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CENTRE FOR MARITIME RESEARCH AND EXPERIMENTATION

Conference Proceedings CMRE-CP-2016-002

Abstracts from the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference

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François-Alex Bourque

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About CMRE

The Centre for Maritime Research and Experimentation (CMRE) is a world-class NATO scientific research and experimentation facility located in La Spezia, Italy.

The CMRE was established by the North Atlantic Council on 1 July 2012 as part of the NATO Science & Technology Organization. The CMRE and its predecessors have served NATO for over 50 years as the SACLANT Anti-Submarine Warfare Centre, SACLANT Undersea Research Centre, NATO Undersea Research Centre (NURC) and now as part of the Science & Technology Organization.

CMRE conducts state-of-the-art scientific research and experimentation ranging from concept development to prototype demonstration in an operational environment and has produced leaders in ocean science, modelling and simulation, acoustics and other disciplines, as well as producing critical results and understanding that have been built into the operational concepts of NATO and the nations.

CMRE conducts hands-on scientific and engineering research for the direct benefit of its NATO Customers. It operates two research vessels that enable science and technology solutions to be explored and exploited at sea. The largest of these vessels, the NRV Alliance, is a global class vessel that is acoustically extremely quiet.

CMRE is a leading example of enabling nations to work more effectively and efficiently together by prioritizing national needs, focusing on research and technology challenges, both in and out of the maritime environment, through the collective Power of its world-class scientists, engineers, and specialized laboratories in collaboration with the many partners in and out of the scientific domain.

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Decision Support and Risk Assessment for Operational Effectiveness 2016 Conference

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Conference Proceedings of the ***Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference*** that took place at NATO STO CMRE facilities on 26-28 July 2016. These Conference Proceedings contain the Abstracts accepted for publication after a peer-review process.

Pages 2-5 of these conference proceedings contain the list of Abstracts (format appropriate to reference these Conference Proceedings Abstracts). Pages 6-38 contain the Abstracts, including author affiliations.

List of Abstracts published on the Conference Proceedings of the DeSRA 2016 Conference:

NATO STO CMRE, "*A Standard-based Data Supply Chain for Decision Making and Recognized Environmental Picture (REP)*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 10, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

Timothy CLARKE, Adrian BAKER, Caroline SLOAN, Richard HAY, Roland ROGERS, and Russell WYNN, "*Towards the Use of Underwater Vehicles for Providing Maritime Environmental Information*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 11, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

Marco COCOCCIONI, "*Lexicographic Multi-Objective Linear Programming for Decision Support and Risk Assessment in Maritime Asset Allocation Problems*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 12, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

Mandeep K. DHAMI, "*Debiasing effects of information visualisation*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 13, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

NATO STO CMRE, "*The use of in-situ environmental perception for Autonomous MCM*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 14, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

Virginia FERNÁNDEZ-ARGUEDAS, Mr. Murray KERR, and Mr. Mariano SÁNCHEZ, "*On-flight satellite image processing for environmental early alerts*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 15, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

Yvonne FISCHER, and Mathias ANNEKEN, "*Knowledge-based and learning-based situation assessment – algorithms, results and challenges*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 16, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Paolo A. GEMELLI, "*The role of a ship's performance uncertainties and the information communication skills in weather routing efficiency*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 18, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Aren HUNTER, Tania RANDALL, and Mark HAZEN, "*Naval Course of Action support tool research program*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 21, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Warren LEWIS, "*An Introduction to AMETOCP-2.1: The NATO Catalogue Of Meteorological And Oceanographic Tactical Decision Aids*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 23, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Ángel MARTÍNEZ-FERRER, "*Wave Forecasting at AEMET: Operational high resolution system. Alternatives for surf areas*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 26, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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NATO STO CMRE, "*Stability analysis to support maritime operational planning aids: an example of application*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 29, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Edwin VAN VELDHOVEN, "*A Priori and In Situ Planning of ASW operations*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 34, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Cdr. ITA-N Andrea BARBERA
NATO COE CSW – NATO Centre of Excellence for Operations in Confined and Shallow Waters

AUV Employment in MCM Operations

Abstract:
Unmanned Underwater Systems are continuing to expand their role especially for MCM Operation.
At the end of 2014, the Italian Navy send to the NATO COE CSW a request for support in order to write a study paper on the employment of AUVs (Autonomous Underwater Vehicles) in MCM (Mine Counter-Measurement) Operations.
The work started at the beginning of 2015 and will be completed before the end of 2017.
The NATO COE CSW is developing this study with the help and the support of the Industry and many other partners (Military, Industry, Academic and Education …).

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Risk-conditioned multiple route planning

Abstract:
The need for planning routes based on spatially- and time-varying information exists in different contexts. For example, a merchant vessel on route to a port may want to avoid areas with inclement weather conditions such as high sea states, while a warship may want to patrol areas known for illicit activities such as smuggling or piracy [1,2]. At first, these problems seem only loosely related. One common thread, however, is the presence of risk, which may vary in space and in time [2].
This contribution proposes a simple approach to propagating ship routes under forecastable risk [3]. Namely, it advocates building a network of the possible routes over the planning horizon, where each vertex is a waypoint and each arc represents a route segment weighted by the corresponding risk value. Through this lens, propagating ship routes conditioned upon risk corresponds to optimizing the risk encountered by one or more platforms stepping through the network.
The approach is illustrated in the context of counter-piracy operations off the Horn of Africa where warships aim to deter and interdict pirates. Such a scenario is germane to current operations conducted under the aegis of the NATO's Operation Ocean Shield. Piracy being the risk factor in this case, a risk forecast is generated based on the observation that prior attacks occur preferably under favourable environmental conditions.

