BALTIC SEA & SPACE CLUSTER

PAN POLSKA AKADEMIA NAUK | Komisja Nauk Kosmicznych

# „Artificial Intelligence – In search for synergy" Conference

Space Sciences Committee Polish Academy of Sciences, Gdansk Branch, in cooperation with the Baltic Sea&Space Cluster and Gdansk University of Technology, invites for a joint conference entitled
"Artificial Intelligence – In search for synergy"

Gdansk University of Technology
Gdansk, 19th November 2020

## HONORARY PATRONATE

Prof. dr hab. inż. Krzysztof Wilde, Rector of Gdansk University of Technology
Dr. Michał Szaniawski, President of the Polish Space Agency

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## PLACE

Gdansk University of Technology
Narutowicza 11/12
80-233 Gdańsk, Poland

**Because of the Covid-19 pandemic situation the Conference is treated as the on-line event**

AI CONFERENCE LINK

# Conference programme

**8.30 REGISTRATION**


**9.00 OPENING SESSION – chaired by Prof. dr hab. inż. Edmund Wittbrodt**

**9.00** Welcome addresses by:
Prof. dr hab. inż. Krzysztof Wilde, Rector of Gdansk University of Technology
Dr. Magdalena Adamowicz, Member of the European Parliament
Dr. Michał Szaniawski, President of Polish Space Agency

**9.30** *Think out of the box Human Being in the Artificial Intelligence Era*, by Dr. Magdalena Konopacka (University of Business and Administration in Gdynia/Department of Private Law, University of Oslo), Prof. dr hab. Zdzisław Brodecki (University of Business and Administration in Gdynia)

**9.45** *AI Bay activities in developing the AI applications*, by Prof. Jacek Rumiński, President of AI BAY, Gdansk University of Technology

**10.00** *AI in space applications* , by Mr. Adam Dąbrowski, Gdansk University of Technology

**10.15 "YOUNG STARS" Session – chaired by Dr. Paweł Chyc**

**10.15** *SEA SLuGG - Unmanned Underwater Vehicle UUV in microgravity*, by Mr. Szymon Krawczuk, Mr. Adam Dąbrowski, Mr. Kacper Loret, Mr. Norbert Szulc, Ms. Dominika Tomaszewska, Mr. Marcin Jasiukiewicz, Mr. Konrad Jeznach, Mr. Wiktor Lachowski, Mr. Wojciech Wysocki, Mr. Rafał Markowski, Mr. Adrian Pluto-Prondziński, SimLE Student's Organisation, Faculty of Mechanical Engineering, Gdansk University of Technology

**10.30** *Religion of Technology*, by Mr. Adam Labuhn, University of Business and Administration in Gdynia

**10.45** *Space exploration or Space Wars,* by Ms. Julia A. Hetlof, Lazarski University

**11.00** *Space for Ambitious,* Ms. Agnieszka Elwertowska, WSB University in Gdańsk

**11.15** *Artificial intelligence and criminal law - can AI commit a crime?*, by Mr. Paweł Mering, University of Business and Administration in Gdynia

**11.30** *Legal aspects of space exploitation,* by Dr. Paweł Chyc, PhD, University of Business and Administration in Gdynia

**11.45** *Satellites in the fight against climate change*, by Ms. Matylda Berus, Lazarski University

**12.15 APPLICATIONS' SESSION – chaired by Prof. dr hab. inż. Marek Grzybowski**

**12.15** *Introduction to practical aspects of Artificial Intelligence in Sea Ports & Maritime Transport & Shipyards,* by Prof. Marek Grzybowski, Baltic Sea & Space CLuster

**12.40** **Panel debate** with participation of representatives of:

- *Artificial Intelligence in Sea Ports*, by Prof. dr hab. inż. Andrzej Stateczny, President of the Marine Technology
- Dr. Eng. Katarzyna Bobkowska, Researcher, Marine Technology
- Mr. Tomasz Lisiecki, President, New Competence Centre
- Mr. Grzegorz Kozłowski, Vice-President, CADOR Consulting
- Mr. Sławomir Nasiadka, Technical and Software Architect Director, Sevenet S.A.

