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INTRODUCING SATELLITE REMOTE SENSING TO THE CURRICULUM AT MARITIME UNIVERSITY

WPROWADZENIE ZAGADNIEŃ TELEMETRII SATELITARNEJ DO NAUCZANIA W AKADEMII MORSKIEJ

Andrzej Borys[1*], William J. Emery[2]
[1] Gdynia Maritime University, ul. Morska 81-87, 81-225 Gdynia
[2] University of Colorado, Boulder, USA
*Corresponding author: e-mail: a.borys@we.am.gdynia.pl

Abstract: This paper describes a plan and a procedure to introduce a course on satellite remote sensing to the curriculum of the engineering faculties of Gdynia Maritime University in Gdynia, Poland. This topic is not presently taught at the university and with the move of the Polish Space Agency to Gdańsk, nearby Gdynia, it would be useful to have remote sensing as a topic in the university curriculum for different degree programs. This plan began with the Fulbright Foundation that funded a 5-week visit of a U.S. remote sensing specialist to give orientation lectures to the faculty and students at the university. From this visit a plan was developed on how to present specific topics in remote sensing while the faculty determined how the subject should be introduced into different fields of study.

Keywords: engineering education, remote sensing, satellites.

Streszczenie: W artykule tym przedstawiono propozycję wprowadzenia zagadnień telemetrii satelitarnej do nauczania w Akademii Morskiej w Gdyni oraz omówiono jej szczegóły. Tematyka telemetrii satelitarnej nie jest w tej chwili przedmiotem wykładów lub innych zajęć ze studentami w ww. uczelni, jednakże wraz z powstaniem i rozpoczęciem działalności Polskiej Agencji Kosmicznej w Gdańsku wydaje się, że korzystne byłoby wprowadzenie do oferty dydaktycznej Akademii Morskiej w Gdyni również tematyki telemetrii satelitarnej – na różnych kierunkach i rodzajach studiów (w mniejszym lub większym zakresie). Prace nad przedstawioną tutaj propozycją zaczęły się od wizyty w Akademii Morskiej w Gdyni stypendysty Fundacji im. Fulbrighta z USA, wybitnego specjalisty w zakresie telemetrii satelitarnej. W czasie pięciotygodniowego pobytu w Gdyni wygłosił on szereg wykładów z powyższej tematyki. W tym czasie powstały także zręby omawianej tutaj propozycji, które później zostały uszczegółowione i dopracowane.

Słowa kluczowe: dydaktyka w dziedzinie inżynierii, telemetria satelitarna.

1. INTRODUCTION

The Faculty of Electrical Engineering at Gdynia Maritime University, Poland, differs from other faculties of this type at Polish technical universities in that its teaching and research activities are, first of all, focused on educating students in accordance with the needs of the maritime community and carrying out scientific investigations within contracts coming from the maritime industry and marine governmental institutions. All four departments comprising the Electrical Engineering Faculty are generally marine oriented. To be more precise, the Department of Ship Automation is engaged in areas such as intelligent ship steering systems, maneuvering control and ship trajectory tracking, application of neural networks in safe ship control, active power filters in marine local power networks, computer game control algorithms in maritime officer training, and other related topics. Further, the main areas of interest in the Department of Marine Electrical Power Engineering are: generation, distribution and utilisation of electrical energy in ships, diagnostic systems with an emphasis on those used in the marine environment, and measurement techniques and systems for performing measurements in ship power engineering networks and ship engine rooms. The next department, the Department of Marine Electronics, is mostly involved in teaching power electronics, semiconductor devices, optoelectronics, and industrial electronics in maritime applications as well as in doing research in these areas. And finally the Department of Marine Telecommunications, which houses the first co-author of this paper, is engaged in teaching telecommunications systems used in the marine environment as well as applied computer science techniques used in maritime applications. A dramatic change has taken place in this department since the year 2000 when the Department of Marine Telecommunications educated students who went (most of them) to work on ships as radio operators (officers). Now, this department has none such students.