References:
[1] W. An, D. Ayala, D. Sidoti, M. Mishra, X. Han, K. Pattpati, E. Regnier, D. Klienman and J. Hansen, "Dynamic Asset Allocation Approaches for Counter-Piracy Operations", 2013.
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[3] A. Bourque, Multiple vessel routing in the GO-DSS: A flow network formulation, CMRE-MR-2016-002, February 2016.

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LtCol. PRT-N Dr. Luís Manuel BRÁS BERNARDINO, and Dr. Marco MARSILI
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CEI-IUL / ISCTE-IUL – Center for International Studies of University Institute of Lisbon, PRT

Increasing military capability through information and communication

Abstract:
The scope of this abstract is to pursue and increase the quality levels of the military instrument to enhance the effectiveness, operational capabilities and overall employability by providing a timely information representation and a catchy and tailored visualization and communication support.
The impact of information and communication on civilian/military maritime operations should be addressed in a social and political perspective.
The success of communication, both indoor and outdoor, is essential for achieving goals. A fully informed and favorable outdoor and indoor environment supports and facilitates the achievement of military objectives.
Communication must be multimedia, multiplatform and multilevel.
Communication to be strength, must represent information in a simply and clear way through short text elements integrated with interactive visual representations: they capture at best the audience attention, without compromising the efficacy of the information content to be transmitted [1].
Online availability through user-friendly and intuitive interface, enabling a positive user experience, is strongly recommended. Language should be natural [2] for not military audience, and glossary should be available. Information should be manually categorized [3] for not military audience.
Communication results should be measured through a validation and verification process.

References:
[1] Michael Averbuch, As you Like It: Tailorable Information Visualization (Database Visualization Research Group: Tufts University, 2004).
[2] Hans H. Wellisch, Indexing from A to Z (New York: H.W. Wilson, 1995).
[3] David C. Blair & M.E. Maron, "An Evaluation of Retrieval Effectiveness for a Full-Text Document-Retrieval System", Communications of the ACM 28(3): 289–299.

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Automated Port Traffic Statistics: From Raw Data to Visualisation

Abstract:
We will present work on extracting, processing, visualising summary statistics on port traffic based on AIS data. For this work we adopted processing techniques for big data and the latest visualisation tools. We created automated pipelines that scale as the data increases and designed an interactive visualisation dashboard with the goal of delivering a tool that is easy to use for maritime traffic subject matter experts [1].

References:
[1] Big Data Architectures in Support of Computational Maritime Situational Awareness - Case Study in Port Traffic Analysis," L. Cazzanti, A. Davoli, CMRE Technical Report, CMRE-FR-2015-021, December 2015. [NATO Unclassified]

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A Standard-based Data Supply Chain for Decision Making and Recognized Environmental Picture (REP)

Abstract:
Service-based data curation is a prerequisite for the generation of authoritative data-driven decision support tools. In particular, the seamless integration of data infrastructures and computing workflows may be beneficial to the efficiency and the accuracy of the Recognized Environmental Picture (REP). Interoperability best-practices based on data-driven services and open standards enable the integration of fusion, tracking, and data analysis software with earth observations and models, facilitating the distribution of relevant information to decision makers in an unified geographical visualization.
Moreover, high quality and standardized metadata allow effective data discovery through web-based data catalogues, linking interoperable data repositories and may pave the way to federated data infrastructures [1]. The presentation will introduce the audience to the approach undertaken at the Centre for Maritime Research and Experimentation (CMRE) for the development of an integrated data management infrastructure for scientific data and products. With a forward-looking perspective, such developments pave the way for the creation of "common enterprise bus" in which scientific data and added-value products are the principal currency. The implementation of some of these standards in the GlidierC2S capability were already tested on the NATO Coalition Warrior Interoperability eXploration, eXperimentation, eXamination, eXercise (CWIX) 2016 on 13-30 June 2016 [2].

References:
[1] A. Berni, G. Cimino, E. Camossi and S. Giannecchini, "From data to decision: An overview of CMRE's information supply chain," OCEANS 2015 - Genova, Genoa, 2015, pp. 1-6.
[2] R. Vicen-Bueno, G. Cimino, D. Cecchi, and B. Garau, "*GliderC2 – Interoperable Unmanned Underwater Glider Command & Control capability at CMRE: Demonstration in NATO Exercise CWIX 2016*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 36-37, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Mr. Timothy CLARKE [a], Dr. Adrian BAKER [a], Ms. Caroline SLOAN [b], Lt. Richard HAY [c], Mr. Roland ROGERS [d], and Prof. Russell WYNN [d]
[a] Defence Science and Technology Laboratory (DSTL), GBR
[b] Navy Command Headquarters (NCHQ), GBR
[c] Maritime Warfare Centre (MWC), GBR
[d] National Oceanography Centre (NOC), GBR

Towards the Use of Underwater Vehicles for Providing Maritime Environmental Information

Abstract:
This presentation will introduce the joint programme between Dstl, NCHQ, MWC and NOC covering the recent work and future plans for the use of unmanned vehicles for collecting maritime environmental information in the context of the Recognised Environmental Picture (REP). The focus for the presentation will be on the use of unmanned surface vehicles and underwater gliders within the UK Ministry of Defence. This will include a discussion on the types of environmental information which can be obtained from these vehicles (both from traditional sensors and inferred data) and lessons learnt on their use in an operational environment. The presentation will end with a description of future plans for the use of unmanned vehicles and the benefits of incorporating the data within the REP in conjunction with traditional sources of tactical maritime environmental information.