**13.30-14.00 LUNCH BREAK**

**14.00 RESEARCH SESSION – chaired by Prof. dr hab. inż. Andrzej Stepnowski**

**14.00** *Establishment and conducting joint second degree studies in Space Technologies in Gdansk and Bremen,* by Dr. Eng. Marek Chodnicki, Gdansk University of Technology

**14.15** *Maritime and cosmic inspirations for AI algorithm,* by Prof. Marek Galewski, Gdansk University of Technology

**14.30** *Application of selected Artificial Intelligence (AI) methods in the energy industry,* by Prof. Jerzy Głuch, Gdansk University of Technology

**14.45** *Challenges and examples of AI application in the area of marine navigation,* by Prof. Jakub Montewka, Gdynia Maritime University

**15.00** *Challenges associated with development of unmanned underwater vehicles to be operated using the AI controlling systems,* by Prof. Mirosław Gerigk, Gdansk University of Technology

**15.15 DISCUSSION AND CLOSING SESSION - by Prof. Edmund Wittbrodt and Prof. Zdzisław Brodecki**

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**Space Sciences Committee of the Polish Academy of Sciences Gdansk Branch and the Baltic Sea&Space Cluster**
**Space and sea – at the meeting point of the horizon**

Marek Grzybowski

The Space Sciences Committee of the Gdansk Branch of the Polish Academy of Sciences has been operating for over 3 years, and has been cooperating with the Baltic Sea and Space Cluster for over 2 years. The Space Sciences Committee is managed by prof. Edmund Wittbrodt, and the Baltic Sea&Space Cluster is managed by prof. Marek Grzybowski. Prof. Zdzisław Brodecki was vice-manager of the Space Sciences Committee.

“The Space Sciences Committee is one of the most active scientific committees of the Gdansk Branch of the Polish Academy of Sciences. The scientific activity of the Committee and its close ties with practice are noticeable and appreciated" said Professor Grzegorz Węgrzyn, President of the Gdansk Branch of the Polish Academy of Sciences, Chairman of the Polish Council of Scientific Excellence, during the yearly meeting of the Committee. The President of the Gdansk Branch of the Polish Academy of Sciences thanked the professors for the active development of space sciences in many scientific fields. Openness and interdisciplinarity is a distinctive feature of the Committee on Space Sciences.


The Committee has been operating for over 3 years, and has been cooperating with the Baltic Sea and Space Cluster for over 2 years. Knowledge transfer between science and practice as well as an interdisciplinary approach to space research and maritime economy is an important area of activity. The transfer of knowledge is visible in the practical activities of the Committee and in the topics, participants and organizers of scientific conferences. One of the topic was a discussion about the philosophy of space and the use of information from satellites to monitor the sea. Scientists and business representatives talked about the economic aspects of the use of space technologies and maritime industries. The use of space and information technologies in ports, the development of autonomous ships and the use of marine and underwater drones were presented from the point of view of science and business. Young scientists, students and startups shred their original ideas and solutions. “During the 3 years of the Committee's operation, a series of unique scientific conferences has been organized with the participation of practitioners, students from research clubs, young scientists and representatives of startups”, said Professor Wittbrodt.

Let us emphasize that conferences like this are not organized by any other research center or cluster in the European Union. The activities of the scientific community interested in the development of space technologies and maritime economy, space law as well as economic sciences and management related to the development of various fields and scientific disciplines in Pomerania in a very short time were integrated. The combination of science and business forces, experience with the energy of young scientists and students contributed to the development of knowledge about space and marine technologies, and to knowledge transfer.


The idea of integrating the activities of the Committee and the Cluster was born during the conference "Space and the sea – at the meeting point of the horizon" (https://www.iopan.pl/KNK2018/) at the Institute of Oceanology of the Polish Academy of Sciences. The idea of cooperation in science and maritime and space business was born on the initiative of 3 professors: Zdzisław Brodecki, Edmund Wittbrodt and Marek Grzybowski, President of the Board of the Polish Maritime Cluster. The idea was quickly transformed into a new organization: the Baltic Sea and Space Cluster. “With this formula, we broke the traditional approach to the integration of industries and science with practice. Because the world combines the aviation and space industries, while we combine knowledge and business in the maritime and space areas," said Professor Brodecki commenting on the creation of a new type of a cluster. “We undertake an initiative that is unique on a global scale and that perfectly supports the activity of Pomerania,” said Professor Wittbrodt at the founding meeting of the Baltic Sea & Space Cluster (http://polishscience.pl/pl/powstal-baltycki-klaster-morski-i-kosmiczny/).

