The University Defence Research Collaboration in Signal Processing: Phase 3

Signal processing in the information age
The UDRC

Collaborative Centre of Excellence for Signal Processing

Aims
• World-class research
• Long-term sustainable skills
• Community of practice

Approach
• Joint funding with EPSRC
• Dstl technical leadership
• Close, early engagement with industry
**Phase 1:** University Defence Research Centre on signal processing

**Phase 2:** Signal processing in the networked battlespace

**Phase 3:** Signal processing in the information age

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**UDRC Timeline**

- **Apr 2008**
- **Apr 2010**
- **Apr 2012**
- **Apr 2014**
- **Apr 2016**
- **Apr 2018**
- **Apr 2020**
- **Apr 2022**

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• Huge academic impact: over 300 peer-reviewed publications
• High rate of exploitation of algorithms for a large variety of defence signal processing applications, including:
  – Compressed sensing algorithms for Low Frequency SAR
  – Incorporation of algorithms into a project on assured underwater mine detection under the Maritime Collaborative Enterprise (MarCE) programme
  – Work at Strathclyde University on radar micro-Doppler has been used for classification for ballistic missile defence
  – Sparsity-based spectral decomposition algorithms adapted for use in in-service Raman spectrometer
  – The release of the Polynomial Matrix Eigenvalue Decomposition (PEVD) Matlab toolbox. This has application in large-array processing
• Non defence applications, including healthcare technologies, autonomous systems, communications technology
• Data release to industry/academia on short timescales
UDRC phase 3 model

Underpinning Signal Processing

Electromagnetic environment
Imaging and detection through complex media

Application theme: TBA

Application theme: TBA

Application theme: TBA

Apr 2018  Apr 2019  Apr 2020  Apr 2021  Apr 2022  Apr 2023

USP Grant:
£4M over 5 years
= £800k per year
= £400k MOD + £400k EPSRC per year

AT Grants:
1st tranche: £1M over 2-3 years 50:50
MOD/EPSRC
Future tranches: will vary
Underpinning Signal Processing

- **Signal processing on large, multidimensional data**
  - Needles in multidimensional haystacks (and needlestacks)
  - Data with high and asymmetric uncertainty
  - Non-traditional correlation (e.g. physics-based sensors with human-sourced information)
  - Assessing the information content of complex data (i.e. what is the method-agnostic upper-bound on the value of processing any given dataset or future collect?)

- **High-volume Signal Processing**
  - Anomaly, outlier and correlation discovery; coping with the incompleteness of any model of normality
  - Fleeting and highly non-stationary signals
  - Non-centralised and pipeline processing
  - Verification of machine-learned models in other domains/scenarios

- **Challenges of the ‘Information Age’**
  - Management of very different types of uncertainty
  - “Hyper-fusion” – Data fusion writ large
  - Automated structure discovery
  - Resource constrained sensor management across wide information sources
  - Performance metrics for sensor management
  - Trust and provenance of information sources
Fostering the signal processing community

Annual Conference

Educating the next generation

Website

Special journal editions, books, articles, theme meetings
Exploitation, impact, community

- Data exchange
- Industrial links
- Secondments to/from industry/government
- Enabling contracts with MOD/Dstl
- Application themes
- SSPD a flagship international conference in signal processing for defence
- Widen the participation of the UK signal processing community
- Government/industry knowledge transfer meetings to generate a forum for defence signal processing requirements.
- Websites, LinkedIn and newsletter updates
Summary

• UDRC phase 2 had a huge academic impact with over 300 peer-reviewed publications, a high rate of exploitation of algorithms for a large variety of defence signal processing applications, and excellent community-building activities.

• UDRC phase 3 aims to continue these activities, while broadening the community and addressing the move from signal processing to information processing.

• UDRC3 runs under a underpinning + applications model.

• UDRC3 application themes in *imaging and detection through complex media* and *electromagnetic environment* begin in 2019.

• Further UDRC3 application theme calls will follow in 2019-2021.