Paul Thomas
Dstl Cyber and Information Systems

OFFICIAL

Ministry of Defence

Academic Industry Meeting day

- One day event at which companies submit a question or commercial challenge within the chosen AIMday topic.

- Multi-disciplinary academics with knowledge on how to address the specific company challenges then self-select the questions which they believe they can add most value to.

- On the day itself, the academics attend a one hour workshop face to face with the company to discuss possible pathways to a solution.
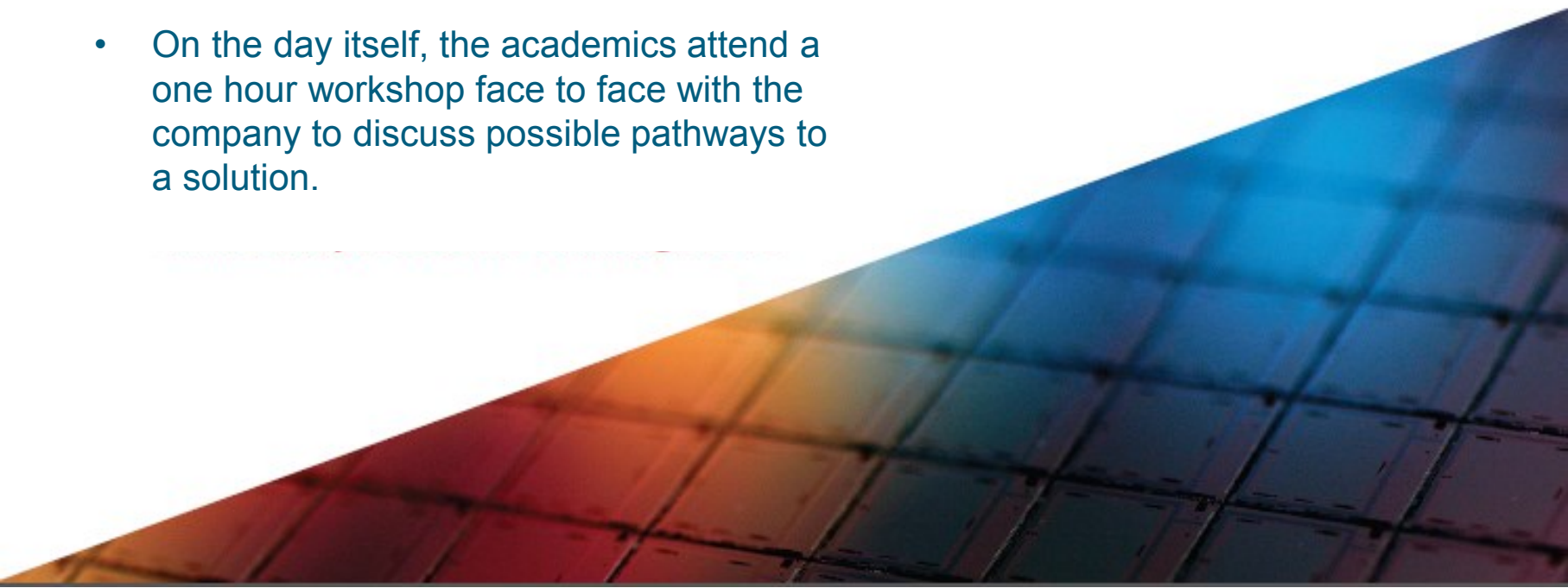
University Defence Research Collaboration (UDRC)

Collaborative Centre for excellence for Signal Processing

Aims:
- World-class research
- Long-term sustainable skills
- Community of Practice

Approach:
- Joint funding with EPSRC
- Dstl technical partnership
- Close, early engagement with industry

Features

- Joint programme with Engineering and Physical Sciences Research Council (EPSRC)

- Technical Challenge led research
    – Provides academic community with guidance on real world problems

- Strong Industry partnership

Automotive Sensing and Signal Analysis

The automobile of the future is also a <u>mobile sensing platform</u>, operating as part of a distributed sensor network.

In general, the deployed sensors have different, complementary strengths.

For example, video and LiDAR sensors can provide detailed 3D maps and provide rich data to recognise other road users and 'furniture', e.g. pedestrians, powered vehicles, cycles, animals, road signs, obstructions, potholes etc.