The partnership of the Space Sciences Committee of the Polish Academy of Sciences with the Baltic Sea and Space Cluster has resulted in international projects. Knowledge transfer between universities and the space and maritime industries has developed at the national and international level. Representatives of such universities like the Naval Academy, the University of Gdansk, the Gdansk University of Technology, and the University of Administration and Business have actively participated in these activities. The contribution of the research workers of the Institute of Oceanology of the Polish Academy of Sciences is very large. They brought a strong potential of knowledge about the use of space in sea research to the activities of the Committee and the Cluster. The participation of business representatives, members of the Baltic Sea and Space Cluster is very important. Among them are: Pomeranian Special Economic Zone, Gdynia and Gdansk Sea Port Authorities, Nauta Shipyard and Crist Shipyard, Hydromega and Cador Consulting, Marine Technology and Sea Data, Echogram and Sevenet. The representatives of the Port of Hamburg,

Hutchison Ports and ICTSI contributed a lot of knowledge during conferences and B2B meetings. A unique activity in the field of education of engineers is the interuniversity studies of the 2nd degree Space and Satellite Technologies, which initiated and successfully develops the Naval Academy, Maritime University and Gdansk University of Technology. Photo: Marek Grzybowski

## AI Bay activities in developing the AI applications

Jacek Rumiński

*Gdansk University of Technology*
*Faculty of Electronics, Telecommunications and Informatics*

AI Bay is a Gdansk University of Technology initiative to integrate regional activities focused on artificial intelligence. The main objectives of the AI Bay are to promote AI research and development, provide training opportunities, organize resources that are fundamental for the AI research (including people, hardware and datasets) and support digital transformation of organizations.

The success of AI development requires well and continuously educated staff. Therefore, AI Bay organizes regular training meetings, courses or special events like conferences and summer schools. For example, the International Summer School on Deep Learning that is co-organized by AI Bay in Gdansk, is one of the best evaluated training events in this field. This year the number of applications was about 500 from 64 different countries. The speakers represent the World best AI institutions and companies that support the event like Amazon or Intel.

The AI Bay participates in Digital Innovation Hub (DIH4.AI) activities providing services to support organisations like SMEs and the public sector in their digital transformation. DIH's services include training, access to AI recourses, demonstrations, advices and many other. For example, a related initiative is the organization of AI Living Lab that provides resources to efficiently perform AI-related experiments at different scales: from mobile devices like drones, robots, or smartphones to modern GPU-based servers.

It is also very important that AI Bay coordinates access to AI researchers that are crucial for many projects that are based on a collaboration between industry and research centres. There are many projects that are currently underway and are focused on AI methods. Examples include remote medical diagnostics, smart cities and spaces with the application of Internet of Things solutions, smart wearables, and many other.

## AI in space applications

Adam Dąbrowski

*Gdansk University of Technology*
*Faculty of Mechanical Engineering*

Space engineering has for a long time been a domain where the need for reliability has driven the design. For that reason, "space heritage" has been a key factor when choosing elements for a specific mission, especially by large national entities, such as national agencies and military. With the growing commercialization of space, the so called "New Space" trend, this is no longer the case. Applications of recent scientific and engineering research, such as artificial intelligence, quantum computing and onboard big data analysis are starting to appear in recently launched satellites. This presentation will cover examples of these technologies in modern spacecrafts, both autonomous and unmanned. Some trends for future will be provided.

## SEA SLuGG - Unmanned Underwater Vehicle UUV in microgravity

Adam Dąbrowski, Kacper Loret, Norbert Szulc, Dominika Tomaszewska, Marcin Jasiukiewicz, Konrad Jeznach, Wiktor Lachowski, Wojciech Wysocki, Rafał Markowski, Adrian Pluto-Prondziński

*SimLE Student's Organisation*
*Faculty of Mechanical Engineering*
*Gdansk University of Technology*

Search for extraterrestrial life has been a drive wheel for space technology research for half a century. Recent research in astrobiology suggests that underwater oceans on Jovian moon Europa, Saturnian moon Titan and possibly asteroids may be a potential habitat for such microbial life. To investigate such environments, utilization of unmanned underwater vehicles (UUV) is proposed. This research proposes validation of a technology demonstrator of a UUV in microgravity conditions. Few typical control algorithms, both linear and nonlinear will be tested during a parabolic flight campaign. Along with visualization of streamlines with dye, this research may be a first insight into technical challenges of operating a UUV in a space underwater mission in search for extraterrestrial life.

