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

SCIENTIFIC RESEARCH IN THE BELGIAN DEFENCE

2017

INTRODUCTION:

Dear reader,

This second military scientific research report provides you with an overview of the projects completed in 2017. Some of them are a continuation of projects previously completed, others are new projects carried out sometimes in new scientific areas unexplored before. This brochure presents the results of the hard work from all the researchers and study directors of the different research institutes within the Belgian armed forces.

It is our intention to provide you each year with such a review to keep you informed about the developments and the evolution in the research projects.

We sincerely hope that this document will spark your interest in research in general and in military research in particular.

Sincerly Yours,

Filip Martel, Lt Col

Director of Scientific and Technological Research of Defence

Table of content:

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From prototype to an efficient intelligent framework for digital image steganalysis

From prototype to an efficient intelligent framework for digital image steganalysis

Background

Steganography is the art of concealing information in innocent-looking objects (cover objects) such as digital images. Nowadays steganography is more and more used by criminal and terrorist organisations and in malware. The used methods evolve constantly and prompt law-enforcement and intelligence agencies to develop rapid and flexible solutions for detection of hidden information **(steganalysis)**. In order to equip the Belgian Defence and in particular Cyber section of our security services with such solutions as well as with general know-how on steganography, a first research study in this domain was conducted. After acquiring a solid knowledge on steganography and steganalysis, a prototype of an intelligent framework was developed.

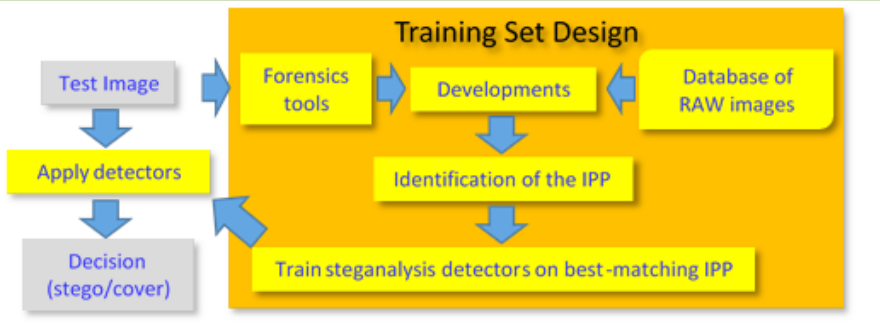
In this study, a follow-on from the one completed in 2016, the focus turned to **"real-world steganalysis"**. Before 2015, all experiments were performed using a common database (the Boss-Base) of test images. However, when applying detectors optimised on this Boss-Base to "real-world" images, it was noted that the performance dramatically drops. In the steganography community this phenomenon is known as the "Cover Source Mismatch" (CSM).

Objectives

The impact of the CSM on detection accuracy depends on many factors. Several factors had already been examined, but parameters related to differences in the manner in which the cover images were acquired and processed had not been examined previously. Determining and quantifying the impact of these differences on the CSM and adapting the detector design for mitigating this impact was the main research topic of this study.

Outcome

The study identified several parameters influencing the CSM. It was found that the acquisition hardware (camera, lens) and settings (ISO-value, shutter speed, etc.) have only a minor impact. On the other hand, the image-processing software and the applied image-processing pipeline (IPP) are very important. Moreover, for JPEG images the compression parameters have the largest impact on the CSM. Taking this into account, we proposed a detection strategy based on training set design for coping with the CSM.



The basic idea is to generate sets of images generated using different IPPs and determining the value closest to the IPP applied to the image under test. A steganalysis detector trained on IPP-created images is then applied for deciding whether or not the image contains hidden information. The proposed approach significantly improved the state of the art and highlighted the importance of obtaining information about the IPP applied to the image examined. **Digital image forensics** can provide such information. Hence a new project was launched in 2018, aiming to exploit the synergy between digital image forensics and steganalysis and to further improve the operational performance of our framework.

Characterisation of new 3rd generation CBRN clothing and impact on the performance during operations

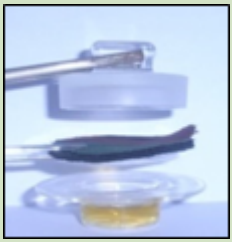
Background

Wearing a CBRN (Chemical, Biological, Radiological and Nuclear) protective clothing introduces a physiological burden on the individual. The end of the Cold War has reduced the threat of large-scale attacks using classical CBRN weapons, allowing CBRN material designers to focus not only on protection but also on comfort and operational capability. Compromises have to be made to get an optimal balance between protection, comfort and ease of use in the different theatres of operation.

Objectives

The aim of this study is to fully characterise the new Belgian 3rd generation CBRN clothing in the area of protection, comfort and mission effectiveness (operational capability).

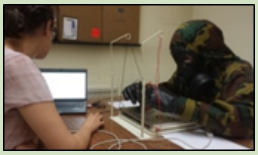
The chemical protection of both swatches of material and full clothing systems has been assessed under different environmental conditions.

The comfort of the CBRN clothing has been evaluated by means of skin model and dummy tests (thermal resistance and evaporation resistance), as well as user tests.