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Dr. Marco COCOCCIONI
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Lexicographic Multi-Objective Linear Programming for Decision Support and Risk Assessment in Maritime Asset Allocation Problems

Abstract:
In many maritime applications minimizing a risk function alone can be ineffective in accurately modeling the problem at hand. As a matter of fact, most of the engineering applications require the concurrent optimization of multiple objectives, in order to obtain a meaningful trade-off solution.
After discussing the state-of-the-art in solving Lexicographic Multi-Objective Linear Programming (LMOLP) problems, we will present an efficient way to solve them, which has been recently proposed in literature [1]. Such an efficient LOMLP solver is crucial to solve the Multi-Objective Weapon-Target Assignment problem (MOWTA) [2, 3]. The MOWTA problem, on its turn, is a powerful metaphor that can be used in several maritime applications, such as:
i) to decide where to direct underwater gliders in order to maximize the information gathered and to minimize the risk of losing them (especially when they are used in denied areas);
ii) to decide where to direct patrolling vessels to contrast illegal immigration in the Mediterranean sea.

References:
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[2] Ni L. et al. “The solution of target assignment problem in command and control decision-making behaviour simulation,” 2016, http://dx.doi.org/10.1080/17517575.2016.1177207.
[3] Li J. et al. “Solving multi-objective multi-stage weapon target assignment problem via adaptive NSGA-II and adaptive MOEA/D: A comparison study," in Proc. of the 2015 IEEE Congress on Evolutionary Computation (CEC), Sendai, 2015, pp. 3132-3139, http://dx.doi.org/10.1109/CEC.2015.7257280.

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Prof. Mandeep K. DHAMI
Middlesex University, London, GBR

Debiasing effects of information visualisation

Abstract:
A large body of psychological research has shown that human decision-making (including that of experts) can be biased by the way information is framed (e.g., in positive vs. negative terms). By contrast, there is relatively less research exploring ways in which to debias people. In the present paper, we demonstrate the debiasing effect of an information visualisation strategy [1]. We do this by using a controlled experiment involving senior police officers in the UK who were asked to make decisions about the accuracy of a hypothetical counterterrorism technique. They were presented with the same information in two different formats (i.e., numerically and visually). We discuss potential explanations for the debiasing effect of information visualisation as well as implications for communicating risk information to experienced, professional decision-makers [2].

References:
[1] Garcia-Retamero, R., & Dhami, M. K. (2013). On avoiding framing effects in experienced decision makers. Quarterly Journal of Experimental Psychology, 66, 829-842.
[2] Garcia-Retamero, R., & Dhami, M. K. (2011). Pictures speak louder than numbers: On communicating medical risks to immigrants with non-native language proficiency. Health Expectations, 14, (suppl. 1.), 46-57.

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The use of in-situ environmental perception for Autonomous MCM

Abstract:
The ANMCM (Autonomous Mince Countermeasures) POW (programme of work) at NATO STO CMRE has been focused on developing on-board AUVs (autonomous underwater vehicles) processing and autonomy for the past 5 years with a strong demonstrated incremental progression supported by bi-annual trials at sea. This presentation will highlight the use of in-situ environmental perception for improved detection and classification of targets, the processing of increased quality synthetic aperture sonar (SAS) images and the overall improvement of mission performance using adaptive techniques. We will briefly describe how the environment is perceived using on-board sensors and processing, and then provide examples with data collected at sea. We will also present videos of autonomous vehicle behaviours tested during trials to compensate for adverse sand ripple effects and/or currents. Finally we will propose our future solution for in-situ on-board real-time perception, which will enable optimised goal-based mission autonomy development.

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Dr. Virginia FERNÁNDEZ-ARGUEDAS, Mr. Murray KERR, and Mr. Mariano SÁNCHEZ
Deimos Space, ESP

On-flight satellite image processing for environmental early alerts

Abstract:
In the last years, satellite image processing has acquired great importance for Earth observation, resources monitoring and risk mapping. Satellites enable global monitoring, enlarging our knowledge and offering numerous capabilities, from anomaly detection to analysis of resources evolution. Due to the Earth observation large implications on environment, economy, safety and security, numerous efforts and resources are invested towards the faster and more detailed acquisition and generation of knowledge.
Currently, satellite image processing is strictly applied in ground segments, entailing a delay between the image acquisition and the visualisation of the image processing results. Such delay has a direct impact on certain areas related to safety, security and risk mapping where on-the-fly information is essential. For instance, scenarios associated to natural disasters require near real-time image processing analysis to feed early-warning systems.
Deimos Space proposes to process satellite images on-flight, supplying not only the acquired satellite images but also some early knowledge to the ground segment. The enriched image would provide final users, i.e. operational authorities, with initial information, detections and locations, in an attempt to reduce the risk exposure and accelerate the response, hence, enlarging the safety and security levels. Satellite limited resources would demand some balance between the image processing techniques requirements and performance.
Dr. Virginia FERNÁNDEZ-ARGUEDAS will present Deimos Space, its research and development areas and the proposed strategy in order to overcome existing challenges in situational awareness.

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Dr. Yvonne FISCHER, and Mr. Mathias ANNEKEN
Fraunhofer IOSB – Institute of Optronics, System Technologies and Image Exploitation, DEU

Knowledge-based and learning-based situation assessment – algorithms, results and challenges

Abstract:
For supporting decision makers in the maritime domain, it is not sufficient just to collect and represent all the vessel traffic and environmental information. This would lead to an information overflow, as the amount of data to be analyzed is too large. In the field of artificial intelligence (AI), there are several approaches for analyzing large amounts of data. In general, two different approaches are common: the knowledge-based and the learning-based approach. In the maritime domain, AI-algorithms can be used for implementing situation assessment services, which are able to analyze the spatio-temporal patterns of specific situations or to identify anomalies in vessel behaviors.
Fraunhofer IOSB performed research on modeling expert knowledge in the maritime domain for recognizing specific situations of interest [1] and also on the development anomaly detection algorithms for identifying suspicious vessel behavior [2, 3]. Both approaches will be presented including recent results and identified challenges.