## Introduction to practical aspects of Artificial Intelligence in Sea Ports & Maritime Transport & Shipyards

Marek Grzybowski

*Baltic Sea & Space Cluster*

In the 21st century, we are witnessing a new wave of the industrial revolution in the blue economy. It includes maritime transport and shipbuilding, ports and logistics, tourism and food production, energy production from offshore wind farms and offshore industry, extraction of mineral resources from the ocean floor. The following were in common use: Maritime 4.0, Port 4.0, Logistics 4.0, Shipbuilding 4.0, Shipping 4.0, Shipyard 4.0. Artificial intelligence is one of the important components of Maritime Industry 4.0. The maritime industry produces huge amounts of data. The global cloud integration of AI and the Internet of Things (IoT) also offers the potential of a more connected intelligence.

**Eight leading maritime countries** have created a new network that will support the preparation of ports for handling autonomous ships. The new agreement was called MASSPorts because it concerns the operation of Maritime Autonomous Surface Ships (MASS). Representatives from China, Denmark, Finland, Japan, the Netherlands, Norway, Republic of Korea and Singapore were convened during a network meeting for the launch of the event on 4 August. The International Maritime Organization (IMO), International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), as well as International Association of Ports and Harbors (IAPH) also joined MASSPorts initiative.

**The operation** of fully unmanned vessels in ports is still not legally possible. In addition, to handle such ships, appropriate infrastructure is necessary, for example, allowing for automatic mooring. Ports must have adequate infrastructure to ensure safe sailing. These are not the only challenges. The initiators of the MASSPorts network highlighted the need to develop standards for autonomous units and wharfs where these ships will moor and electric ships will charge their batteries. It is also necessary to establish a common terminology so that technical, legal and organizational solutions guarantee full ship safety in ports. These problems were widely discussed by the members of the Baltic Sea and Space Cluster during the scientific conference “Sea Port + Space Infrastructure. Synergic Network Under Common Management" in 2018. The results and conclusions of the research can be found in the book *Per Mare ad Astra. Space Technology, Governence and Law*. It

discusses technical, organizational and legal aspects related to the integration of knowledge in the field of marine and space technologies. The book was published by the Polish Academy of Sciences, Gdańsk Branch.


"**Autonomous navigation** is an important part of our plans to be a future-ready port. We see MASS having the potential to enhance navigational safety and increase productivity," said Quah Ley Hoon, Chief Executive of the Maritime and Port Authority of Singapore. Network participants will focus on developing detailed guidelines and conditions for the operation of autonomous ships in ports. Port operations are to take place under the IMO Interim MASS Test Guidelines. The problem is to coordinate the movement of manned and unmanned ships. This problem was checked at the Port of Gdynia in 2019. We would like to remind you that attempts to operate unmanned vessels have already been successfully carried out at the Port of Gdynia. Two members of the Baltic Sea and Space Cluster: Marine Technology and Centrum Techniki Okrętowej (Maritime Advanced Research Centre) presented their vessels on the waters of the port of Gdynia last year. It was the first maneuver of two unmanned units without interrupting handling and vessel traffic in the port in the world.

**Maritime Industry 4.0** is a consequence of the development of Industry 4.0. It caused a dynamic demand for solutions and the use of artificial intelligence. Globalization and internationalization resulted in the dynamic development of the maritime industry. Global changes in the industry also influenced the development of Maritime Industry 4.0. Automation, Digitization and Internet of the Things are the main areas of application of artificial intelligence in maritime 4.0. In Shipbuilding 4.0 „artificial intelligence (AI) can be highlighted as a support to the other technologies, such as vertical integration of naval production systems (e.g., connectivity, Internet of things, collaborative robotics, etc.), horizontal integration of value networks (e.g., cybersecurity, diversification, etc.),

and life cycle reengineering (e.g., drones, 3D printing (3DP), virtual and augmented reality, remote sensing networks, robotics, etc. (2020, Alejandro Sánchez-Sotano and others: Trends of Digital Transformation in the Shipbuilding Sector, in: New Trends in the Use of Artificial Intelligence for the Industry 4.0**).**


**AI Shipping.** Microsoft Research Asia (MSRA), Microsoft's world-class research arm, and Orient Overseas Container Line Limited (OOCL) announced their partnership in applying Artificial Intelligence (AI) research to improve network operations and achieve efficiencies within the shipping industry (OOCL press info).

