Chapter 18

Guidance Algorithm for Unmanned Aerial Vehicles on a Basis System of Technical Viewing

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EXECUTIVE SUMMARY

The chapter considers a description of developed control system for a group of unmanned aerial vehicles (UAV) that has a software capable to continue the flight in case of failures by using alternative control algorithms. Control system is developed on vision system by using methods of image recognition. Grouped coordinated flight of UAVs can significantly improve the performance of surveillance processes, such as reconnaissance, image recognition, aerial photography, industrial and environmental monitoring, etc. But to control a group of UAVs is a quite difficult task. In this chapter, the authors propose a model that corresponds to the principle of construction by the leading UAVs. In the case of using this model, the parameters of the system motion are determined by the direction of motion, the speed, and the acceleration of the UAVs' driving. The control system based on the methods of image recognition expands the possibilities of coordinating the group of UAVs.

BACKGROUND

Unmanned aircraft systems (UAS) are playing increasingly prominent roles in defense programs and defense strategy around the world. Technology advancements have enabled the development of both large unmanned aircraft (e.g., Global Hawk, Predator) and smaller, increasingly capable unmanned aircraft (e.g., Wasp, Nighthawk). As recent conflicts have demonstrated, there are numerous military

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applications for unmanned aircraft, including reconnaissance, surveillance, battle damage assessment, and communications relays.

Civil and commercial applications are not as well developed, although potential applications are extremely broad in scope, including environmental monitoring (e.g., pollution, weather, and scientific applications), forest fire monitoring, homeland security, border patrol, drug interdiction, aerial surveillance and mapping, traffic monitoring, precision agriculture, disaster relief, ad hoc communications networks, and rural search and rescue. For many of these applications to develop to maturity, the reliability of UAS needs to increase, their capabilities need to be extended further, their ease of use needs to be improved, and their cost must decrease. In addition to these technical and economic challenges, the regulatory challenge of integrating unmanned aircraft into national and international airspace needs to be overcome.

The terminology unmanned aircraft system refers not only to the aircraft, but also to all of the supporting equipment used in the system, including sensors, microcontrollers, software, ground station computers, user interfaces, and communications hardware. This text focuses on the aircraft and its guidance, navigation, and control subsystems (Beard & McLain, 2012).

One of the important and actual purposes of using UAVs is the application of it in mixed groups, including manned and unmanned aerial vehicles, or as a part of operating autonomously UAVs group. To solve the navigational task for UAVs group, we use a control system based on image recognition methods. The methods of image recognition are based on tracking, identification, and detection of mobile and stationary air and land objects. To create a system, it is necessary to analyze the problem of classifying terrestrial stationary objects for constructing the flight trajectory of a group.

Formation flight control of multiple UAVs is an active topic for numerous researches see (Das et al., 2002; Hammer et al., 2004;Soleymani & Saghafi, 2010; Gosiewski & Ambroziak, 2013), with the much practical application: reconnaissance, communication, search and rescue.

There are many research methods proposed for implementation of multiple UAVs control, especially for control of UAVs formation flying, such as leader following (Soleymani & Saghafi, 2010), behavior-based approach (Hammer et al., 2004), virtual leader (Gosiewski & Ambroziak, 2013) and artificial potential functions (Paul, et al., 2008). In these methods, most appropriative is our leaders' methods.

The big problem information control is a question of creation and full usage of the neighbor-to-neighbor communication and synchronization. The well-known today methods for communication and synchronization inside of formation of UAVs are methods of use of video information (Das et al., 2002), and methods of use of radio transmitting data (Paul, et al., 2008).

The current development of aviation sets the task of implementation of the formation flight of unmanned aerial vehicles.

The necessity of development of technology for control of formation flying UAVs now opens a very important area: the creation of between onboard unmanned navigation systems (BONUS) for UAVs with very limited weight and volume. This need is determined by the fact that the absence of equipment onboard the UAV BONUS can greatly limit their opportunities.

Development of systems like a BONUS goes by two approaches: the creation of autonomous systems that do not depend on ground guiding systems, and onboard systems using ground-based radio beacons (Paul et al., 2008). Each of these ways has its own advantages and disadvantages. The autonomous management system can solve the problem of formation flight without restrictions imposed by the channels for communication with ground control, as well as in radio jamming.