Impact Factor: 9.9 ISSN-L: 2544-980X

Navigation Systems for Unmanned Aerial Vehicles

Qodirov Sodiq Salimovich [1]

Abstract: This article studies and analyzes the current use of unmanned aerial vehicles (UAVs) in military operations. It classifies military UAVs based on functionality, technical characteristics, and applications. Special focus is given to the development of platform-less inertial navigation systems (BINS), crucial for accurate and reliable UAV navigation. The article covers the evolution of these systems from concept to current technologies and discusses their future applications, highlighting their importance for high-precision positioning and navigation in military operations.

Key words: autonomous flight, satellite navigation system, platform-free inertial navigation system, unmanned aerial vehicles, developmental work, problem solving.

The article analyses the application and classification of modern military drones. The stages of development of platform-free inertial navigation systems are considered, as well as the possibility of their application on military drones. The generalised structural scheme of platform-free inertial navigation systems with a sensing element based on laser gyroscope is presented.

The global experience of using unmanned aerial vehicles (UAVs) in various armed conflicts demonstrates the increasing role of UAVs in combat operations. Analyses of the directions and methods of combat use of forces and means, as well as the development of the system of operational support for combat operations show that the activity and range of tasks performed by UAVs is constantly expanding. At the present stage UAVs fulfil a wide range of tasks: reconnaissance tasks, REB tasks, geoinformation and topographic and geodesic support tasks, defeat of point ground and surface targets. The use of UAVs against area targets by forming a "swarm" is becoming more relevant [1].

At present, the Russian Federation is intensively carrying out development work to create reconnaissance-impact (RI) UAVs capable of performing almost all known reconnaissance and combat missions. The development of such UAV systems is aimed at high-altitude, long-term autonomous flight [2]. The work on their development is a priority for the construction of the UAV application system in the Russian Armed Forces.

UAVs are multifunctional types of weapons and military equipment that improve the effectiveness of any nation's weapon system. Figure 1 shows the Russian Armed Forces' UAVs of various types in service and in the future.

[1] Senior Lecturer of the Faculty of Training and Advanced Training of Aviation Specialists of the Military Aviation Institute of the Republic of Uzbekistan, Lieutenant Colonel

