ТЕХНИЧЕСКИЕ НАУКИ

Orazkanov A.A., Temirbekuly A., Baiseikov G.N., Tynybaev S.K., Kasenov D.D.
National Defense University

CONTROL SYSTEM OF A PROMISING DOMESTIC UNMANNED AERIAL VEHICLE OF A TACTICAL COMMAND LINK.

In conditions of intensive development of systems and means of automation, robotization and intellectualization, the development of unmanned aerial vehicles is a dynamically developing area.

In 1898, Nikola Tesla designed and demonstrated a miniature radio-controlled ship.

In 1910, Charles Kettering developed an experimental unmanned "air torpedo", which became the forerunner of cruise missiles. Unmanned vehicle control was carried out by an inertial automatic control system.

After the start, powered by electricity from the engine, the gyroscope provided directional stabilization. The gyroscope was connected to a vacuum pneumatic autopilot.

The simplest autopilot functions provided for controlling the elevator and rudder, counting the distance traveled, turning off the engine, and resetting the wings.

The disadvantages of the control system were the problems of providing directional stability and the possibility of only unidirectional flight from the launch point to the target .

The 30s of the twentieth century were marked by the appearance of radio-controlled aircraft.

Radio control allowed drones to follow difficult routes and perform complex maneuvers in the air. Devices got the opportunity to return to the starting position, which increased the number of their use.

Increased speed and range. However, the problem of increasing flight altitude has not yet been resolved. The equipment allowed the efficient use of UAVs only in the zone of visibility of the operator.

During the second World War, fascist Germany developed the V-1 projectile, a prototype of modern cruise missiles, as part of the Retaliation Weapons project.

During the development of the project, it became necessary to introduce stabilizers and a gyroscope to stabilize the device during the flight.

On the ground before launching the unmanned vehicle, the altitude and course were set, as well as the flight range . Guidance was carried out using a magnetic compass. After starting the device, the control was performed by autopilot at a given course and at a predetermined height. Heading and pitch stabilization was carried out on the basis of the readings of a 3-degree gyroscope: they were summed in pitch with the readings of the barometric height sensor; at the rate – with values of angular velocities from two 2-degree gyroscopes used to reduce projectile vibrations. Roll control was absent due to the high stability around the longitudinal axis.

Currently, unmanned aerial vehicles are controlled by flight controllers, which are a control board with a microchip for connecting a microprocessor, sensors and other circuitry elements, as well as software that provides logicmanagement and recognition of connected devices.

A promising unmanned aerial vehicle of a tactical command link that performs reconnaissance missions should be of a multi-rotor type and have a miniature automated control system with the ability to switch to the following control modes :

1.Manual control mode by the operator.

2.Automated mode of flight stabilization, altitude and location retention.

3. Automatic return mode to the starting point.

4. Automatic mode on points of a predetermined route.

5. The mode of automatic take-off and landing.

To increase the autonomy of the UAV, it is necessary to provide the mathematical apparatus of the theory of artificial intelligence in the control system, including a computer vision system and adaptive control algorithms.

Automatic flight control should be carried out in radio silence mode. This mode is necessary when the UAV leaves the radio channel visibility zone or under the influence of enemy electronic equipment.

In case of jamming by GPS (coordinate change), the device must switch to control by inertial control system or by magnetic compass.

In order to protect the radio channel from interception of radio suppression and the impact of electronic equipment in urban areas, a regime of fast pseudo-random tuning of the operating frequency should be provided.

In general, a UAV control system for a tactical command link means an unmanned aerial system, including onboard UAV control systems, one or a group of payload aircraft, and a ground control system.

The onboard control complex should include:

Hardware and computing platform:

1. Flight microcontroller with connected modules:

Satellite navigation module – for receiving a signal from a satellite navigation system and transmitting to a block for calculating orientation angles the values of geographical coordinates, track angle, angles of magnetic declination and inclination .

Spatial orientation module – for determining the position and stabilization of a UAV in flight with sensors of an inertial measuring system (accelerometer, gyroscope, magnetometer, barometer, electronic magnetic compass, and others).

Module for accumulating and removing information about flight parameters and storing configuration files.

2. Radio signal receiver for automated UAV control.
3. Motor controllers receiving pulse width modulation signals.
4. External pulse width modulation input and output ports for signal recognition from the receiver and control of motor controllers.
5. UART ports for receiving GPS modules and wireless telemetry.
6. USB or COM port for debugging and testing software.
7. Lithium polymer battery.

For ensuring the computing processes of the UAV control logic should be responsible for the software consisting of:

–A set of libraries for working with the periphery of the microcontroller;

– A set of libraries for working with the internal devices of the microcontroller (accelerometers, gyroscopes, magnetometer, barometer, GPS receiver, wireless telemetry module, memory card and others);

–Operating system – high level programming code;

–Radio channel cryptographic protection system;

UAV payload should contain;

– View information devices;

–Satellite navigation system (GLONASS / GPS);

–Devices for radio lines of view and telemetry information;

–Command and navigation radio devices with an antenna-feeder device;

– Command information exchange device;

–Information exchange device;

–Onboard digital computer;

–View information storage device.

As a ground control complex, a command and staff vehicle with equipment for receiving, processing, transmitting information and debugging control processes is proposed.

Creating a control system for a promising domestic unmanned aerial vehicle of a tactical command link can be carried out using one of three approaches:

1) By developing the entire system from scratch in accordance with regulatory documents and standards;
2) By purchasing finished products;
3) Combined approach:

–To develop a circuit diagram of the components of the control system;

–Create a 3D model of a hardware-computing platform board;

–Purchase ready-made components for the board on the market of electronic equipment;

–Make a control board with all the necessary electronic components;

–Develop software and "flash" the board of the hardware-computing platform.

Literature

1. K. E. Shilov. Development of a system for the automatic control of an unmanned aerial vehicle of a multi-rotor type - Trudy MIPT. – 2014. – Volume 6, №4, p. 139

2. Description of unmanned aerial vehicle control systems [Electronic resource]. –2010 .–URL: https://www.bestreferat.ru/referat-176711.html (Date of treatment: 11.16.2018)

3. Evolution of control systems for unmanned aerial vehicles: from appearance to the present day. / https://russiandrone.ru/publications/evolyutsia-sistem-upravleniya-bespilotnykh-letatelnykh-apparatov-ot-poyavleniya-do-nashikh-dney-aerogeo/.-article on the Internet. 11/10/2018

4. UAV use in combat conditions / https://specnazspn.livejournal.com/1777209.html– an article on the Internet. 11/10/2018

5. General information about the UAV control and data transmission channels [Electronic resource]. – URL: http: //specintek.ru/media/uav/uav_detection/ (Date of access: 11.16.2018)

6. Ivanova I.A., Nikonov V.V., Tsareva A.A., Ways of organizing the control of unmanned aerial vehicles [Electronic resource]. –2014. – URL: https: //publikacia.net/archive/2014/11/1/14 (accessed date: 11/17/2018)