Royal Higher Institute for Defence
Department Scientific and Technological Research of Defence

SCIENTIFIC RESEARCH IN THE BELGIAN DEFENCE

2015 - 2016

INTRODUCTION:

Dear Reader,

This military scientific research report is intented for a broad audience, larger than Defence. Its aim is to provide an overview of research done inside the Belgian Armed Forces in the period 2015 - 2016 to address their specific needs, whether in the short term, mid term or long term. This brochure intends to give you a flavour in the wide-ranging research in defence technology, military medicine, military psychology and social geosciences.

The selected topics give insights into the multifaceted military research.

We are confident that, while reading or scrolling through this report, your interest in Belgian research will thrive. We appreciate any feedback, questions or suggestions either via me or the study directors of the individual studies.

Sincerly Yours,

Tim Van Langenhove

Director of Scientific and Technological Research of Defence

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Study on cryptographic methods with special attention for symmetric key algorithms and hash functions

Director:
Prof. D. Van Heule
Researchers:
F. Lafitte,
Sr Capt (Air) H. Bruyninckx

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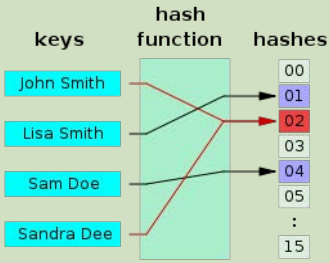
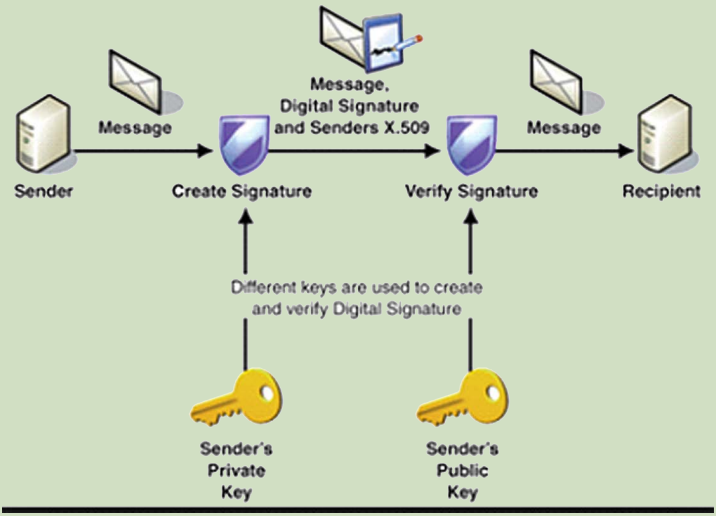
Study on cryptographic methods with special attention for symmetric key algorithms and hash functions

Background

A **random number generation** is the generation of a sequence of numbers or symbols that cannot be reasonably predicted better than by a random chance, usually through a random number generator.



A **hash function** is any **function** that can be used to map data of arbitrary size to data of fixed size. The values returned by a hash function are called **hash** values.
The study is also part of the doctorate of Fréderic Lafitte (2015) and air force senior captain Helena Bruyninckx (2016) in collaboration with the Université libre de Bruxelles (ULB).



Objectives

The project IS-06 is the continuation of the previous projects F94, F99, IS-04 and IS-05, the main objective of which has always been to assist SGRS[1]-SI/S/CIS & Cyber security with understanding and eventually adapting the cryptographic algorithms and protocols. The current project focuses on the generation of random numbers, on automated verification tools and on hash functions.
One part aims at replacing the TRNG (True Number Generator) with a pseudo-random number generator (PRNG) to mimic the truly uniform distribution by the TRNG.

As a verification tool, the open source software "cryptosat" has been developed. It allows automatic verification of a large range of symmetric key algorithms. So far the tool has been successfully applied to block ciphers and stream ciphers.
As for hash functions, their aim is to destroy (hash) any structure of a variable length input (e.g. a file, a password) to produce a fixed length output. In order to be secure, hash functions need to satisfy at least one of the following properties:

- it is practically impossible to find the input corresponding to a given output;
- it is practically impossible to find two inputs that produce the same output.

Outcome

To have at one's disposal an own crypto directly usable by the services of SGRS-SI/S/CIS & Cyber Security.

[1] Service général du renseignement et de la sécurité (General Intelligence and Security Service, GISS)

Study and development of an intelligent framework for steganography/ steganalysis in digital images

Director:
Prof. D. Van Heule
Researcher:
D. Borghys

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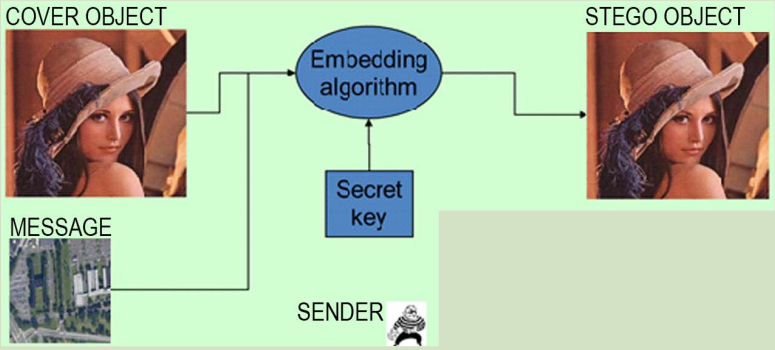
Study and development of an intelligent framework for steganography/ steganalysis in digital images

Background

Steganography is the art of hiding information in innocent looking objects. Contrary to cryptography, steganography hides the very presence of the message. Since the mid-nineties the number of developed steganographic methods and tools which are freely available has grown exponentially, especially in digital media (images, video and audio mediums). Steganalysis is the research field which aims to detect and reveal the presence of hidden information.