Radar systems are able to penetrate poor atmospheric conditions and can have longer range, but generally have poor resolution so it is difficult to distinguish between different entities on the road.

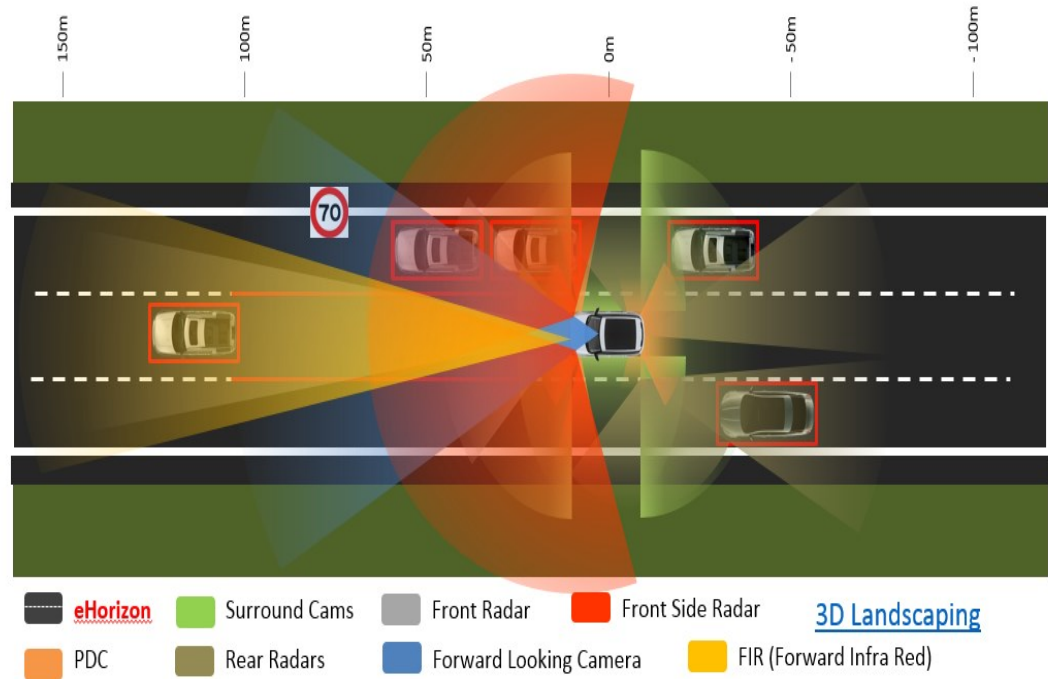|				
eHorizon	Surround Cams	Front Radar	Front Side Radar	**3D Landscaping**
PDC	Rear Radars	Forward Looking Camera	FIR (Forward Infra Red)	

Image courtesy of Jaguar Land Rover.

<u>Situational awareness</u> is the key to both vehicle autonomy and driver assistance. In general, this translates to a complete 3D map of the surrounding environment, together with identified and located users, hazards and static objects including road signs and buildings so that the vehicle can steer or be steered according to safe and efficient principles.

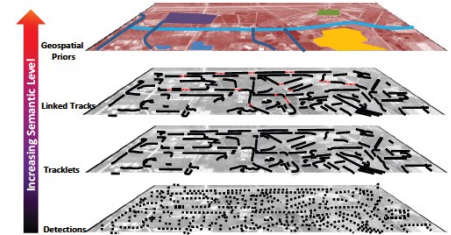# Key Challenges in Signal Analysis
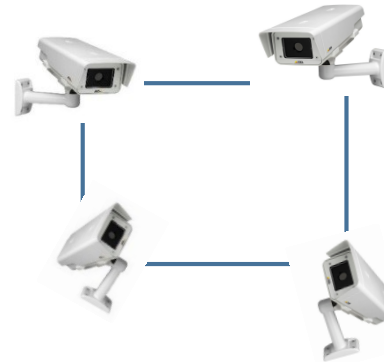
- First and foremost, safe (autonomous) driving requires very high (perfect?) <u>accuracy of classification</u>.

- Second, <u>3D mapping has to be excellent</u> for safe and comfortable driving.

- Third, how do we combine the data from the several different sensors, i.e. <u>data/track/decision level fusion</u>?

- Fourth, how do we operate <u>off road and in bad weather</u>?

- Fifth, how do we <u>manage finite computational resource</u>?

