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UNMANNED VESSELS AS A STEP INTO THE FUTURE OF WATER TRANSPORT

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Abstract. The article considers the relevance of unmanned vessels (UV). Over the past decade, many countries have been developing UV of different classes and the interest in UV is growing every year. That is why Russia actively engaged in this process within the framework of the National Technology Initiative. The relevance of crewless shipping (CS) is beyond doubt. Safety is one of the main conditions for high–quality transportation by any type of transport. The main and most frequent cause of accidents at sea remains the human factor. We should not ignore that technological progress presents both opportunities and challenges. The problem of regulatory support remains. Pioneer-M is the first unmanned research vessel in Russia. The training of specialists in the field of unmanned vessels operation is one of the most complex challenges. There is a need to introduce an educational program to train unmanned vessel operators and to retrain navigators of traditional type.

Keywords: unmanned vessel, high-tech direction, human factor, advantages of UV, challenges, training of specialists, Pioneer-M project

БЕСПИЛОТНЫЕ СУДА КАК ШАГ В БУДУЩЕЕ ВОДНОГО ТРАНСПОРТА

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Аннотация. В статье рассматривается вопрос актуальности безэкипажного судовождения. В последние десятилетия многие страны занимаются разработкой безэкипажных судов различного класса. Интерес к этому вопросу растет с каждым годом, и Россия активно включилась в этот процесс в рамках «Национальной технологической инициативы». Актуальность безэкипажного судовождения вне сомнений. Основной причиной несчастных случаев на море остается человеческий фактор. Мы не можем игнорировать тот факт, что технологический прогресс дает нам не только новые возможности, но и бросает вызовы. Остается проблема нормативно-правового обеспечения. Проект Pioneer-M – первое безэкипажное исследовательское судно в России. Одной из наиболее сложных задач в сфере эксплуатации безэкипажных судов остается подготовка специалистов. Существует необходимость введения образовательной программы по подготовке операторов таких судов, а также программы переподготовки судоводителей традиционного типа.

Ключевые слова: безэкипажное судно, высокотехнологичное направление, человеческий фактор, преимущества безэкипажного судна, вызовы, подготовка специалистов, проект Pioneer-M

Introduction

Technological progress currently affects all aspects of our lives. However, for quite a long time, water transport was not considered a promising field of information technologies. Among the main reasons were industry's traditional conservatism and expensive telecommunication infrastructure. Nevertheless, at present, the emergence of unmanned vessels (UV) has become a real global trend. Over the past decade, many countries have been developing UV of different classes: from small boats to container ships.

Working projects and prototypes, including catamaran and trimaran versions, are C-Enduro Thomas; Datamaran; Salidrone; Submaran; Mayflower Autonomous Research Ship (MARS). Unmanned vessels are considered in civil projects (MUNIN, AAWA, Hrönn, etc.), military, as well as dual-use projects [1, 94-103].

So, what is an unmanned vessel? The definition of IMO is as follows: "Maritime Autonomous Surface Ship (MASS)" is defined as a ship, which, to a varying degree, can operate independently of human interaction [2]. Pinskii A.S. gave a more voluminous definition: an UV is a transport that can move in semi–automatic or automatic mode, with partial use of the crew or completely without it. The appearance of CS will reduce operating costs, increase the capacity of ships, and reduce the influence of the human factor on the safety of navigation [3, 43]

Interest in UV is growing every year. For any country, participation in the creation and implementation of such technology is a chance to develop a new high–tech and promising direction; for Russia, it is an opportunity to advance the introduction of new technologies on the world market, the prospect of strengthening the competitiveness of shipping companies, reducing dependence on foreign technologies. That is why Russia actively engaged in this process and within the framework of the National Technology Initiative, a working group and a roadmap MariNet were formed.

The Russian president set a task to conduct an experiment on the trial operation of UV under the Russian flag from 2021 to 2025. The emergence of wireless shipping requires a complete revision of current navigation standards. The Russian Federation approved a roadmap to improve legislation and eliminate administrative barriers for implementing the National Technological Initiative in the direction of marinette.

Causes of Navigation Accidents

The relevance of CS is beyond doubt. Safety is one of the main conditions for high–quality transportation by any type of transport. Nowadays, it is of particular importance in maritime navigation [4, 45-47]. In the statistics of accidents in the waters of the Russian Federation, which is given below because of the analysis of this information, the main causes of accidents are identified. It is noted that the main and most frequent cause of accidents at sea remains the human factor.

Let us consider the statistics of accidents in the waters of the Russian Federation (Tab.1).