References:
[1] Y. Fischer and J. Beyerer, "Modeling of Expert Knowledge for Maritime Situation Assessment," International Journal on Advances in Systems and Measurement 6 Nr. 3&4, IARIA, 2013, pp. 245-259.
[2] M. Anneken, Y. Fischer and J. Beyerer, "Evaluation and comparison of anomaly detection algorithms in annotated datasets from the maritime domain," SAI Intelligent Systems Conference (IntelliSys), 2015, London, 2015, pp. 169-178.
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Unmanned Search And Rescue in the Maritime Environment

Abstract:
The experience gained during recent disasters confirmed that there exists a large discrepancy between robotic technology developed in laboratory, and the use of such technology for SAR (Search and Rescue) operations.
The overall purpose of the ICARUS (Integrated Components for Assisted Rescue and Unmanned Search operations) [1] project is to apply its innovations, a toolbox of integrated components for unmanned SAR, for improving the management of a crisis by facilitating involved personnel mission. To accomplish this global goal is crucial to achieve higher levels of autonomy and interoperability for the robotic assets operating in the scenario.
CMRE has designed, realized and tested at sea a generic autonomy toolkit for USVs (Unmanned Surface Vehicles), including a set of behaviours [2] combined with real-time sensor data fusion, able to achieve high performances in terms of speed, safety and reliability, and interoperable with other robotic assets.
This toolkit combines a set of ad-hoc hardware solutions (radar, gyro-stabilised laser scanner, thermal sensors) and behaviours to achieve augmented levels of autonomy. The adoption of the JAUS (Joint Architecture for Unmanned Systems) [3] protocol has granted system interoperability and a common C2 (command and control) station.
Implemented behaviours tested during the maritime scenario have proved the robustness of the autonomous USV to changes in the environment, the high level of interoperability between the robotic assets, and the effectiveness in maritime SAR missions.

References:
[1] www.fp7-icarus.eu
[2] S. Fioravanti, A. Grati, M. Stipanov, ICARUS – USV autonomous behaviour in search and rescue operations, Proceedings of the RISE Conference, Lisbon, January 2015.
[3] SAE AS5684A, "JAUS Service Interface Definition Language", AS-4C Information Modeling and Definition Committee, July 2010.

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Mr. Paolo A. GEMELLI
Himmel & Matter Srl, ITA

The role of a ship's performance uncertainties and the information communication skills in weather routing efficiency

Abstract:
Weather routing may provide helpful information for the improvement of a ship's safety, the reduction of fuel consumption and the improvement of comfort aboard [1].
Nevertheless its efficiency is related to the quality and the resolution (time and space) of weather forecasts, the knowledge of a ship's performance at sea and, last but not least, information communication skills.
The incomplete knowledge of a ship's (or boat's) performance at sea results in incorrect position and METOC conditions estimation. This may seriously affect the subsequent algorithm steps and may lead to incorrect decisions [2].
In my 17 years of experience in providing weather routing to very different kinds of customers (merchant ships, super yachts and racing boats) I have learnt that the voyage plan is not a "static document" but, on the contrary, a dynamic one, constantly updated by onboard information (position, heading and velocity), weather observations and forecast updates.
Most of the time our information is provided by using a "two –way-communication- protocol" based on sat links and able to provide immediate feedback from the ship [3].

References:
[1] N. Bowditch, "The American Practical Navigator," Deffense Mapp. Agency Hydrogr., no. 9, p. 882, 2002.
[2] J. Szlapczynska and R. Smierzchalski, "Adopted Isochrone Method Improving Ship Safety in Weather Routing With Evolutionary Approach," Int. J. Reliab. Qual. Saf. Eng., vol. 14, no. 06, pp. 635–645, 2007.
[3] P. Gemelli, L. Onorato, and S. Gallino, "An efficient way to provide meteorological informations in extreme conditions," in European Meteorological Society Annual Meeting, 2006.

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LtCdr. DEU-A Christian GERBER
NATO HQ SACT – NATO Headquarters Supreme Allied Command Transformation

Environmental Functional Service (Env-FS)

Abstract:
PowerPoint Presentation about the future NATO Env-FS and its current status.
Environmental-Functional Service (Env-FS) is a NATO capability project within a wider AIS capability package and as part of NATO's transformational goals, the Environmental Capability will ensure coherent provision of environmental information in support of the full range of missions at all levels of command within the Bi-SC AIS architecture.
Therefore the Env-FS is aimed to deliver the capability providing products and web services with environmental information, which shall be considered at any military planning and monitoring activities.
The Env-FS capability will focus on strategic and operational levels, but must be able to support (as appropriate) all levels of command, including NATO Force Structure (NFS) and Non-NATO Force Contributing Nations operating at the tactical level. It shall be a key input for the future NATO Common Operation Picture (NCOP), better enabling commanders to achieve Decision Superiority.

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Where is it sailing to: benefits of contextual and prediction information in detection of anomalous destination

Abstract:
Estimating probabilities of occurrence of maritime anomalous events from imperfect maritime data together with the potential associated losses helps to evaluate potential threats, determine the risks and identify the appropriate courses of action. In particular, a significant challenge in design and development of automated maritime anomaly detection systems for decision support is the veracity of AIS data due to their potential inconsistency, incompleteness, ambiguity, latency or deception. We assess the role of context and the impact of the imperfection of information in detecting vessel's deviation from destination within an uncertainty graphical model. The focus is on the exploitation of non-kinematic information, contextual information in the form of routes, and the predicted kinematic features as outputs of a vessel-tracking algorithm. An uncertainty graphical model example is designed manually to represent expert knowledge and measurement uncertainty. The assessment is performed in terms of availability and variability of contextual information, and in terms of reliability (i.e. observability and correctness) of non-kinematic information. The obtained results facilitate the requirements and design specifications for the design and development of an efficient both model and data driven system for maritime anomaly detection.

