNS research is the design and development of event based sensors.

ADVANTAGES OF NEUROMORPHIC EVENT-BASED SENSORS

Event-based sensors can deliver a superior and sustainable advantage in a wide range of applications. They have several advantages over conventional sensors:

- → High speed detection time
- → High Dynamic Range
- → Performance enhancement from motion
- → Low power consumption
- → Highly efficient sparse and low data rate output
- → Potential to integrate into a sensory network

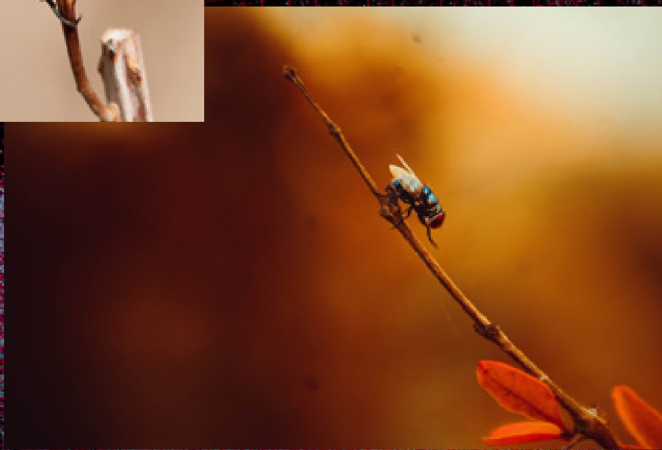
In order to fully leverage the sustainable advantages of the event based sensors, ICNS have developed new image processing algorithms and platforms.

Current computer vision algorithms operate on conventional frame-based images. Constructing frame-based images from the sensors requires accumulating events in time, which defeats the temporal precision that it affords. Current algorithms also require modern computing resources that are power-hungry, difficult to transport and hackable. In situations where time is precious, or where modern computing resources are inaccessible or compromised, existing image processing algorithms have serious shortcomings.

THE ANIMAL KINGDOM

The animal kingdom has already implemented an algorithm that satisfies many current computing constraints. Animals utilise nervous systems that process sensory spikes online and make accurate decisions within milliseconds. Dragonflies solve complex tasks that are directly relevant to defence - within 20 milliseconds of prey entering their field of view, dragonflies begin to move their heads to position it on their retinae. Five milliseconds later, it begins beating its wings. Dragonflies intercept their target at a very high success rate (95% +).

System designs based on these types of capabilities provide the potential for a sustainable advantage in situations where fast decision-making and prediction and reaction are needed. This approach delivers the fastest available detection devices with that can be coupled with, the fastest and most accurate algorithms for processing data. The hardware implementations of those algorithms are compact, lightweight, power efficient, and impossible to hack from a distance.



POTENTIAL APPLICATIONS FOR EVENT-BASED SENSORS AND SYSTEMS INCLUDES:

SPACE SITUATIONAL AWARENESS

Governments and commercial operations need to track and predict the location of orbiting satellites and debris to aid them in protecting and managing their space based assets.

Conventional cameras for telescopes track targets across the sky to negate their motion during long exposure times. Atmospheric scattering of satellite light leads to blurred images. The event based sensors detects motion, so satellite movement across the sky and atmospheric effects actually make them easier to locate. Since event based sensors performance is aided by vibrations and motion, we can view satellites with mobile telescopes instead of fixed observatories whose positions are known. We will be able to observe satellites while the telescope is in transit, e.g. from a ship at sea or a truck on the road. The high dynamic range of the sensor allows it to detect satellites during daylight as well as night time, effectively doubling the observation time.

AUTONOMOUS MICRO-AIR VEHICLE NAVIGATION

An autonomous drone is navigating a complex urban environment.

The event based sensor is an ideal sensor for the drone to detect its environment and avoid collisions during navigation. The sensors consumes less power than conventional cameras. Their batteries can be smaller and lighter, so the drone can fly for longer between charges and be more manoeuvrable. Since the sensors can detect impending collision with microsecond precision, the drone can avoid collision even if it is flying very fast. The performance of the sensors is agnostic to lighting conditions, so the drone can navigate dim or bright environments equally well.

BULLET TRACKING

A soldier is patrolling an urban environment when an enemy fires at them from an unknown location. It is difficult to locate the enemy by the sound of the gunshot because the acoustic environment is complex. The soldier needs to locate the enemy as soon as possible to take appropriate action.

An infrared event based sensor can detect the heat generated by a bullet as it passes through the air. It can detect bullets within microseconds, so the soldier can take effective action immediately. Unlike conventional cameras, the sensor does not need to be stationary to make accurate detections, so its performance does not depend on whether the soldier is moving or not. It is sufficiently small and lightweight to mount several of them comfortably on a helmet. The dynamic range of the sensor is large enough to detect a bullet's heat even if the sensor is facing directly into the Sun.

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#Astrosite

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