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ADAPTIVE METHOD OF UNMANNED AERIAL VEHICLES (UAV) DRIVING IN AN OBSCURE ENVIRONMENT

In our country, despite difficult economic and geopolitical conditions, the development of unmanned aerial vehicles (UAVs) is taking place as part of the development of domestic aviation. All over the world, this area is being actively developed, and it has definitely been supported by domestic researchers. Unmanned systems are being actively developed in the geodesic, agro-industrial and aerospace industries, used in everyday life and have many prospects for their practical application. Researcher`s interest in this area has made it possible to achieve certain results in a short time, but there are still many unresolved issues. One important area of research is the problem of adapting the autonomous UAV to the external environment. The task is much more complicated if the UAV flies at low altitudes above a complex terrain. In other words, the external environment is unknown or little known and can change dynamically. These are current scientific and practical challenges that need to be addressed.

Analysis of recent research and publications. In the literature, an unmanned aerial vehicle (abbreviated UAV) is used to identify aircraft intended for flight without a crew. Previously, these vehicles were united by the concept of unmanned aviation - aircraft whose controls (piloting) are performed without a pilot, with the help of various systems, radio (radar, television) transmit commands to autopilot. The elements of the control system are kept outside the aircraft and can be on the ground, on the water and in the air, at the starting point, on the flight route and in the target area it is possible to outline, the main types of tasks that the UAV can perform. For example, monitoring of airspace, land and water surfaces, air traffic control, retransmission of communications, military and police tasks, environmental control, transportation of cargo to hard-to-reach or hazardous locations and the like. To solve this type of task, the UAV must be equipped with special sensors, which enable it to have a positive impact on the environment with an information processing system that performs its cognitive functions, as well as with a solution machine for generating actions.

The UAV can be implemented on the basis of one of these management systems: software, adaptive or intelligent. The choice of the management scheme is designed by the machine, which determines the task, goals and limitations of practical implementation, as well as the experience and knowledge of the researcher. Today, there are many models and approaches used for the development and maintenance of autonomous and semi-autonomous UAVs.

The development of UAVs is quite closely linked to robotics. In fact, an unmanned aerial vehicle is an autonomous mobile platform (robot). Dictionaries call such UAVs drones. Given that robotics as an industry has emerged as part of research on artificial intelligence, we can see a certain connection between research on artificial intelligence theory and the approaches used to develop autonomous drones. For example, the artificial intelligence agent approach examines the interaction between the intellectual agent and the environment. Different classes of agents and methods of their interrelationship are discussed in the works of D. Kennedy and R. Eberhart, D. Ferber, V. Brenner, V. Khoroshevsky, V. Gorodetsky, V. Tarasov, and others. Among the Ukrainian authors there are V.A. Ermolaev, M.M. Glibovts, S.S. Gorokhovsky and others. The issue of mobile robots has been discussed in the works of such scientists as: V.A. Golembo, P.V. Mokrenko, A.V. Godich and others.

Analyzing the current state of development in the field of creating autonomous UAVs, it is possible to determine the tasks that remain unsolved. Such problems include limitation of independence in decision making, low adaptability of UAVs, rather narrow specialization in the problem area and tasks.

The aim of this work is to investigate adaptive navigation models to solve the problems of autonomous flying objects moving in dynamic, a priori unknown or little known environments.

The behaviour of UAVs, like any intelligent system, conditioned by specific targets, i.e. UAV has a defined system of goals and implements targeted behavior, formed as a consequence of defining goals. In a certain sense, it is possible to define adaptability as the ability of the machine to make decisions and behave independently, depending on the state of the external environment and guiding by a system of goals.

The task of navigating an autonomous UAV is to automatically find a path to a predetermined target point. The problem of navigation has been considered from such points of view. Firstly, the navigation task is seen as generating the path to a certain point on a known static map. Secondly, the problem of adapting to dynamic changes on a known map of the environment is considered. Thirdly, the task of navigation is viewed as finding a way in a previously unknown environment. This makes both local and global navigation methods available.