Objectives

The framework consists of two main parts:

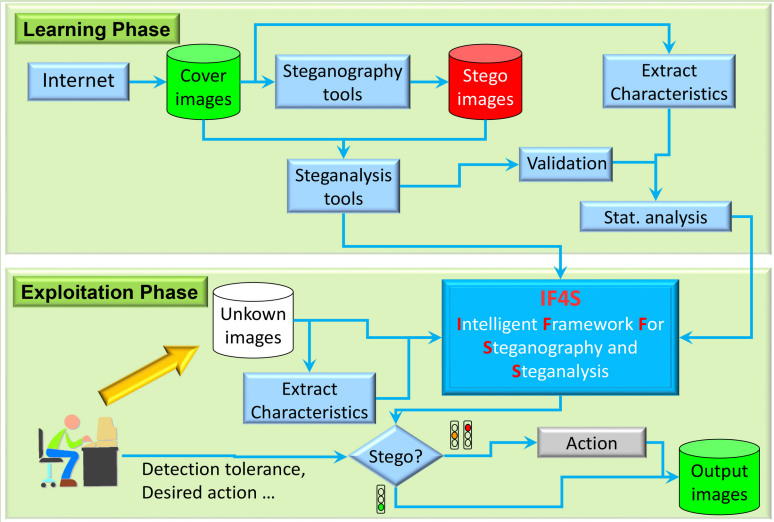
- the learning phase, in which a database of known steganographic images is collected and, for each of the available steganographic tools, a corresponding database of stego-images is constructed. A set of detectors are applied and their performance for each type of steganography is evaluated;

- the exploitation phase, during which unknown images are fed into the system to detect any possible hidden information. Based on the evaluation, the detector with the best performances is used. Via a graphical front-end (GUI) the user selects the images to investigate, and decides thresholds to be fixed and actions to be taken in case of positive detection.

The design easily allows to introduce "new" steganography software for which the system so far did not develop a detector.

Outcome

A first intelligent prototype has been developed. The developed detection methods have been tested against a large database of known cover images and stego-images. This allowed characterising the correlation between image properties and detector performance and suggesting the best detector for a given image type and for each of the investigated steganographic methods.
A semi-automatic framework was set up that also offers the possibility to destroy the embedded information (sanitisation).
A follow-on study is ongoing in order to further develop, in close collaboration with the client, the prototype and hand it over to the services of GISS.



Shipboard force protection: behaviour analysis of various targets in port context

Directors:
Prof. A. Muls
Lieutenant D. Florins
Researcher:
A. Borghgraef

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Shipboard force protection: behaviour analysis of various targets in port context

Objectives

Automatic detection of small floating objects on an agitated sea surface is a major problem due to, amongst others, the background of the waves, certainly when a sea state of 2 or higher is attained (wave height >0,5 m). The method used here is the behaviour subtraction method. Its core idea is to look at events in a video sequence, not at individual frames. Then, the features of these events can be extracted, analysed, compared to a learned background model and used to detect outliers to the background model.

MWIR data of drifting mine from the Castor trial

P901 Castor with ELBIT Micro-CoMPASS MWIR sensor in the mast

BE Defence-Jorn Urbain

The algorithm was validated by conducting several measurement campaigns. Experiments both with the F930 Leopold I (at sea) and the P901 Castor (in the harbour) have been conducted using a metal practice mine at a distance of approximately 250 m as a simulation for a real mine along with a number of sequences of swimmers and small boat activities.

Outcome

The project has shown that small objects hard to spot, such as drifting mines, can be detected by behaviour analysis-based algorithms. There are still unknowns to be solved, mainly due to a lack of open sea data.
Since the end of the project, the Castor has recorded mid-wave infrared (MWIR) footage of drifting targets at sea, which should resolve the last question (still under investigation).

Director:
Prof. X. Neyt
Researchers:
C. Beumier
M. Idrissa

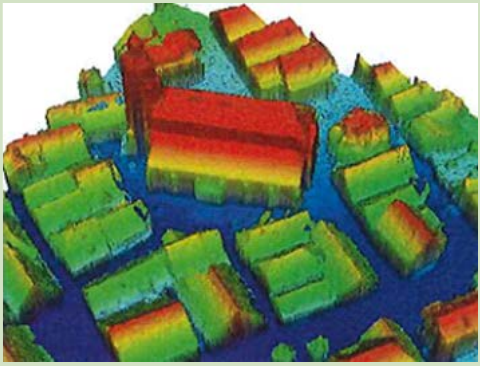
4

Digital surface model and applications

Background

Digital surface models (DSM) or digital terrain models (DTM) are of key importance for military missions and to civil society, whether it concerns security, humanitarian or environmental activities. Typical applications are assisted navigation, planning, risk assessment and change detection. Our two clients, GISS-I/M (from the Belgian Ministry of Defence) and the Belgian National Geographic Institute (NGI), are top users of these models.