- … and what about driver/machine interaction, networks of sensors, the use of a-priori data (GPS, road traffic) and urban vs motorway driving and …..
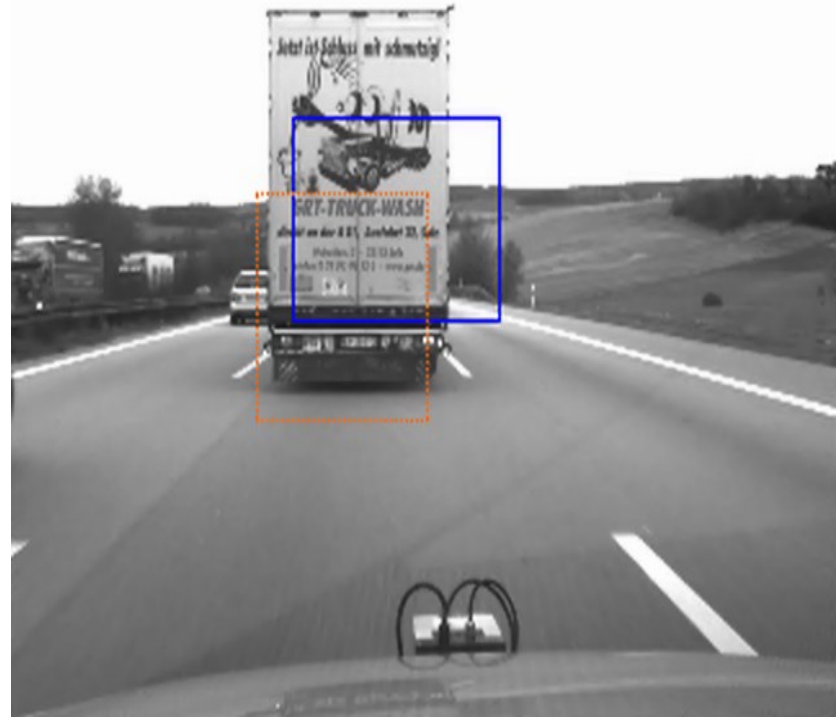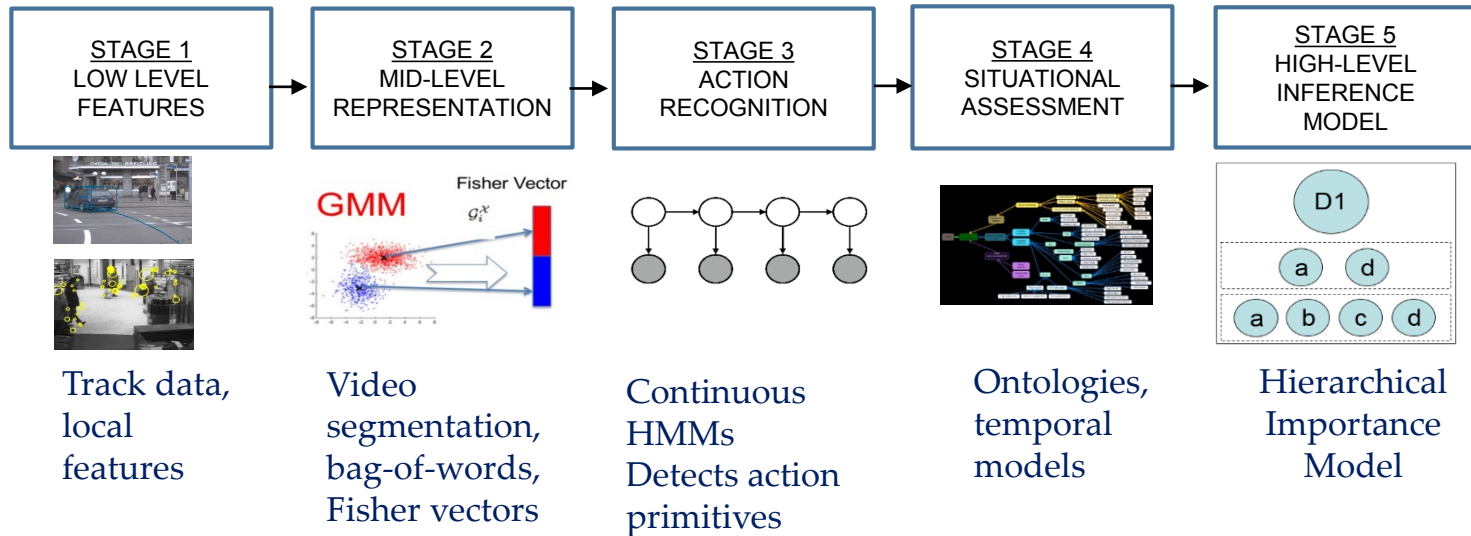