The operational capacity of a soldier wearing the CBRN clothing system (suit mask gloves overshoes) was evaluated by physiological monitoring (heart rate and core temperature) and measuring cognitive abilities and dexterity while performing different physical tasks.






Outcome

This study has shown that, in static conditions, the chemical protection remains acceptable (even with aging, repeated laundering and double contamination density). But in more challenging environments with realistic dynamic conditions, higher wind speed and double contamination density, clothing can only offer protection for two hours. This underlines the importance of immediate decontamination.

Due to a lower evaporation resistance of the clothing system compared to the former 2nd generation CBRN suit, physiological comfort characteristics have improved.

While the cognitive ability and dexterity remain stable even after highly challenging physical tasks, wearing the protective clothing system will limit the duration of a heavy-duty mission. It has been observed that the drinking capacity is a key factor.

Due to constraints in time and availability of operational personnel, the number of tests in this study was limited. Further investigation to support the above conclusions is recommended.

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Development of multiplex bead-based assay for rapid detection and identification of pathogens involved in orthopedic infections

Background

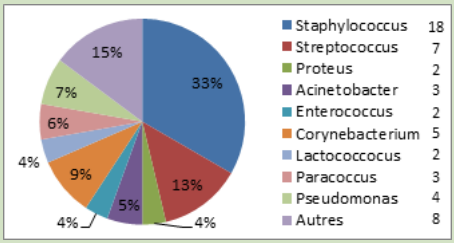
Pathogen cultures are currently used to identify pathogens involved in orthopedic infections and are considered as the gold standard. However, cultures have limited sensitivity and frequently do not provide any result due to difficult growth of some challenging bacteria or in case of a prior antibiotic therapy. Moreover, this approach is time-consuming, sensitive to environmental contamination and is contributory in only 40-50% of proven infections. Clinicians must frequently deal with negative cultures caused by (a) the nature of the pathogen (the culture of some bacteria and most of the fungi is challenging), (b) the use and sometimes misuse of antibiotics prior to the sampling, or (c) the biofilm development complicating or preventing any microbiological identification. Broad-range amplification targeting 16S ribosomal RNA (16S rRNA) has proven to be an alternative to culture for clinical samples, however it is not widely used due to some design and experimental challenges.

Objectives

To circumvent these drawbacks, this study focused on the development of a culture-independent, rapid, reliable and operational protocol for the identification of the most relevant pathogens involved in orthopedic infections. This assay is an in-house developed multiplex qPCR assay targeting nine specific bacteria combined with a 16S rRNA-based broad range qPCR assay. The multiplex qPCR assays' targets are either species-specific or genera-specific genes aiming the detection of anaerobic or difficult-to-grow bacteria involved in orthopedic and/or nosocomial infection. Throughout the project, clinical samples from burn patients (High and Medium Care from MHQA) and orthopedic patients (from Cliniques Universitaires Saint-Luc, Woluwe-Saint-Lambert) were collected in order to validate the developed tool.

Outcome

Throughout this project, 147 orthopedic samples and 84 burn patient samples were analysed with specific and/or 16S rRNA qPCR assay. Regarding the orthopedic samples, 57 were found positive by PCR and, in 52 cases, it was possible to identify the genera of the bacteria involved by amplicon sequencing (Figure 1A). For the burn patients, 74 out of the 84 samples were found positive but, for approximately 20% of the samples, the identification was compromised by the presence of background noise (Figure 1B). More interestingly, in about 30% of the burn cases a co-infection (presence of 2 or more pathogens) was revealed. This occurrence was notably higher than the 1.3% detected in orthopedic samples. The "burn samples" were also tested with the multiplex specific qPCR assays and 5 samples came out positive for either one or two of the targets. Importantly, those pathogens were not previously identified with the 16S rRNA assay, demonstrating the need to use both strategies (i.e. specific and 16S rRNA-based broad range qPCR assays) in parallel in order to obtain clinically relevant data.



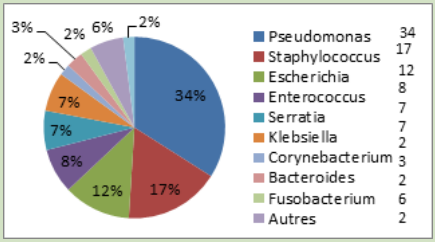


Figure left: Identification results for orthopedic samples by 16S rRNA qPCR assay.

Figure right: Identification results for burn patient samples by 16S rRNA qPCR and multiplex assays.

Director:
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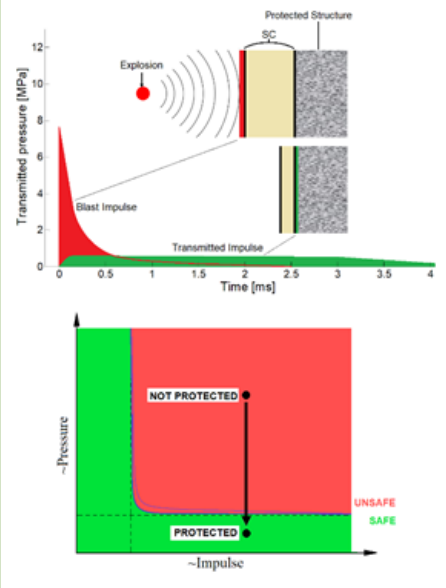
Study of sacrificial coating as protection against the effects of explosions