Multi-view at 10 cm of Vaihingen (DE) and reconstruction in 3D



Objectives

The study concerns, on the one hand, automatic DSM extraction from very high space and radiometric resolution images through a multi-view approach and, on the other hand, obtaining derived products (digital models (DM), orthophotos, change detection, landscape modelling) in the cases of air and satellite images.

Outcome

Detecting changes in order to update vector databases thanks to recent images is a key concern for NGI. The former study showed the relevance of height data and of vegetation and colour indices for detecting buildings, when profitably combined through a histogram classification. In this study, an object-based approach has been considered. It consists in extracting homogeneous zones from an image and in attributing to each image spectral and geometric parameters. The object-based approach has also been considered for another NGI interest theme: the road network. Homogeneous zones in terms of colour and height have been automatically deep-etched.

Safe handling of EOD in hazardous EME, support to MoD

Director:
Prof. M. Piette
Researcher:
Ch. Tsigros

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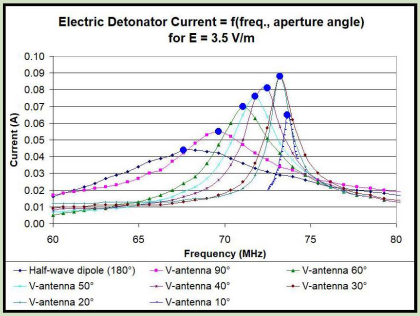
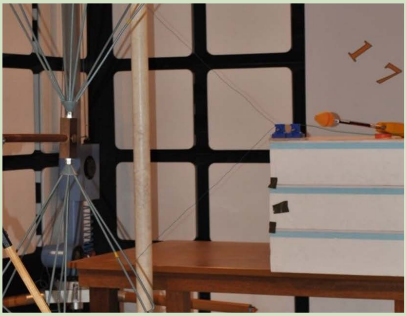
Safe handling of EOD in hazardous EME, support to MoD

Background

With the aim of acquiring a new scientific expertise in the assessment of radiofrequency wave effects on explosive devices and making it available for the Belgian Defence, tests have been performed in order to determine the minimal risk for bomb disposal experts in the presence of an emission source. It is essential to guarantee the physical safety of its personnel, particularly members of the Belgian EOD (DOVO-SEDEE) during on-site interventions in the presence of radio transmitters.

The Belgian Defence regularly asks for expertise and measurements. The study contributes to answering and anticipating these requests.





Testing of the detonator with its lead forming an aperture angle of 90°

Objectives

In order to improve the security for all persons in contact with explosives, and more particularly for the demining units, it is of utmost important to know the worst case scenario in order to avoid such appearances. In order to make this more evident and to state other dangerous situations, a multitude of tests have been made with different antennas and different aperture angles. Subsequently new safety distance values need to be taken into account.

Outcome

It is shown both by measurements and simulation that the worst case configuration for the lead wires of an electric detonator loaded with a hotwire bridge is a V-antenna, and not half-wave dipole as considered in several standards and reference guidelines. This assumption is valid for low DC resistance/impedance electric detonators as they better match the input impedance of the antenna. When the aperture angle is between 20° and 30°, an amplification of the induced current by a factor of 2 compared to the half-wave dipole is demonstrated. This factor reduces the safety margin of demining personnel manipulating the electric detonators. For safety assessments, it is recommended to increase the safety distance by a factor of at least 2 if worst case configurations are considered.

Performances of antennas in presence of perturbing structures

Director:
Prof. M. Piette
Researcher:
T. My Dung

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Performances of antennas in presence of perturbing structures

Background

The Wingene antenna site occupies an area of 0.9 km² with twenty-five large antennas of six different types. The frequencies range from 1.6 MHz to 30 MHz, with a relatively high power (up to 20 kW). This high concentration of antennas (distances are sometimes less than 100 m, corresponding to 10 times the wavelength at 30 MHz but less than 2 times the wavelength at 2 MHz) raised a concern about radiation hazard to personnel or people occasionally on site to repair.

Objectives

The primary objective of the project was to conduct a near-field radiation hazard assessment with the aim of setting up a new antenna amongst the existing ones. The location is much closer to the neighbouring antennas than usual, around 0.6 times the wavelength. The LEMA lab of the RMA therefore proposed to evaluate the operational impact of the new antenna before its installation.

Outcome

Based on the information about the ground characteristics from the Wingene site, five different types of ground were simulated and compared: PEC (Perfect Electrical Conductor), loamy dry, loamy wet, sandy wet and sandy dry. As an exemple the figure shows the gain of HD antenna at 8 MHz above these types of ground. The total gain is higher with PEC ground than with other types of ground, but the radiation patterns are quite similar.

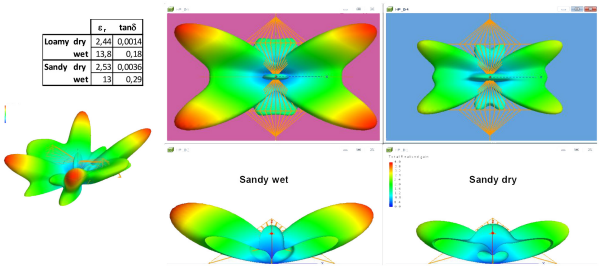
An extensive measurement campaign has been set up at well-chosen locations to measure both the E and H fields. These measurements were then compared to the simulated results.

The evaluation of the new antenna could be done quickly and easily by simulation since the whole field modelling was available thanks to a previous measurement campaign.