References:
[1] C. Ray, C. Iphar, A. Napoli, R. Gallen and A. Bouju, DeAIS project: Detection of AIS spoofing and Resulting Risks, OCEANS'15 MTS/IEEE, Genoa, Italy, May 2015.
[2] L. Snidaro, J. Garcia and J. Linas, Context-based information fusion: a survey and discussion. Information Fusion, 25, 16-31, 2013.
[3] G. Pallotta, M. Vespe and K. Bryan, Vessel Pattern Knowledge Discovery from AIS Data: framework for anomaly detection and route prediction, Entropy, 15, 2013.

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Ms. Aren HUNTER, Mrs. Tania RANDALL, and Mr. Mark HAZEN
DRDC - Defence Research and Development Canada, CAN

Naval Course of Action support tool research program

Abstract:
Defence Research and Development Canada (DRDC) Atlantic Research Centre is currently investigating ship-board decision making processes with the intent of developing a prototype ship-board planning tool to support decision making across a spectrum of Maritime Information Warfare activities. Current Canadian Forces Operational Planning Process (OPP) doctrine presents a linear five-stage process - initiation, orientation, course of action (COA) development, plan development and plan review. Observational studies investigating the application of the OPP in the Royal Canadian Navy (RCN) suggest that the OPP is often modified to deal with time-pressures, increasing complexity of information and uncertainty [1]. Thus the application of the OPP in an operational setting is less analytic than the OPP doctrine would imply, and more of a combined analytic and intuitive decision making process. The presentation will discuss the initial research program aimed at better understanding the analytic and intuitive decision-making characteristics of the OPP, as well as the selection and development of decision aids to be included in the planning tool. A discussion of the overall COA assessment tool and planned future year program will also be included in the presentation.

References:
[1] Bryant, D.J., Bruyn Martin, L., Bandali, F., Rehack, L., Vokac, R., Lamoureux, T. (2007). Development and Evaluation of an Intuitive Operational Planning Process. Journal of Cognitive Engineering and Decision Making, 1, 434-460.

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Mr. Clément IPHAR [(a)], Dr. Aldo NAPOLI [(a)], and Dr. Cyril RAY [(b)]
[(a)] MINES ParisTech, FRA
[(b)] French Naval Academy Research Institute (IRENav), FRA

Falsification Discovery in AIS Messages

Abstract:
The SOLAS convention created an electronic system of message broadcasting between vessels: the Automatic Identification System (AIS).
Albeit initially designed for security purposes, some people use the system another way, such as fleet surveillance, and the system suffers from errors, falsifications and spoofing.
AIS data structure is complex, with 27 different messages, each one having a given number of data fields with various size, importance and type [1].
We propose a method based on the data quality dimensions and particularly the integrity of data within the message to assess the confidence in each message received, with a data processing done both on-the-fly with coming data and when data is stored in the database for comparison with archived data [2] and signal-based assessment we propose [3]. Each message will be assigned a confidence coefficient based on the processing of a checklist of ad-hoc items.
The purpose is to assign a grade of alert and a level of associated risks (such as boarding, pollution, terrorism) to each message, group of messages sent by the same vessel or situation, suitable to be given for further studies to relevant authorities such as coast guards or MRCCs.

References:
[1] Tunaley, 2013. Utility of Various AIS Messages for Maritime Awareness. In proceedings of the 9th ASAR Workshop. Longueuil, Canada, October 2013.
[2] Iphar, Napoli et Ray, 2016. Risk Analysis of falsified Automatic Identification System for the improvement of maritime traffic safety. In proceedings of the ESREL 2016 conference, Glasgow, United Kingdom, September 2016.
[3] Alincourt, Ray, Ricordel, Dare-Emzivat et Boudraa, 2016. Methodology for AIS Signature Identification through Magnitude and Temporal Characterization. In proceedings of the OCEANS'16 SHANGHAI conference, Shanghai, China, April 2016.

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Dr. Warren LEWIS
Met Office, GBR

An Introduction to AMETOCP-2.1: The NATO Catalogue Of Meteorological And Oceanographic Tactical Decision Aids

Abstract:
Tactical Decision Aids (TDA) incorporate weather and environmental information, along with information on the mission and the equipment being used (e.g., platforms and sensors), to allow a meteorologist/oceanographer, or the operator, to predict the effect that environmental conditions have on military systems and equipment, and the impact that this might have on a specific operation.

Over the years a significant number of TDAs have been developed by the NATO nations and there is a clear need to harmonize, or standardize, the TDAs or the TDA models being used. This will be particularly important in the context of multinational operations, where the provision of consistent tactical advice is essential. Furthermore, it is essential that the various TDAs used to support air, land and maritime operations should produce consistent results.

The purpose of AMETOCP-2.1 [1] is to define and document a suite of TDAs that are available for use by all NATO nations and its partners. Through the availability of the NATO METOC TDA Catalogue the METOC community is promoting interoperability while, by the co-operative way in which the catalogue has been compiled, assisting the nations in improving their meteorological support capabilities. Thus the NATO catalogue of TDAs will help to ensure the consistency of TDAs on various national and NATO systems, thus improving the consistency of tactical METOC advice and supporting interoperability within NATO.

References:

[1] AMETOCP-2.1: The NATO Catalogue of Meteorological and Oceanographic Tactical Decision Aids. Edition B, Version 1, July 2016.