Background

Accidental and intentional explosions in the vicinity of civil or military structures can have disastrous effects. These effects are due to the generated blast wave and/or the fragmentation and debris projection. In order to minimise the effects on the structure, sacrificial claddings (SC) can be used to mitigate the energy of the blast wave. SC consist of a crushable core sandwiched between two thin plates: a front and a rear plate. The latter is attached to the structure to be protected. The role of the front plate is to ensure a uniform distribution of the blast load on the crushable core. The front plate is accelerated by the applied blast load and compresses the core, which is often a cellular solid, e.g. aluminum foam, allowing for a large plastic deformation under a relatively low constant pressure (see figure). Through this mechanism, SC transform the hazardous blast load into a potentially less dangerous transmitted load to the structure, which leads to the reduction of the threat regarding the structural integrity and to the increase of the survivability of personnel.



Objectives

The aim of the project is to identify relevant decision criteria for the selection of SC systems in the context of a real threat scenario, e.g. in the framework of the protection of operational compounds by the engineering troops or for critical infrastructures. Different possible materials or SC structures are studied, using analytical, numerical and experimental approaches, to maximise the mitigation of the energy delivered by a blast wave. The replaceable and low cost SC should further facilitate the protection of installations against the threat of an explosion.

Outcome

The study of the state of the art related to SC showed some discrepancies between theory and practice (i.e. the actual performance) of such SC systems. It is found that existing models for the evaluation of the mitigation capacity of a given SC design are often not experimentally validated. Therefore, several experimental tools and set-ups are developed within the project, which in combination with numerical modeling enable to verify and improve theoretical models and to understand the contribution of every characterising parameter of the SC design. These research tools have been useful to show that aluminum foam, which is presented as an efficient core material in SC by several authors, does not offer a suitable protection for building components. The present research showed that this is due to the interaction between the resistance of the crushable core and the flexibility of the protected structures.

This explains why other potential SC materials were prospected. Among others, polyurethane (PUR) foam has been selected in this project because of its light weight, its low cost and the higher compatibility of its resistance with the flexibility of the protected structures. However, despite its optimal characteristics and promising results on a small scale, PUR showed reduced performances at larger scale due to the non-uniformity of the loading. Although the project did not yield an optimal SC design with PUR foam as crushable core, it succeeded, for large-scale problems, in identifying design tools/requirements, based on the combination of developed experimental setups/procedures and improved theoretical models.

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Effect of body posture and load on the soldier's performance

Background

Firing a weapon generates a short intense force acting on the shoulder. Highly repetitive exposure can lead to injuries for soldiers. The weapon performance analysis should therefore not be restricted to the technical specifications of the considered system: the operator must be considered as an integral part of the complete weapon system. Next to the risk of injuries, recoil also has an influence on the shooter's performance. However, the human factor remains difficult to quantify.

Objectives

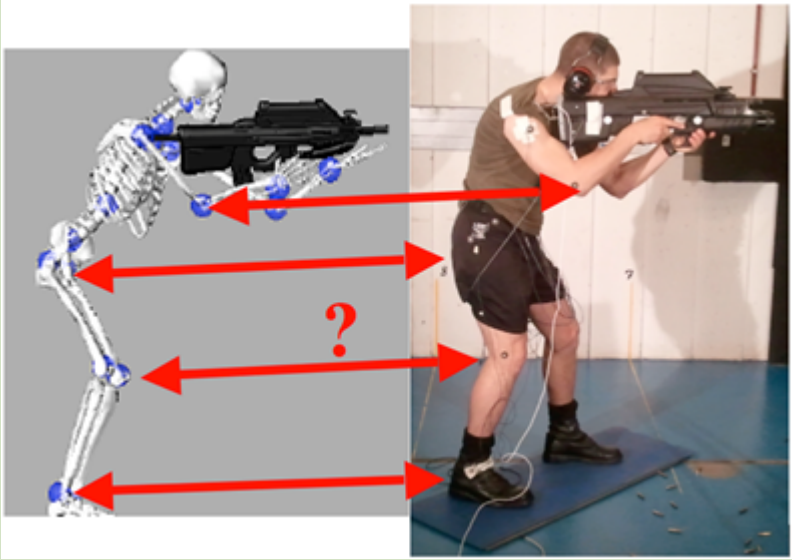
This study investigated the effect of the recoil of a firearm on a soldier, with and without extra load (helmet and backpack). Techniques for measuring the recoil forces and the cinematics of the operator's body had to be validated and implemented. Experimental results had to be compared with simulation models. This project required the combination of medical techniques with engineering techniques, and is therefore cooperatively conducted by the Military Hospital Queen Astrid's Center for musculoskeletal disorders and the Royal Military Academy's Department of Weapon Systems and Ballistics .

Outcome

Measurement and modeling techniques for dynamic analysis of the recoil-shoulder interaction were developed. For instance, force sensors in the stock butt of the weapon, acceleration sensors on the shooter's body and electromyography were used for the evaluation of the shooter-weapon dynamics.

These techniques provide a more precise analysis of the interaction between the shooter and its weapon and lead to a better understanding of the dynamics of recoil and its effect on the shooter.