It showed that the new antenna did not significantly impact the working of its neighbouring antennas while having itself acceptable performances.

Total realised gain of HD antenna with different grounds at 8 MHz

		ε_r	tanδ
Loamy	dry	2,44	0,0014
	wet	13,8	0,18
Sandy	dry	2,53	0,0036
	wet	13	0,29



Synthetic aperture land application tools (SARLAT)

Director:
Prof. A. Muls
Researchers:
N. Milisavljevic
D. Closson

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Synthetic aperture land application tools (SARLAT)

Background

The mission of the General Intelligence and Security Service (GISS) – Geospatial section – is to provide technical reports to the Belgian Defence and the Belgian Government, based on the analysis and interpretation of satellite images. The quality of these files varies with the degree of emergency and the space-borne sensors available in a zone at a given time.

Early 2000, during the implementation of GISS Imagery section, the existing supply in high-resolution satellite imagery led officials to use data acquired exclusively in the visible wavelength (HELIOS). However, from 2008, the recurring difficulty of obtaining a usable scene at a time and in a specific place, without weather or diurnal cycle constraints, has prompted authorities to look at the radar imagery. Interferometric Synthetic Aperture Radar (InSAR) is a valuable technique for measuring surface deformation with high spatial resolution and high accuracy, independently of weather conditions. It has been successfully applied to the monitoring of landslides, earthquake deformations, volcanic activities and urban subsidence as well as anthropogenic deformation caused by mining, oil, gas and groundwater extraction. However, human interpretation of radar images in different environments, with a variety of wavelengths as well as different spatial resolutions and acquisition times, is far from being easy.

Objectives

In the period 2008-2012, under the C4-18 project of STRD, hundreds of radar images were acquired from high-resolution satellites TerraSAR-X, SAR-Lupe and COSMO-SkyMed over nineteen targets distributed worldwide. They were studied under the aspect of military intelligence: airports, harbours, minefields, missile and electronic warfare sites, damage assessment with the automatic detection of craters, etc.

Programs were developed with the Model Maker module of ERDAS IMAGINE software.

The SARLAT project follows the line of C4-18. The aim was and still is to provide relevant and current knowledge to analysts, as well as to improve their ability to interpret and analyse radar images. Information fusion remains at the heart of research and development.

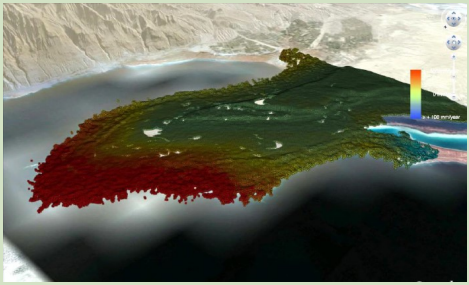
SARLAT covers the transitional period 2013-2017, which corresponds to the gradual setting up of an expert team in the interpretation of radar images. In this period "pre-MUSIS" (MUltinational Space-based Imaging System for Surveillance, Reconnaissance and Observation), it is crucial to train analysts in using radar images in an operational context.

Outcome

Thanks to the "SARLAT" results, major improvements in the operational sequence have been achieved, namely:

- Image processing or preparation of thematic data (e.g., coherence or 3D models). The processing is carried out with the Radar Mapping Suite of ERDAS and SARscape module of ENVI;
- Processing of thematic data. Programs are developed into the Model Maker module of ERDAS and in C++;
- Geomatics. The data are centralised in the geographical information system ArcGIS. This software is used for the production of cartographic documents.

Dead sea area, Jordan: Dikes stability monitoring and subsidence.



Al-Lisan peninsula : average displacement rate in the 2003-2010 period

Assessment of kinetic energy non-lethal weapon systems

Project Director:
Maj A. Papy, PhD MSc Eng

Researchers:
C. Robbe, PhD MSc Eng
N. Nsiampa, PhD MSc Eng

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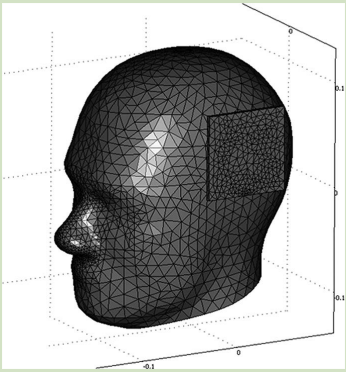
Assessment of kinetic energy non-lethal weapon systems

Background

Minimising civilian casualties and unnecessary collateral damages during military or law-enforcement operations has always been a tough challenge. Non-lethal weapons allow a gradual response in case of continuous escalation in force deployment. kinectic energy non-lethal weapons (KENLW) are the most widely spread category of these types of weapons. Kinetic energy non-lethal projectiles are mainly used to impart sufficient effect onto a person in order to deter uncivil or hazardous behaviour with a low probability of permanent injury. Since their first use, real cases indicate that the injuries inflicted by such projectiles may be irreversible and sometimes lead to death. The nature and severity of injuries resulting from their use depend, among others, on the impacted body part. Due to the phenomenon of ballistic dispersion, more vulnerable parts, like the head, may be unintentionally hit. While the reported number of non-lethal projectile impacts to the head may be less when compared to the other vital body parts, more serious injuries have been attributed to the head impacts. Therefore, there is a necessity to assess the head impact in order to allow a safer use of non-lethal projectiles.



