ZESZYTY NAUKOWE AKADEMII MARYNARKI WOJENNEJ
SCIENTIFIC JOURNAL OF POLISH NAVAL ACADEMY

2016 (LVII) 3 (206)

DOI: 10.5604/0860889X.1224747

Zygmunt Kitowski*, Ryszard Soliński*

APPLICATION OF DOMESTIC UNMANNED SURFACE VESSELS IN THE AREA OF INTERNAL SECURITY AND MARITIME ECONOMY — CAPACITIES AND DIRECTIONS FOR DEVELOPMENT

ABSTRACT

The paper presents the issues associated with the domestic construction of unmanned surface vessels, which are in the limelight of western counties as one of the reinforcing elements of internal security and maritime economy. Also discussed are some experiences from construction of the first such vessel named 'Edredon', and on the example of Gdansk Bay and the seaport of Gdynia a number of selected tasks that can be carried out by a vessel in the process of state's maritime services protection, and in monitoring and protection of the seaports and objects of critical infrastructure. Moreover, the directions for further development (autonomous vessels, in particular) that can be accomplished in a short period of time, based on domestic scientific abilities and shipbuilding industry are indicated.

Key words:
unmanned surface vessels, internal security, sea ports and critical infrastructure protection.

INTRODUCTION

The breakthrough in the possibilities of the application of unmanned surface vessels in military activities occurred after the end of the Cold War when the reinforcement activities of the fleet landing operations as well as reinforcement of its activities in coastal waters were found necessary (essential). An important role

* Polish Naval Academy, Faculty of Mechanical and Electrical Engineering, Śmidowicza 69 Str., 81-127 Gdynia, Poland; e-mail: z.kitowski@amw.gdynia.pl; rsol51@o2.pl

of asymmetric activities in which even high-tech naval vessels being on confined waters had limited abilities to defend against such threats as attacks with the application of fast speed boats, scuba divers, etc. The problem has been solved by the introduction of unmanned surface vessels intended for harbor protection and force protection activities. Those were standard surface vessels of RHIB (Rigid-Hull Inflatable Boat) type which depending on the type of mission, were equipped with appropriate armament modules. Those vessels have proved to be very useful for the own forces protection along with the policing of the coastal regions. Incidentally, many other advantages of that type of constructions were recognized, and the only limitations on the application of USVs had been their low technical reliability, independency and the influence of unfavorable hydro-meteorological conditions on their operations (high state of the sea, in particular). It is important to underline that missions presently carried out by USVs encompass more and more a broader spectrum of tasks, and yet utilized equipment and armament make them ever more refined tools in military activities. The development of that kind of vessels is posing a new challenge for (theoretical military thinkers) military think tanks, forcing them to elaborate a new set of rules on the effective application of that type of vessels in sea operations as well as rules for their cooperation with unmanned aerial vehicles (UAVs), airplanes, or naval vessels. It is important to underline that the USVs are not to replace naval vessels, but to support them in the accomplishment of their tasks in coastal regions, in particular.

It appears that currently, there is a great need to shift a portion of the tasks which are carried out in harbors and coastal areas, in particular, from manned units to unmanned surface vessels. Those tasks in the security area are [7, 10]:

- own forces protection;
- reconnaissance;
- sea mines hunting, detection, and destruction;
- anti-submarine warfare (ASW);
- state sea security;
- surface warfare prosecution;
- support of special forces operations;
- seabed mapping;
- radio-electronic warfare prosecution;
- support of secret sea operations;
- coastal areas, rivers mouth operations, etc.;
- towing targets during a small caliber artillery exercises.

The Polish participation in the NATO structures until now shows that to effective protection of state's maritime interests Polish Navy and other state services (Border Guards, Police, Maritime Offices, etc.) must-have to be equipped with small unmanned surface vessels to ensure the protection of offshore areas. The Basic burden of pursuit and intervention activities could be rested with these units. They work well with the supervision of harbor basins, roadsteads, anchor sites, approach roads to harbors and other areas of a ships' intense traffic. The unmanned surface vessels (equipped with e.g. machine guns, depth grenade launchers, etc. may also carry on a continuous surveillance of those areas and units over there [5, 6].