In the framework of the project, the acquired insights also found an application in other cases, such as the load of a helmet on a pilot's neck.



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Study of an ICRH antenna for a stellarator

Director:
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Dr J. Ongena

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Study of an ICRH antenna for a stellarator

Background

Fusion is the energy process that fuels the sun and other stars. Reproducing fusion reactions on Earth inside a reactor is a promising solution to the global energy problem: it is inherently safe, stable and the fuel (hydrogen isotopes) is virtually inexhaustible. Various methods and machine types are being studied, but the most understood and promising ones are based on magnetic confinement, which uses a set of magnetic field to confine the hot gas (plasma) where the reactions occur. The stellarator is one of the most advanced concepts using magnetic confinement, and the stellarator Wendelstein 7X (W7X) located in Greifswald, Germany, is the largest in the world. This device's main aim is to study the plasma confinement in an optimised stellarator geometry and to check the potential of this concept for a future fusion reactor. One of the main scientific objectives of the W7-X project is to experimentally prove the predicted good confinement of high-energy ions.

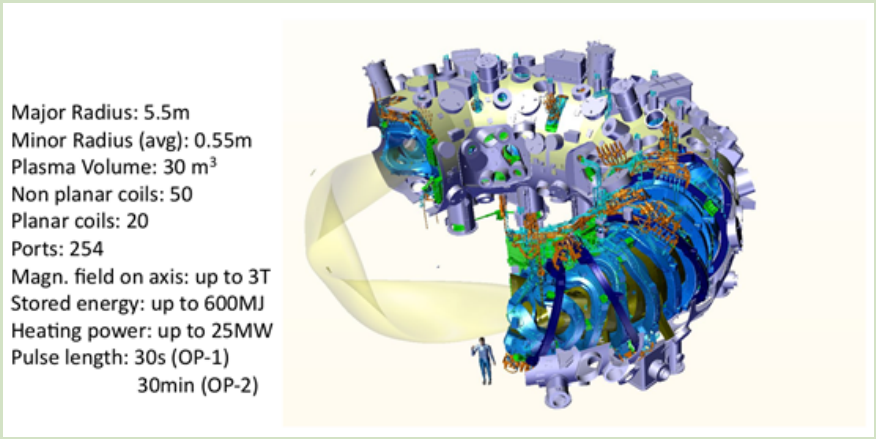

Figure 1: H.-S. Bosch et al 2013 Nucl. Fusion 53 126001

Objectives

The aim of this work is to develop a heating system for W7-X. This system is based on the ion cyclotron resonance heating (ICRH) method, where an electromagnetic wave is launched into the plasma, tuned to a natural resonant frequency of the plasma, and then transfers its energy to the ions through a mechanism of resonance between the wave and the rotation motion of the ions in a perpendicular plane with respect to the magnetic field of the device. This method enables to heat the plasma but also to generate fast ions.

The projects consists in two parallel tasks:
- the development of heating scenarios apprpriate to W7-X;
- the electromagnetic design of the antenna, followed by its construction.

Outcome

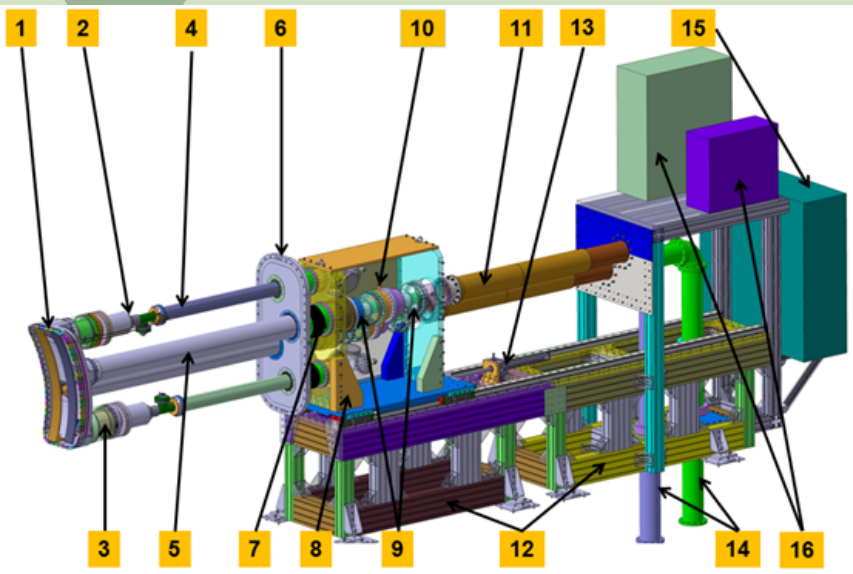

Figure 2: Ongena et al., AIP Conference Proceedings 1580, 105 (2014); https://doi.org/10.1063/1.4864508

An ICRH antenna for W7-X was designed and the construction is almost finished. The antenna will be installed in a very near future in the machine. Also a novel ICRF heating scenario, extremely promising for the generation of high-energy ions in W7-X with ICRF, was identified. The proposed scheme relies on the presence of three ion species in the plasma and was successfully tested on other machines. The prestigious Landau-Spitzer Prize 2018 was awarded for this beautiful result.