Tab.1

Statistics of accidents in the waters of the Russian Federation

Types of sea accidents	Quantity (accident/very serious accident)	
	1 quarter 2022	quarter 2023
1. Navigation, total:	3	1
Bulk	0	0
Collision	0	0
Grounding	3	0
Ground touch	0	1

Tab.1 (continued)

Statistics of accidents in the waters of the Russian Federation

Types of sea accidents	Quantity (accident/very serious accident)	
	1 quarter 2022	quarter 2023
Collision with a blunted object	0	0
Damage to an object of marine infrastructure	0	0
Of these, ships were lost	0	0
2. Technical, total:	6	7
Deprivation of the possibility of maneuvering	1	3
Damage to structures or machinery	4	3
Explosions, fires	0	1
Loss of stability, buoyancy	1	0
Displacement of the load or change of its properties	0	0
Loss of towed object	0	0
Of these, ships (towed objects) were lost	0	0
Total lost vessels	0	0
3. Death of a person (missing), cases	0	2
Total deaths, people	0	2
4. Cases of severe bodily injuries	1	2
Total severe bodily injuries, people	0	2
5. Accidents related to the applicable international regulations for the prevention of marine pollution	0	0
Total	10	12
Total accidents at sea	10	12

Information provided by Ministry of Transport of the Russian Federation, the Federal Authority for Transport Oversight, https://rostransnadzor.gov.ru

Causes of navigation accidents:

1. Lack of proper control over the anchorage during watchkeeping.
2. Failure of the ship's Master to take the necessary measures to ensure the safety of the anchorage when detecting the drift of the vessel at anchor.
3. The Master of the vessel does not take into account stormy hydrometeorological conditions when anchored.
4. Not taking into account forecasts of hydrometeorological conditions and ice conditions along the route.
5. Violation of the terms of the shipping season in the waters of the Northern Sea Route (NSR).
6. Ignoring the recommendations about the developing ice situation along the route from the Headquarters of the Maritime Operations of the NSR and not following its instructions on the timely withdrawal of the tugboat from the waters of the NSR.
7. The failure of the Maritime Operations Headquarters to respond appropriately, in accordance with its business functions and rights, aimed at preventing the tugboat from getting into difficult ice conditions for navigation.
8. Not taking into account the maneuverability characteristics of the vessel and hydrometeorological conditions of the navigation area.
9. The poor organization of interaction "Master -Pilot".
10. The gyrocompass failure.

11. Breakage of the towrope due to the failure of the tugboat captain to take into account the prevailing hydrometeorological conditions in the navigation area. A possible reason for the breakage of the towrope could be its snag for an underwater obstacle.

Advantages of UV

The human factor remains the main cause of accidents at sea. The introduction of unmanned navigation technologies will lead to a gradual reduction in the number of crews and complete automation of the process.

The advantages of unmanned vessels include improving the environmental situation, increasing the reliability of transportation and economic efficiency. Such vessels will also help reduce piracy due to their design.

Challenges

Technological progress opens up new opportunities, but also creates problems that require careful study. Among the negative consequences of the introduction of unmanned vessels are a possible increase in unemployment among qualified specialists, possible failures in the work of artificial intelligence and regulatory issues.

IT Sea projects in Russia

Russia is conducting number of studies on scaling unmanned ships to larger vessels. Thus, the project "Crewless navigation of Commercial Fleet" is being implemented (development of a single technological platform for unmanned control of commercial vessels of various purposes). As part of this project, unmanned control of a tanker, a dry cargo ship and a self-propelled boat is being worked out. Technologies for the project are being developed by Joint Stock Company "Kronstadt Technologies", Joint Stock Company "Central Research Institute "Kurs", St. Petrsburg Polytechnic University, Joint Stock Company Scientific-Production Enterprise "AME", Autonomous non-profit organization "Industry Center MARINET", Limited Liability Company "Zebreins", Limited Liability Company "Impulse" and Limited Liability Company "Marine Cargo Bureau". In 2016, the Kronstadt Company became the executor of the largest project to create a test e-Navigation water area [5, 50-53].

The Hermitage project includes part of the Gulf of Finland, Neva, Svir and Lake Ladoga. The test water area will allow combining all e-Navigation zones, combining 13 ports, training centers, more than 300 sea vessels, as well as several vessel traffic control systems (VTS) into a single electronic space. During the development work, researchers are constantly introducing new equipment, testing its functions, as well as training the crew, pilots and dispatchers of the VTS [6].

Pioneer-M is the first unmanned research vessel in Russia. It was built in St. Petersburg, for Sevastopol State University. The vessel passed through the inland waterways of Russia for about 2,800 kilometers and arrived in Sevastopol in October 2022. Pioneer-M will explore the Black and Azov Seas.

Pioneer-M

The Pioneer-M, Project 25700 is a small catamaran–type research vessel with a hull made of composite materials. It is intended for complex studies of the marine coastal water area. In its creation, a new design methodology is used, including a product lifecycle management system. The vessel was built to perform a wide range of complex scientific research in the coastal areas of the Black Sea, including oceanographic, hydrobiological, hydro chemical, geomorphological, hydroacoustic and diving operations.