With the onset of modern integrated electronic devices, satellite communication systems, and mobile small computers, most of the highly time-consuming activities of radio officers began to disappear. With new technologies, their tasks began to be routinely carried out by other ship crew members and/or they were simply automated. The final termination for this discipline came when a system called GMDSS (Global Maritime Distress and Safety System) was deployed. The communication standards implemented in the above system do not require a human radio specialist on the ship. His/her duties and tasks can be taken over by another member of the ship's electrical department, as for example an electrical or electro-technical engineer working under the ship's chief engineer. This point of view has been enshrined in the corresponding documents and recommendations regarding the crew compositions of present merchant vessels.

Telecommunications departments of maritime universities responded differently to this new situation. Some of them restricted their activities. In contrast

to this, the Department of Marine Telecommunications at Gdynia Maritime University decided to extend its offerings by introducing a specialization named Information and Communication Networks and Systems within the following: Electronics and Telecommunications. The intention of this initiative was to address a wider spectrum of prospective telecommunications oriented students. Thereby, the Department followed a policy practised at many universities to attract as many students as possible.

It must be stated that the above policy was effective during the last twenty years, at least in Poland. However, recently, circumstances begin to change radically. Now, they can be characterised in the following way:

1. In Poland as well as in many other European countries, the number of young people who have decided to study technical fields at universities has declined, and this tendency continues each year.
2. The boom for telecommunications engineers that occurred in Europe in the eighties and nineties of the last century is over.
3. Having a choice, young people used to prefer to study telecommunications rather than electrical engineering – but now, we observe the opposite tendency.
4. Now, most young people having a choice between studying electronic engineering, electrical engineering, telecommunications, and computer science choose computer science.

These circumstances explain the fact that the current policy of the Department of Marine Telecommunications became ineffective, particularly in face of institutions that have highly developed faculties of electrical and/or electronic engineering, telecommunications, and computer science.

What could a solution look like for the Department of Marine Telecommunications in this situation? The answer seems to be obvious. The Department must search for a new policy and practice for its teaching and research activities that exploits fully its specific strengths. The purpose of this paper is to present a proposal and an implementation plan for achieving such a goal.

The remainder of the paper is organized as follows. In Section II, the educational platform of the Department of Marine Telecommunications of Gdynia Maritime University and its prerequisites for modifications are presented. In the next section, a proposal for a course on satellite remote sensing to begin a revision of the departmental curriculum is introduced. In Section IV, an initiative of Gdańsk and Gdynia universities to launch a new inter-university field of study named Space and Satellite Technologies is briefly presented. The next section contains the contents of the proposed course on satellite remote sensing systems and its description. Finally, Section VI presents a roadmap for introducing remote sensing to the curriculum of the Gdynia Maritime University. In the next section, chances for project success and threats to its realization are considered. For evaluation of its success, a survey among

students has been carried out. The results of this survey and conclusions drawn from it are discussed. The paper ends with some conclusions.

2. THE DEPARTMENTAL EDUCATIONAL PLATFORM AND PREREQUISITES FOR ITS MODIFICATIONS

One of the underlying ideas of the proposal presented in this paper is to introduce changes to the existing courses in an evolutionary, rather than a sudden fashion. To consider how to do this, let us start with a short review of the existing educational platform of the Department of Marine Telecommunications for the students of the related specialization (Information and Communication Networks and Systems) and for degree students of other faculty departments taking classes in telecommunications as well as for students of postgraduate studies.

With regard to the telecommunications area, the Department of Marine Telecommunications teaches such basic topics as systems and signal theory, probability theory and stochastic processes, principles of telecommunications, basics of optical fiber telecommunications, digital signal processing, digital modulation techniques, coding theory, wireless systems, theory of electromagnetic waves, electromagnetic compatibility, and related topics that comprise the standard telecommunications curriculum at electronics and telecommunications faculties of technical universities in Poland, as well as in other countries. Moreover, in this department are also taught the fundamentals of programming, computer operating systems, advanced programming methods, optimization methods and algorithms, computer networks, databases, distributed programming, internet applications programming, artificial intelligence, field-programmable gate arrays, embedded systems programming, microprocessor programming, etc. The latter topics are basic subjects of computer science curricula at most other universities.

