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DIRECTION FINDER ANTENNA FOR THE TERRITORY PROTECTION SYSTEM AGAINST UNMANNED AERIAL VEHICLES

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Abstract. *The work is devoted to the design the proposed construction of the antenna system for the direction-finding complex of the unmanned aerial vehicle (UAV). The experimental part is represented by the results of mathematical modeling the behavior of the antenna in different parts the operating frequency range. The effectiveness of the adopted design solutions was evaluated in comparison with analogues of leading companies in the world. Based on the results of the research, the areas of application the antenna as part of the built-in functional mobile UAV direction finding systems were determined.*

Keywords. *UAV, antennas, radiation pattern*

Introduction

Direction finding and positioning the location of the source of radio emission (RES) is an important task in the implementation of the introduction of measures for radio monitoring, solved in the interests of civil and special services, including during antiterrorist and military operations. Specified the characteristics of the radio direction finder are largely determined by the parameters of the antenna system used. Therefore, research and development radio direction finders for small UAVs [1] is a very relevant scientific practical task for: increasing the accuracy of measuring the angular coordinates of RES; increasing resolution in angular coordinates; increasing the sensitivity of the receiving antenna system; reducing the weight and size parameters of the equipment.

Antenna modeling

At the current moment in the development of antenna systems for the design of direction-finding complexes of UAVs, it is possible to single out the design of the TCI antenna [2,3,4]. In general, the design of such an antenna is based on the general provisions described above regarding the parameters of the Vivaldi antenna. However, the key feature of such antennas is the use of ultra-broadband directional antenna elements that do not have a phase center. The antenna contains systems of the TEM horn type (built on two identical mirror-curved relative to each other conductive plates) with strips that expand, and each of the strips is divided into two parts by a gap (analogous to the Vivaldi antenna discussed [5]).

The article will present the results of modeling the characteristics of antenna elements of antenna systems using software modeling tools. ANSYS 2022 FHSS software was used as software for modeling elements of antenna systems. An antenna system for full-azimuth direction finding of radio emission sources with arbitrary polarization in the frequency range from 1 GHz to 5 GHz, which consists of slotted elements, has been developed and studied. As a single antenna element of the developed antenna system, it is proposed to use a pair of orthogonal elements of the Vivaldi type with metamaterial polarization-selective lenses in their openings. The conducted studies have shown that without changing the design of the antenna radiator, completely different radiation patterns can be obtained by changing the phase relationships at the inputs of the antenna vibrators. This feature will be used in the construction of a UAV amplitude direction finder with high resolution. Consider the features of the development of a broadband radiator of the antenna system. During the calculations, the following was found: it is impossible to cover the required frequency rangeof 100–3000 MHz with a simple TSA antenna element; it is impossible to obtain an acceptable standing wave ratio (SWR) of the antenna element in a wide frequency range; the shape of the DC antenna element retains acceptable characteristics of the frequency range within an octave.

To use the element under study as part of the radio direction finder antenna system, a two-stage amplitude-phase direction finding method is proposed, which involves the introduction of tables of mutual phases between adjacent antenna elements, for which the amplitudes of the signals received at the current time are maximum. The initial bearing estimate is determined by the amplitude method. The corrected bearing is determined by the phase distribution of the signal on the elements with the maximum amplitude. The correlation-interferometric method can also be applied.

The correlation-interferometric method can also be applied direction finding [1]. However, in this case, the antenna system will have to be supplemented with an antenna element with a circular radiation pattern, as implemented but in TCI

direction-finding antenna systems [3], and tabulate the amplitude-phase radiation patterns of the elements. Thus, in this section, an antenna system for full-azimuth direction finding of radio emission sources with arbitrary polarization has been developed and studied. The advantages of the proposed design include the following:simplicity of design and manufacturability;metamaterial lenses in the apertures of antenna elements allow; correct phase distortions and improve their radiation pattern, input characteristics and cross-polarization isolation; simultaneous reception of signals on two orthogonal polarizations.

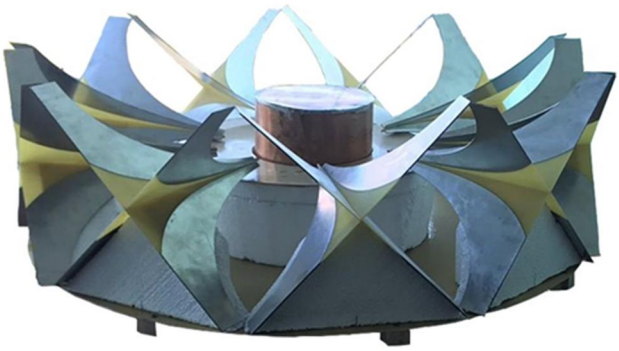

Figure 2 – Prototype of the manufactured antenna

Conclusions

The paper presents the results of the development and modeling of a broadband antenna system for UAV direction finding. The research covered the issues of analytical description of the antenna system based on the prototype – the Vivaldi antenna. The main trends in the modern design of broadband antenna systems are determined. The main parameters of the proposed broadband antenna are determined by the method of mathematical modeling. The parameters of the proposed antenna in the frequency range under various excitation conditions are investigated, and the specifics of the application of such a system under the conditions of its possible operation as part of UAV direction-finding complexes are given.

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