Survivability of combat vehicles and their crew

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Survivability of combat vehicles and their crew

Background

The project focused on the analysis, modeling and simulation of the most recent combat vehicle in the Belgian army, the AIV (Armed Infantry Vehicle), from a survivability perspective. Survivability is the ability of a combat vehicle to withstand a hostile environment created by the enemy, including guns, missiles or any other threat which can damage it, destroy it or kill its crew. The development of a survivability model enables performing risk assessments prior to the deployment of these vehicles in operations.

Objectives

The aim was to develop a simulation model allowing for:

. the prediction of the probability of survival of vehicles and crew in well-defined combat scenarios,

. the use of these predictions for the optimisation of tactics, technics and procedures in order to maximise the probability of survival and success in operations.

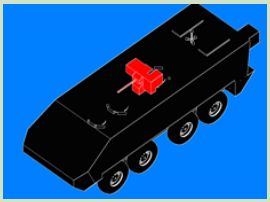
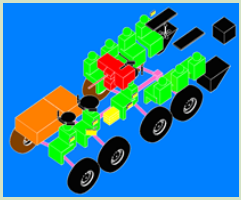
An important part of the project was the development of simulation time reduction methods. Indeed, since probabilistic simulations are very time-consuming, it is essential to speed up the simulations as much as possible.

Outcome

Different simulation time reduction methods were implemented and compared for different scenarios. It was shown that the optimal method does not exist, each scenario having its own optimal simulation time reduction method. The modeling and simulation was performed in the high-level dynamic language Julia.

A computer-aided design (CAD) model of the AIV was created in the 3D software Rhinoceros, as shown in the pictures. The model includes the hull of the vehicle and its interior vital elements, such as crew members, weapon systems, communication equipment and propulsion system. For all elements, a vulnerability model is included, enabling the residual operationality of the vehicle after impact of one or more projectiles can be analysed. The impact points of the projectiles on the vehicle and the interior elements – in case of perforation of the hull – are calculated by a ray-tracing module in Rhinoceros.

The method developed in this project was successfully used to study the survivability of the bridge of a M frigate attacked by small caliber weapons.

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Director:
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Co-director:
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Detection and neutralisation methods for buried submarine mines

Detection and neutralisation methods for buried submarine mines

Background

The safety of maritime communication lines is of vital importance for an open economy such as in Belgium. In this context, mine threats are particularly important for a country with two major international ports. Moreover, during missions to other theatres, maritime transport is the only kind of transport that allows for the transportation of large quantities of equipment at a reasonable cost.

In this context, the detection of buried sea mines has long been recognised as one of the major weaknesses of our current systems, and improving our detection capabilities remains a priority. The problem was investigated in the scope of a previous research study in which a simulation environment and a method for locating and characterising magnetic objects were developed. The present study builds on these results and provides significant improvements.

The current study is also the Belgian contribution to the European Defence Agency (EDA) UMS-Buried Mines B3 project (BURMIN), in which different types of sensors (acoustic, magnetic, electrochemical, and electromagnetic) have been tested and combined. Data fusion algorithms were also developed.

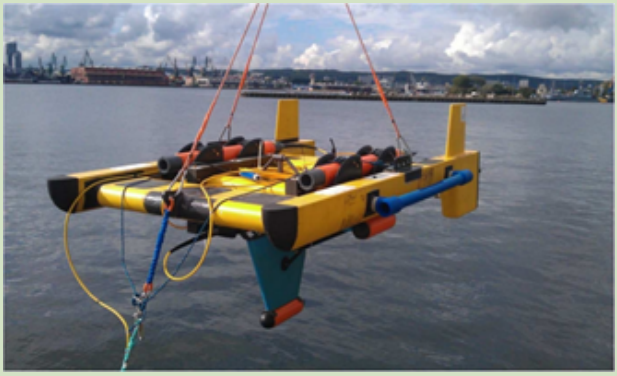

Figure 1. Platform used for BURMIN test campaigns.

Objectives

The objective of the UMS-Buried Mines B3 project (BURMIN) was to eliminate technological gaps in the field of detection and neutralisation of buried submarine mines, as well as to establish common standards for future European Unmanned Maritime Systems.

The main objective of the Belgian contribution was an improvement of the gradiometer detection and localisation algorithm. In the former study, the model assumed a single target. In this study, the objective was to extend it to allow for multiple targets as well as to better characterise and take into account the various sources of noise: the intrinsic noise of the sensors, the noise due to the geological environment and the error in the position of the gradiometer.

Outcome

A geologic noise model was developed. This model is based on the hypothesis that the magnetisation is inhomogeneous and fractal.

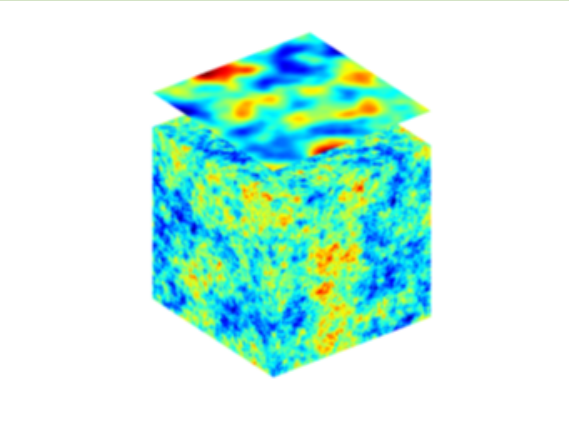

Figure 2. Fractal model of the magnetisation of the soil.