Another, very relevant, kind of tasks for unmanned surface vessels is their participation in the environment pollution detection and working out the violators, and also their participation in the rescue operations at sea, etc.

By the application of the USVs, it is possible to create an efficient and effective system for protection of the state economic interest at sea and protection of its security from such threats as e.g. smuggling (drugs and other harmful substances) and terrorism. The plurality of unmanned surface vessels' application results from the possibility of exchange the modules that they can be equipped with. Those vehicles decisively are able to support the reconnaissance system of a coastal area and also do the reconnaissance by themselves. However, during the radio-electronic warfare they can constitute its vital element. The broad range of applications also allows the sea mines haunting, detection and destruction, along with the support of the Special Forces operations. Among many other applications a support of artillery training can be identified, in which they can tow targets for a small caliber artillery exercises. In addition to the listed above, military vessels can also be applied for an economic and scientific civil activity, including exploration and exploitation at sea as well as a dangerous materials shipment.

ADVANTAGES OF THE USV APPLICATION

The key advantages of the application of the USVs both in maritime borders protection, and maritime economy may include [9]:

- a wide range of applications;
- the possibility of carrying out tasks in the environment harmful to health;
- no the risk of the loss of human life or a crew health during dangerous missions;
- the possibility of carrying out long-lasting and monotonous tasks with an equal efficiency;

- the possibility to continuous monitoring of environment (many objects in complex hydro-meteorological conditions), due to the relocation of majority of activities into littoral areas;
- the possibility of carrying out long-lasting missions taking into account only the rotation the crew of an unmanned surface vessel maneuvering post or of an autonomous unit supervision post;
- rapid response time to any arisen threats;
- small dimensions of a unit that ensure a secrecy of performed tasks;
- the possibility of applying them to a wide range of additional tasks.

All of above-mentioned needs (requirements, tasks) meets an unmanned surface vessel 'Edredon' (fig. 1), the first constructed in the country, technology demonstrator build under the development project No. 0 R00 0004 07 — 'An unmanned multi variant floating platform for the state maritime services protection'. The leader of the project carried out over the period 2009–2011 was the Polish Naval Academy and the consortium composed of the Gdansk University of Technology and the SPORTIS Inc.

The construction of USV 'Edredon' was base on a rigid body of a hybrid boat (RIB — Rigid Inflatable Boat) made of the ORCA rubber fabric, though the general idea is the possibility of applying several types of bodies and propulsions without changes to any systems mounted on them.

The technical characteristics of the USV 'Edredon' [2, 4]:

- length 5.7 m'
- speed up to 30–35 knots;
- weight without equipment (with the engine) about 1000 kg;
- carrying capacity 1000 kg;
- endurance 7–30 hours (dependent on the speed, the state of the sea and the load);
- buoyancy up to state of the sea 4;
- radio control range up to 20 km;
- possibility of modules exchange, depending on the type of tasks to be pursued by the potential users (mid-caliber machine gun, grenade launcher, unmanned underwater vessel, nonlethal weapon, hydro graphic measurements, etc.);
- man load (a crew version) from 2 to 4 person;
- the possibility of an instant switching to a manual control.

Fig. 1. The unmanned surface vessel 'Edredon' during the sea trials [R&D project No. 0 R00 0004 07 documentation]

The vessel was equipped with the following systems [2–4]:

- navigational (GPS, electronic compass, radar — with ARPA, auto-pilot, depth finder, plotter, nautical electronic chart, distance recorder);
- tracking and vessel's position on water region display;
- remote control of the engine and the rudder operations;
- control of navigation equipment, technical surveillance equipment, as well as sensors and pick-ups mounted on the vessel;
- displaying the parameters of devices' works;
- power supply, including other units, e.g. tugged an underwater mine haunting platform, etc.;
- surveillance (camera day/night coupled with a laser distance gauge, panoramic camera for the circular surveillance, sonar);
- sensors (chemical, meteorological, radioactive contaminations, etc.);

– communications (control signals transmission, the transmission of pictures from the day cameras and two optoelectronic cameras, the radar, the camera placed in the unmanned underwater vehicle, the voice communication, the data transmission for the sensors).

