THE FLYING WILL SEE THE ROAD

Biard R., McLain T. Small unmanned vehicles: theory and practice / Trans. from English. Moscow, Technosphere publ., 2015, 312 p.

ABSTRACT

The book, published in the series «World of Radio Electronics», is addressed to those involved in unmanned aerial vehicles. The emphasis in the book is on systems for increasing the sustainability of control of these miniature aircrafts, designed primarily for applied purposes. Other publications that would cover the issues of modeling the dynamics of this class of unmanned aircrafts, assessment of their state and prospects, calculation of the flight trajectory, according to the authors who prepared the book for publication, are currently not available.

Keywords: small unmanned aerial vehicles, modeling, kinematics, dynamics, autopilot, control, navigation, scope of application.

Speaking enthusiastically, often in vain, without due respect, about modern flying equipment and the electronics accompanying it, we sometimes do not bother ourselves with the duty to recognize those new (sometimes revolutionary) meanings that this progressive environment brings to our lives. But much has changed very radically. And the book of Randal Biard and Timothy McLain is an awesome illustration. And here it is not necessary at all, we suppose, to make a traditional review to explain or clarify why the textbook prepared by these authors (as they call their scientific work) seems so «self-speaking» that it does not need third-party interpreters.

In our opinion, the concept of the book is fully provided by two opening elements – the foreword of the translation editor and the foreword of the authors themselves, the fragments of which, in fact, will replace our usual review.

* * *

The development of modern technologies in the field of aerodynamics, composite materials, inertial and satellite navigation systems, advances in electronics, and the development of robotics and computer technology have made it possible to reach a qualitatively new level in the development of unmanned aerial systems (UAS). Unmanned aerial vehicles as part of UAS have already found their place in modern activities. Among the priorities are defense and rescue operations, law enforcement and nature protection activities, scientific research and environmental monitoring. The development of the Arctic, work on environmental protection are more and more acute.

Unmanned flying robots enter emergency nuclear reactors, ascend to the upper atmosphere, descend into the vents of volcanoes, effectively patrol land and sea boundaries. In other words, the development of technology, new opportunities in the field of security allow people more and more actively to send unmanned robots instead of themselves to the most inaccessible places.

The book, the translation of which is presented here, has interested the editor of the translation, first of all, in that the volume knowledge in the field of creation of unmanned aerial systems has been comprehensively disclosed and widely represented in it.

Disclosure of laws and control algorithms for unmanned aerial vehicles, the process of creating an autopilot, and the construction of flight assignments constitute the main goals and objectives of the book.

This book details the knowledge accumulated both in the field of system engineering, aerodynamics, control systems of autonomous systems, and in the field of programming and robotics, starting with the architecture of an unmanned aerial system, control dynamics, designing and programming an autopilot, creating a flight task, navigation with the help of optoelectronic devices and ending with programming in Simulink.

It should be noted that the experience acquired by JSC NPP Radar mms for several decades, including in the field of developing and programming of flight tasks, was also effectively used in the field of research and development in creation of unmanned aerial vehicles and complexes of both aircraft and helicopter types.

As a result of a number of research and development works, at JSC NPP Radar mms unmanned aerial vehicles «Sterkh» Avis and a range of unmanned aerial vehicles of a helicopter type with take-off weight from 5 to 500 kg were created. All unmanned systems are developed with the help of 3B-design with the use of modern composite materials, equipped with modern autopilots and software of in-house design, and ground control stations that are part of unmanned systems, prepare flight missions, manage payloads such as optoelectronic devices with video and thermal imaging cameras, radiation detectors, detectors for various gases, delivery and discharge systems for various purposes.

The book can be useful to both students and engineers working in the field of creation of unmanned aerial vehicles.

General Director – General Designer of JSC «NPP» Radar mms», Ph.D. (Eng.) G.V. ANTSEV

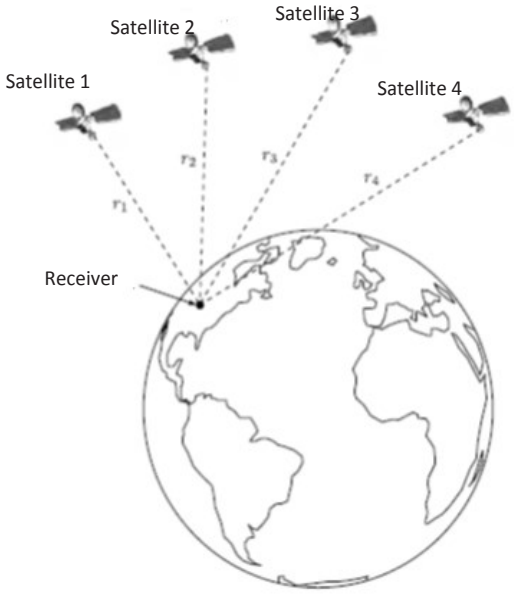
Throughout the world, unmanned aerial vehicles (UAV) play an increasing role in defense programs and defense strategies. Technological advances have enabled the development of both large (e.g. Global Hawk, Predator) and small unmanned aerial vehicles (e.g. Wasp, Nighthawk) with increasing capabilities. As the recent military conflicts have shown, for unmanned aerial vehicles, there are many military

areas of application, including reconnaissance of terrain, observation, assessment of damage resulting from combat, and retransmission of communications.