Probability (expectation density) and risk maps were computed in a Bayesian framework using a reversible jump Markov chain Monte Carlo (RJMCMC). The risk maps show areas with a low mine presence probability (green), areas with a high mine presence probability (red), and areas where information is not sufficient in order to draw conclusions (yellow). The knowledge of this last area is crucial in an operational context and is not highlighted by usual algorithms. In the context of mine hunting, such maps could be useful to estimate the target localisation errors, to delimit the covered area and to support the decision to be taken after an alarm is given (neutralisation, send another sensor to improve target localisation accuracy, etc.). In the context of a route opening, the maps produced enable to define a mine-free area.

The algorithm developed is able to cope with the complexity and non-linearity of the problem, allows for multiple targets and does not require the number of targets to be known. It rigorously takes into account the various sources of noise. Its consistency was validated on a large number of simulations. The algorithm was also validated on real measurements performed in the Bay of Gdansk. A map was produced and all magnetic targets were correctly detected and accurately localised.

Finally, a Bayesian fusion scheme was implemented in order to combine the output of the various sensors used in the BURMIN project (acoustic, magnetic, electrochemical, and electromagnetic) and good results were obtained on the measurements made during the test campaigns performed in the scope of BURMIN.

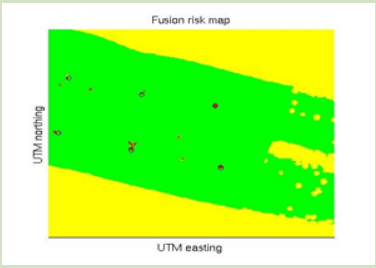

Figure 3. Example of produced fused risk map.

Cognitive radio in tactical mobile ad-hoc net-works

Director:
Col Bart SCHEERS
Researcher:
Vincent Le Nir

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Cognitive radio in tactical mobile ad-hoc networks

Background

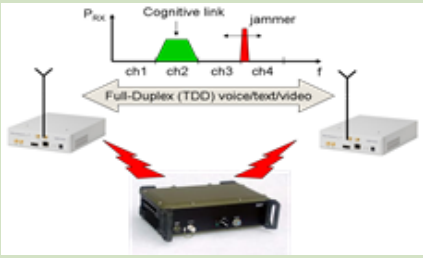
A cognitive radio network is an intelligent radio network that autonomously changes its communication parameters in response to user demands and to changes in the electromagnetic environment. Adaptation to user demands or changes in the electromagnetic environment can occur at physical layer (frequency, transmit power, modulation, bandwidth, etc.), link layer (multiple access control, etc.), network layer (routing, etc.), application layer (message length, traffic pattern, quality of service), cross layer (involves several parameters at different layers or several layers). Adaptation at physical layer can also be called dynamic spectrum management (DSM) or dynamic spectrum access (DSA). The motivation for cognitive radio network in a military context is to have an efficient use of spectrum through dynamic frequency allocation, ease of deployment and more robust links in case of jamming or bad channel conditions.

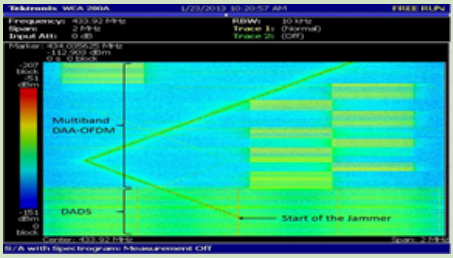
Objectives

The objectives of this research project are to study, develop and implement cognitive waveforms for mobile ad-hoc networks in order to enhance and facilitate the management of the radiofrequency spectrum and the reliability of the wireless communications in a military environment.

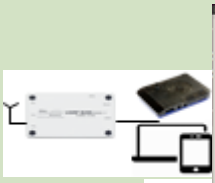
Outcome

Several waveforms have been implemented and evaluated in our own open-source radio network simulator/emulator, called CogWave. CogWave uses several libraries to enable real-time transmission of text, voice, video, and internet packets between software-defined radio (SDR) platforms. A cognitive engine is able to modify the parameters of each waveform and to switch between several waveforms.

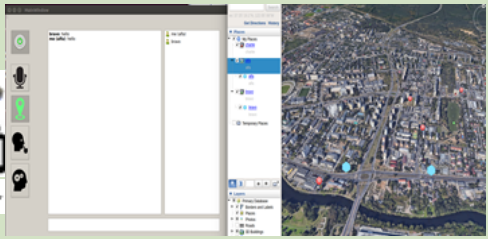


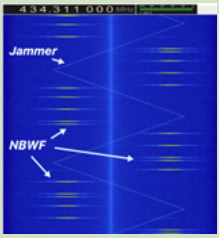


The full physical layer and most important parts of the link layer of the new NATO narrowband waveform for tactical VHF communications (STANAG 5630) were also implemented and tested with SDR platforms. An enhancement technique based on cognitive radio was also applied to the NATO NBWF and enables to detect and avoid channels with interference in real-time.