The subjects mentioned above, compose the basic educational platform of the Department. Further, as pointed out, they are very well embedded in the teaching activities of telecommunications and applied computer sciences. Therefore, any radical changes in the present educational platform are not advised. Changes should be evolutionary rather than abrupt or radical. Since the educational platform is strongly related to the present skills, abilities, experience, and knowledge possessed by the members of the department, the skills and abilities of these people must be expanded and extended in future years.

The educational platform described above is related to all three levels of study conducted by the Faculty: undergraduate (degree of engineer), graduate (degree of master of science), and postgraduate (to fulfil the requirements for receiving a doctoral degree). So, reforming the study programs for these levels

should be carried out with some specific gradations in mind. Hence, only some minor modifications should be performed in the basic level program, but greater change in the higher ones. Furthermore, all the changes carried out in the curriculum should be done in a comprehensive manner.

Finally, the teaching staff of the Faculty should be convinced that the proposed modifications of the educational platform of the Department of Marine Telecommunications will substantially improve the attractiveness of the studies in the Faculty.

3. WHY SATELLITE REMOTE SENSING?

An overview of the educational platform of the Department of Marine Telecommunications in the previous section reveals a lack of subjects such as maritime environmental sciences, advanced satellite communications, and satellite remote sensing. We believe that these subjects should be added and in what follows, we will present some arguments for these additions.

At least six big governmental research institutes and universities are located in the Tricity (joint name for the following cities in Poland: Gdańsk, Sopot, and Gdynia) that are involved in research and/or teaching for maritime services and industries. These are the following:

1. Institute of Oceanology of the Polish Academy of Sciences in Sopot (this is a strictly research oriented institution but it does involve student researchers who are enrolled at nearby universities; possesses a remote sensing laboratory and a research vessel).
2. Institute of Oceanography, Faculty of Oceanography and Geography at the University of Gdańsk (active in both teaching and research; concentrated primarily on topics of marine biology, ecology, chemistry, geology of the Baltic coast/sea, and physical oceanography).
3. Faculty of Ocean Engineering and Ship Technology, Gdańsk University of Technology (this academic institution is primarily involved in educating ship engineers in the following areas: ship mechanics and construction, hydromechanics and hydroacoustics, design of maritime engines, and maritime mechatronics).
4. Department of Marine Electronic Systems and Department of Geoinformatics, Faculty of Electronics, Telecommunications, and Informatics, Gdańsk University of Technology (they are active in both teaching and research; primarily they are involved in embedded systems for maritime applications, but they also offer courses in geoinformatics and mobile applications for telecommunications for computer science students).
5. Polish Marine Fisheries Research Institute (MIR) in Gdynia (this is a strictly research institution that carries out investigations regarding fish resources,

fisheries oceanography and marine ecology; again they may involve student researchers).
6. Polish Naval Academy in Gdynia (this is a military university educating, first of all, officer cadets for the Polish Navy, but it also has civilian students studying navigation and marine oriented mechanical engineering, and other related topics; to some extent, this university also does research).

The research and teaching topics that are most important for the above institutions are also included on the earlier list. Evident among this list is a lack of satellite remote sensing and satellite-based communications, as a topic of a given institute/university/department. These topics contribute an auxiliary role in the area of maritime environmental sciences.

Our Department of Marine Telecommunications aims at complementing the research and educational offerings described in points 1–6 above. In addition, the Polish Space Agency (POLSA) headquarters was relocated to Gdańsk last year. A cooperative agreement between Gdynia Maritime University and POLSA has been signed. Considering the needs of POLSA for specialists in the area of remote sensing and aerospace engineering, we desire to develop a curriculum in these areas to educate students to work at POLSA. We plan to begin with a specialization in satellite remote sensing methods, devices, and networks. A further spin-off effect of this activity we anticipate will be the beginnings of a scientific collaboration with POLSA.

Finally, since our Department of Marine Telecommunications is marine oriented it is best suited to deal with satellite remote sensing of the sea. This includes: mapping sea surface temperature for air-sea interaction and mapping surface currents, monitoring ocean color to map biological productivity in the Baltic, analysing Synthetic Aperture Radar (SAR) data to compute surface currents and estimate wind speed, using scatterometer data (where available) to map winds over the Baltic (locate wind farms, design and construct shore facilities, etc.), and the analysis of satellite altimetry for the computation of surface currents in the highly eddied environment of the Baltic.