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Dr. Warren LEWIS, and Mr. Jon SPARKS
Met Office, GBR

Met Office Engagement in CWIX 2016

Abstract:
The Met Office CWIX Meteorological and Oceanographic (MetOc) services capability demonstrates UK's ability to provide MetOc Designated Geospatial Information (DGI) environmental services for mission-specific, decision-support activities, via recognised national and international non-proprietary standards, primarily delivered through OGC (Open Geospatial Consortium) web-services.
The demonstration and test strategy focuses on the UK's Spatial Data Infrastructure (SDI) concept and associated C4ISR programmes; contributing towards the development and test of MetOc 'foundation' data for use within C4ISR system capability.
Within the NATO/coalition-partner context, the output MetOc services will contribute towards a better understanding of the interoperability requirements, testing of functionality and arising issues, whilst working within a coalition GeoMetOc team; contributing towards the 'Recognised Environmental Picture' (REP); supporting the 'operational decision making' process and providing elements of information and intelligence to help compile the 'operational picture'.
This capability is part of the UK MoD SDI 'Innovation Sandbox' infrastructure; connecting to national/international networks and ultimately to coalition/partner C4ISR systems within the NATO CWIX environment.
The capability uses proven technology which underpins the Met Office's Horace V and NAMIS XP systems that deliver meteorological based 'environmental impact' information and visualisation to support Defence requirements for planning and 'real-time' decision making in a variety of operational scenarios.

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Dr. David R. MANDEL
DRDC - Defence Research and Development Canada, CAN

Monitoring Forecasting Skill in Strategic Intelligence

Abstract:
The forecasting skill of 2,013 probabilistic forecasts extracted from Government of Canada strategic intelligence reports was examined. The forecasts focused on geopolitical topics and were produced by civilian strategic intelligence analysts. Two skill components, calibration and discrimination, were found to be exceptionally good. There was little difference in these skill measures between forecasts made by analysts that used numerical probabilities and those that did not. Forecasting skill was virtually identical for key and non-key judgments. Forecasts given with very high levels of certainty (P = .95 or higher or P = .05 or lower) had worse discrimination than less certain forecasts and calibration did not differ between these subsamples. The findings generalize earlier results reported in [1] and do not support the hypothesis advanced in [2] that the basis of good forecasting in this population is mainly due to picking easy topics. This study, which verifies the quality of forecasts qualified with verbal probabilities using results from [3], further shows that intelligence organizations do not have to adopt the use of numerical probabilities in intelligence assessment in order for outcome-based accountability processes, such as forecasting skill verification, to be implemented. This should be welcome news for the intelligence community.

References:
[1] Mandel DR, Barnes A (2014) Accuracy of forecasts in strategic intelligence. Proc Natl Acad Sci USA 111, 10984–10989.
[2] Mandel DR (2015) Accuracy of intelligence forecasts from the intelligence consumer's perspective. Policy Insights Behav Brain Sci 2: 111-120.
[3] Tetlock P, Mellers B (2014) Judging political judgment. Proc Natl Acad Sci USA 111: 11574-11575.

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Mr. Ángel MARTÍNEZ-FERRER
AEMET – Spanish Meteorological Agency, ESP

Wave Forecasting at AEMET: Operational high resolution system. Alternatives for surf areas

Abstract:
Weather Forecast Products are required to be highly skilled in terms of accuracy, resolution, promptness and, lately, being supplied on a probabilistic base.
Ocean waves changes substantially from deep waters up to breaking at the shore. Also, wave modelling has many empiric terms and several numerical formulations. Then, AEMET decided to use WW3 (Wave Watch III) for open sea and SWAN (Simulating WAves Nearshore) at coastal regions. The surf area needs a special treatment.
Increasing resolution also implies forcing with high-resolution fields. Atmospheric Local Area Models are available at 5 km (HIRLAM - High Resolution Limited Area Model) and 2.5 km (HARMONIE) resolutions. AEMET is carrying out experiments on HARMONIE at 1 km resolution.
Among other processes, waves entering the surf area experience turbulent breaking. Its upper layer is taken into account with the roller term in the energy equation, making a big difference on the final results.
Choosing a model for the surf area depends on the user's needs, rather than on solution promptness. Thus, some are focused on coastal engineering management, and others on the physical properties of the wave phenomenon itself. The later users are the ones to be attended by the Meteorological Services. The presentation will discuss about available surf models: SURF 3.2, XBEACH, SWASH and DELFT3D.

References:
[1] Holthuijsen, L.H. 2010. Waves in Oceanic and Coastal Waters, Cambridge University Press, 387 pp.
[2] Tolman, H.L. 2014. User Manual and System Documentation of WAVEWATCH III version 4.18, NOAA-NCEP-Environmental Modelling Center, 311 pp.
[3] Mettlach, T.R. et al. 2002. Software Design for the Navy Standard Surf Model Version 3.2, Naval Research Laboratory, 189 pp.

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Passive Acoustic Detection and Tracking of Multiple Targets Using Autonomous Mobile Platforms

Abstract:
We propose a new approach for passive acoustic detection and tracking of multiple targets using autonomous mobile platforms. Due to their long endurance and discreteness, wave gliders and underwater gliders hosting smart passive sensors can significantly improve intelligence, surveillance and reconnaissance (ISR), and counter anti-access/area denial strategies (A2/AD). In our approach, a volumetric hydrophone array [1] is used as a sensor for detection and tracking of multiple surface vessels. From each pair of hydrophones, time-difference of arrival (TDOA) measurements [2], are obtained by means of generalized cross-correlation estimation. Target detection and tracking from these TDOA measurements is complicated by the highly non-linear TDOA measurement model and by measurement origin-uncertainty (i.e., unknown association of measurements with targets). To address these challenges, we use a data fusion algorithm based on belief propagation message passing [3], which is able to accurately approximate Bayes-optimum multitarget tracking from TDOA measurements and has a very attractive computational cost.

References:
[1] A Tesei et al.: "Passive acoustic surveillance of surface vessels using tridimensional array on an underwater glider", Proc. OCEANS-15, May 2015.
[2] F. Gustafsson and F. Gunnarsson: "Positioning using time-difference of arrival measurements", Proc. ICASSP-03, Apr. 2003.
[3] F. Meyer, et al.: "Tracking an unknown number of targets using multiple sensors: A belief propagation method", Proc. FUSION-16, Jul. 2016.