Usually the task of navigation is to find a route between two given points. Global navigation methods assume that the map is known. In contrast, local navigation methods are based on the fact that the terrain map is unknown or dynamic unknown objects may appear on it. In this case, the UAV primarily relies on information obtained from its sensors. The global and local navigation methods have their advantages and disadvantages, as well as known combinations of these methods.

In general terms, the structure of the adaptive system of an autonomous UAV can be represented by a diagram (Figure). Sensors and the module for recognising the signals received are of great importance. Many authors suggest using neural network apparatus or evolutionary algorithms to process signals and recognise objects in the external environment. In this work we propose to use the results of the theory of intelligence to model the adaptive navigation of the autonomous UAV.

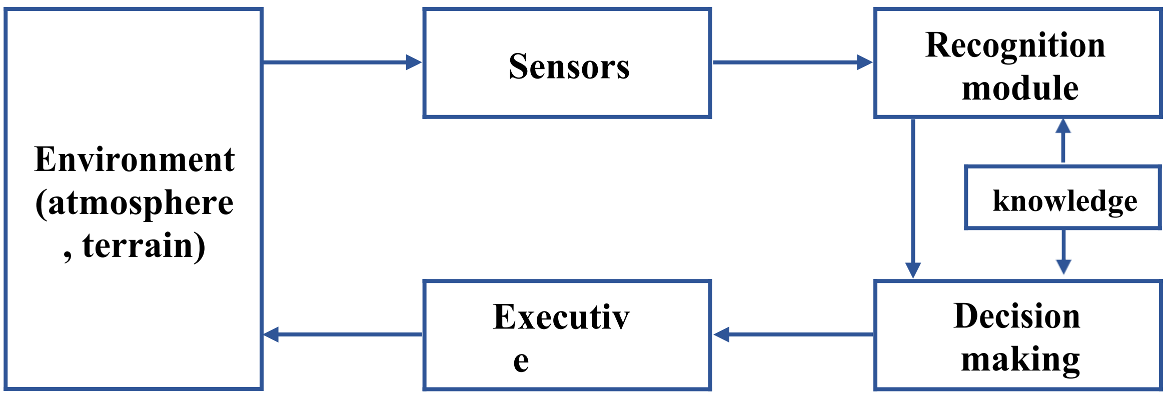

Figure 1. Basic components of an adaptive navigation system model.

For the construction of an adaptive navigation system model, mathematical tools based on algebra of finite predicates are defined. Predicate algebra allows you to describe knowledge of facts and together with the algebra of predictive operations can be used to model databases and knowledge. The formal model introduces a universe of U elements, which contains all possible objects. On Cartesian works $M_{/)}$ x $M_{1)}$ x . . . x $M_{m)}$ sets formed from the elements of the universe are defined by P_{+} predicates (where j = 1, ..., n), which characterise the operation of the sensory signal processing system.

A binary logical network is an undirected graph, graphically representing a system of binary relations derived from a possible decomposition of one relation. This approach is fully consistent with the activity of the human intellect. Using the method of building a binary logical network, relationships between subject variables can be graphically constructed. The logical network built in this way schematically represents the implemented knowledge base, which performs parallel processing of information. In the course of the logical network, all its branches have a two-way movement of information, which is accompanied by linear logical transformations. In the process of solving the task of recognising the signals received from sensors and forming commands of executing devices, the network forms knowledge using known knowledge at its at certain fields.

In order to implement the adaptation model on the basis of the proposed approach, it is necessary to develop a set of navigation rules allowing you to choose a path in a dynamic environment based on the facts obtained about the state of this environment, as well as using knowledge stored in the knowledge base.

Conclusions. The proposed approach to the modelling of adaptive navigation systems makes it possible to create different systems, providing such properties as flexibility and extensibility. A significant advantage of the proposed approach is that the developed models of navigation rules can be implemented both software and hardware, which significantly increases their practical value.

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