With regard to teaching satellite communication techniques, we possess some experience as we offer two series of lectures at a basic level. First of them is entitled “Maritime radio communication systems” and the second “Satellite radio communication systems”. They are offered to students of the fourth, fifth, and sixth semesters, respectively, for our specialization Information and Communication Networks and Systems. We foresee a significant extension of activities in this area.

Finally, we started last year to discover in our department the uses of maritime infrared and microwave remote sensing (sea surface temperature), and also how to teach it effectively. This was possible thanks to a visit at our department of prof. William Emery from the University of Colorado at Boulder, USA. He spent one month in Gdynia as a Fulbright Specialist, giving a series of

lectures on the following subjects: introduction to space science, infrared remote sensing, remote sensing instrumentation, synthetic aperture radar, satellite altimetry, passive microwave and the analysis of satellite and airborne remote sensing data. Moreover, we had discussions with him on physical processes in the ocean responsible for upward signals in the optical range, neural networks, and artificial intelligence in geoscience and maritime engineering issues. We also talked about the use of unmanned aerial vehicles (UAVs) for future remote sensing data collection. Further, we discussed also a remote sensing degree program, and assessing and developing academic curricula for future specializations at the Electrical Engineering Faculty of Gdynia Maritime University.

We learned a great deal from Prof. Emery because of his wide experience in satellite remote sensing including infrared remote sensing, passive and active microwave remote sensing, applications of neural networks in aerospace engineering sciences, processing satellite airborne remote sensing data and images, the development of software for aerospace applications, remote sensing instrumentation, basics of physical oceanography, and applications of unmanned aerial vehicle in remote measurements.

4. NEW ENVIRONMENT AND CONDITIONS

The Department of Marine Telecommunications started to work on details of the project described above in the autumn of 2015. At around the same time, we began to also write this paper. But at the end of 2015, the initiative of Gdańsk University of Technology and POLSA arose to launch a new inter-university field of study named Space and Satellite Technologies. And Gdynia Maritime University and the Polish Naval Academy in Gdynia were invited to participate in this project. Obviously, both of the universities agreed to take part in creating the aforementioned joint field of study. It was offered to the graduate students (leading to a degree of master of science) at all the three educational institutions mentioned above.

Furthermore, the proposal included the launch of four specializations. One of them was named Maritime Space and Satellite Systems and assigned to Gdynia Maritime University. In this setting, a course entitled “Maritime applications of space and satellite systems” was created by the Department of Marine Telecommunications. And the first co-author of this paper was scheduled to be a lecturer of the above subject. His aim was to devote the course to satellite remote sensing systems.

5. THE CONTENTS OF THE COURSE ON SATELLITE REMOTE SENSING SYSTEMS

Building on the knowledge gained during the lectures [Emery 2015] of Prof. William Emery held at the Maritime University of Gdynia as a Fulbright Foundation Specialist to this university in July 2015, the first co-author of this paper prepared the description of the course on satellite remote sensing systems. The most important excerpts from it are presented in this section.

The objective of the course is formulated in Table 1.

Table 1. Objective of the course

Tabela 1. Cel przedmiotu

The goal of this course is to get students acquainted with the problems of data acquisition exploiting satellite techniques for determining sea and ocean conditions. It aims also at providing them the necessary knowledge about the methods of processing such data. Students will gain basic knowledge about sensors and devices installed on the seas and oceans that work with satellites. Furthermore, they will get acquainted with the specific character of maritime remote sensing and telemetric systems

In the Polish system of university education, the expected learning outcomes must be determined for each course. For the course discussed here, they were formulated as summarized in Table 2.

The expected learning outcomes of the course listed in Table 2 were suited to the expected learning outcomes of the whole field of study mentioned before, i.e. Space and Satellite Technologies. Moreover, procedures and measures of verification of the former were also defined.

