Remote control system for the unmanned floating platform

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Abstract. The paper presents the results of modelling the coverage areas of a communication system in the Wi-Fi range for organizing a wireless data transmission channel between the coastal and onboard control subsystems of an unmanned floating platform, for which the main navigation zones near the coast are determined. It is shown that the use of a communication system based on the IEEE 802.11 standard makes it possible to ensure stable data exchange within the specified navigation zones of the unmanned platform. A generalized block diagram of a remote control system for an unmanned floating platform has been developed. It includes a video surveillance subsystem and a subsystem for engine control and collection of metrological data from various sensors. In this case, the floating platform is controlled both from a stationary post and using a mobile console. Functional diagrams of the onboard video surveillance and control system, as well as the coastal subsystem have been developed.

1. Introduction

Today, work is being actively carried out on the development of unmanned floating craft intended for solving research problems, monitoring the state of the environment and the coast, solving commercial and other practical problems [1]. At the same time, among others, the issues of building a remote control system for an unmanned craft [2, 3] and the organization of a wireless communication channel [4] are being solved.

When solving the first of these problems, it is important to build both a stationary coastal control subsystem and a mobile terminal. The second question is largely based on the requirements for the navigation area of the controlled object: near the coast, within the line of sight or on long routes.

The complexity of the structure of the onboard control subsystem is determined by a set of requirements for the floating craft, the navigation area and its practical purpose: complex intelligent systems [5] for maintaining a given course, video surveillance systems with improved discrimination of objects in conditions of poor visibility [6], mooring [7], development and testing algorithms for trajectories of unmanned aerial vehicles [8], etc.

In some cases, a more simplified configuration of the control system is required: with a decrease in the total cost, energy consumption and weight-dimensional parameters of the object, with a limited area of its navigation within the line of sight from the operator.

The report discusses the problem of building such a control system for a small floating platform.

2. Analysis of communication conditions in the areas of floating platform application

The wireless communication channel of the coastal and on-board subsystems of the unmanned floating platform (UFP) is organized using the IEEE 802.11 communication standard.
For modelling, the free software "RadioMobile" was used, which uses open-source terrain and elevation maps. The IEEE 802.11 standard is used to organize wireless data transmission in Wi-Fi networks. Simulation is carried out for the following parameters of communication systems:

- operating frequency ranges 2400 - 2500 MHz;
- Omni-directional airborne antenna and coastal antenna with a sector radiation pattern with a gain of 15 - 20 dBi;
- the power level of the transmitters of the coastal and onboard subsystems was selected taking into account the existing regulatory requirements.

The option of placing the coastal control subsystem of the UFP in the area of the Sevastopol Bay at the points shown in figure 1.2: point P1 is located on the coast of the Gollandiya Bay (the height of the ground above sea level is 50 m, the height of the antenna placement on the building and the support tower is 20 m), point P2 is on the shore of the Streletskaya Bay (the height of the earth above sea level is 50 m, the height of the antenna placement on the building and on the support tower is 25 m). The map shows the priority navigation areas of the unmanned platform (areas L1 and L2).

![Figure 1. The zone of reliable communication when placing the coastal subsystem antenna at point P1.](image1)

![Figure 2. The zone of reliably communication when placing the coastal subsystem antenna at point P2.](image2)
The simulation was carried out within a 2 km radius of the onshore subsystem antenna. In figure 1, taking into account the terrain relief when placing the coastal subsystem antenna at point P1, the zone of reliable communication (in green) and the area of weak signal (in red) are shown. According to the publicly available elevation map, there is a ship in the bay that is not on the map. A small area of shadow created by this vessel is indicated in the bay (conventionally indicated in figure 1). Figure 2 shows the zone of reliable communication when the antenna of the coastal subsystem is located at point P2.

Figure 1.2 shows that using a wireless communication channel in the frequency range 2.4 - 2.5 GHz provides reliable communication within the unmanned platform sailing areas L1 and L2.

3. The structure of the control and video surveillance system of the UFP

A block diagram showing the implementation of the remote control and video surveillance system of the UFP has been developed (figure 3). The generalized block diagram consists of two main blocks: the onboard subsystem and the coastal subsystem.

![Block diagram of the remote control and video surveillance system](image)

Figure 3. Block diagram of the remote control and video surveillance system.

The coastal subsystem allows remote control of the UFP, displaying video images from CCTV cameras located on the platform, and displaying data from onboard sensors.

The use of the remote control panel is due to the need in the process of testing the BPP to have the possibility of “mobile” control. The operator can move after the UFP or be next to it on the watercraft, which excludes the use of a personal computer. In this case, the operator needs a portable control panel.

The second task solved by the remote control is to reserve the control channel of the UFP in case the connection over the Wi-Fi channel is unstable.

The onboard subsystem manages the movement of the UFP, video surveillance of the state of the platform and the near-water space, collection of information from onboard sensors and transmission of their readings to the shore.

The functional diagram of the on-board video surveillance subsystem is shown in figure 4.

The onboard video surveillance subsystem assumes the use of bow and stern IP video cameras, as well as the presence of a backup channel for connecting an additional IP video camera to view the platform itself (take-off and landing areas of the unmanned vehicle, measuring equipment installation site, and so on).
Figure 4. Functional diagram of the onboard video surveillance subsystem.

Figure 5. Functional diagram of the coastal video surveillance and remote control subsystem.
The coastal control subsystem consists of a personal computer, equipment for receiving and transmitting Wi-Fi signals, and a remote control panel (figure 5). To ensure data exchange with the onboard control subsystem via the Wi-Fi channel, the same equipment as in the onboard video surveillance subsystem is used.

The functional diagram of the onboard control subsystem is shown in figure 6.

One of the main elements ensuring the interaction of the onboard subsystem with the coastal one is a single-board computer. The Raspberry Pi 3 ModelB was chosen for implementation in the project.

![Functional diagram of the onboard control subsystem.](image)

For remote control of the Platform, software has been developed that allows smoothly displaying the readings of onboard sensors, setting the speed of the traction and thrusters within the range of \(-100 - 100\%\), for traction motors the “-” sign corresponds to reverse, for thrusters - to turn to the right.

The program interface is shown in figure 7. In the central part of the program window there is a compass with a central arrow that indicates the direction of movement of the platform.

![Remote control program interface.](image)
4. Conclusion
An analysis of the coverage areas of coastal control subsystems has been carried out, which has shown the possibility of organizing a reliable communication channel with the UFP within the required limits using standard Wi-Fi equipment.

The block diagram of the remote control and video surveillance system at the UFP has been developed. Video streams are transmitted from the UFP via a Wi-Fi channel. The platform can be controlled both from a stationary point via the same Wi-Fi channel, and from a remote control panel.

Functional diagrams of onboard and coastal video surveillance and control subsystems have been developed.

An operator program for remote control of the UFP from a fixed point has been developed.

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