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Long-Range Glider Missions for Environmental Characterization 2016 (LOGMEC16)

Abstract:
The combined oceanographic/acoustic sea trial LOGMEC16 was conducted on 02 May – 30 June. In the oceanographic part, two underwater gliders named Dora and Jade, were deployed for a two-month mission in the Ligurian Sea (Western Mediterranean). Their tracks were synchronized in space and time with the footprints of four orbiting satellites equipped with altimeters. Dora completed a 56-day mission successfully, but Jade had to be substituted by another glider because communication was lost after about 38 days. First analyses of the glider data sets provide strong evidence for an increase of temperature and salinity at intermediate depth levels on climatological time scales. Four ocean circulation models were operated in near-real time, providing nowcasts and forecasts of environmental parameters. All glider data were sent in near-real time to the CORIOLIS Data Centre in Brest (France), and thereafter were distributed by the Copernicus Marine Environment Monitoring Service. They were also sent to the NATO STO CMRE GliderC2S capability running in classified networks during the NATO Coalition Warrior Interoperability eXploration, eXperimentation, eXamination, eXercise (CWIX) 2016 on 13-30 June 2016 [1].

References:
[1] R. Vicen-Bueno, G. Cimino, D. Cecchi, and B. Garau, "*GliderC2 – Interoperable Unmanned Underwater Glider Command & Control capability at CMRE: Demonstration in NATO Exercise CWIX 2016*", Proceedings of the Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, vol. 2016, no. 1, pp. 36-37, 26-28 July 2016, NATO STO CMRE, La Spezia, Italy.

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Stability analysis to support maritime operational planning aids: an example of application

Abstract:
To support operational planning of expeditionary warfare and littoral operations, an understanding of the environmental variability is critical to the successful accomplishment of a mission and thus a key enabler for NATO transformation. The purpose of the presentation is to describe a methodology to form and interpret an initial spatial-temporal variability characterization of maritime areas [1] that may be implemented on physical factors, such as the meteorological and oceanographic (METOC) parameters (e.g. Sea Surface Temperature - SST, currents), as well as social factors (e.g. amount of vessel traffic or fishing activity through an area of interest). As an example of study, the analysis of the SST in the Black Sea from historical time-series of Remote Sensing (RS) imagery and Numerical Ocean Model (NOM) data is presented and validated with in-situ measurements from moorings [2]. The analysis is focused on monthly spatial-temporal variability of the SST, generating a capability able to provide stability maps displaying the geospatial distribution of environmentally stable/unstable areas along a year. The results show how the proposed methodology captures the temporal variability of the SST in the Black Sea through comparison with in-situ measurements and provides useful information for the identification of environmentally stable/unstable areas.

References:
[1] Pennucci G., Fargion G., Alvarez A., Trees C. And Arnone R., A methodology for calibration of hyperspectral and multispectral satellite data in coastal areas, SPIE 8372, Ocean Sensing and Monitoring IV, 83720K (2012).
[2] Loeches J., Vicen-Bueno R., Pennucci G. , Russo A.,
Identification of sea surface temperature (SST) variability areas through a statistical approach using remote sensing and numerical ocean model data, SPIE 9459, Ocean Sensing and Monitoring VII, 945910 (2015).

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Mr. Luca REPETTI, and Mr. Matteo GUIDERI
IHI – Italian Hydrographic Institute, ITA

The Italian Hydrographic Institute experience in the support to naval operations

Abstract:
The Oceanography and Marine Geophysics Department of the Italian Hydrographic Institute (IHI) has the important task to provide the Navy with Environmental Briefing Dockets, STOICs, Climatological Atlases, current and wave numerical modelling to support naval operations. Concerning numerical models, the first step was to create bathymetric grids from the hydrographic data the IHI collected and validated. The second step was to implement a procedure to input such bathymetric grids into an automatic process for the creations of relocatable numerical models. The maps obtained were then collected and disseminated along with the other products to the users.
Our presentation in DeSRA 2016 illustrates the methods and techniques used in the production and dissemination process of such products for Italian Navy and/or NATO exercises and operations.

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NATO STO CMRE [a], and Dr. Alberto ÁLVAREZ [b]
[a] NATO STO CMRE – NATO Science and Technology Organization Centre for Maritime Research and Experimentation
[b] IMEDEA – Instituto Mediterráneo de Estudios Avanzados, ESP

Environmental variability in maritime domains: ongoing and perspective studies at CMRE

Abstract:
Variability of METOC conditions may strongly affect operations at sea. The talk will present studies that were conducted for estimating the environmental variability in the Eastern Ligurian Sea [1], where the Long-Range Glider Missions for Environmental Characterization 2016 (LOGMEC16) [2] sea trial (hold by CMRE through May and June 2016) was planned, on the basis of public available model and data products. The dataset collected during the sea trial will be used to evaluate at which extent applied methodologies were effective in predicting the environmental variability of the area. Perspectives of continuing research in domains characterized by extreme weather conditions (e.g. High North) will also be presented.

References:
[1] A. Russo, A. Alvarez, I. Borrione, S. Falchetti, P. Oddo, Estimate of environmental variability in the area of the Glider Persistency Trial, CMRE Technical Progress Report, 2016.
[2] R. Onken, Long-Range Glider Missions for Environmental Characterization 2016 (LOGMEC16), Proc. Decision Support and Risk Assessment for Operational Effectiveness (DeSRA) 2016 Conference, 26-28 June 2016, NATO STO CMRE, La Spezia (Italy).

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Maj. USA-AF Matthew F. STANLEY
NATO ACO SHAPE METOC – NATO Allied Command Operations Supreme Headquarters Allied Powers Europe Meteorological and Oceanographic

ACO METOC Support of NATO Operations

Abstract:
Operational commanders combine weapon-system specific guidance, Tactics Techniques and Procedures, operational lessons learned, and experience/skill level of their operators to assess, manage and accept mission risk. ACO METOC's brief will provide an operational perspective into METOC personnel's support of ACO Operations, NATO decisions and risk assessments and METOC policy that enable the support, the Integrated METOC principle. It will also look at current efforts to implement MC 0632, the Recognized Environmental Picture (REP).