Table 2. Expected learning outcomes

Tabela 2. Oczekiwane wyniki nauczania przedmiotu

Description of the expected learning outcome
Student possesses a basic knowledge of sensors and telemetric systems used in satellite measurements of parameters determining sea and ocean conditions
Student acquires appropriate knowledge allowing her/him to modify correctly known methods of signal and information processing for computer processing data received from satellites
Student is able to choose appropriate sensors and appropriate telemetric system to best accomplish tasks, concerning measurements of sea and ocean parameters with the use of satellite data she/he receives
Student is able to choose as well as to modify known methods of signal and information processing to tailor them to tasks concerning satellite measurements of ocean parameters

The subjects which are given in this course are presented in Table 3. This table contains the most important topics upon which the students can base their further studies of satellite-based measurement techniques used in the maritime environment.

Table 3. Subjects lectured

Tabela 3. Wykładane tematy

Subject description
Principles of satellite remote sensing
Satellite sensors applied to the maritime environment and principles of their operation
Calibration requirements of satellite temperature sensors for acquisition of sea surface temperature (as an example of satellite calibration)
Sensor design principles for maritime applications, costs, and cooperation with designers of solid state devices and circuits
Infrared detectors, their construction, design principles, costs, and applications
Microwave and optical sensors for maritime applications
Physics of space and the Earth's atmosphere and their influence on satellite-based measurement systems (radiative transfer modeling)
Problems associated with geolocation errors
Bootstrap and jackknife methods for sensor parameter estimation
Some selected methods of space analysis, time series, filtering, tensor analysis, and the so-called blind source separation techniques in tackling processing of large amounts of data acquired from satellite-based sensors

As mentioned before, we offered this course to the graduate students of the inter-university field of study Space and Satellite Technologies in the academic year 2016/2017. After one-year's experience in teaching it, we plan to carry out its evaluation and assessment of the results achieved. On this basis, we anticipate to split first its topics into two parts:

1. The first part having a more basic character and tailored to the needs of undergraduate studies, and
2. A second part possessing more advanced material addressed to graduate students.

Then, we want to refine the subjects in the above two groups and, depending upon their needs, supplement this information with some additional topics.

As a result, we hope to arrive at two courses on satellite remote sensing, one for undergraduate and a second one for graduate studies. Obviously, thanks to the procedure sketched above they will be consistent with each other. Simply put, the course for graduate students will be an advanced continuation of that for the lower level students at our university.

6. ROADMAP FOR INTRODUCING SATELLITE REMOTE SENSING

As argued in the previous sections, we view the new course on satellite sensing systems as a beginning of a reform of the teaching offerings in our faculty, which we view as an essential part of a maritime university. We planned to start this revision of our curriculum at the same time as the launch of the inter-university field of Space and Satellite Technologies at our maritime university, which started in the academic year 2016/2017. At the moment, it is postponed. This and other important dates (milestones) are presented in Table 4.

Table 4. Roadmap for introducing satellite remote sensing

Tabela 4. Tzw. mapa drogowa dla procesu wprowadzenia nauczania telemetrii satelitarnej

Academic year	Concerns the following field of study	Department involved in teaching
2017/2018	Introductory	Department of Marine Telecommunications (elaboration of concepts and preparation of lecture notes)
2018/2019	Space and Satellite Technologies	Department of Marine Telecommunications
2019/2020	Electronics and Telecommunications	Department of Marine Telecommunications and Department of Marine Electronics
2020/2021 and next ones	Other fields of studies conducted by the Faculty of Electrical Engineering and other faculties of our university according to wishes of their academic staff	Department of Marine Telecommunications and Department of Marine Electronics

Observe from Table 4 that the dates presented therein show the evolutionary character of the curriculum changes for the students.

7. CHANCES FOR PROJECT SUCCESS AND THREATS TO ITS REALIZATION

It is worthwhile in any project to perform an evaluation regarding its chances for success and to identify potential risks before beginning proceeding with the project's implementation. We have done such a forecast in our case. To accomplish this, we have used the opportunity that the undergraduate (degree of engineer) students of the specialization Information and Communication Networks and Systems (at the

Department of Marine Telecommunications) finishing their studies in June this year decided to further their career and education. These students, among many choices, could choose also the field of study of Space and Satellite Technologies mentioned in section IV – for their graduate (degree of master of science) studies. Because of this we used the above group to carry out a questionnaire among them which would allow us to evaluate the chances for success of our project and identify potential risks.

