Little Crow Conference

Date - 7th Novembermber 2012

Venue - CSIR, Building 22, Pretoria

12h30 – 13h00	Registration	All
13h00 – 13h10	Welcome & Opening	Christo Cloete & Gerrie Radloff
13h10 – 13h50	Simulating the DIRCM engagement: component and system level performance	Cornelius Willers, CSIR DPSS
13h50 – 14h30	Commensal Radar	Francois Louw, Peralex
14h30 – 15h00	Report on Aardvark Roost Activities	Board Members
15h00 – 15h15	Break	All
15h15 – 15h55	Weak communication signal detection	Jacobus Vlok, CSIR DPSS
15h55 – 16h35	Architecture for ES Receiver Systems Targeted at Commercial Wireless Communications	Warren P. du Plessis, CSIR DPSS
16h35 – 17h15	Hardware in the Loop Radar Clutter Simulation	Jurgen Strydom, CSIR DPSS
17h15 – 17h25	Closing address	Gerrie Radloff
17h25 – 19h00	Informal function and networking	All

Simulating the DIRCM engagement: component and system level performance

Cornelius J. Willers, CSIR DPSS

The proliferation of a diversity of capable ManPADS missiles poses a serious threat to civil and military aviation. Aircraft self protection against missiles requires increased sophistication as missile capabilities increase. Recent advances in self protection include the use of directed infrared countermeasures (DIRCM), employing high power lamps or lasers as sources of infrared energy. The larger aircraft self-protection scenario, comprising the missile, aircraft and DIRCM hardware is a complex system. In this system, each component presents major technological challenges in itself, but the interaction and aggregate behaviour of the systems also present design difficulties and performance constraints.

This paper presents a description of a simulation system, that provides the ability to model the individual components in detail, but also accurately models the interaction between the components, including the play out of the engagement scenario.

Objects such as aircraft, flares and missiles are modelled as a three-dimensional object with a physical body, radiometric signature properties and six-degrees-of-freedom kinematic behaviour. The object's physical body is modelled as a convex hull of polygons, each with radiometric properties. The radiometric properties cover the 0.4–14 µm spectral range (wider than required in current technology missiles) and include reflection of sunlight, sky radiance, atmospheric effects as well thermal self-emission. The signature modelling includes accurate temporal variation and spectral descriptions of the object's signature. The object's kinematic behavior is modelled using finite difference equations. The objects in the scenario are placed and appropriately orientated in a three-dimensional world, and the engagement is allowed to play out.

Low-power countermeasure techniques against the missile seekers include jamming (decoying by injecting false signals) and dazzling (blinding the sensor). Both approaches require knowledge of the missile sensor and/or signal processing hardware. Simulation of jamming operation is achieved by implementing the missile-specific signal processing in the simulation (i.e. accurate white-box modelling of actual behaviour). Simulation of dazzling operation is more difficult and a parametric black-box modelling approach is taken. The design and calibration of the black-box dazzling behaviour is done by heuristic modelling based on experimental observations. The black-box behaviour can later be replaced with verified behaviour, as obtained by experimental laboratory and field work, using the specified missile hardware.

The task of simulating a DIRCM system is scoped, by considering the threats, operational requirements and detailed requirements of the respective models. A description is given of the object models in the simulation, including key performance parameters of the models and a brief description of how these are implemented. The paper closes with recommendations for future research and simulation investigations

Bio:

Cornelius J Willers completed a B.Sc (Honns) Electronics Engineering at the University of Pretoria in 1976 and a MS (Optical Engineering) at the University of Arizona in 1983. He is currently hunting for an exciting topic for a PhD degree. He is registered as a professional engineer. His 30 years work experience includes electro-optical system development, system architecture and systems engineering, software development, simulation and more recently, information warfare and agent-based systems. His most notable achievements include being the architect and technical lead in the establishment of imaging infrared missile seeker head technology in South Africa, spearheading advanced physics-based image simulation and writing a book on the theoretical foundations of electro-optical system design. A more recent research interest is the modelling and simulation of complex systems using agent based modelling techniques. He has published a number of technical reports and articles on infrared system simulation and the modelling of military conflict using agent based techniques. He is presently preparing a book on radiometry for publication with SPIE Press in April 2013. His other interests include reading non-fiction, listening to a wide range of music and maintaining a healthy lifestyle.

Completed an MS (Optical Engineering) at the University of Arizona in 1983 and is a chartered/professional engineer. His 30 years work experience includes electro-optical system development, system architecture/engineering, software development and simulation. His most notable achievements include being the architect and technical lead in the establishment of imaging infrared missile seeker head technology in South Africa, spearheading advanced physics-based image simulation. He is presently preparing a book on advanced radiometry for publication with SPIE Press in April 2013.

Commensal Radar

Francois Louw, Peralex

An introduction to Commensal Radar: an ongoing collaborative project between Peralex, UCT and CSIR using the latest techniques and technologies to make passive radar viable.

