Application of small spacecraft for automatic identification of vessels

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Abstract

The work is devoted to the development of a specialized complex based on a CubeSat 3U nanosatellite for receiving and processing signals from the AIS system. With the help of such system, it is planned to form a domestic AIS space constellation. The urgency is connected with the current absence of the Russian Federation's own satellite means of obtaining AIS data for monitoring the movement of ships in the world's oceans and in its own water area. Access to this data is becoming critical in connection with the development of the Northern Sea Route and the development of shipping in the Azov, Black Seas and the Far East.

Keywords: *CubeSat, AIS, space receiver, marine communication systems*

1. Introduction

The AIS system is a set of transceivers located both on ships and at coastal base stations (Chen & Wu (2023), Putra et al. (222)). These devices are capable of exchanging information about ships - location, course, speed, and other technical data. AIS also allows the exchange of additional information, which is provided by the standards, including broadcast and address messages (Spadon et al. (2023), Oumimoun et al. (2022)). Since the AIS operates in the VHF band and the installation height of the transceivers is limited by the height of the vessel, the communication range is on average about 50-70 km (about 30 nautical miles). This determines the size of the zone in which the ships can exchange all the information provided. The AIS uses a self-organizing multiple access system, which guarantees the ability to receive and transmit messages without conflicts with other transceivers within the same zone.

If the ship is far from the coast, it is not possible to exchange information with the base station, which raises the problem of monitoring remote ships. To solve this problem, spacecraft are used. A nanosatellite platform is used as such a device - a simple, reliable and proven solution with low cost and the possibility of mass production.

2. Satellite AIS receivers

On August 9, 2022, on the "Soyuz-2.1B" launch vehicle, several CubeSat 3U spacecrafts were launched into orbit, carrying a payload - on-board space receivers of AIS signals. Since 2023, AIS data collected by these vehicles from orbit has already been used for monitoring and safety of the movement of fishing vessels. The spacecraft themselves were developed by Sputnix in collaboration with leading Russian universities (Fig. 1). These nanosatellites have been launched into Earth orbit and are still active and functioning.

The onboard AIS receiver is a hardware and software system designed specifically for installation in a CubeSat satellite (Fig. 2). The device was developed and tested at Peter the Great St. Petersburg Polytechnic University. The receiver receives and processes AIS signals transmitted on 161.975 MHz and 162.025 MHz channels from transmitters of both class A and class B (with reduced power). The receiver has one antenna input. The sensitivity of the receiver allows it to confidently receive signals with a power of 2 W at distances of more than 2500 km. All processing and decoding is done directly in the on-board receiver.

Figure 1. Left: spacecraft CubeSat 3U SXC3-214-MIET-AIS, on which the onboard receiver of AIS signals is installed. Right: spacecraft CubeSX-HSE-2, on which the onboard receiver of AIS signals is installed.)

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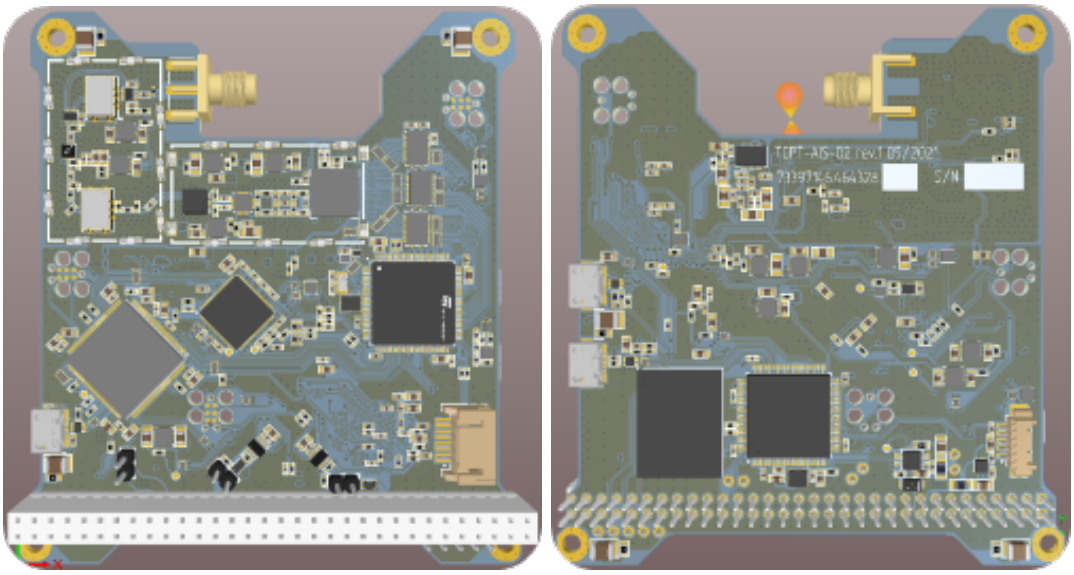

Figure 2. External view of the model of onboard AIS receiver.)

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The device transmits the received information to the onboard computer of the spacecraft, then the collected information is dumped from the spacecraft to the Earth using a network of ground stations. The stations receive telemetry from vehicles, transmit control commands and receive information from the payload. Since the launch of the spacecraft, a number of tests have also been carried out, during which the correct functioning of the vehicles and the payload was assessed.

3. AIS information from space.

The result of processing information from the onboard AIS receiver is data on sea and river vessels, coast stations, buoys and other devices equipped with AIS transmitters. After processing using specialized software, you can display the location of ships on the map (Fig. 3), as well as build tracks for their movement. Fig. 4 shows accepted sea vessels on the Northern Sea Route, the Far East, as well as river vessels of the Russian Federation.

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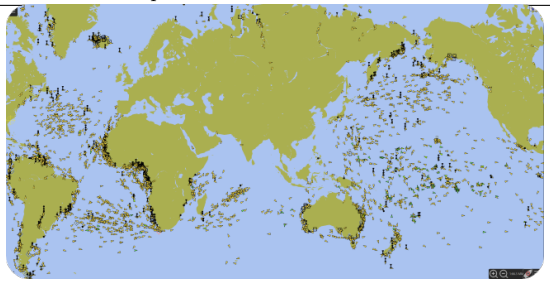

Figure 3. Visualization of information received from the onboard receiver.

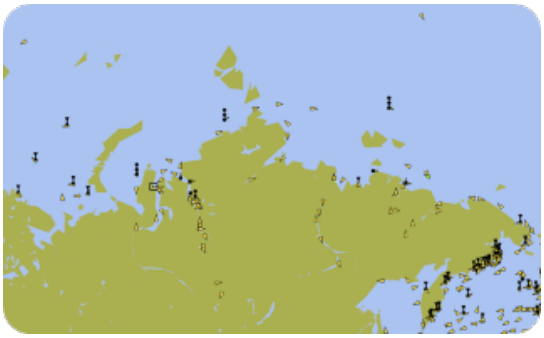

Figure 4. Display of sea and river vessels in the waters of the Russian Federation.

4. Conclusion

The launch of CubeSat format spacecraft carrying on-board AIS receivers as a payload was carried out. These devices were developed at Peter the Great St. Petersburg Polytechnic University. Spacecraft receive information for monitoring navigation: the name and ownership of the vessel, type and status, IMO number (number in the International Maritime Organization (International Maritime Organization)), location, course and speed of the vessel, date, and port of destination. The work was done under the Space-Pi program.

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