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Objectives

A new methodology based both on experimental laboratory tests and digital simulations has been developed in order to assess the efficiency and damages of kinetic energy non-lethal weapons on rib cage and head, and concerning skin penetration. Minimum and maximum engagement distances of such weapons can be determined in this way. Two launchers – the FN303 and the FN303P – have been assessed within the framework of the study. The developed methodology is also valid for whatever system of the same category.

The overall objective of this project is to develop a usable evaluation method for determing the effect of kinetic energy non-lethal weapons. The main influences that were studied, both theoretically and experimentally, are for impact on the thorax, the head and the penetration in the skin. The minimal and maximal engagement distances for such weapons can thus be deduced.

Outcome

Despite the current limitations to carry out the risk assessment of the non-lethal projectile head impacts, including accessibility to adequate data, the present project is the first study in the literature comparing assessment methods of the risks concerning such impacts. The maximum impact force seems to be a good predictor to assess the injury risk of the non-lethal projectile head impacts. These measurements and acceptable injury risks can then define an employment doctrine for non-lethal weapon users. Nevertheless, further investigations should be carried out in order to refine the critical thresholds of the maximum impact forces.

Alternative ship propulsion through artificial fins

Project Director:
Prof. W. Bosschaerts
Researcher:
J. Mattheijssens, PhD MSc Eng

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Alternative ship propulsion through artificial fins

Background

The detection of sea mines in the presence of unmanned surface vehicles (USVs), among others by the noise of their screws, is a huge problem. Within this study, the possibility has been investigated to propel the USV in a much more quietly manner thanks to fins.

Several institutions recently conducted research about artificial fins for small unmanned submarines. With these fins, it is possible to generate enough thrust force and execute precise manoeuvres, while consuming less energy. For application on larger surface vehicles, there are additional difficulties: influence of the free surface, limited space under the hull and a higher required thrust and speed.

The know-how is currently in an advanced state, but is not complete.

Objectives

To study the possibilities of a fin-propelled USV with a focus on propulsion and noise reduction.
To compare the performances of natural and artificial swimmers and flyers, in theoretical, computational and experimental ways.

Outcome

The Belgian Defence now has at its disposal a working prototype of silent propulsion system and the knowledge to optimise it and bring it into action on USVs. The research was part of a doctoral thesis in collaboration with the Vrije Universiteit Brussel (VUB).

Dynamic behaviour of stiff compo-site armour plates subjec-ted to ballis-tic impact

Project Director:
Maj F. Coghe, PhD MSc Eng
Researchers:
A. Vicario, MSc Eng
A. Azevedo, MSc Eng

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Dynamic behaviour of stiff composite armour plates subjected to ballistic impact

Background

This research project is specifically aimed at identifying possible design tracks for future ballistic helmet designs and assessing the feasibility of a much improved helmet design (even offering protection against high-velocity rifle bullets). In the framework of this project, an elaborate state-of-the-art prototype was developed showing the current level of technology for ballistic helmets, and also identifying the physical and technological "bottlenecks" for further improvements. The project among others extensively tested the Belgian Schuberth helmet against a number of emerging threats for which it was initially not designed. In order to do so, a number of specialised measurement techniques and setups were developed or acquired, permitting to evaluate not only the ballistic resistance of the helmet, but also the risk on behind-helmet blunt trauma like skull fracture or traumatic brain injury. This will also allow an extensive evaluation in the framework of a future helmet acquisition by the Belgian Armed Forces. The acquired information was already used as an input by the working group (formed with ACOS Ops & Trg and DGMR) for the future replacement of the Schuberth helmet.

Objectives

The aim is to develop an extended knowledge base on the dynamic behaviour of different composite armour configurations for advanced ballistic helmet design.

Outcome

Advanced numerical models were developed in order to further assist in evaluating the biomechanical consequences of a non-perforating impact on a ballistic helmet. Thanks to this, the project also allowed developing a methodology to escape the catch-22 situation the helmet manufacturing industry finds itself in. This has led to the development of a new ballistic shell offering protection against the ubiquitous 7.62x39 Kalashnikov round.

Finally, the latter result has been integrated in a newly started research project that will try to revolutionise the existing body armour systems (ballistic vests and helmets) and create a balanced solution for the eternal mobility-firepower-protection challenge.

Virtual and physical environmental testing : vibrations

Project Director:
Maj K. Harri, PhD MSc Eng
Researcher:
Sr Capt J. Martino, MSc Eng

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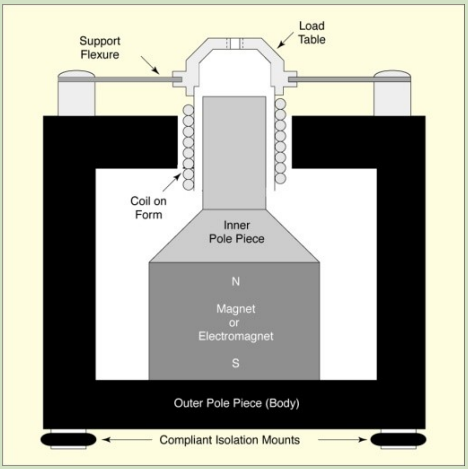
Virtual and physical environmental testing: vibrations

Background

Military vehicles, aircraft and weapon systems in general are permanently subjected to vibrations, what we call environmental vibrations. Commercial systems are designed to resist environmental vibrations by complying with vibration standards. The latter are useful for comparison, design or validation, but they also have a limiting aspect: they tend to globalise the whole life excitation under a single envelope which is not always very representative, especially for Defence applications. By nature, military systems must comply with very strict requirements. Furthermore, in order to have a weapon system that better satisfies the needs, the Belgian Defence often adapts and modifies the system's structure. By modifying the structure, we also change the structure response. This can lead to a breakdown, or even ruin the system.