The control of the vehicle is implemented by [2, 4]:

– the transmission of control signals in the transmission band of pictures;
– control on the VHF frequencies (backup, emergency);
– control with a hand manipulator, e.g. from a ship board in the range of visual visibility.

Fig. 2. The arrangement of the navigation devices and communication system antennas on the mast [R&D project No. 0 R00 0004 07 documentation]

Fig. 3. The manual control of the USV 'Edredon' from a ship's deck [R&D project No. 0 R00 0004 07 documentation]

On the bow of the vessel a turn-table has been installed for any accessory necessary to accomplish a task at hand. Now, two floodlights are installed here. Also, an installment of a remotely controlled machine gun on the vessel has been planned in the project. Planning and setting up trials of such solutions, at the preliminary stage of the project, allows for similar prospective solutions undertaking, thus providing the possibility of extending the purpose of the vessel.

Fig. 4. The vessel equipped with a small caliber machine gun or interchangeably floodlights, a non lethal weapon, an unmanned flying vehicle, etc. [R&D project No. 0 R00 0004 07 documentation]

The vessel's control is carried out from a mobile command post inside a container. Such solution allows applying the vessel in any area of the Polish Coast or a water region, ensuring its high mobility.

There are three sites in the container for: the operator which controls the vessels and carries the navigation; the operator of on-board systems which controls the technical observation system, the sniper, the underwater vehicle, the optoelectronic camera or armament (depending on the type of mission); the mission planning. Also foreseen is the simultaneous control of both the USV and the UUV or the UAV.

Fig. 5. The command post (the container) and its equipment [R&D project No. 0 R00 0004 07 documentation]

On the basis of the above mentioned project over the period 2011–2012 a consecutive project, No. R00 0106 12 called 'Integrated planning system of protection and monitoring of marine ports and critical objects based on the autonomous unmanned units'. The project leader was the PJWSTK, and the consortium composed of the Polish Naval Academy and the SPRINT Inc. As a part of the both projects, among other things the following issues were solved:

- the development of management engineering of: an electronic map, geographical data, AML layers, and data bases;
- the implementation of the project of the architecture of a mission planning system;
- the construction of the integrated site for mission plans generation under different hydro-meteorological and navigational conditions, including The International Regulations for Preventing Collisions at Sea 1972 (Colregs), based on the environment simulator where the of the USV planned missions will be planned;

- the construction of autonomous control system for the USV which lets the automatic correction of the prearranged by the operator mission when the emergence of an unforeseen obstruction to navigation or the change of the decision on the mission nature, i.e. by sending the command to track a dubious object;
- the construction of a simulator intended for: unmanned surface vessels (USV) operators training, and autonomous surface vessels (ASV) mission planning;
- the development of algorithms for the support of mission planning using the methods of artificial intelligence;
- introductory trials of the platform control by the VSAT satellite communications were conducted;
- implementation of the controlling signals encryption system;
- designing and implementation the platform, located on the unmanned surface vessel, for launching and recovering of the underwater vehicle;
- the implementation of control system for an operator from command post for the underwater vehicle launched from the USV;
- an initial project of electric drive.

As the result of these works, the surface platform (USV) equipment has been enriched with:

- the autonomous control system that carries out the prepared mission plan, works out simultaneously any necessary corrections to this plan after receiving a signal from the USV monitoring system about any stationary or movable obstructions to navigation on its track;
- the launching and recovering system for the underwater vehicle mounted on the unmanned surface vessel as well as the remote control and transmission the information from the sensors installed on the underwater vehicle of the ROV type;
- systems for underwater situation monitoring, detection, and materials identification: explosive, chemical, biological, and radioactive.

And the mobile command post (Command Center) has been enriched additionally with:

- the remote control post of the underwater vehicle;
- the integrated post for mission's plan generation (fig. 6);
- the signals encryption system and satellite communication system;
- the simulator of the environment where the elaborated plans for the ASV are to be carried out;
- the simulator intended for USV and ASV operators training.