Switching attention (blue boxes) to identify other road users using video (as other sensors do other things…)

Activity recognition and anomaly detection in video

Ioannis Kaloskampis, Yulia Hicks

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

- **Multiple sensors**
  - ➤ Overlapping/non overlapping field of views
  - ➤ Variable sensor configuration

- **Multiple data modalities**
  Video, Radar, HCI, maps

DARPA WPAFB 2009

- **Proposed framework:**

STAGE 1 LOW LEVEL FEATURES	STAGE 2 MID-LEVEL REPRESENTATION	STAGE 3 ACTION RECOGNITION	STAGE 4 SITUATIONAL ASSESSMENT	STAGE 5 HIGH-LEVEL INFERENCE MODEL
Track data, local features	Video segmentation, bag-of-words, Fisher vectors	Continuous HMMs Detects action primitives	Ontologies, temporal models	Hierarchical Importance Model

GMM   Fisher Vector $g_i^{\mathcal{X}}$

D1
a d
a b c d

Network Anomaly Detection System

Unsupervised Anomaly-based IDS[1]:

- Uses **novel statistical algorithms** for automatic detection of anomalies and intrusions
- Able to operate in **real-time**
- Makes use of metrics from **multiple layers** of the TCP/IP stack
- **Dempster-Shafer (D-S) Theory** is used as data fusion technique
- Detects different types of **injection attacks**