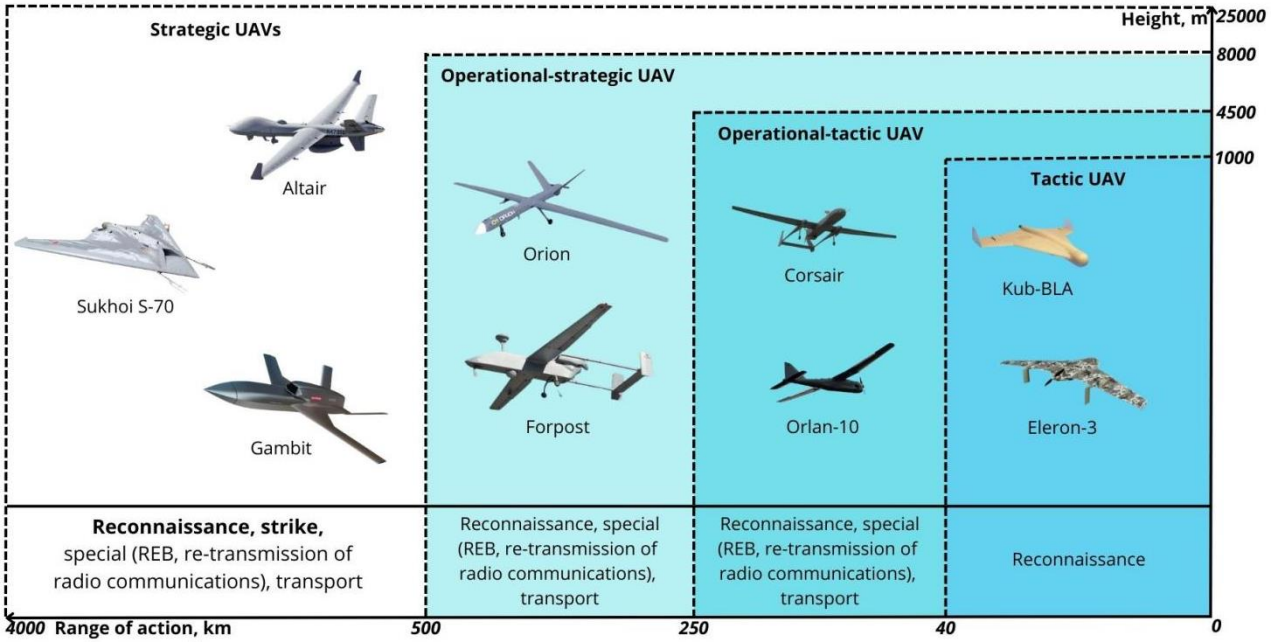


Figure 1 - Classification of Russian Air Forces UAV types

As classification features, the data on flight time limit, altitude and accuracy requirements of the autonomous navigation system are investigated. At the current stage of development of the Russian Armed Forces' UAV RIs, the most promising ones are considered to be: "Okhotnik-U" and "Altair".

For UAVs, the use of inertial navigation aids is a prerequisite for combat use. In the situation of active electronic countermeasures from the enemy, inertial navigation systems (INS) will allow drones in autonomous flight mode to perform reconnaissance and strike missions even in the case of complete loss of communication with the control centre and absence of signals from ground and satellite navigation systems [3].

The most demanded and attractive for UAVs are platform-free inertial navigation systems (BINS), which have a number of advantages: high informativeness, versatility, accuracy of output information formation and speed of information delivery; sufficient reliability, providing resistance to vibration and shock effects; acceptable mass-size parameters and power consumption [4].

The military leadership of the Russian Armed Forces considers UAVs of all types as one of the most important means of enhancing the combat capabilities of the Russian Armed Forces. Analyses of trends in the improvement of methods and forms of combat operations show that the existing types of UAVs provide the entire range of combat applications in modern military conflicts.

The solution of tasks of automatic and automated control mode of UAV and its target load (technical means of reconnaissance and weaponry) in the autonomous flight mode is achieved by using measurement systems based on inertial methods of measuring motion and orientation parameters, the most advanced of which are BINS based on optical gyroscopes.

This is due to the fact that they provide complete information on navigation parameters of motion - heading, pitch (trim), roll, acceleration, speed and coordinates of the object. At the same time, they are practically autonomous during active flight, as they require minimum external information. Due to the possibility of determining the angular position of an object with high accuracy in any angle range and with high frequency of information delivery, BINSs have no alternative to date [5].

At present, existing and prospective UAV RIs use BINSs used in manned aviation. The main stages of BINS development are presented in Figure 2

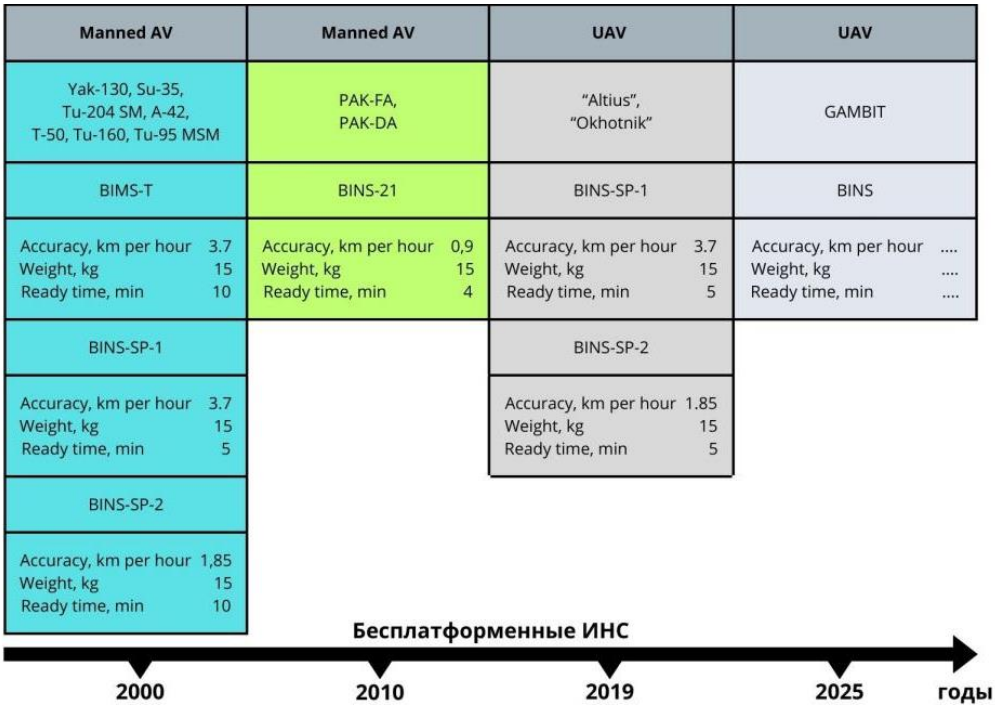
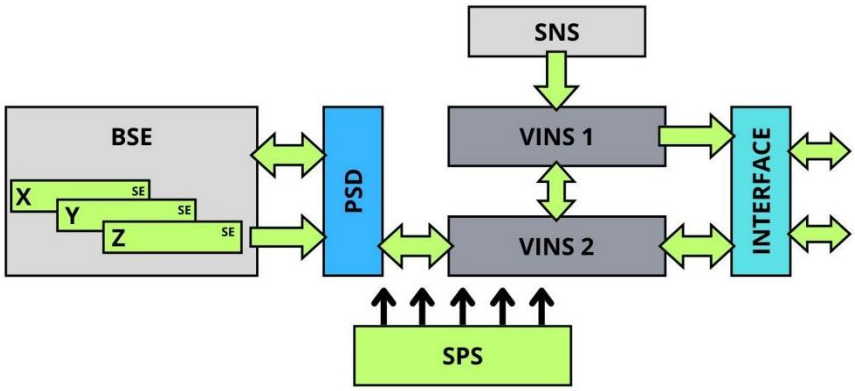