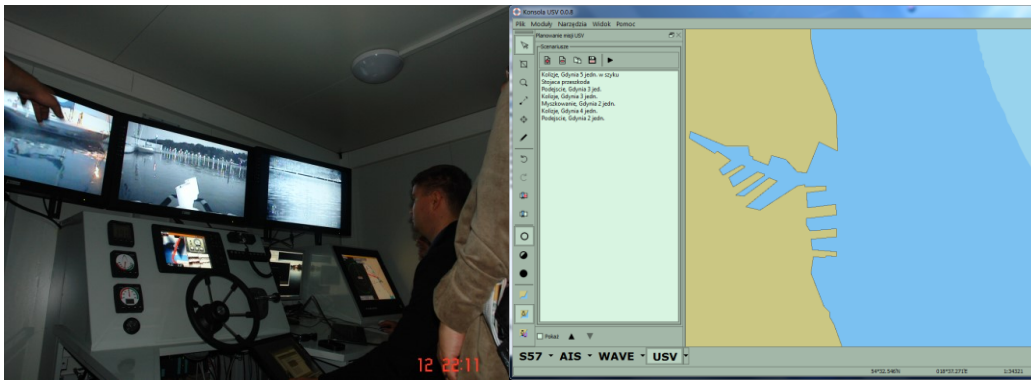

Fig. 6. The conning station and the post for mission plans generation and the view of the main application panel — the USV's console [R&D project No. 0 R00 0004 07 documentation]

The mission planning system and the ASV control system make, depending on configuration, the basis for derived systems of:

- simulation environment for a new software;
- training post for mission planning operators.

The main objective of the designed system has been creation of a universal platform for implementation of many tasks related to the ASV management. The system is characterized by such features as [1]:

- *openness*: one of the main problems is integration of many services and technologies; it has been achieved due to the application of open architecture based upon high-tech, but verified solutions;
- *portability*: the system is to work on a variety of hardware platforms such as an USV boat, a container with command and control post as well as on training sites;
- *scalability*: concerns mainly simulation — the system should make both single real time and massive, automatically repeatable simulations;
- *reliability*: the software for such type of task must have a high degree of reliability; it has been achieved by the application of widely applied and well tested solutions and libraries;
- *modularity*: bearing in mind the multitude of goals, it was necessary to provide an open-ended internal architecture of the system that ensures a possibility of multiple applications of its key elements together with an easy replacement of different elements with their alternatives.

The architecture of the system for mission planning and the AVS control with regard to its most important elements is presented on figure 7.

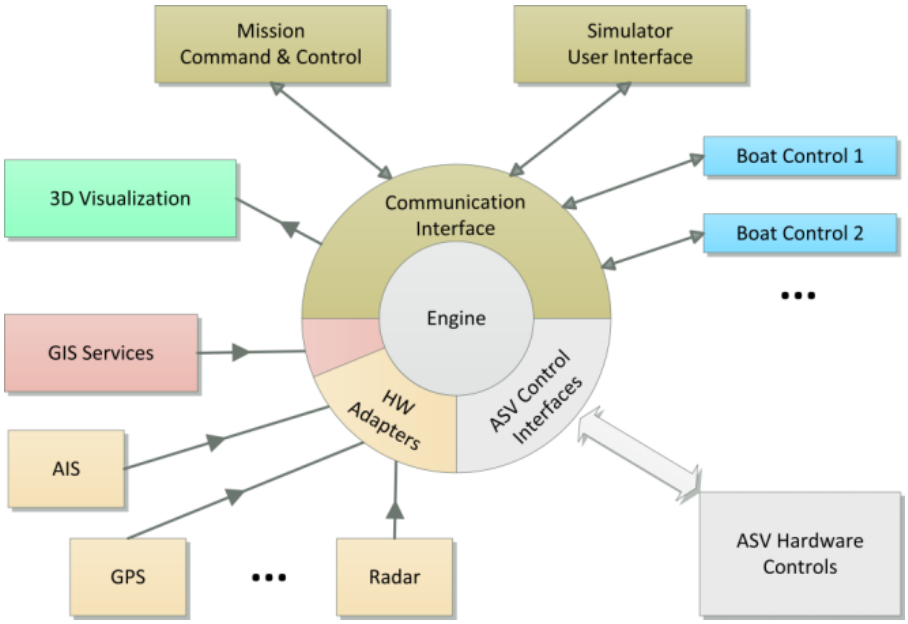

Fig. 7. The architecture of the mission planning and the ASV control [R&D project No. O R 00 0010612 documentation]