Current work: Adding **available high-level information** to the detection process
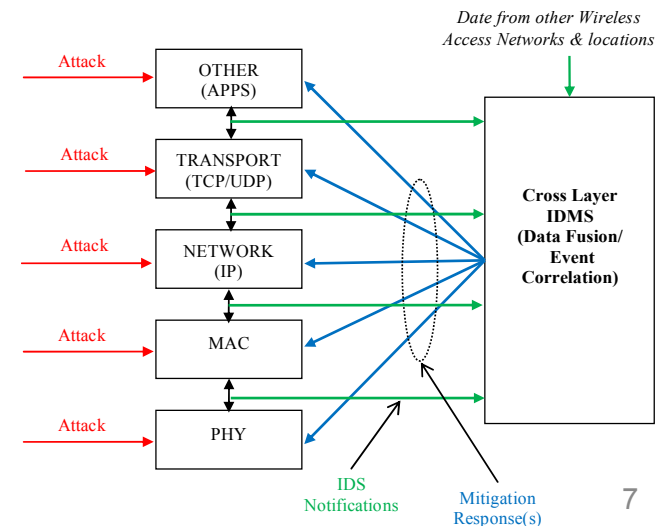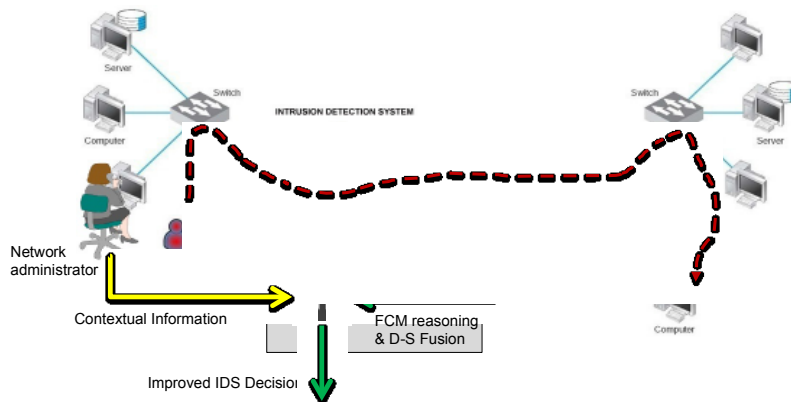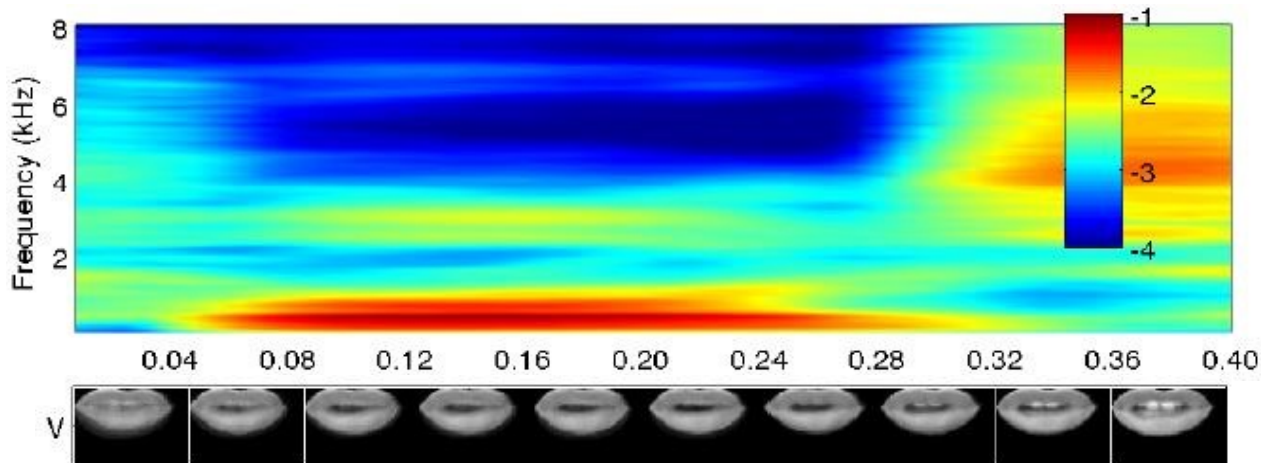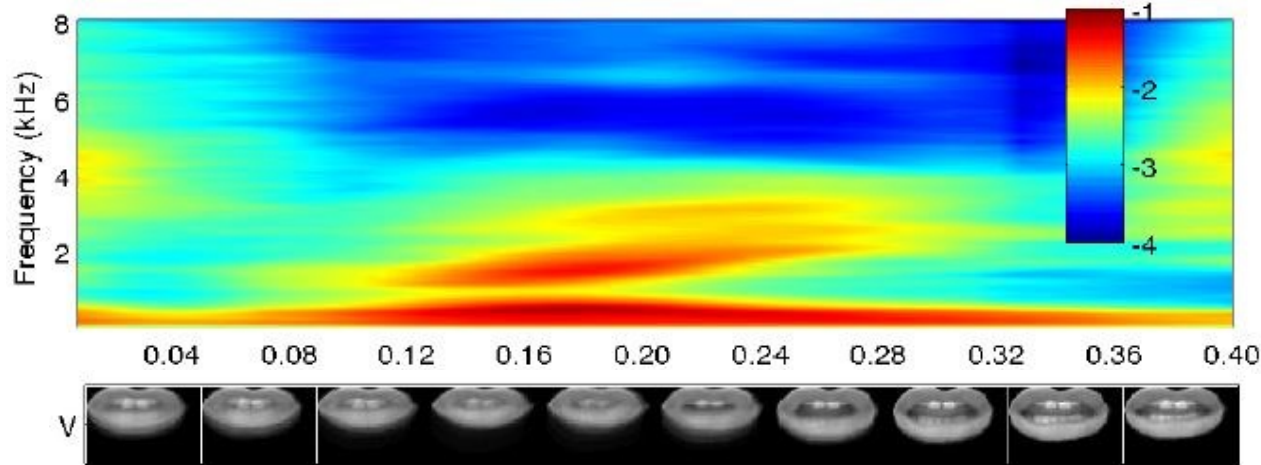
[1] K. G. Kyriakopoulos, F. J. Aparicio-Navarro, D. J. Parish, "Manual and automatic assigned thresholds in multi-layer data fusion intrusion detection system for 802.11 attacks," in IET Information Security, vol.8, no.1,