Objectives

For the reasons mentioned above, specific analyses, whether physical or simulation ones, have to be performed to prevent damages due to vibrations and to ensure the system integrity.

Outcome

This study, conducted in collaboration with a related PhD, contributes to a better understanding of environmental vibrations. The main focus lies on the modelling and simulation of a vibration environmental test. An acquisition and simulation interface was developed allowing to conduct both physical and simulation vibration tests. Moreover, functions were implemented to use new excitation signals and to perform specific field acquisitions.

Those functionalities increase the level of knowledge and expertise available to Defence that also contributes to the improvement of education at the Royal Military Academy as part of the course “Dynamics of Mechanical Structures” and “Mechanical Design”. In addition, they enable, within a single software environment, to carry out specific vibratory field analyses as well as the related physical tests carried out in the laboratory and the simulations of those tests. The combination of these two points makes it possible to develop or analyse new excitation profiles that better represent the military reality, and to study their influence.

Last but not least, this study may serve as a basis for both further studies as specific implementations of very applied vibratory test cases, such as aircraft testing or road profile characterisation.

Project Directors:
Ph. Francois, PhD MSc Eng
B. Augustyns, PhD MSc Eng
Researcher:
C. Delhaize, PhD MSc Eng

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Contaminated samples – Chemical part analysis

Background

Within the framework of suspect parcel reception and analysis by the Belgian Federal Orientation Laboratory (FOL), the potential biological agent inactivation methods, which are essential before any analysis, have been systematically assessed, in order to improve the preservation of the chemical components of the relevant samples.

BE Defence-Malek Azoug

Objectives

The current inactivation methods have the non-desired effect of degrading the chemical agents. This project aims at developing an optimised methodology for contaminated sample analysis excluding this inconvenience. Multiple axes of improvement have been identified.

Outcome

- Adaptation of the existing ionisation procedure for bio-decontamination, in order to no longer destroy chemical agents in the samples. This is being made possible by adjunction of specific antioxidants to the samples;

- Looking for chemical alternatives for bio-decontamination: glutaraldehyde has been proven to be effective and also compatible with several chemical agents in the samples;

- Analytical methods for analysing synthetic polymers and proteins have been developed and positively tested against several agents in different configurations;

- DeconGreen (US Armed Forces) can be used for decontamination instead of sodium hypochlorite with the advantage of preserving the infrastructure.

The results still require further investigation before they can be considered finalised.

Project Director:
E. Colon, PhD MSc Eng
Researchers:
S. Berrabah, PhD MSc Eng
K. Verbiest

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Network multi-robot systems

Background

The project aims at showing the advantages and the possibilities of using a group of interconnected drones working in dangerous, dull or dirty environments.

Typical obstacle avoidance

One of the robots used for this study

Objectives

The project aims at developing, testing and evaluating tools and methodologies for a group of heterogeneous unmanned vehicles accomplishing Recce, Surveillance & Target Acquisition (RSTA) missions.

Outcome

- Several software packages have been tested and evaluated; Algorithms for coordination have been developed, tested and evaluated for a mobile group of robots with reconnaissance and surveillance tasks;

- Individual capabilities have been reached and tested; some cooperative testing has been performed;

-The implementation of an operational cooperative multi-robot system is to be done in a follow-on project.

Model-
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behaviour
of
activa-
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carbon
filters

Project Director:
Col P. Lodewycks, PhD MSc Eng
Researcher:
I. Berezovska, PhD MSc Eng

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Modelling of multi-component breakthrough behaviour of activated carbon filters

Background

As our troops are regularly deployed in (semi-)industrialised areas, the threat of industrial gases, such as chlorine or ammonia, has increased significantly. In the past, research focused on estimating the protection offered by our protective equipment against a number of specific industrial agents. However, little or no information was available on the interaction of these substances with each other or with organic vapours (e.g. co-released as a result of a fire) during filtration.

Objectives

Expanding the existing model for the estimation of the breakthrough time of activated carbon filters to the mixtures of inorganic gases and mixtures of organic and inorganic compounds.

Outcome

The study has significantly contributed to the knowledge of the gas mask filters in responding to different threats. It has given an increased understanding of the underlying mechanisms and has shown which combinations seem to be the most dangerous ones.

Development of a portable platform for operational multi-identification of bio-agents

Project Director:
Med Col J-L. GALA
Researchers:
A-S. Piette, PhD MSc Eng
S. Van Cauwenberghe, MSc Eng
C. Delcorps, MSc Eng

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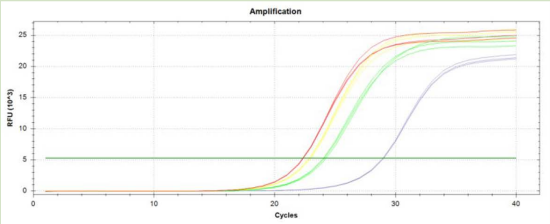
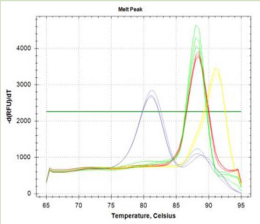
Development of a portable platform for operational multi-identification of bio-agents

Background

The capacity of the bio laboratory was already operational, but not really productive.