Multifunctionality is realized due to a modular system of scientific laboratories of container type, used alternately. The project assumes year-round operation of the vessel in the waters of the Black and Azov Seas with a distance of up to 20 nautical miles off the shore.

Pioneer-M is designed according to the modular principle. This is a carrier vessel: all laboratories are built into it in the form of a separate container, while the focus of the laboratory can be diverse: from botany to underwater archaeology. Robotics, geology, marine bioresources, environmental surveys – the modular Pioneer will cope with any of the tasks.

The project of a "student" modular multifunctional research vessel originated in 2015 at Sevastopol State University, where the Center for Marine Research and Technology was created. The new structure needed its own research vessel and it was decided to create it independently, widely attracting students. About 50 students from eight Russian universities were involved in the creation of the research vessel itself and mobile laboratories on its basis. Pioneer-M received approval from the Ministry of Science and Higher Education, the United Shipbuilding Corporation (USC) and in 2016 entered the leadership list of the Agency for Strategic Initiatives.

On June 21, 2016, the vessel was presented to Russian President Vladimir Putin. He was interested in unmanned control: "This is a very important direction. In some countries, such projects are not on paper, but it has already been implemented, and such unmanned vessels have been put into service," the President said. "I draw attention to the fact that this may be a dual–use project" (from the speech of V.V. Putin at the Forum of Strategic Initiatives on 21 July, 2016).

This is the first ship in Russia which will practice the technology of unmanned navigation. The vessel is equipped with a Russian navigation satellite system. This system allows you to plot the exact ship's course, to record the ship position, which is important for research work. It was originally designed to be unmanned. Some of the necessary devices for this have already been installed, the plan is to modify the systems and make Pioneer-M completely independent. (www.miit.ru)

The design of the vessel at the initial stage involved the Central Design Bureau "Coral" (2017), then – "Company Marine" (2018), the designers of which created a technical project. Then the specialists of USC-T (technologies) (2019-2020) took up the design, some work was carried out in the Almaz Central Design Bureau. The vessel was laid down on May 21, 2019 at the Sredne-Nevsky Shipyard. Later, in July 2020, the head of the USC, Alexey Rakhmanov, reported to the President of Russia on the completion of the design of the Pioneer-M (Fig.1).

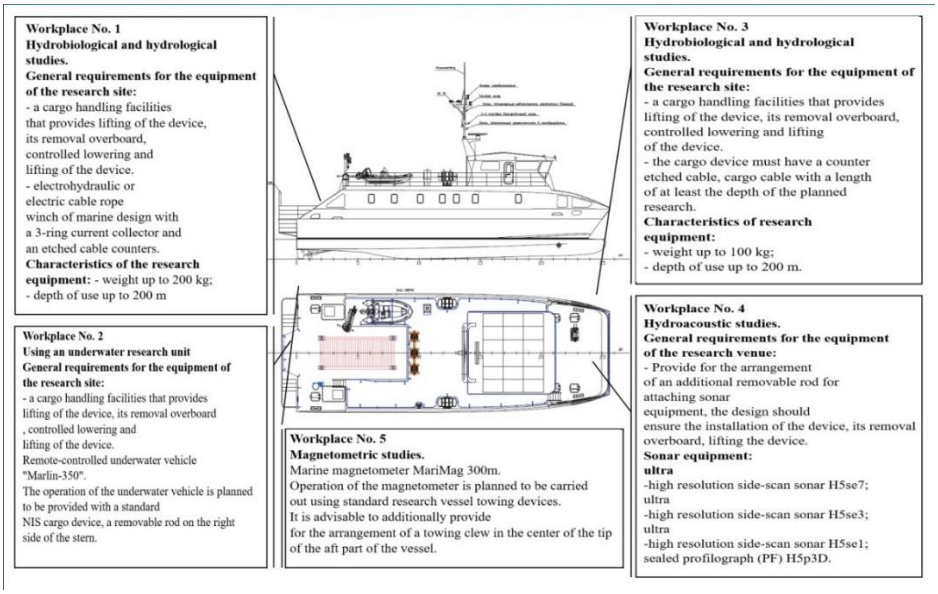

Fig.1. Project 25700, Pioneer-M

The project number 25700, corresponds to the length of the vessel – 25.7 m; width – 9.1 m, height of the side amidships – 3.1 m, draft with propellers – 1.5 m, displacement – 82 tons. The power of the power plant is 2 * 246 kW. The area of solar panels is 35 square meters. Speed – 10 knots (maximum)/8 knots (operational), autonomy – 6 days, cruising range on fuel reserve – 500 miles, seaworthiness – 3.5 points.