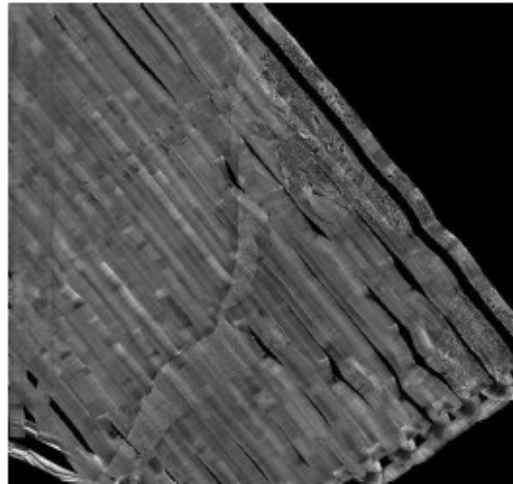# Audio-visual dictionary learning for source separation

Long Speech

Sheerman-Chase et al.
LILiR Twotalk database
2011
Lip tracking,
Ong et al. 2008

The first AV atom represents the utterance "**marine**" /mᵊriːn/ while the second one denotes the utterance "**port**" /pɔːt/.
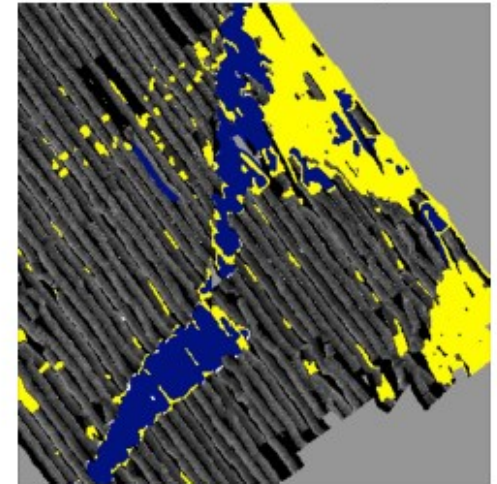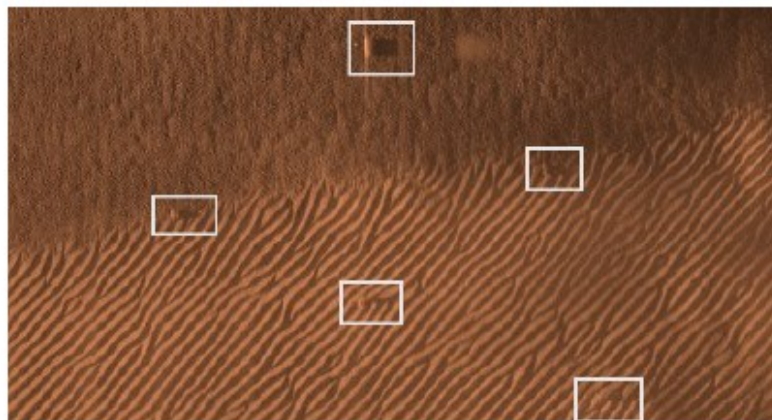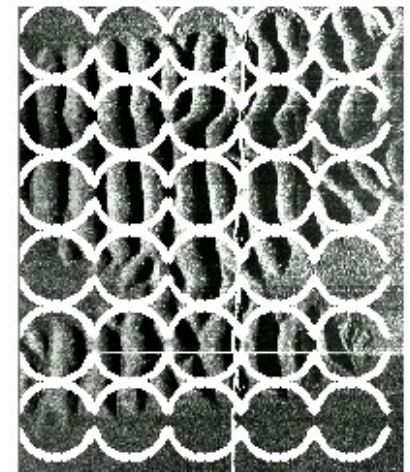
Data interpretation - Sonar

Raw Data

2km

Machine Learning

Markov Models

Data Fusion

Level Sets

Classified Map

Target Detection using cascade classifiers

$$E(C) = \lambda_1 \int_{int(C)} \left| I(x,y) - c_1 \right|^2 dxdy + \lambda_2 \int_{ext(C)} \left| I(x,y) - c_2 \right|^2 dxdy + \mu \int_C ds$$

Building a Signal Processing community

Conference

Sensor Signal Processing for Defence Conference

SSPD 2016

22 - 23 September
Royal College of Surgeons
Edinburgh

Important Dates:
Submission of Papers: 22nd April 2016
Notification of Paper Acceptance: 24th June 2016
Final version of Paper Due: 22nd July 2016