Objectives

The aim is to develop a portable platform (biochip) to detect all bio-agents via a one-shot test by using the sequences patented by the Defence's bio lab.

Outcome

- A deployable Ops platform has been developed and tested for one-shot detection of multiple bio-agents;

- Flexible design of the biochip allowing mission-tailored detection patterns;

- Automated hybridisation and reading; reducing workload and presence of highly qualified personnel;

-Significant improvement of the deployable Ops Med capability;

-Side-study: characterisation of closely-related neighbours of anthrax.

Development of human cellular dermal matrices and living skin equivalents for the treatment of severely burned patients

Director:
J-P. Pirnay, PhD
Researchers:
J-P. Draye, PhD
G. Verbeken, PhD

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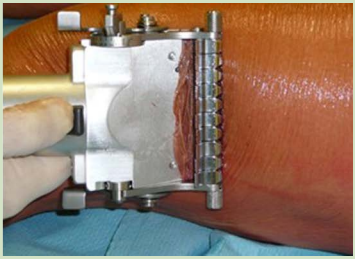
Development of human cellular dermal matrices and living skin equivalents for the treatment of severely burned patients (Skin tissue engineering)

Background

After patient stabilisation, the most favourable care for severely burned patients includes early removal of necrotic tissues by excision and early skin grafting to re-create a barrier to timely limit both microorganism invasion and body liquid loss. Accessibility to human acellular dermal matrices (HADMs) and living skin equivalents (LSE) would greatly help those patients which are confronted with limited available donor sites.



Objectives

HADMs can be used both for the treatment of patients and for the development of LSE. It is essential that the HADMs are immunologically inert and exhibit well-preserved structure and properties that allow either in vitro or in vivo repopulation with different skin cell types.

Outcome

It has been demonstrated in vitro that it was possible for the selected dermis to be repopulated by keratinocytes and human fibroblasts. It has also been demonstrated and published that it is possible to remove the epidermis while preserving the basal membrane on the dermis. It has also been shown that it is possible to prepare a dermal matrix while preserving dermal papillae, vascular spaces, elastic fibres as well as its three-dimensional structure. Moreover, it has been shown in vitro that human fibroblasts can not only proliferate in the dermal matrix, but also gradually reorganise its structure.

This cooperation's aim is to develop improved (vascularised) living skin equivalent for the treatment of burned patients.

Learning Organisations in High-Risk Environments: The Role of Leadership Style and Performance Measurement Systems

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Supervisor Virginia Tech (USA):
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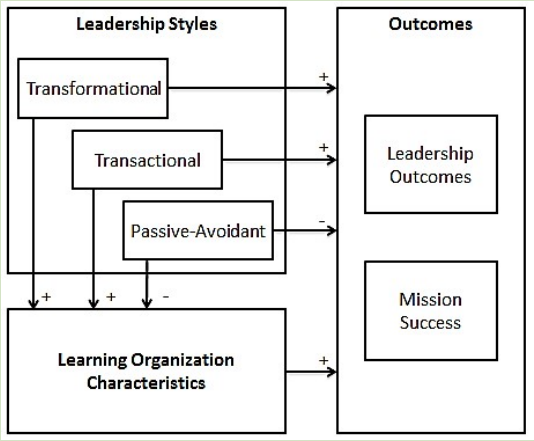
Learning organisations in high-risk environments: the role of leadership style and performance measurement systems

Background

Organisations that operate in crisis settings need to adapt quickly to changes in their complex, hostile and volatile environment and, as such, become a "learning organisation" (LO). This should in particular be true for military organisations often facing challenges and unforeseen events in the context of missions abroad.



Objectives

This research first investigates to what extent military crisis units develop LO characteristics (i.e. shared vision, team learning, personal mastery, mental models and systems thinking) as opposed to military units engaged in territorial activities. Additionally, this project focuses on the role of leadership and performance measurement systems (MS) in the development of these characteristics. Investigation methods include an assessment of the leadership style used by officers deployed in Belgian missions abroad over the last five years.

Semi-structured interviews with these officers also provide specific illustrations of transformational and transactional leadership practices (including the use of performance measurement systems) that support the development of military LOs.

Understanding how LO characteristics develop in this context may support the development of strategies to improve training programs for units preparing for deployment.

Outcome

The results suggest that deployed units do develop the characteristics of a LO, and that both leadership style (LS) and LO characteristics are significantly related to MS. In addition, the results show that there are two distinct aspects of MS (i.e. "technical success" and "social success"), which are affected by different elements of LO characteristics and LS.