OOCL processes and analyzes over 30 million vessel data every month. By leveraging AI technology and machine learning, the company develops predictive analytics on vessel schedules and berth activities. "With MSRA's efforts and expertise, we expect to save around USD10 million in operation costs annually by applying the AI research and techniques for optimizing shipping network operations from our most recent 15-week engagement" said Steve Siu, Chief Information Officer of OOCL.
Maersk has invested in New York-based freight-booking artificial intelligence (AI) start-up Loadsmart as it looks to diversify its operations away from purely maritime transportation. Through its automated platform, shippers can book a truck in seconds, as well as reduce their spot exposure by 50% and procurement execution by 90% (https://balticcluster.pl/?page_id=7919).

**AI in the Port 4.0.** Over the centuries, ports have evolved in the field of cargo handling, storage and logistics. Port 1.0 is characterized by human intensive use in all port operations. They use

cranes, wheelbarrows and other tools for reloading. Port 2.0 uses process management (transhipment, storage, distribution, production, packaging). Port 3.0 is an enrichment of Port 2.0 with automated hardware. Processes are optimized by algorithms. People perform non-standard operations (reloading, project cargo logistics), maneuvering large ships, handling passenger ships. This is management by exception. In the Port 4.0 model ("from manage to orchestrate") AI palys important role. „Future port will enlarge their role by orchestrating physical and information flows inside and outside terminals to enhance the port ecosystem's broader, systemwide efficiency. Forward-looking ports will push toward this next horizon, beyond automation, in the coming Port 4.0 era. Every player—terminal operators, trucking companies, railroads, shippers, logistics companies, and freight forwarders—will be connected to optimize not just the port itself but also its entire ecosystem" (2018, Fox Chu and others: The future of automated ports, https://www.mckinsey.com/industries/).

The above mentioned AI led port operations and management are still on the way of technical development and institutional arrangement. *Kenji Ono and others write that „m*ajor challenges however may include: 1) smooth introduction of the newest sensor technologies for efficiently and effectively collecting all terminal operation related information as digitalized data, 2) materializing an accurate big data transmission between on-site sensors and the terminal control host computer through IoT channels, 3) developing man-machine interface for assisting operator's prompt decision making, 4) renovating current terminal operating system by employing AI based architecture, and 5) introducing appropriate countermeasures against computer virus and hacking (2020, *Kenji Ono and others:* AI Port Initiatives - Possible Modernization Of Port Operation And Management Through Cutting Edge ICTs).

## Artificial Intelligence in Sea Ports

Andrzej Stateczny

*Marine Technology Ltd.*

Marine Technology is carrying out the project "System of Autonomous Navigation and Automatic 3D Hydrography of Unmanned Floating Platform", POIR.01.01.01-00-0899/18, acronym HydroNav3D. The subject of the project is a significant improvement of Marine Technology's product called HydroDron - an autonomous/remote-controlled multi-purpose floating platform for operations in port areas, on roadsteads, anchors, floodplains, bays and lakes, rivers and other restricted areas by developing a system of autonomous navigation and automatic 3D hydrography platform. Significantly improved platform will perform measurement missions in bathymetric, sonar and other measurements in fully autonomous mode, realizing adaptive planned trajectory and automatic 3D analysis of measurement data about the situation around the platform in near real time. The project includes 3 stages that make up the whole process of realization and validation of significantly improved platform, starting from the stages of development of individual components of the system through their integration into the whole to the development of a prototype operating in real conditions. The implementation of the system uses artificial neural networks, especially for anti-collision tasks, recognition of bottom objects and the type of bottom and to determine the area of acceptable platform maneuvers.

The system of autonomous navigation and automatic 3D hydrography of the unmanned floating platform will perform functions previously unheard of in world solutions on unmanned craft. None of the currently produced unmanned surface vehicles in the world intended for hydrographic works performs the mentioned tasks. The following modules will be developed within the project:

1. Adaptive planning and realization of measuring profiles based on the actual width of the measuring strip, depending on the depth of the reservoir and type of bottom in near real time. The benefit of the module will be better measurement efficiency by optimizing measurement time,

energy consumption and reduction of redundant data due to avoiding the acquisition of data from previously searched areas. It is assumed that the optimum aperture value (overlap of adjacent search lanes), recommended by organizations standardizing hydrographic measurements, will be obtained, with a width of 20% of the total search lanes. The assumed tolerance for obtaining the optimum aperture value is 15-25%. Although the task of adaptive profile planning seems to be a geometric one, it should be noted that in the process of filtering and reducing measurement data, methods based on artificial neural networks are analyzed.

2. Automatic classification of the type of bottom of the measuring reservoir. The system will automatically, without the participation of an operator, realize the classification of the type of the bottom of the basin for the needs of dredging works or the editorial of navigation maps. It is planned to identify 4 types of bottoms: silts, anthropogenic sands and silts, fine sand, coarse sand. The assumed index of correctness of bottom type classification is 80%. In the process of bottom type detection the use of deep learning is expected.