POSSIBLE APPLICATIONS OF THE USV 'EDREDON'

Designed and built within both projects the unmanned surface vessel 'Edredon' may be applicable in a maritime economy among other things to the following tasks [8]:

- navigational safety monitoring inter alia protection against pirates, fire actions; ships' monitoring in order to detect smuggling, illegal immigrants, narcotics;
- monitoring of the condition of hydro-technical infrastructure (piers, waterfronts, bridges, dams) from the water side; the units that can get on board underwater vessels (e.g. of ROV type) are applied to the inspection of underwater infrastructure (pipelines, cables);
- monitoring and the protection of objects that are important for economy such as oil platforms and wind farms;
- protection of maritime objects belonging to critical infrastructure;
- fishing monitoring inter alia the real size of catches;
- water environment monitoring of e.g. the area already contaminated or being at the risk of chemical, biological or nuclear contamination (spillages, dangerous substances sinking, environmental disasters);

- oceanography explorations (meteorological, geological, biological, chemical);
- search and rescue missions (related to the activities of, rescue services) etc.

The scope of tasks of the USV 'Edredon' on the example of Gdansk Bay

Among potential tasks to carry out by an unmanned surface vessel, on waters of Gańska Bay, the following can be highlighted [8]:

- policing of the maritime state's borders along a mapped out route;
- policing of uncertain and navigationally hazardous zones (shallow waters, swamps overgrown with reeds close to the shores of Puck, Chałupy, Władysłowowo regions where due to the intensity of tourism the number of accidents of sport equipment users or anglers is becoming increasingly frequent);
- participation in search and rescue sea operations;
- police missions of anchorage regions and water ways;
- execution of protection and defense tasks for units in littoral zone;
- execution of the barometrical sounding of landing approaches, water ways, anchorages, etc.;
- supervision of the correct run of maritime economy;
- supervision of sport and recreation units movement in bay waters;
- supervision of respect for the rules, e.g. of underwater works, sport diving, picking up of historic objects for the bottom, etc.;
- acquisition of hydro-meteorological and oceanographic information about a region;
- water sampling for further analysis (e.g. in respect of the periodical occurrences of chemical substances, algae expansion, etc.);
- monitoring of the ecological situation of the region;
- condition of the navigational signs in the region (buoys, beacons, etc.);
- making the maps of the sea bottom;
- monitoring of the seaside condition from the water side.

The scope of tasks of the USV 'Edredon' on the example of the seaport of Gdynia protection

A set of missions provided for an unmanned surface vessel may encompass [8]:

- policing of the sea port;
- monitoring of the surface and seashore situation in the external protection zone of the port, units identification;

- making the depth measurements;
- pilot assist;
- monitoring of the underwater situation;
- rescue missions on the port site, breakwaters and the external protection zone of the port;
- performing inspections of the underwater parts of hulls;
- protection and defense of the naval base zone;
- carrying out the monitoring of ecological, chemical, biological and radiation port situation;
- monitoring of the state of port infrastructure;
- conduct of the intervention activities towards units and objects breaching the safety zones, breaking the rules, etc.

The scope of tasks of the USV 'Edredon' during policing of the seaport Gdynia

The elements of the seaport of Gdynia policing include among other things [8]:

- monitoring of the water way that leads to the port in the administrative zone of the Harbor Master of the seaport of Gdynia (buoys G1, G2 — in cooperation with the vessels' traffic service [VTS]), anchorage, and roadstead;
- external policing of breakwaters, star-blocks (naval base), marinas;
- supervision over vessels' movement (mainly motor-yachts, fast sport boats, hybrid--boats, etc.) by their detection, tracking and identification, establishing communication, calling to show the crew documents;
- depth monitoring in external waters (landing approach, roadstead, anchorage) and internal waters (turning basin, wharfs);
- creation the map the bottom of the port, roadstead, anchorage, and the closest region waters as a data base about its form to later comparison with the results of periodical measurements (including clarification of the characteristic underwater objects such as boulders, debris, sandbanks, and other places suitable for the secrecy of mine ordnance assurance);
- inspection of the underwater cables, pipes, etc.;
- monitoring of underwater situation (underwater object or sabotage means detection);
- units protection within Maritime Security;
- running the ecological situation monitoring by taking sampling from the systems for contamination detection;