Annex A

Centres of expertise in the RMA

Web address: http://www.rma.ac.be/nl/rma-research-centres-nl-guide.html

1. Department of Weapon Systems and Ballistics (ABAL)

Research unit : Survivability and Risk Assessment
Research unit : Local Response to Ballistic Impact and Blast Loading
Research unit : Human Body Response
Research unit : Numerical Modelling and Simulation
Laboratory : ABAL Laboratory of weapon systems and ballistics

2. Department of Chemistry (CHCH)

Research unit : Energetic Materials
Research cell : Explosives & Propellants Engineering
Research cell : Explosives Analysis & Forensics
Research unit : Protection against CBRN threats (chemical, biological, radioactive, nuclear)

Laboratory : LEM Laboratory for Energetic Materials

3. Department of Communication, Information, Systems and Sensors (CISS)

Research unit : LEMA Electromagnetics
Research unit : RUASP Audio Signal Processing
Research unit : RUCD Cyber Defense
Research cell : Cryptography and Steganography
Research cell : Cyber defense research cell
Research unit : RUGENA Geodesy and GNSS (Global Navigation Satellite Systems)
Research unit : RUIP Image Processing
Research unit : RUNFE Near Field Electromagnetics
Research unit : RUOF Optical Fibers
Research unit : RURCS Radar Cross Section (RCS) and InfraRed (IR) Signatures
Research unit : RURN Audio Radio Networks
Research cell : Performance evaluation

Research unit : RURSP Radar Signal Processing
Research unit : RUTHZ Terahertz
Research cell : Cyber defense research cell

4. Department of Civil and Materials Engineering (COBO)

Research unit : Materials Engineering
Research cell : Plasticity
Research cell : Ultimate limit state behaviour of metallic materials systems
Research cell : Dynamic Material Behaviour
Research unit : Civil and Military Engineering
Research cell : Building materials
Research cell : Structural behaviour for accidental loads
Research cell : Blast resistance of materials and structures

Laboratory : LAEE Laboratory for the Analysis of explosive Effects

Laboratory : LME Laboratory for Materials Engineering

5. Department of Conflict studies (COST)

6. Department of Economics, Management and Leadership (DEML)

Research unit : RCDM Risk, Crisis and Disaster Management

7. Department of Operations

8. Department of Mechanics (MECA)

Research unit : Environmental Mechanics
Research unit : Mobility Applications
Research unit : UVC – Applied robotics for high risk applications

9. Department of Mathematics (MWMW)

Research unit : MSO Competence Center Modeling, Simulation & Optimization
Research unit : RUHYP Hyperspectral Imaging
Research cell : Performance evaluation
Research cell : Cryptography and Steganography

10. Department of Physics (PHYS)

Research unit : ICRH Technology
- Research cell : ICRH Technology : ITER
- Research cell : ICRH Technology : JET
- Research cell : ICRH Technology : W7-X

Research unit : ICRH Physics
- Research cell : ICRH Physics : Experiments
- Research cell : ICRH Physics : Theory

Research cell : Turbulence

Research cell : Laboratories

11. Department of Behavioral Sciences (SCGW)

Research unit : Center for Military Social Research (CMSR)
Research unit : Psychology
Research unit : Law
Research unit : RUME Military ethics

12. Research Poles (combining 2 or more research units from one or different departments):

CBRNE	Protection against chemical, biological, radioactive, nuclear, explosive threats
DYMASEC	Dynamic Material Behaviour and Security Applications
EMMA	Environmental Mechanics & Mobility Applications
LIFE	Life Sciences
LPP	Laboratory for Plasma Physics
RCDM	Risk, Crisis and Disaster Management
SIC	Signal and Image Centre

Annex B

Centres of expertise in the DLD

Web address: https://ng3.economie.fgov.be/NI/belac/labotesting/applic/

accreditedc_fr.asp?certificatienummer=050-TEST

- Chemical analysis

  Chemical products Lubricants & coolants

- Health and Hygiene

  Military equipment

- Nuclear techniques

  Nuclear application

- Physical analysis

  Measuring equipment Military equipment Textiles

- Safety

  Military equipment

Centres of expertise in the Military Hospital

Military Hospital Queen Astrid (MHQA)	Locomotor Centre
Military Hospital Queen Astrid (MHQA)	Centre for Excellence in Infectious Diseases
Military Hospital Queen Astrid (MHQA)	Laboratory for Molecular and Cellular Technology
Military Hospital Queen Astrid (MHQA)	Centre for Mental Health
Military Hospital Queen Astrid (MHQA)	Centre for Hyperbaric Oxygen Theraphy
Military Hospital Queen Astrid (MHQA)	Hypobaric Medicine
ACOS WB	*Épidémiologie et soins préventifs*

Glossary:

DC :	Direct Current (as opposed to AC: Alternating Current)
DG MR :	Directorate General Material Resources
DLD:	Defensie Laboratoria/Laboratoires de la Défense
DSM :	Digital Surface Model
DTM :	Digital Terrain Model
E-field:	Electromagnetic field
EME :	Electro Magnetic Environment
EOD :	Explosive Ordnance Disposal
FOL:	Federal Orientation Laboratory
GISS:	General Intelligence and Security Service
GUI:	Graphical User Interface
HADM:	Human Acellular Dermal Matrices
InSAR:	Interferometric Synthetic Aperture Radar
LSE:	Living Skin Equivalents
MoD:	Ministry of Defence
MWIR:	Medium Wavelength Infrared
NGI:	National Geographic Institute
PEC:	Perfect Electrical Conductor
RMA :	Royal Military Academy
RSTA:	Reconnaissance, Surveillance and Target Acquisition
SGRS:	Service Général du Renseignement et de la Sécurité
STRD :	Scientific and Technological Research of Defence
USV:	Unmanned Surface Vehicles

DEFENCE

Royal Higher Institute for Defence
Departement Scientific and Technological
Research of Defence

Responsible editor : Director-general Tim Van Langenhove, Colonel