Integrated Intelligence, **Surveillance and Reconnaissance**

Collection and integration of information from ISR sources and tactical systems in real or near real time to support decision making. Interoperability with allies. Automated information processing and reasoning. Distributed multi-domain networks. Human and Artificial Intelligence (AI) interaction.

Successful military operations rely on effective and integrated Intelligence, Surveillance and Reconnaissance.

DEFENCE RESEARCH CAPABILITY CATEGORY: **INTEGRATED INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE**

UWA Competitive Advantage

- Infrared Imaging Array technologies with applications in: Night vision and security; Remote weapons targeting systems; Intelligence, surveillance, and reconnaissance (ISR); Missile detection systems; Missile guidance and targeting; Space situational awareness; and Remote sensing.
- Optical micro-electro-mechanical systems (MEMS) based technologies with applications in: Stand-off detection of improvised threats; Multi-spectral remote sensing and imaging; Space situational awareness; Target signature recognition and identification; Optical waveguide switching for electronic warfare; High sensitivity magnetometers; Gas, chemical, and bio sensing.
- Modelling and measurement of the effects of the atmosphere on free-space light propagation.
- Modelling of the effect of atmospheric scintillation in satellite/ground optical communications.
- Remote Sensing and Sensing Networks research groups with robotics and automation expertise in:
  - » sensor networks and data integration
  - » image analysis and recognition systems
  - » automatic target detection, recognition and tracking
  - » audio-visual biometrics dealing with authenticating persons accessing sensitive data or secure areas
  - » acoustic array design and signal processing
  - » acoustic scene classification
  - » audio source separation and enhancement – spoofing and counter-measures

  - » GIS and remote sensing including via satellite and drones that involve use of remotely sensed data and drone-collected information
  - » rigid body motion, flocking and collective motion
  - » monitoring dynamic systems with incomplete information
  - » statistical analysis of key events
  - » spatial analytics
  - » analytic and differential geometry
  - » very large-scale data analytics.
- Information Systems/Technology including economic and quantitative analysis.
- Compliance Monitoring for Anomaly detection (CMAD) in complex environments including the stock market, energy and petroleum industry; engineering asset management; aerospace and defence.
- Information management including, knowledge management, decision support, Agent technology, e-Commerce, Artificial Intelligence applied to Business, and Asset Management work flow decision support.
- Research into creating nanomaterials for camouflaging 3D objects including expertise from biology, physics, visual psychology, art, and computer vision.

Outcomes and Impact

- Investigative forensics (effectively DNA barcoding), including trace botanical DNA provides spatio-temporal biomarkers to supply evidence on the relationships and movements of materials and people of interest.
- New data processing and modelling techniques and systems are being developed to make sense of big data including algorithms to identify features of interest and then mining to discover the underlying patterns and structure. Research in data management, optimisation and analytics at the exa-scale contributes to the following areas:
  - » real-time streaming, processing data at the time of acquisition for cleaning and efficient storage.
  - » data representation, designing quality representation frameworks for efficient storage, retrieval and servicing of data.
  - » unstructured data, designing efficient methods for pre-processing and integrating different types of data (numerical, textual, images, audio, video).
  - » integration data from many different sources.
  - » cleaning raw data to minimise inconsistencies that prevent automatic analysis.
  - » Data modelling involving mathematical, statistical and computational methodology is used to understand complex systems and processes and problems. Applications include;
  - » decision making for reliability and asset management, with a focus on longitudinal and time-to-event methodology, particularly designing remaining useful life models for machinery.
  - » behaviour and stability of complex systems, or example the effect of renewable energy generation in distributed power networks.
  - » predicting crowd dynamics and social interaction, the spread of disease among remote communities, or the spread of bushfire through varied terrain.
  - » computer vision and pattern recognition, tomography and geometric methods, combined with machine learning to analyse image-based data sets, to map out and identify data patterns for interpretation.
- Low cost sensing technologies designed for real-world applications with foci including the environment, infrastructure monitoring and airborne remote sensing.
- A new class of sensors operating in the IR part of the spectrum that provide unique multi-spectral sensing capabilities with reduced size, weight and power requirements. Applications in multi-spectral imaging, night vision, and standoff spectroscopy sensors, with a strong focus on ISR applications in defence and security.

Capabilities and facilities

- UWA is a member of the Pawsey Supercomputing Centre, which operates multiple supercomputers, data-intensive machines and storage systems that use the most advanced technologies available.
- The International Centre for Radio Astronomy Research (ICRAR), which supports the development of the world's largest radio telescope, the Square Kilometre Array (SKA). ICRAR's engineering program specialises in antenna design, radio-frequency engineering, electromagnetic compatibility, high-performance computing, digital systems and software engineering.
- The School of Biological Sciences has capabilities in:
  - » identification of biological material through DNA barcoding.
  - » identification of complex pollen mixtures through DNA metabarcoding.
  - » biogeographic interpretation of botanical data, and comparison of species composition across samples.
  - » method development in forensic applications of DNA barcoding and metabarcoding.
- The Microelectronics Research Group runs a completely vertically integrated Facility for sensors, from materials growth, through device design, fabrication and testing, to packaging and sub-system assembly.

Contact Details

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