3. Automatic recognition and identification of bottom objects during the near-real time measurement mission. Automated identification of bottom objects without the participation of the operator will enable automatic mapping of detected objects without the participation of the system operator, leaving only supervisory functions to the operator. It is planned to identify 9 types of objects including natural objects: boulders, sunken trees and artificial objects: corpses of wanted people, elements of hydrotechnical structures, wrecks, fishing networks, pipelines, cables, solid contaminants. The assumed index of correctness of bottom objects identification is 80%. Deep learning is also expected to be used in the process of recognition of bottom objects.

4. Automatic construction of numerical bottom model (DTM) and sonar mosaic (DSM) in near real time. The construction of numerical model of the terrain and sonar mosaic in near real time will enable significant improvement of the process of processing of measurement data and construction of bathymetric map of the basin and report from the examination of the bottom cleanliness. Construction of the numerical model of the basin floor and the sonar mosaic with a delay not exceeding 5 seconds. Assumed time tolerance of the construction of the numerical model of the seabed and the sonar mosaic of 1-2 seconds. In the DTM and DSM process, self-organizing artificial neural networks and radial networks are tested.

5. Coastline extraction to determine the area of acceptable platform and zero isobath maneuvers based on the fusion of sensory images from radar, LiDAR and video cameras. The platform will automatically determine the course of the shoreline in order to determine the area of the water body allowing for hydrographic measurements and the area of acceptable maneuvers,

including anti-collision ones, in the areas where electronic navigation maps have not yet been made, especially the rivers and lakes covered by the measurements. Extraction of the coastline with the accuracy of the unarmed coastline, required by geodesic regulations, not worse than 0.5m. Assumed tolerance of accuracy of staking of the coastline 10-20 cm. Sensory fusion of the measurement sensors will be preceded by image processing using deep learning.

The autonomous navigation system implements a module for tracking detected objects by means of a tracking filter based on a coupled pair of artificial neural networks type GRNN (Stateczny A., Kazimierski W., Method and system of determining the vector of traced objects. Patent Number: PL212560-B1).

**Sławomir Nasiadka**

Sevenet

Today's companies see a great chance in analyzing digitalized data. That data can be represented in a form of models - e.g. digital twins, that mathematically describe objects and their behaviour. Digital twins allow to further gather additional data e.g. from simulations reflecting changes in real world. Such changes in the physical world are recognized and read by sensors and are saved in a form of time series data in popular NoSQL databases. Sensors are distributed devices, and are often combined with actuators - together performing as DINDs (Distributed Intelligent Network Devices). DINDs are substantial part of context-aware systems. Data collected by those systems is interpreted as context, and is used to adjust application's behaviour to its current conditions. During last years we see great advance in using data delivered by different kind of devices. IoT (Internet of Things) use all mechanisms created for before-mentioned concepts, and defines additional requirements for analysis and processing large amounts of data (BigData). Distributed devices, that read data from physical world, and are connected over the Internet deliver today high volume of traffic. Along with IoT evolution, digitalized data became even more common asset for today's companies. To efficiently use information extracted from that data, there are several requirements related to computation power, security, information reliability, consistency and algorithms for data analysis. Artificial Intelligence (AI) is nowadays used to analyze big data sets. Equipped with high computing power, and more and more sophisticated algorithms, AI opens new opportunities for companies to optimize their processes.

Sevenet delivers and deploys advanced AI, IoT and ICT solutions. Starting with physical and network layers, that have to be redundant, fast, virtualized, reliable, adaptable and secure Sevenet makes proper foundation for complex software that handles many interactions at the same time. That layers more and more use AI mechanisms to adapt to network conditions. For instance advanced security solutions analyze network traffic using machine learning algorithms to recognize potential threats. Thanks to SDN (Software Defined Network) approach, network can dynamically change its configuration and becomes more suited to current needs of users or devices. Large IoT installations also need reliable infrastructure, that successfully handles traffic coming from different type of devices, communicating using different industry protocols (like Modbus). Gathered data has to be stored in BigData-ready databases. That requires large amount of space. IA algorithms that work on the data need large amount of computation power to execute. Sevenet delivers those resources in a form of private cloud, public cloud secured connectors or custom solutions. On top of those, Sevenet finally designs algorithms, making gathered data useful and concluded information ready exactly when it is needed.