Civil and commercial use of unmanned aerial vehicles (UAV) is not yet well developed, although the field of potential application of UAV is very extensive and includes monitoring of the environment (pollution monitoring, weather monitoring and scientific research), monitoring of forest fires, ensuring national security, patrolling borders, preventing the import of drugs, aerial reconnaissance and mapping, as well as traffic control, accurate land-use, disaster relief, specialized communications networks, agricultural research and rescue of victims. To provide the necessary level of solution for many of the above problems, it is necessary to increase the reliability of unmanned aerial complexes (UAC), further development of the potential of UAC, UAV, increase the ease of operation and reduce the cost of such complexes. In addition to these technical and economic problems, it is still necessary to overcome the administrative problems of integrating unmanned aerial vehicles into national and international airspace.

The term «unmanned aerial complexes» (UAC) refers not only to the aircraft itself, but also to all the auxiliary equipment used in the system, including sensors, microcontrollers, software, ground station computers, user interfaces and hardware means of communication. In this book, the emphasis is on the flying machines themselves and their control, navigation and control subsystems. Unmanned aerial vehicles (UAV) can be broadly divided into two categories: with invariable wing geometry and rotory-wing flying devices. Both types of aircraft have distinctive features, which make it difficult to calculate their autonomous behavior. The book focuses exclusively on aircraft with the unchanging geometry of the wing, which can be broken down into categories by their size in the first approximation. The book will use the term «small UAV» for a class of vehicles with an unchanging geometry of the wing with a wingspan of 5 to 10 feet (1.5 to 3 meters). Small UAVs usually operate on a gasoline engine and need a runway for take-off and landing, although Boeing's ScanEagle UAV, using a take-off catapult and a hook-and-hold to grab and land, is a notable exception. Small UAVs are usually designed for flights lasting from 10 to 12 hours with a carrying capacity of approximately 10 to 50 pounds (5 to 23 kg).

The term «miniature UAV», in respect of which a mini-UAV (MUAV) acronym will be used, and which will designate a class of aircraft with an unchanging wing geometry which wingspan does not exceed 5 feet (1.5 m). Mini-UAV (MUAV) usually operate on an electric engine (batteries), run from the operator's hand, land on the fuselage and therefore do not need a runway. They are designed to work (perform a flight) for a certain period of time from 20 minutes to several hours. The range of lifting capacity is from several ounces to several pounds (from hundreds of grams to several kilograms). Low load capacity severely limits the number of sensors and the type of computing device that can be installed on board of the mini-UAV (MUAV). These limitations pose interesting problems for developers to design autonomous operation modes. While most of the concepts described in this book are applicable to both larger unmanned aerial vehicles and even smaller micro-UAV, the book focuses on problems that are inherent in the control of small UAV and mini UAV with limited load capacity.



This textbook was inspired by the desire to create for master programs students and Ph.D. students a course that would prepare them for work in the field of the unified control of unmanned aerial vehicles. Most of the students come with a basic education in electrical engineering, computer engineering, engineering or computer science. Only a few of them receive training in the field of aerodynamics; students who have received training in electronics and computer technology usually do not have training in kinematics, dynamics or mechanics of liquid media, but most of the students have completed training in the study of control in technical systems, control systems with feedback, robotics and machine vision.

One of the characteristic features of this book is the connection of development works. The course is designed for a gradual transition from homework, which can be performed using a pencil and paper, to tasks on computer modeling. It was found that the students are more interested in studying the material and try to understand it better when they apply certain concepts in computer modeling.

In the process of studying this course, students develop a complex flight simulator that has realistic flight dynamics, models of sensors, an autopilot model, and a flight trajectory calculation. By the end of the training on this course, they can already adapt each element of the mosaic and therefore understand how all these elements are put together. In addition, students understand already the internal mechanisms of a rather complex flight modeling package, which can be used in their future research projects.

Randal W. BIARD, Timothy McLain

* * *

As you can see, everything is said to understand what to do next. With what to begin to read, what reference points to put. The ancients said: «The road will be mastered by the going». We can correct this aphorism: «The flying will see the road». A small unmanned aerial vehicle controlled from the ground. With the transmitter on board. ●