- running the radiological, chemical and biological supervision regarding the presence of toxic, hazardous substances;
- policing of the naval base zone;
- assist the ships calling in the port;
- checking the condition of hydraulic engineering appliances (localization of damages due to storms, icing, and potential wharf collisions);
- running the inspection of underwater part of hulls, underwater part of port's hydraulic engineering infrastructure with the use of the unmanned underwater unit (optionally after the development of technology of the UUV launching and recovery, technical parameters and equipment of the unmanned underwater vehicle specification).

The scope of tasks of the USV 'Edredon' in coastal waters

One of the core tasks entrusted to the USV 'Edredon' in coastal waters are the following:

- policy and supervision service. Running visual and radio-electronic reconnaissance;
- specific water region monitoring (including ecological monitoring);
- logistic support;
- sea rescue (SAR);
- research projects;
- supervision over floating navigational signs;
- police-order tasks;
- counteraction and the fight against terrorism;
- policy service in littoral regions;
- underwater camera or sonar detection of scuba divers;
- protection of surface naval vessels, ships, and important maritime objects against the attacks special forces units and fast surface suicidal units;
- meteorological and hydrographical data acquisition, etc.

SUMMARY

Unmanned surface vehicles, despite the fact that in terms of technical capabilities, technology and implementation policies are behind their counterparts (UUV,

UAV, etc.), given new emerging threats, low construction costs , and especially in view of their positive features find more and more applications not only in the area of defense protection, but also in civil uses. At the same time, however today's USV application creates technical and technological problems to be overcome. These include, inter alia, communication problem, limited capability to the real time reaction, small size of USV limits the size of used sources of energy, autonomous decision making, etc.

At the end of 2013 the U.S. Department of Defense (DoD) published, a quite significant for the future of unmanned systems in the U.S. armed forces, document that is 'Integrated road map of unmanned systems for 2013–2038'. There are indicated the areas that demand improvement in the document. The same applies also to purely technical problems as well as to those from the area of operators training, application of unmanned systems and their daily operation and service. The document assumes that the future unmanned systems should be capable to action in all circumstances, even when an adversary is capable to effective combating, namely has effectors capable of combat unmanned systems effectively.

Looking at the above document and taking into account present state of development of domestic USVs as well as domestic defense industry, the fundamental direction of the domestic's unmanned surface vessels (USV) and autonomous surface vessels (ASV) development should include:

- the further fast development of remote control systems of USV and ASV;
- increasing the required qualities of effectiveness and efficacy, accessibility, interoperability and integrity in the context of future operation needs;
- application of open architecture of systems;
- application of modular construction of surface platforms;
- increasing seaworthiness and carrying capacity of platforms;
- using new materials and available space technology in vehicles construction;
- training operators of unmanned vehicles , the development of simulators and training simulators;
- optimizing the propulsion and energy systems;
- application of new sources of energy;
- cooperation between unmanned and manned platforms;
- transition from systems that carry out programmed tasks in programmed way to systems that carry out tasks in the way worked out during mission execution;
- development of new constructions of launching and retrieving systems on board of surface platforms;

- introduction of diagnostics systems on USV as ASV boards;
- designing long range control systems (incl. satellite systems);
- designing autonomous control systems of vehicles in heavy traffic of restricted waters;
- improving the onboard system of launching and recovering of an underwater vehicle;
- expanding the autonomy of operations, aiming to the full autonomy based upon elements of artificial intelligence;
- designing a new, alternative to the GPS, navigation system;
- solution to legal and moral issues related with application of autonomous platforms;
- using the stealth technology in construction of surface platforms;
- improve the grade of integration with the other elements of combat components;
- improvement of performance parameters and operational capabilities;
- information encryption, necessary to assure the higher security of the data, critical to mission success, transmission;
- development of new weapon BSP dedicated systems;
- protection and data processing, etc.