Figure 2 - Stages of BINS development

Structurally, the used BINSs are made according to the traditional monoblock scheme with an inbuilt satellite navigation system (SNS) receiver. Generalised structural scheme of the used BINS is shown in Figure 3.



BSE - block of sensitive elements, SE - sensitive elements, PSD - high-speed analogue-to-digital converter, VINS - high-performance low-energy on-board computer, SNS - satellite navigation system. VIP - secondary power supply.

Figure 3 - Generalised structural diagram of the used BINSs

In accordance with the tactical-technical requirements (TTC) of the UAV SU, its navigation system (NS) must ensure the accuracy of determining its own coordinates and coordinates of mobile objects no worse than ±30 metres. The achievement of this accuracy is realised by means of complexing the NSS with the standard BINS, which realises the operational readiness of the UAV's NS and provides autopiloting in the autonomous flight mode.

The use of autonomous BINS will significantly reduce the UAV's radio range visibility and increase its immunity to interference. Thus, the presence of autonomous BINS for UAVs is mandatory, and their improvement is one of the main tasks of science and industry.

REFERENCE LIST

1. Verba, V.S. Complexes with unmanned aerial vehicles. In 2 books: Book 1. Principles of construction and peculiarities of application of complexes with UAVs. Monograph / Edited by V.S. Verba, B.G. Tatarskiy. - Moscow: Radiotekhnika, 2016. - 507 c.
2. Nesenyuk, L. P. Free platform inertial systems. Review of the state and prospects of development / L. P. Nesenyuk // Gyroscopy and Navigation. - 2002 - № 1(36). - C. 13 - 22.
3. Fomichev, A. V. Results of improving the software and mathematical support of the BINS-SP-2 system on the materials of flight tests / Fomichev, A. V., Kukhtevich S. E., Izmailov E. A.// Proceedings of MIEA, Navigation and control of aircraft.- 2013.- № 7 - P.19-29
4. Babich, O. A. Information processing in navigation systems / O. A. Babich. M.: Mashinostroenie, 1991.−512 c.
5. Yuferev S. Prospects for the development of Russian UAVs [Electronic resource] // Information and news portal ARMY MAN. INFO. Title from the screen. Access mode: http://armyman.info/stati/15140perspektivy-razvitiya-rossiyskih-bpla.html.
6. Kondratyev A. Perspectives of development and application of unmanned and robotised. means of armed struggle in the Armed Forces of leading foreign countries [Electronic resource] // Zarubezhnoe Voennoe Obozrenie: informational and analytical illustrated journal of the Ministry of Defence of Russia.
   Russian Ministry of Defence. - 2011. - № 5. - C. 14-21. - Access mode: http://pentagonus.ru/publ/perspektivy_razvitija_i_primenenija_bespilotnykh_i_robototizirovannykh_sredstv_vooruzhennoj_borby_v_vs_vedushhikh_zarubezhnykh_stran/19-1-0-1772.- Title from the screen.
7. Trend of UAV development [Electronic resource]. 2020. https://ispace.news/tech/malaya-bespilotnaya. pdf