DOI: 10.37102/24094609.2020.34.4.001

DEVELOPMENT OF THE TECHNOLOGICAL POTENTIAL OF AUTONOMOUS UNDERWATER VEHICLES

Yu.V. Matvienko, V.V. Kostenko, A.F. Scherbatyuk, A.V. Remezkov

Prospects of designing autonomous and remotely operated underwater vehicles (AUV and ROV) of the new generation rely on developing hybrid autonomous and remotely-operated vehicles (ARV), which combine functions of AUV and ROV. It is necessary to expanse significantly AUV's technological capabilities by equipping it with new instruments, upgrading onboard control systems, involving operators in the technological process for real-time control of work progress, and execution order and conditions of novel technological operations. ARV is capable of performing a wide specter of contactless operations: approach the target of research according to the stated program, perform operations related to establishing a data exchange channel with control station, and then carry out contact operation in supervisory mode. Priority tasks of hybrid vehicles designing consist of the development of AUV's functional properties, including:

- intellectualization of onboard control systems;
- provision of supervisory control involving an operator in control flow;
- expansion of instrumentation and optimization of structural solutions;
- providing a network means for underwater navigation;
- providing an infrastructure for underwater deployment while carrying out long-term missions on the maintenance of underwater mining complexes.

Work demonstrates a principal achievability of designing an ARV based on robotic complexes and their systems developed in the IMTP FEB RAS for the past years.

Key words: autonomous underwater vehicles, hybrid underwater vehicles, supervisory control, underwater robot deployment.

Recommended citation:

Matvienko Yu.V., Kostenko V.V., Scherbatyuk A.F., Remezkov A.V. DEVELOPMENT OF THE TECHNOLOGICAL POTENTIAL OF AUTONOMOUS UNDERWATER VEHICLES // Underwater Investigation and Robotics. 2020. No. 4 (34). P. 4–14. DOI: 10.37102/24094609.2020.34.4.001

REFERENCES

1. Inzartsev A.V., Kiselev L.V., Kostenko V.V., Matvienko Yu.V., Pavin A.M., Shcherbatyuk A.F. Underwater robototechnics complexes: systems, technologies, application. Vladivostok: IMTP, 2018. 368 p.

2. Ageev M.D., Kiselev L.V., Matvienko Yu.V. et al. *Avtonomnye podvodnye roboty: sistemy i tekhnologii*. M.: Nauka, 2005. 398 p.

3. Inzartsev A.V., Kamornyy A.V., L'vov O.Yu., Matvienko Yu.V., Rylov N.I. *Primenenie avtonomnogo neobitaemogo podvodnogo apparata dlya nauchnykh issledovaniy v Arktike.* Underwater Investigations and Robotics. 2007. No. 2. P. 5–14.

4. Inzartsev A.V., Matvienko Yu.V., Pavin A.M., Rylov N.I. Technologies of seabed monitoring based on intelligent processing of search systems" data onboard the autonomous underwater vehicle. Underwater Investigations and Robotics. 2015. No. 2 (20). P. 20–27.

5. Vaulin Yu.V., Inzartsev A.V., L'vov O.Yu., Matvienko Yu.V., Pavin AM. The configurable navigation and control system for multifunction underwater robots. Underwater Investigations and Robotics. 2017. No. 1 (23). P. 4–13.

6. Ageev M.D. *Osnashchenie i upravlenie ANPA pri obsledovanii podvodnykh truboprovodov. Podvodnye tekhnologii*. 2005. No. 1. P. 68–73.

7. Petraglia F. R. et al. Pipeline tracking and event classification for an automatic inspection vision system. Proceedings of 2017 IEEE Int. Symp. on Circuits and Systems (ISCAS). Baltimore, USA, 2017. P. 1–4.

8. Inzartsev A. V., Pavin A. M., Rylov N. I. Development of the AUV automatic docking methods based on echosounder and video data. Proceedings of 2017 24th Saint Petersburg Int. Conf. on Integrated Navigation Systems (ICINS). Saint Petersburg, Russia, 2017. P. 1–6.

9. Pavin A., Inzartsev A., Matvienko Y. Experience of AUV automatic homing to hydroacoustic transponder. Proceedings of the Sixth Int. Symp.on Underwater Technology. Wuxi, China, 2009. P. 201–206.

10. Zagatti R. et al. FlatFish Resident AUV: Leading the Autonomy Era for Subsea Oil and Gas Operations. Proceedings of Offshore Technology Conference. Houston, USA, 2018.

11. Lainati A. et al. Clean Sea: From R&D to Business Application. Proceedings of Offshore Mediterranean Conference and Exhibition. Ravenna, Italy, 2017.

12. Maurelli F. et al. The PANDORA project: A success story in AUV autonomy // proceedings of IEEE OCEANS 2016. Shanghai, China, 2016. P. 1–8.

13. Ageev M.D., Boreyko A.A., Gornak V.E., Matvienko Yu.V., Vaulin Yu.V., Zolotarev V.V., Shcherbatyuk A.F. *Modernizirovannyy TSL – podvodnyy apparat dlya raboty na shel'fe i v tonnelyakh* // *Morskie tekhnologii*. Vol. 3. Vladivostok: Dalnauka, 2000. P. 23–38.