The training of specialists

The training of specialists in the field of unmanned vessels operation is one of the most complex challenges. There is a need to introduce an educational program to train unmanned vessel operators and to retrain navigators of traditional type. This program should include in-depth knowledge of IT-technologies in addition to navigation studying. Qualification requirements should be developed and established for both the crew of the unmanned vessel and for the operators of unmanned vessel. Most appropriate legal instrument for determining such qualifications is International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).

In 2021, the Sitronics Group Company (Russia) presented a simulator for training of unmanned vessel operators. This simulator is a platform for virtual modeling of crewless navigation. It includes a control unit of operation, the so- called bridge. Every type of ship has its own typical bridge, with its special devices, indications and control systems. This event certainly turned out to be a real breakthrough in the training of specialists for CN. Unique and the only navigational simulator in the country was installed at the Russian University of Transport (RUT (MIIT). This year at the University, the representative of "Rosmorport" received the first in the world certificate of captain of the center of remote control of autonomous vessels in Russia. The training was held at the training Center of RUT in the frame of program "Captain of the Center for Remote Control of Autonomous Ships". Crews of the ferries "General Chernyakhovsky" and "Marshal Rokossovsky" also have undergone retraining on the simulator.

Conclusion

Russia keeps developing and implementing the idea of crewless shipping and much has been achieved during the last few years. A good start has been made in that process, but much remained to be done.

The issue of personnel training is the fundamental task nowadays. In our opinion, it would be appropriate, within the framework of the implementation of the major educational program of higher education in the specialty 26.05.05 Navigation, to consider the inclusion of vocational training programs or parallel introduction of additional professional training programs in the unit of optional classes. In this case, it is necessary to include the practical training on the simulator.

We believe, that such an approach will lead to a more effective solution both the problem of staffing and increase the competition of specialists in this field.

References

1. Titov A. V., Barakat L. Perspektivy tekhnologicheskogo razvitiia i vnedreniia bezekipazhnykh sudov [Prospects for technological development and implementation of unmanned vessels]. Morskie intellektualnye tekhnologii, 2018, Vol. 1, No. 3 (41), pp. 94-103. (In Russ.)

2. IMO takes first steps to address autonomous ships, 2018. Available at: https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-mass-scoping.aspx (accessed: 12.11.2024).

3. Pinskii A. S. E-Navigatsiia i bezekipazhnoe sudovozhdenie [E-navigation and crewless navigation]. Transport Rossiiskoi Federatsii, 2016, No. 4 (65), pp. 50-54. (In Russ.)

4. Sinel'shchikov A. V., Kirilova M. A. Issledovanie vliianiia intsidentov na transportirovku gruzov morskim transportom [Investigation of impact of incidents on goods transportation by sea]. Vestnik Astrakhanskogo gosudarstvennogo tekhnicheskogo universiteta, 2012, no. 2 (54), pp. 45-47. (In Russ.)
5. Zaikova S. N., Titov A. V. Pravovoi status vneshnego kapitana avtonomnogo nadvodnogo morskogo sudna [Legal status of external captain of autonomous surface sea vessel]. Transport Rossiiskoi Federatsii, 2018, No. 5 (78), pp. 50-53(In Russ.)
6. Segmenty testovoi akvatorii e-Navigatsii «Ermitazh» [Segments of e-navigation test area Hermitage]. Available at: https://enav-hermitage.ru/ru/segmenty-testovoj-akvatorii.html (accessed: 10.11.2023).

Список литературы

1. Титов А. В. Перспективы технологического развития и внедрения безэкипажных судов / А. В. Титов, Л. Баракат // Морские интеллектуальные технологии. – 2018. – № 1-3(41). – С. 94-103.
2. IMO делает первые шаги по решению проблемы автономных судов, 2018 [Электронный ресурс] – URL: https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-mass-scoping.aspx, (дата обращения: 12.11.2024).
3. Пинский А.С. Электронная навигация и безэкипажное судоведение. Транспорт Российской Федерации. №. 4 (65), С. 50-54
4. Синельщиков А. В., Кириллова М. А. Исследование влияния инцидентов на транспортировку грузов морским транспортом. Вестник Астраханского государственного технического университета, 2012, № 2 (54), С. 45-47.
5. Зайкова С.Н., Титов А.В. Правовой статус внешнего капитана автономного надводного морского судна / С.Н. Зайкова, А. В. Титов //Морские интеллектуальные технологии. – 2018. – № 5(78). – С. 50-3.
6. Сегменты тестовой акватории е-Навигации «Эрмитаж» [Электронный ресурс] – URL: https://enav-hermitage.ru/ru/segmenty-testovoj-akvatorii.html (дата обращения: 10.11.2023).

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