Cognitive radio functionality





Director:
Prof. Jan Leysen
Researcher:
Alonso Pena Pablo

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From individual trauma to organizational trauma: theoretical definition and measuring instruments

Background

An organizational trauma (OT) is defined as an "organization's "over"-adaptation to the rupture of its protective emotional membrane, caused by a potentially traumatizing event and involving the appearance of emotional and organizational disturbances." In chaotic economic and political times, ever more organizations are confronted to such potentially traumatic events. Hence, the probability grows that an organization will develop this organizational pathology. Because of its role, its missions and the difficult context, also the Belgian Defense it at risk of being impacted by organizational trauma.

Objectives

In order to evaluate to what extent the Belgian Defense is affected by an organizational trauma, this research has focused on two points. First, to conceptualize the symptomatology of the pathology and its underlying process. Secondly, to operationalize this in order to measure the impact on the organization.

Outcome

The research resulted in the design of a diagnostic tool (OUDITO) validated and applied to the Belgian Defense. The questionnaire has allowed to highlight the impact of organizational trauma and the stage of traumatization on the Defence organization. OUDITO is composed of 48 items which measure 6 symptomatic dimensions, corresponding to the successive stages of an organizational trauma: Internal communication and cohesion, Relationship with the organization, Organizational functioning, Emotional reaction, Employee wellbeing, and Leadership.

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Combined risk assessment on behind-armour blunt trauma of small calibre ammunition against personal protection systems

Background

The increasing threat of small caliber armour-piercing rounds in current operational theaters has led to the wide-spread use of adapted body armour solutions, typically consisting of a flexible, soft body armour combined with a ballistic insert composed of a high-hardness ceramic impact face and a fiber-reinforced backing. As these ballistic protection systems pose a literally heavy load on the soldier, solutions have to be found to decrease the weight of these systems. Although material breakthroughs have lowered the weight, only incremental improvements have been made in this field. In order to make a revolutionary breakthrough, this project proposal aims at developing a new methodology to evaluate body armour performances. The performance of body armour is currently evaluated using a double criterion, namely ballistic resistance (no penetration) and acceptable behind-armour blunt trauma or BABT (maximum allowable indentation in a witness material).

Objectives

Up to this day, the correlation between the indentation in a clay witness material and the real risk on behind-armour blunt trauma remains unclear. This project hence aimed on the one hand at elucidating on the real risk on behind-armour blunt trauma in comparison to witness material measurements, and on the other hand at developing a ballistic testing methodology that is capable of quantifying ballistic resistance and risk on behind-armour blunt trauma of a certain body armour system in comparison to the currently used ballistic standards. The combination of the respective results would not only lead to a better assessment when evaluating body armour systems, but also lead to better balanced and possibly considerably lighter personal armour systems.

Outcome

Using a combined experimental-numerical approach, an advanced material model for the used clay witness material in ballistic tests was developed and validated, both using conventional mechanical testing results, as well as dynamic and ballistic results. Both the experimental and numerical results obtained with the clay witness material were then compared with the results for a specifically in-house developed finite element model of the human thorax. In this way, correlations have been made between the results of typical ballistic evaluation tests and the real risk on typical injuries associated with BABT. The numerical model also allows for evaluating the risk associated with the initial shock wave for high-velocity rifle impacts on ceramic inserts, a risk which can currently not be evaluated using the clay witness material.

The obtained knowhow is currently being applied in a follow-up research project regarding the development of an optimized body armour solution for a specific rifle threat.

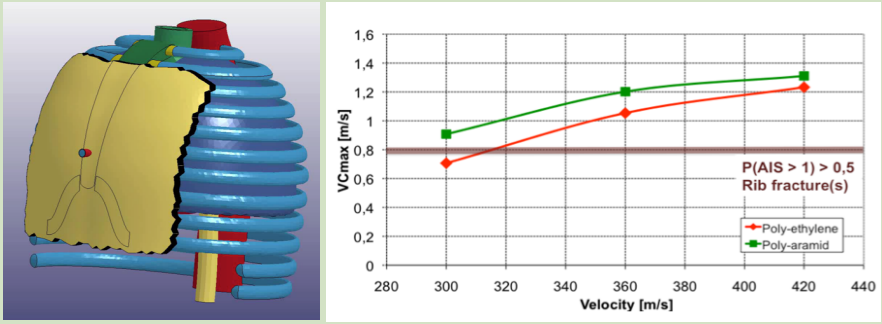

Figure: (a) FE model of the impact of a 9mm Para on a polyaramid armour system in contact with the thorax and (b) the associated risk on injury (in casu rib fracture).

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The impact of demographic change on the recruitment and retention of personnel within European armed forces

Background

Within the European Union, demographic trends indicate that the number of young people entering the labour market (age group 15-24) will diminish and the ratio of older people in the population will increase. Western postindustrial societies, which were once quantitatively dominated by younger cohorts, are on their way to becoming societies in which older cohorts constitute the majority. At the same time, most EU Member States are also becoming more diverse as a result of immigration, and the trend will keep accelerating in the near future, given the differences in fertility rates. The result of these trends is that in most Western countries the native labour force will shrink, while the immigrant workforce will grow. Defence organisations have to adapt to these changes.