Bio:

Francois Louw received his B.Eng (Electrical & Electronic) degree Cum Laude at the University of Stellenbosch in 2003. He worked as a software engineer in the development of spectrum monitoring and radio direction finding systems at Peralex Electronics, specializing in digital signal processing, direction finding algorithms, digital receiver design and implementation of code for high performance computing until 2008. Francois was also a technology consultant for Altran where he was involved in the development of interventional X-Ray systems for Philips Healthcare as well as imbedded software. Since 2010, he rejoined Peralex as a project manager, whilst still maintaining a technical lead as a System Architect in the development of Spectrum Management and Monitoring systems.

Hardware in the Loop Radar Clutter Simulation

Jurgen Strydom, CSIR DPSS

The testing and evaluation of a modern radar is becoming increasingly difficult owing to the adaptive nature of such radars, and the wide range of clutter backscatter encountered in the radar environment. In general there are two approaches to this problem: Firstly the radar development house can design and build specialised test equipment for each radar. Secondly more generic test equipment can be designed which can be used to test a class of radars. This second approach is especially important to organizations, such as defence evaluation and research institutes (DERI) and other government agencies, which specialize in independent review, acceptance testing and optimisation of the operational utilisation of radar systems. The problem with the in-house test equipment in the first option is to prove that it is not biased towards the specific radar it was designed to be a test instrument for. The use of the more general, independently developed advanced EW, EMS test systems is thus required for independent testing and evaluation of radar systems. The CSIR DRFM hardware technology is used as the basis of these test systems. DRFMs are traditionally used for EW applications, but processing power of FPGAs have made the testing and evaluation of complex radar systems possible. The clutter sensed by a radar which surveys a section of ocean, and the radar mounted on a moving airborne platform that surveys a section of land, probably encounters some of the most complex of all possible scenarios. Sea clutter is extremely complex to suppress because of its dynamic nature, and large dependence on weather conditions. Clutter for an airborne platform is difficult to suppress due to the power reflected trough the sidelobes, and the ambiguities introduced in high PRF radar operational modes. The simulation of these complex clutter scenarios on DRFM hardware platforms will be presented.

Bio:

Jurgen Strydom graduated from the University of Pretoria in 2009 with a Bachelor in Electronic Engineering where he completed his final year project on synthetic ground clutter simulation on DRFM systems. He completed his masters degree at the University of Cape Town in 2012 on the topic of generic ground clutter simulation for radar testing and evaluation. He has been employed by the CSIR from the start of 2010 and is currently working in the experimental electronic warfare team as a systems engineer and signal analyst. His field of speciality is the generation of synthetic clutter on DRFM platforms for hardware in the loop radar testing and evaluation.

Weak communication signal detection

Jacobus Vlok, CSIR DPSS

The detection of communication signals, and specifically weak signals, forms part of ES COMINT and is the foundational component of communications EW. Efficient detection of weak communication signals will enhance communication interception, DF and jamming. Detection of weak communication signals are also applicable to the wider field of LPI detection, which include radar signals, since the underlying modulation techniques are similar. The presentation will consider recent research work on weak communication signal detection with a focus on DSSS signals performed at the CSIR. Classic detection methods will be reviewed and possible new techniques presented.

Bio:

Jacobus Vlok completed his M.Eng (Electronic) at UP in 2006 in the signal processing and digital communications research group under Prof. Louis Linde. He then joined CSIR DPSS REW in 2007, mainly working in the communications EW domain. He recently enrolled for the PhD under Prof. Corne Olivier at UTAS with the topic: Detection of DSSS signals.

Architecture for ES Receiver Systems Targeted at Commercial Wireless Communications

Warren P. du Plessis, CSIR DPSS

Commercial wireless communications system are increasingly being used by criminal, paramilitary and military operators. The detection and location of such systems is thus crucially important in many applications. Modern electronic support (ES) systems are descended from systems intended for the detection of small numbers of high-power radar systems, and are thus not suitable for the low-power transmitters and dense signal environments typical of commercial communications networks. An ES system architecture suitable for commercial communications systems is proposed, and the benefits of this architecture are outlined.

Bio:

Warren du Plessis received the B.Eng. (Electronic) and M.Eng. (Electronic) and Ph.D. (Engineering) degrees from the University of Pretoria in 1998, 2003 and 2010 respectively, winning numerous academic awards including the prestigious Vice-Chancellor and Principal's Medal.

Dr du Plessis spent two years as a lecturer at the University of Pretoria, and then joined Grintek Antennas (since split between Poynting Antennas and Saab EDS) as a design engineer for almost four years. Since 2006, he has been working in Electronic Warfare (EW) at Defence, Peace, Safety and Security (DPSS), a division of the Council for Scientific and Industrial Research (CSIR) in Pretoria, South Africa. In his time at DPSS, he has won awards for "Excellence as a Young Professional" and "Outstanding Contribution by an Individual." His current primary research interests are cross-eye jamming, and thinned and sparse antenna arrays.

Dr du Plessis is lead or sole author of seven papers published in international journals (five in IEEE Transactions journals), and is author of thirteen published and accepted peer-reviewed conference papers (lead or sole author of ten of these papers), and is author or co-author of a further seven conference papers and tutorials. He is a Senior Member of the Institute for Electrical and Electronics Engineers (IEEE), is a member of the Association of Old Crows (AOC), is an Adjunct Senior Lecturer in the School of Engineering at the University of Tasmania, and has had his CV published in Who's Who in the World.