Summer School

UDRC Summer School
27 - 30 June, 2016
University of Edinburgh

IMPORTANT DATES
• Application for UDRC Summer School 2016 Opens: 11 January 2016
• Deadline for Application: 30 March 2016
• Notification of Application: 11 April 2016

This four day school is for researchers in industry, defence and academia with an interest in Signal Processing for Defence and a knowledge of Mathematics/Statistics at Masters level.
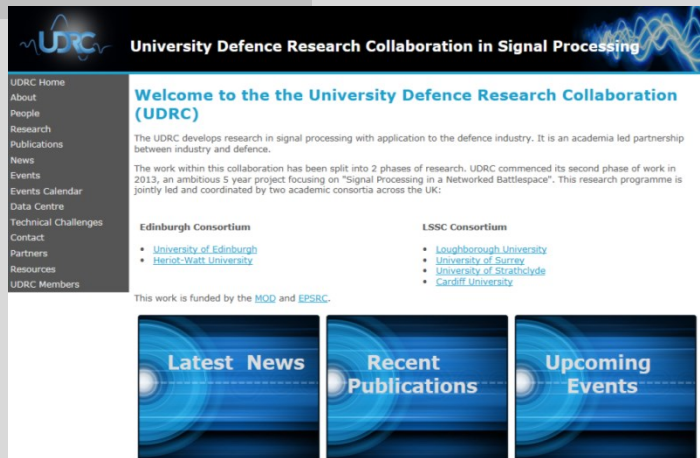
Summer School Programme

Monday 27 June	Statistical Signal Processing
Tuesday 28 June	Tracking
Wednesday 29	Pattern Recognition and Classification
Thursday 30 June	Source Separation

This summer school is delivered under the University Defence Research Collaboration (UDRC) in Signal Processing for a Networked Battlespace and is funded by EPSRC and Dstl.

Expressions of interest – email janet.forbes@ed.ac.uk
More information – http://www.mod-udrc.org/events/2016-summerschool

UDRC Website

UDRC University Defence Research Collaboration in Signal Processing

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Welcome to the the University Defence Research Collaboration (UDRC)

The UDRC develops research in signal processing with application to the defence industry. It is an academia led partnership between industry and defence.

The work within this collaboration has been split into 2 phases of research. UDRC commenced its second phase of work in 2013, an ambitious 5 year project focusing on "Signal Processing in a Networked Battlespace". This research programme is jointly led and coordinated by two academic consortia across the UK:

Edinburgh Consortium
University of Edinburgh
Heriot-Watt University

LSSC Consortium
Loughborough University
University of Surrey
University of Strathclyde
Cardiff University

This work is funded by the MOD and EPSRC.

Latest News   Recent Publications   Upcoming Events

Events

UDRC Themed Meeting - Space Surveillance and Tracking

The date for the new UDRC themed meeting has been set for the Wednesday 23rd November. More information coming soon.

Signal Processing AIM Day

Date: 21st September 2016
Location: University of Edinburgh

Event Description:

The UDRC are welcoming companies, organisations and academic researchers to discuss specific industry challenges in the field of Sensors & Signal Processing.

Edinburgh Research and Innovation
A UK leader in commercialising research and entrepreneurship

THE UNIVERSITY of EDINBURGH

UDRC

Sensor Signal Processing & Imaging

Welcome

Overview

- How AIMday works

- Additional support

- The day ahead…

Aim of the day

Meet new contacts from academia and industry who can offer unique perspectives on your challenge

1 hour facilitated workshop - to explore possible pathways to a solution

- 5 minutes introductions
- 5-10 company presentation
- 45 minutes discussion of the question
- 5 minutes wrap up and next steps

Additional Support

- Small pots of funding available now to take forward ideas
- EPSRC Impact Acceleration Account (IAA) Funding

We can help you identify appropriate funding support

General

- Hook Marine Ltd - Tausend Room, Facilitator, Laura Mackie
- Roke Manor Research – Wadsworth Room, Facilitator, Janet Forbes
- Thales – Facilitator, Logan Turner Room, John Jeffrey

2:15 – 2:30 Refreshments

2:30 – 3:30 Session 2

- Leonardo – Tausend Room, Facilitator, John Jeffrey
- Thales – Wadsworth Room, Facilitator, Laura Mackie

3:30 – 3:45 Refreshments

3:45 – 4:45 Session 3

- Thales - Tausend Room, Facilitator, Janet Forbes