This was a group of 30 students; 25 of them took part in the questionnaire.

From the scientific point of view, our method of investigation and evaluation applied in this section belongs to the area called heuristic forecasting. One of its variants is the questionnaire approach. In our case, we utilize this approach. However, note a small difference here with respect to its standard version. This difference lies in the fact that the respondents in our survey were not just anybody, but relative experts (better or worse ones) in the related technologies (to the space and satellite ones).

Following the guidelines regarding the topics of forecasting and design of the questionnaires found in the literature [Armstrong 2001; Burgess 2001; Emery 2015], we prepared our questionnaire which we will describe in what follows. As we know, developing an appropriate questionnaire that would be well-suited to the researcher's task is both challenging and time-consuming. The questionnaire designers often have the impression that their final designs are not optimal for the problem or problems considered. Obviously, this position is tempered by following the recommendations as given, for example, in [Burgess 2001; 2016]. Our questionnaire, which will be presented below, has been prepared with due care according to the aforementioned recommendations.

The general population which regards our questionnaire comprises all the undergraduate students who study now (more precisely, those who studied in June 2016) at the Faculty of Electrical Engineering of Gdynia Maritime University and those who will enrol in their studies at Gdynia Maritime University in the future. Further, the sample population, which is a subset of the general one, comprises this group of students who were mentioned at the beginning of this section.

We also remark that our questionnaire was prepared by us without the aid of any computer programs available for automatic questionnaire generation.

Now, let us discuss our questionnaire in more detail. To this end, we begin with presentation of all the questions. They are listed below.

List of questions:

A. General questions

1. Do you know that a new inter-university field of graduate study named Space and Satellite Technologies will be launched at our Faculty in the summer semester of the academic year 2016/2017 ? *Short explanation follows*: The above field of graduate studies is a joint initiative of three universities: Gdynia Maritime University, Gdańsk University of Technology, and the Polish Naval

Academy in Gdynia. Two faculties of Gdynia Maritime University are directly involved in this initiative. That is the Electrical Engineering Faculty and the Navigation Faculty, being responsible for the specialization Maritime Space and Satellite Systems.

2. If you were aware of the above or learned about it now, please answer the following question: do you intend to continue your studies as a graduate student within the new field of Space and Satellite Technologies?
3. Do you think that obtaining the degree of Master of Science in Space and Satellite Technologies within the specialization of Maritime Space and Satellite Systems can help you to get an interesting and well-paying job?

B. Specific questions

1. How do you evaluate the influence of the relocation of the Polish Space Agency (POLSA) headquarters from Warsaw to Gdańsk last year for creating new jobs in the Tricity and in the Pomeranian Voivodeship which are related with the satellite and space technologies?
2. How strongly do you evaluate your professional expectations regarding the development of the satellite and space technologies in the Tricity and in the Pomeranian Voivodeship?
3. To what extent do you think the new field of study Space and Satellite Technologies will be important in attracting young people to study at the Electrical Faculty of the Gdynia Maritime University?
4. How do you evaluate taking into account the topics of the satellite and space technologies in the present program of the specialization Information and Communication Networks and Systems?
5. How do you evaluate taking into account topics of the satellite and space technologies in the present program of the specialization Marine Electronics?
6. How do you evaluate taking into account topics of the satellite and space technologies in the present program of the specialization Ship Automation and Computer Control Systems?
7. *Short explanation*: In the program of the new field of study Space and Satellite Technologies, the specialization Maritime Space and Satellite Systems, a course entitled "Maritime applications of space and satellite systems" has been launched. *Question*: How do you evaluate its importance for the above field of study and specialization mentioned?
8. What is your opinion as to what should be the elements of the course "Maritime applications of space and satellite systems" taking into account a modified future program of the specialization Information and Communication Networks and Systems?