14. Goy V.A., Kostenko V.V., Naydenko D.N., Mikhaylov D.N., Rod'kin D.N. *Opyt razrabotki i ispytaniy teleupravlyaemogo neobitaemogo podvodnogo apparata s avtonomnym istochnikom pitaniya.* Proceedings of nauchn.-tekhn. konf. «Tekhnicheskie problemy osvoeniya mirovogo okeana». Vladivostok, 2015. P. b101–106. ISBN 978-5-8044-1363-2.

15. One-on-One with Martin McDonald, SVP, ROV Division, Oceaneering. – URL: https://www.maritimeprofessional.com/news/with-martin-mcdonald-division-oceaneering-344416 (usage date: 15.09.2020).

16. An Autonomous Underwater Vehicle using Remote Piloting Technology via 4G Internet. – URL: https://www.sut.org/wp-content/uploads/2018/06/Aaron-Leather-v2-AUT-Freedom-Rev3-Final-Submission-draft-2-21.10.2019.pdf (usage date: 15.09.2020).

17. Kraige D. Retractable UUV Antenna Buoy with Smart Tether GPS // KCF Technologies, US Naval Sea Systems Command SBIR. No. 04. P. T020.

18. Patent No US 8,813,669 B2, USA. Towed Antenna System and Method / Roger E. Race, Jacob C. Piscura, David S. Sanford. *Zayavl*. 09.06.2010; *opubl*. 26.08.2014.

19. Nishida Y. et al. Development of an autonomous buoy system for AUV. Proceedings of IEEE OCEANS 2015. Genova, Italy, 2015. P. 1–6.

20. Kostenko V.V., L'vov O.Yu. Combined systems of communication and navigation for autonomous underwater robot equipped with a float towed unit. Underwater Investigations and Robotics. 2017. No. 1 (23). P. 31–43.

21. Bluecomm 100 – Wireless underwater optical communication. – URL: https://www.sonardyne.com/product/bluecomm-underwater-optical-communication-system/#requestInformation (usage date: 15.09.2020).

22. Manley J. E. et al. Aquanaut: A New Tool for Subsea Inspection and Intervention. Proceedings of OCEANS 2018 MTS/IEEE. Charleston, USA, 2018. P. 1–4.

23. Vaulin Yu.V., Dubrovin F.S., Shcherbatyuk A.F. AUV MMT-3000 integrated positioning and communication system and experience of its operation in deep-water extended routes. Underwater Investigations and Robotics. 2017. No. 2 (24). P. 14–19.

24. Boreyko A.A., Vorontsov A.V., Kushnerik A.A., Shcherbatyuk A.F. Algorithms of video images processing for some AUV navigation and control tasks decision. Underwater Investigations and Robotics. 2010. No. 1 (9). P. 29–39.

25. Akulichev V.A., Morgunov Yu.N., Borodin A.E. Regional System of Underwater Navigation Provision and Remote Control**.** Fundamental and Applied Hydrophysics. 2014. Vol. 7, No. 2. P. 36–40.

26. Gerasimov V.A., Filozhenko A.Yu., Chepurin P.I. Structure of the system noncontact energy issue of the autonomous undersea device. Izvestiya SFedU. Engineering sciences. 2013. No. 3 (140). P. 47–55.

27. Matvienko Yu.V., Remezkov A.V. *Kontseptsiya sozdaniya robotizirovannogo kompleksa obsledovaniya i monitoringa tekhnicheskogo sostoyaniya ob"ektov podvodnoy dobychi. Gazovaya promyshlennost'. Avtomatizatsiya.* 2020. No. 2 (802). P. 30–37.

ABOUT THE AUTHORS

MATVIENKO Yu.V. – doctor of engineering, senior research scientist.

Institute for Marine Technology Problems FEB RAS

Research interests: hydroacoustics, underwater robotics, hydroacoustic navigation and communications.

Adress: 5a, Sukhanov Str., Vladivostok, 690950.

Phone: +7 (423) 243-25-78.

E-mail: ymat@marine.febras.ru.

Orcid ID: 0000-0002-4486-3719

KOSTENKO V.V. – Ph.D. in technical sciences, laboratory director.

Institute for Marine Technology Problems FEB RAS

Research interests: autonomous, remote-controlled and hybrid underwater robots, executive bodies of underwater robots, motion modeling.

Adress: 5a, Sukhanov Str., Vladivostok, 690950.

Phone: +7 (423) 243-24-16.

E-mail: kostenko@marine.febras.ru

Orcid ID: 0000-0002-3821-3787

SCHERBATYUK A.F. – Institute for Marine Technology Problems FEB RAS director, Corresponding Member of the Russian Academy of Sciences, professor.

Institute for Marine Technology Problems FEB RAS

Research interests: underwater robotics, control and navigation systems, group control.

Adress: 5a, Sukhanov Str., Vladivostok, 690950.

Phone: +7 (423) 243-24-16.

E-mail: scherba@marine.febras.ru.

REMEZKOV A.V. – head of rechnology rransfer department, Far Eastern Federal University.

Far Eastern Federal University.

Research interests: technologies for monitoring subsea production complexes.

Adress: 690950, Vladivostok, Russky Island, FEFU Campus, bldg. A, level 11, A 1125.

Phone: +7 (423) 265-24-24 (доб. 2481), +7 (914) 705-73-90.

E-mail: remezkov.av@dvfu.ru

Manuscript received: 10.09.2020
Published: 25.12.2020