To offset the shrinking base of recruitment and successfully meet the challenges of the demographic transition, defence organisations have to increase the number of candidates in segments previously under-represented (for example, women and ethnic-cultural minorities), and/or to broaden the base (by raising the age limit), while trying to keep employees longer by reducing attrition or increasing the retirement age for certain categories of personnel.

In addition, this study was also rooted in a project of the European Defence Agency (EDA) on the impact of demographic change on recruitment and retention of personnel (IDCRR) in European armed forces. This project brought together researchers from Belgium, The Netherlands, Sweden, and Norway, as well as from Switzerland and Canada (the last two on an informal basis).

Objectives

The two main objectives of this project were:

1) to understand what the job expectations of young people from these six countries were, how attractive they judged the military as an employer, how they perceived their armed forces in general as well as how open they thought they are to women and ethic-cultural minorities (ECMs), and
2) to make recommendations on possible ways to face this important challenge for military organisations in terms of recruitment and retention.

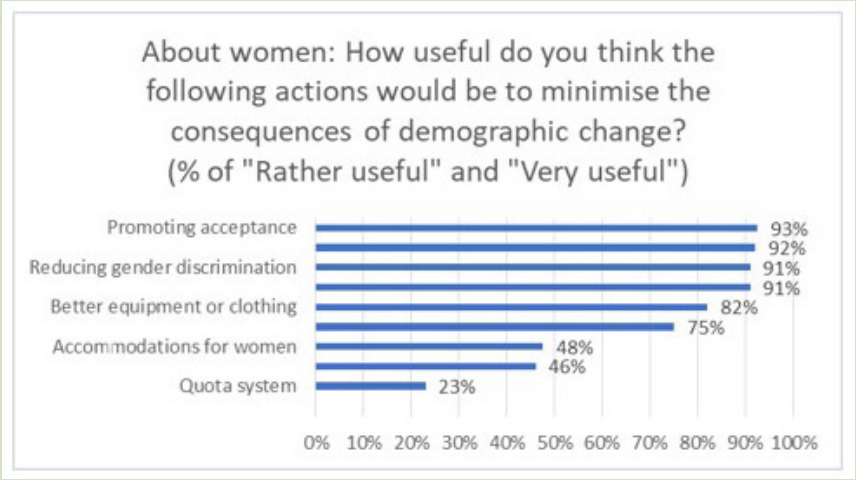
Outcome

In order to achieve the main research goals, two multinational common survey instruments were developed. The first instrument was an online survey among youth prospects. Its goal was to measure their job expectations and the attractiveness of armed forces as an employer. The second online survey was aimed at "experts" in human and social sciences, defence managers, policymakers, and journalists specialised in defence issues. Its goal was to see whether demographic change was perceived as a problem and/or a challenge for the armed forces of advanced Western industrial societies, and what their recommendations were to minimise the impact of demographic change on defence organisations.

The results of the youth survey indicated which characteristics are most associated with the armed forces, namely: training and promotion opportunities, a stimulating work environment, and a well-recognised employer. With regard to the attractiveness of the military, the armed forces came in first place in Belgium (95%), Sweden (81%), and Norway (80%), both among men and women. In Canada, the armed forces were only in ninth position (22%). Respondents from all countries were more interested in the Army than in any other branches of service. Most of the respondents were more interested in combat or operational functions, except in The Netherlands where relatively more people were interested in technical or logistic functions.

The main reasons for joining the armed forces were a challenging job and personal growth. In Belgium, people wanted to join the armed forces because of the job diversity, comradeship, service to the country and for the missions abroad. In Sweden, people wanted to join because of the job diversity, comradeship, service to and defence of the country. In Canada and Norway, people were interested in joining the armed forces because of the educational and career opportunities, and to stay fit. In The Netherlands, people wanted to join to provide peacekeeping and humanitarian help, for the job diversity and to work with different people. Finally, in Switzerland people wanted to join because of comradeship, job security, to stay fit and job diversity. In all countries, the armed forces were considered as an essential organisation.

Although experts from most countries thought that their countries were already impacted by the demographic change (64%), most experts agreed that it was still important to be prepared for the demographic change. Two important population groups could help the armed forces face the recruitment problems that will rise with the demographic change: women ant ethnic-cultural minorities (ECMs). In almost all armed forces, these two population categories are highly under-represented.



For example, in order to better attract women, experts agreed on four important actions; two of them were external actions, while the other two addressed more internal problems. The two external actions were clearly public-oriented, i.e. the idea that armed forces should show more women as role models (92%) and promote the acceptance of women inside their ranks (93%). In addition, it was thought to be important for armed forces to reduce gender discrimination (91%) and sexual harassment (91%).

Concerning ethnic-cultural minorities, the same pattern as for women was visible: experts agreed that there should be more ECMs as role models (87%) and that armed forces should promote acceptance of minorities (86%).

Glossary:

DC :	Direct Current (as opposed to AC: Alternating Current)
DG MR :	Directorate General Material Resources
DLD:	Defensie Laboratoria/Laboratoires de la D fense
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 G n ral du Renseignement et de la S curit
STRD :	Scientific and Technological Research of Defence
USV:	Unmanned Surface Vehicles

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