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Real time passive sonar performance prediction with AIS shipping

Abstract:

Building upon successful testing at CWIX15 the CMRE MSTPA (MultiStatic Tactical Planning Aid) tool has been upgraded to allow for real time generation of passive acoustic predictions taking into account nearby noisy shipping [1]. Testing at CWIX16 showed that predictions could be made using platform positions obtained from C2 systems, METOC information from CMRE capabilities, and commercial shipping details obtained from live AIS streams.

The tool obtains a complete global stream of AIS platform information, which must first be filtered before carrying out the more time consuming passive predictions – accounting for the wide frequency spectrum of passive sonars. Firstly, the smaller Class B platforms are removed since they are less likely to impact passive sonar performance. Any stationary platforms, such as those in ports and harbors, are also removed. The model then determines the radiated noise of the remaining platforms as a function of their speed and size. A simple cylindrical spreading loss algorithm is then applied to quickly determine those platforms that are likely to have the greatest effect on the passive receiver. These ships are then included in the full passive sonar predictions taking into account range dependent transmission loss and the effects of beamforming and side lobe levels.

References:

[1] C. Strode and F. Traverso and M. Oddone, Towards real-time passive sonar performance prediction with AIS shipping, CMRE-FR-2016-001, January 2016.

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Mr. Edwin VAN VELDHOVEN
TNO – The Netherlands Organisation for Applied Scientific Research, NLD

A Priori and In Situ Planning of ASW operations

Abstract:
In the near future, the Royal Netherlands Navy (RNLN) will introduce two new underwater sensors on its platforms: the Low-Frequency Active-Passive Sonar (LFAPS) on the M-frigate and the Helicopter Long-Range Sonar (HELRAS) on the NH90 helicopter.
The RNLN wants to develop a decision support tool, the Multi-Use Acoustic Support Suite (MUASS), for planning the effective and efficient deployment of these sensors in Anti-Submarine Warfare (ASW) operations. MUASS will support both ‘a priori’ and ‘in situ’ planning, where ‘a priori’ is about planning at the tactical level, both long (months) and shortly (weeks, days) before a mission, and ‘in situ’ is about sensor performance and sensor settings during a mission.
For the development of MUASS, TNO has built demonstrator tools for both types of planning of ASW operations. TNO’s ongoing research is focused on creation of acoustic maps for an operation area, and on improvement and speeding up of the ‘a priori’ planning for the deployment of sonar systems. Speeding up is necessary because ‘a priori’ planning implies the evaluation of a large number of possible tactical variations. The acoustic maps will be used both for ‘in situ’ decision support and for improving the ‘a priori’ tactical planning support.

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GliderC2 – Interoperable Unmanned Underwater Glider Command & Control capability at CMRE: Demonstration in NATO Exercise CWIX 2016

Abstract:
NATO STO CMRE has demonstrated in a NATO coalition exercise that can run a long-term deployment of underwater gliders and provide the acquired information in quasi real-time in an automatic and reliable way to NATO and national systems/capabilities. This work has been done in coordination with the CMRE-lead sea-trial LOGMEC16 (Long-Range Glider Missions for Environmental Characterization 2016) [1]. The GliderC2 capability has been demonstrated during the NATO Coalition Warrior Interoperability eXploration, eXperimentation, eXamination, eXercise (CWIX) 2016 on 13-30 June 2016. This is an incremental step from last year participation [2, 3], achieving a certain level of maturity that allows this capability to work in a NATO coalition with a high security classification level. During this exercise, NATO STO CMRE provided glider positions and tracks (planned missions), as well as oceanographic observations and forecasts as planned [4] to contribute to different NATO concepts, such as Recognized Environmental Picture (REP), Rapid Environmental Assessment (REA) and Common Operational Picture (COP). For doing so, the GliderC2 capability implements highly interoperable standards approved by NATO. This information was remotely provided in a full-automatic way (no human interaction) from underwater gliders operating at sea in Italian waters (Ligurian Sea) to Command and Control (C2) and COP capabilities deployed at the NATO Joint Force Training Centre (JFTC) in Bydgoszcz, Poland. Information was successfully transferred, used and displayed 2,000 km far from gliders.

References:
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MIVIS: METOC and INTEL-driven Vessel Interdiction System for planning and analysing maritime interdiction operations

Abstract:
NATO STO CMRE presents a decision support system (DSS) to improve interdiction operations at sea driven by intelligence (INTEL) information and meteorological and oceanographic (METOC) forecasts. The system is called MIVIS: METOC and INTEL-driven Vessel Interdiction System. This system interfaces Command and Control (C2) systems to support interdiction operations. MIVIS yields the best location along a predicted path (coming from INTEL) to interdict a vessel in the best METOC conditions (safest for the interdiction crew) and taking the fastest and safest track. The system includes two main processing stages: the routing algorithm and the decision-making stage. The routing algorithm finds out the minimum-cost optimum routes to the predicted interdiction locations through an optimization algorithm. The algorithm is guided by means of a navigation model that employs METOC variables, such as the significant wave height or the wind. A numerical ocean model (NOM) provides the METOC forecasts, which is provided by the University of Genova [2]. The decision-making stage arranges the proposed solutions according to a risk metric, which is computed by an objective function. The best solution corresponds to the lowest metric. As a final step, the ranking of solutions is visually presented to the operator. To illustrate the MIVIS performance, a case study within the Mediterranean Sea is developed that yields satisfactory results. Future work should be done to make it interoperable with NATO and national C2 systems, as done for the GliderC2 capability at NATO STO CMRE [3].

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