Acknoledgements

The research work financed by The National Centre for Research and Development during period of 2009–2011 as the development project No. O R000 0004 07 and during the period of 2010–2012 as the development project No. O R 00 00106 12.

REFERENCES

[1] Bednarczyk M., Hass E., Kitowski Z., Neumann J., Pawłowski W., Pilecki J., Przybyszewska-Chudzik A., Konefał S., Wierzchoń S., *Platforma ASVCaSP* [*ASVCaSP Platform*], 'Polish Hyperbaric Research', 2012, No. 3 (40), pp. 185–206.

[2] Kitowski Z., *Polish Unmanned Surface Vehicle*, 'Polish Journal of Environmental Studies', 2010, Vol. 19, No. 4A.

[3] Kitowski Z., T. Żygowski, *Bezzałogowe pojazdy nawodne w telemetrycznym zabezpieczeniu antyterrorystycznym portów i baz morskich*, III Konferencja Dni Przemysłu, Warszawa 2010 [*Unmanned surface vehicles in the telemetric antiterrorist protection of ports and naval bases*, Proceedings of the 3rd Conference Industry Days — available in Polish].

[4] Kitowski Z., *Architecture of Control System of Unmanned Surface Vehicle in Harbours Protection*, 'Solid State Phenomena', Mechatronic Systems, Mechanics and Materials, 2011, Vol. 180, pp. 20–26.

[5] Kitowski Z., *Autonomiczny bezzałogowy pojazd nawodny 'Edredon'* [*Autonomous Unmanned Surface Vehicle 'Ededron'*], 'Polish Hyperbaric Research', 2012, No. 3 (40), pp. 7–21.

[6] Kitowski Z., *Autonomous Control System of Unmanned Surface Vehicle*, 'Monografie, Studia, Rozprawy', Scientific Aspects of Unmanned Mobile Objects, University of Technology, Kielce 2014, pp.78–88.

[7] Kubiak K., Makowski A., Mickiewicz P., *Polska wobec zagrożenia terroryzmem morskim*, Publishing House: Trio, Warszawa 2005 [*Poland against the threat of maritime terrorism* — available in Polish].

[8] Materials development project No R00 0106 12 'Integrated planning system of protection and monitoring of marine ports and critical objects based on the autonomous unmanned units' Gdańsk 2010–2012.

[9] Szubrycht T., *Unmanned Surface Vehicles — Main Task*s. *Perspectives for the Development of Rescue, Safety and Defense Systems in the 21th Century*, AMW, Gdynia 2005.

[10] Unmanned Systems Integrated Roadmap FY2013-2038 [online], http://www.defense.gov/Portals/1/Documents/pubs/DOD-USRM-2013.pdf [access 23.06.2016].

WYKORZYSTANIE KRAJOWYCH BEZZAŁOGOWYCH PLATFORM NAWODNYCH W OBSZARZE BEZPIECZEŃSTWA WEWNĘTRZNEGO I GOSPODARKI MORSKIEJ — POTENCJAŁ I KIERUNKI ROZWOJU

STRESZCZENIE

W artykule przedstawione zostały problemy związane z konstrukcją w kraju bezzałogowych pojazdów nawodnych będących w centrum zainteresowania państw zachodnich jako jeden z elementów wzmacniających bezpieczeństwo wewnętrzne i gospodarkę morską. Omówiono doświadczenia wynikające z konstrukcji pierwszego w kraju pojazdu tego typu, który otrzymał nazwę 'Edredon' oraz omówiono na przykładzie Zatoki Gdańskiej i portu Gdynia wybrane zadania, jakie mogą być realizowane przez pojazd w procesie zabezpieczenia działań morskich służb państwowych oraz ochrony i monitoringu portów morskich i obiektów infrastruktury krytycznej. Przedstawione zostały także kierunki dalszego rozwoju (zwłaszcza pojazdów autonomicznych), które mogą być zrealizowane w krótkim czasie w oparciu o krajowy potencjał naukowy i przemysł okrętowy.

Słowa kluczowe:
bezzałogowe platformy nawodne, bezpieczeństwo wewnętrzne, ochrona portów i obiektów infrastruktury krytycznej.