9. What is your opinion on to how the elements of the course "Maritime applications of space and satellite systems" should be organized in a modified future program of the specialization Marine Electronics?
10. What is your opinion on to how the elements of the course "Maritime applications of space and satellite systems" should take into account a modified future program of the specialization Ship Automation and Computer Control Systems?
11. To what extent do you think the following subjects: satellite and airborne remote sensing, specific sensors installed in the marine environment and principles of their communication with satellites, etc. should be represented in the lectures of the course "Maritime applications of space and satellite systems"?
12. To what extent do you think the following subjects: physics of the Earth atmosphere and space, their influence on the remote sensing systems, etc. should be represented in the lectures of the course "Maritime applications of space and satellite systems"?
13. To what extent do you think the following subjects: selected methods of space analysis, time series, filter theory, tensors, and blind source separation algorithms for big data processing, etc. should be represented in the lectures of the course "Maritime applications of space and satellite systems"?

In the case of the general questions A1, A2, and A3, the possible answers were "yes" or "no". But, for the detailed question 1 – 13 above, we assumed the following five possibilities: 1 – very small, 2 – small, 3 – middle, 4 – large, and 5 – very large.

Table 5. Summary of answers to general questions A1, A2, and A3

Tabela 5. Podsumowanie odpowiedzi na pytania ogólne A1, A2 i A3

Explanation	**Knowledge about new field of study among the members of the group**	**Intention to begin the graduate studies within the new field of study**	**Assessment of its utillity in getting a job**
Number of „yes" answers	22	5	12
Number of „no" answers	3	20	13
Percentage	22/25=0,88→ 88%	5/25=0,20→ 20%	12/25=0,48→ 48%

The 88% in the second column of Table 5 witnesses that the large majority of the respondents in our questionnaire were persons who were, at least to some extent, interested in the topics of space and satellite technologies. The number 20% in the

third column shows that one of five students asked considers very seriously continuation of her/his studies as a graduate student within the new field Space and Satellite Technologies. Maybe the 20% is not particularly large but in our opinion, it can be interpreted as a clear positive for the realization of our project. And the last number 48% in the fourth column of Table 5 can be interpreted similarly. That is a clear positive for the realization of the reform discussed in this paper.

In Table 6 we present a summary of the answers to the specific questions 1–13 of the questionnaire.

Table 6. Summary of answers to specific questions 1–13

Tabela 6. Podsumowanie odpowiedzi na pytania szczegółowe 1–13

Explanation	Mean value	Standard deviation	Confidence interval for mean value
Question 1	3,08	1,12	3,08 ±0,38
Question 2	2,20	0,96	2,20 ±0,33
Question 3	3,24	1,45	3,24 ±0,50
Question 4	3,68	1,28	3,68 ±0,44
Question 5	3,12	1,42	3,12 ±0,49
Question 6	2,84	1,52	2,84 ±0,52
Question 7	3,32	0,95	3,32 ±0,32
Question 8	2,72	1,17	2,72 ±0,40
Question 9	3,00	1,08	3,00 ±0,37
Question 10	3,24	1,13	3,24 ±0,39
Question 11	3,52	0,87	3,52 ±0,30
Question 12	3,60	1,00	3,60 ±0,34
Question 13	3,36	1,11	3,36 ±0,38

The confidence intervals for the mean values in Table 6 were calculated with the use of Excel confidence.t function. The assumed confidence level $100(1 - \alpha)$ % was equal to 90%. That is the parameter α equalled 0,1.

Based on the results of the statistical analysis presented in Table 6, we make only some very generalized conclusions regarding our project.

1. In most cases (11 from total 13), the mean value is equal to or higher than the middle scale value (3). Maybe this is not an optimum result, however, we seek that it can be interpreted as a clear positive for the realization of our project.

2. The values of the standard deviations presented in the third column of Table 6 and those of the confidence intervals given in its fourth column entitle us to view the sample population in our questionnaire as credible.
3. The mean values around 3, but not significantly higher than this value, which are given in the second column of Table 6 indicate that there are risks associated with a successful implementation of the particular solutions of the reform proposed in our project. Obviously, all the persons engaged in this project will be forced to work hard to achieve success in this endeavour.

8. CONCLUSIONS

We have proposed in this paper introducing satellite remote sensing systems to the curriculum of the faculties of Gdynia Maritime University as a beginning of a reform of the course offerings. This proposal is a reasonable next step for the environment and circumstances, in which we teach now at our maritime university. We hope also that this idea presented here can be adopted by other maritime universities.

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