Distributed, secure, AI-ready infrastructure for IoT solutions can be used in smart ports and smart ships. That areas are dynamic, context-aware by nature and need efficient mechanisms to change distributed data into useful information. Optimization of ships traffic, fuel and resource consumption, efficient computation solutions for autonomous sea vehicles, new models of critical areas are only examples. Those, and many more, can only be successfully implemented if the

environment is enriched with smart sensors, reliable and secure IoT infrastructure, as well as feasible computation power used to extract right information at right time.

**Establishment and conducting joint second degree studies in Space Technologies in Gdansk and Bremen**

Marek Chodnicki

*Gdansk University of Technology*
*Faculty of Mechanical Engineering*

The main aim of the project is to educate a high level specialists very much expected by the European market of space technologies. This aim will be achieved by starting the international stationary course as the general academic profile second-degree studies. These studies will be based on the current experiences obtained during the "Aerospace Technologies" and "Computer Science" lectures given at the Hochschule Bremen and "Satellite and Space Technologies" (Technologie Kosmiczne i Satelitarne) conducted at the Faculties of Mechanical Engineering and Faculty of Electronics, Telecommunications and Informatics of Gdansk University of Technology together with the Maritime University Gdynia, Naval Academy in Gdynia and University of Gdansk.

The demand for such the graduates in Poland and Germany is motivated by the dynamical development of the space sector of both the economies. There is a growing number of entities (companies) of the space sector which can see the benefits following from starting the courses educating the specialists of the widely understood space technologies including the management in the space sector.

The target group are the graduates of the first-degree studies obtaining the title of engineer or graduates of the second-degree studies obtaining the degree of Master of Science in engineering. The second target group of the project is the academic staff lecturing and interested in increasing its competences and skills.

According to the joined field of study the students will have the possibilities to obtain the scholarships and visit the partner universities. The additional activities will be associated with training the staff. The training activities will concern the new methods and techniques of education including the distance learning via internet. There will be a possibility to have the language, adaptive and intercultural training for the students and staff.

The aim of education will be to lecture the theoretical widely understood knowledge and professional knowledge necessary from the space technologies point of view including the telecommunication, satellite remote sensing, space missions, space mechanisms and structures, electronics, avionics and software, legal aspects and security technologies in space. Additionally the educational and training programs will offer the courses connected with the systems engineering and management in the space sector. It is expected to support the education and training by the specialists from the space sector companies.

The students will have a direct access to the research performed during the course. Therefore they will be prepared to do the independent formulation and for solving the problems including the selection and using the source knowledge, communication within the group of students and by presenting the results.

## Maritime and cosmic inspirations for AI algorithms

Marek A. Galewski

*Gdansk University of Technology*
*Faculty of Mechanical Engineering*

One of the important area of Artificial Intelligence (AI) algorithms applications are optimization problems. Authors of such algorithms take various inspirations. Probably the most common one is the nature. For example Artificial Neural Networks were inspired by human brain and nervous system structure while Genetic Algorithm were inspired by the biological evolution process. Amongst AI algorithms used in optimization especially a large, and still broadening group are swarm intelligence algorithms gained much interest. Swarm algorithms are based mainly on observations of social and food searching behaviours of various species for example birds, ants, fish, bats, bees and many other. However, there are also other algorithms that implement physics laws or environmental phenomena like laws of gravity, hydrologic cycle, water evaporation etc.

Despite large number of swarm intelligence algorithm there is no one ultimate algorithm that solves all types of problems (single- and multi-objective, uni- and multi-modal, with and without boundaries, etc.). Thus there is a permanent need for new algorithms with new, original inspirations.

In the presentation, a short review of selected, interesting swarm intelligence, optimization algorithms that draw inspirations from maritime nature and cosmic space are briefly presented. These are Gravitational Search Algorithm, Artificial Fish Swarm Optimization, Krill Herd, Whale Optimization Algorithm, Salp Swarm Algorithm and Dolphin Echolocation.

## Application of selected Artificial Intelligence (AI) methods in the energy industry

Jerzy Głuch

*Gdansk University of Technology*
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Artificial intelligence has ceased to be a fashion, and has become a useful tool in many areas of human activity. It plays an increasingly important role in the energy industry. It concerns not only electricity generation, but also heat generation and, finally, any industrial production that depends on energy transitions. All these applications are important for the quality of these energy transitions. The paper presents the fields of application of selected artificial intelligence methods for steam turbines power units generating electricity. The author's experience on the use of artificial neural networks (ANN), fuzzy logic (FL) and genetic algorithms (GA) in the modelling of energy transformations processes in power plants and in applications for thermal and flow diagnostics of power units is described.

