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B. G. BABAEV, a student of gr. 3-IAIT-6 (SSTU)
E. PANTELEY, PhD student, software engineer (SSTU)
Scientific supervisor A. N. MOCHALKIN, director of the SCP
Samara

AUTOMATIC WASTEWATER INSPECTION WITH USING AUTONOMOUS UNDERWATER VEHICLE

During the operation of the hydroelectric power plant, waste water is formed, which gets back into the reservoirs. Thus, the waters that have passed through the power plant are called sewage. Waste water is the water whose properties are changed as a result of domestic, industrial, agricultural or other processes. Wastewater containing neutral salts, acids, alkalis in the majority do not pose a danger to the inhabitants of flora and fauna, since they do not have specific toxic properties. But they increase the salinity of reservoirs, while oil products appearing in the effluents of power plants pose a great danger. Oils intended for cooling turbines, bearings, pumps and other functional elements. Electrical equipment and auxiliary services, such as de-po, garages, emit additional toxic substances, the concentration of petroleum products in which can reach 50 mg/ and higher. According to recent data, the Volga River has become the most polluted river in Russia, more than 6 cubic meters of wastewater enters the Volga basin annually, 90% of which are insufficiently treated.

In addition to the presence of toxic substances in wastewater, the drained waters have a high temperature, which has a bad effect on the inhabitants of the reservoirs, the waste creates a favorable environment for bacteria and algae, according to images taken by the Sentinel 2B/MSI satellite in July 2021, characteristic breeding centers of blue-green cyanobacteria are observed in the Volga River basin near the cities of Samara and Togliatti (Fig. 1), followed by reports of mass death of fish and other inhabitants due to overheating reservoirs. It is necessary to develop a method for determining the places of contamination of reservoirs, as well as inspections, underwater parts of hydroelectric power plants, in order to analyze the content of toxic substances.