## Challenges and examples of AI application in the area of marine navigation

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There exist numerous examples of machine learning and AI applications for ship steering and propulsion, however navigating a ship is still performed on a basis of human skills predominantly.

However, in the era of incremental shift of shipping towards autonomous navigation on one side and decreasing popularity of seafaring among young people on the other, it is essential to properly translate human knowledge into machine language, while the former still exists.

In this presentation examples are given of successful translation of specific human-based knowledge into algorithms supporting safe autonomous navigation of ship in distinct and hazardous environmental conditions experienced annually in the northern Baltic Sea

To this end, a routing tool for ships navigating in ice is presented, adopting the state-of-the-art numerical models of environment and ship performance therein, supported by the knowledge of experienced ice pilots and extensive tempo-spatial analysis of AIS data describing ship movements.

To delineate the application area of the tool, a validation workshop was carried out. Therein, the response of the tool – a calculated route between two predefined harbors in the Baltic Sea – was collated with a route planned manually by experienced masters and pilots. The tool, including its novel features such as speed map and time map in ice, has been found useful, particularly for navigators with low experience in ice navigation.

## Challenges associated with development of unmanned underwater vehicles to be operated using the AI controlling system

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**Introduction.** The last decade has been devoted towards further development of the UUV unmanned underwater vehicles. There is a still growing interest to obtain the successful implementations of a fully AUV autonomous underwater vehicles. The main drivers for further development of such the AUV vehicles are the sensors' and effectors' technologies, materials' technologies, energy supply technologies, innovative propulsion systems, IT technologies and stealth technologies. A fast development of IT technologies including the steering, navigation and communication under the water surface has brought a vision of fully autonomous AUV vehicle into practice. The AUV vehicles may perform some conventional patrol, reconnaissance or combat missions being accompanied by the existing underwater hardware and software. But a big challenge is to have a kind of an intelligent AUV vehicle. Such the AUV vehicle should be equipped with the sophisticated sensor subsystems combined with the advanced steering system as a sensitive hardware and software brain of the AUV-AI vehicle.

**Key drivers of AUV-AI vehicles.** The major features of AUV-AI vehicles should be their functionality, performance and safety. An additional set of features of the AUV-AI vehicles should guarantee to be silent, invisible, autonomous and intelligent (AI). It has to be underlined that obtaining an intelligent AUV-AI vehicle does not mean to equip her with a steering system consisting of the advanced hardware and AI-based software. The AUV-AI vehicle requires an innovative hull form and is keen on diving in an "intelligent way". It simply means that she likes diving as using the sensors and effectors. Therefore the AUV-AI vehicles may have more advanced hull forms covered by the stealthy coats, materials used, energy supply sources and propulsion systems. The navigation and communication subsystems are a part of steering system working rather as the sensor-effector subsystems. The limited boundary layer and wake, limited emission of the noise and vibration and other factors may enable the AUV-AI vehicle not only not to be detected but be mainly better prepared to perform her mission. It may means to better detect the obstacles in the water or perform the dedicated tasks.

**The key solution.** The sensor system and AI-based steering system decide about the AUV-AI vehicle senses. The visual, pressure, electromagnetic and hydro-acoustic signals are processed by the AI-based steering system.

The AI-based steering system works as a kind of Inference Engine combining the Forward and Backward Chaining algorithms. Such the approach enables to compare the AUV-AI-Mask (virtual reality) with the reality being described using the sensor systems.

**The results.** The preliminary results of the research have shown that it is possible to let the AUV-AI vehicle to be a kind of intelligent vehicle if the functional, performance, operational (mission, tasks) and safety standards, limitations and criteria are under control by the AI-based steering system.

The methodology of work of the AI-based steering system is according to the following main steps: setting the requirements, defining the AUV-AI operational conditions (defined mission and tasks, mission route, key points of mission route, energy supply source state, autonomy state: time and range, control points, coded communication), identifying the operational hazards and event scenarios during the mission, assessing the AUV-AI vehicle performance during the mission, estimating and assessing and managing the mission risk, making the decisions on safety, selecting the best operational solutions that meet the requirements, optimizing the mission.

**Conclusions.** The AUV-AI vehicle concept including the sensor and AI-based steering systems has been worked out. The basic functional, performance, operational and safety features of the vehicle have been investigated.