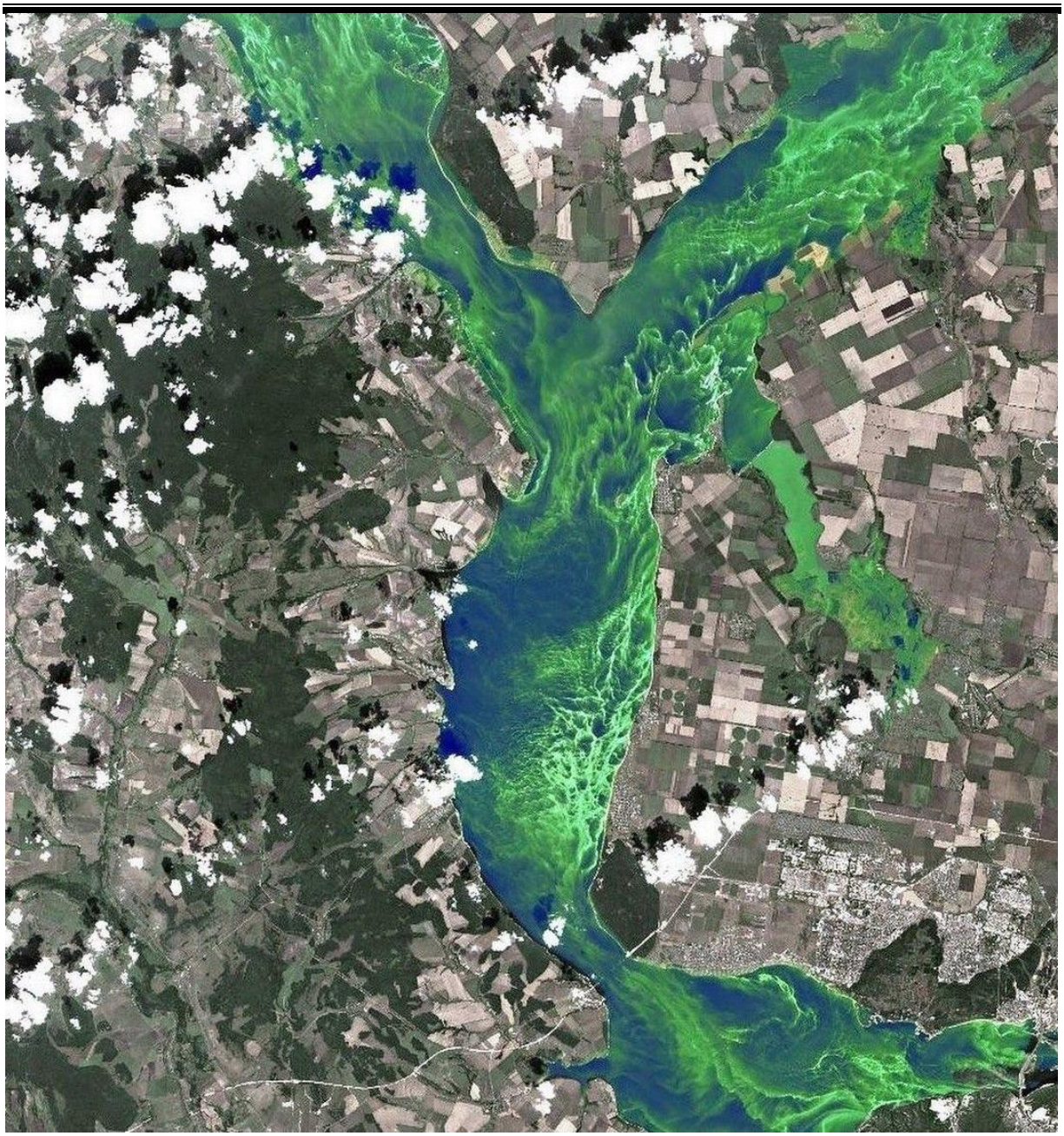

Fig. 1 Photos taken by satellite 2B/MSI

The solution may be surface-underwater robotic complexes. An autonomous uninhabited vehicle (AUV) "Glayderon" is being developed on the basis of SSTU together with LLC "NPK "Network-Centric Platforms" (Fig. 2). Having technical characteristics: 80 kg of payload, 12 hours of autonomous operation with the possibility of increasing, an economical speed of 5 km / h, a margin of navigation autonomy up to 5 miles, a distance of direct (surface) radio communication with the operator - 1 km.

Fig. 2 AUV "Glayderon"

Having these characteristics, the device can already fully ensure the formation of situational awareness areas for solving the tasks of monitoring the surveyed water areas. The Glideron AUV can carry 80 kg of payload, which makes it possible to place water intake devices, sensors for the concentration of living organisms in the water. The device will be able to analyze and search for the ejection site in automatic mode. Using additional side-view sonars installed on board with a range of up to 50 meters, it is possible to search for the dumping site and obtain evidence with GPS coordinates.

Methods and algorithms of the work of the AUV were developed to search for places of discharge on the Volga River. In general, the devices pass through a given area in automatic mode on the surface of the water to search for potential suspicious places where samples are collected, while maintaining the location of sampling. Subsequently, potential locations are checked manually at different depths.

It is advisable to use satellite images in the summer period as auxiliary data for the formation of a wastewater detection mission. Based on the images, it is possible to identify the most priority points that will be considered when building a route for robotic vehicles. Equally important is the creation of a knowledge base on previous studies, where not only data on coordinates should be stored,

but also on the results of chemical/biological analysis, if it was carried out. An equally important task is to create a knowledge base about the environment and the territory in which research is conducted. Based on the knowledge base, considering the characteristics of the devices, a route is built along the surface of the water to obtain primary information and select points for diving. It is advisable to carry out this part of the mission in automatic mode.

Before the mission, it is possible to retrofit the devices with the necessary payload, for example, an oxygen sensor. If the delivery of the device to the place of examination by land is difficult, it is advisable to equip AUV with additional battery units and deliver the device to the place by water. The main interest is the following signs of contamination: the presence of turbidity, biogenic substances, a decrease in the amount of oxygen.

Underwater research takes place point-by-point, when suspicions are detected on a site of limited size. This is due to the difficulties of navigation and communication under water. Work under water is performed automatically. To implement this mode, the devices need to determine and make decisions depending on the event.

An event in the water area is understood as the implementation of a random process in a selected fragment of the water area associated with the manifestation of a predicted or previously ignored factor. Of interest are both external events (the influence of the external environment) and the event generated by the AUV itself as a result of its active actions. Often the source of the event remains undetermined, and its impact on the functioning of the robotic means is critical. To achieve autonomy, a knowledge base should be developed about events in the environment and the characteristics of the device.

The area available for examination by one device is limited, and often due to the large volume of water spaces it is impossible. To increase efficiency, it is advisable to consider the possibility of using not one device, but a group.

Illegal drains are a danger not only for humans, but also for all biological species living in reservoirs and near waters. Year-round detection of emissions by traditional methods is labor-intensive, since it is impossible without human participation and has low accuracy. When using autonomous devices, this process can be made faster and economically feasible. To date, the most well-developed strategy for the search for wastewater in fresh water bodies is the use of AUV in the above-water mode, but not effective enough. Maximum detection is possible with a mixed survey mode – surface and underwater. The latter today, unfortunately, has a number of significant technical limitations.

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Information about the authors:

Babaev Bogdan Germanovich, student gr. 3-IAIT-6, SSTU, 443100, Samara, Molodogvardeyskaya str., 244, babaev.bogdan.ru@gmail.com

Panteley Ekaterina, PhD student, software engineer, SSTU, 443100, Samara, Molodogvardeyskaya str., 244, panteley@smartsolutions-123.ru

Mochalkin Alexander Nikolaevich, Director of RUNC, SSTU, 443100, Samara, Molodogvardeyskaya str., 244, a-mochalkin@mail.ru