Improving the precise motor skills of aircraft control hands

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PhD, Associate Professor **A.V. Meshcheryakov**[1]
PhD, Associate Professor **R.R. Salimzyanov**[1]
[1]Ulyanovsky Institute of Civil Aviation named after Chief Marshal of Aviation B.P. Bugaev, Ulyanovsk

Corresponding author: aleksei236632@yandex.ru

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Abstract

Objective of the study is to identify the optimal way to hold the drone controller sticks and develop a set of exercises to improve piloting skills.

Methods and structure of the study. The drone operators showed well-developed small muscles of the forearms and hands involved in controlling the drone. The dominant and most effective ways of holding the controller and manipulating the joysticks while piloting the drone were identified. Exercises aimed at improving fine motor skills were selected. The experiment involved students of the first and second years of study at the Ulyanovsk Institute of Civil Aviation. Sociological tools (interviews, questionnaire filling), analytical and synthetic approaches, as well as the competitive method were used.

Results and conclusions. When analyzing the control of the UAV using the control panel, it was found that the main load is carried by the following muscle groups of the hands: the muscles of the middle part of the hand, the muscles of the posterior surface of the forearm (both superficial and deep), the deep muscles of the anterior surface of the forearm, as well as the muscles controlling the movements of the thumb. It has been experimentally confirmed that using the pinch grip of the sticks provides increased control accuracy, while controlling the sticks with only the thumbs allows for a higher reaction speed. The majority of students (70%) prefer the pinch control method. The introduction of specialized physical exercise complexes into the educational process enabled the team of cadets from the experimental group to demonstrate high results in UAV piloting competitions.

Keywords: *fine motor skills of the hands, unmanned aircraft, comfortable grip, external pilot, operator, remote control sticks, control efficiency, small arm muscles, remote control hold, exercises.*

Introduction. The Order of the Government of the Russian Federation approved the "Strategy for the Development of Unmanned Aviation in the Russian Federation for the Period up to 2030 and for the Future up to 2035" (2023). It emphasizes that today the pace of implementation of unmanned aviation technologies outpaces the capabilities of the education system to train personnel in this area, there is an increase in the demand for training specialists from employers. In the future, the demand may reach a million specialists. Of these, 60% should be operators of unmanned systems (external pilots) [6]. Currently, the implementation of the program for training specialists in this area is based on the Federal Project "Personnel for Unmanned Aircraft Systems" (2024), which can be implemented on the basis of educational organizations.

In connection with the development of unmanned systems in aviation, sea, rail and road transport, today there is a special interest in the topic of improving the coordination of finger movements. It is known that the motor (movement) processes that a person possesses give an idea of the level of development of his coordination and intelligence [2].

Fine motor skills can be considered as the ability to perform tasks that require coordinated actions of the nervous, muscular and skeletal systems, the work of analyzers, the ability to perform small movements of the fingers. Fine motor skills of the hands interact with higher mental functions and properties of consciousness: attention, imagination, thinking, visual-spatial

perception, motor and visual memory, speech. Therefore, the development of new methods using various approaches to the development of fine motor skills for adults is a relevant area in physical education. Physical education at a university is the most important vector for solving the problems of training a specialist [4].

With properly organized classes, in the process of systematic work, the hand gains confidence, accuracy, and the fingers become mobile, movements – highly coordinated. Prospects for the development of systems and means of complexes with unmanned aerial vehicles should take into account the role of the human factor in their control [1, 5].

Objective of the study is to determine the most comfortable grip for the UAV remote control sticks and select exercises aimed at improving the efficiency of unmanned aerial vehicles (UAV) control.

Methods and structure of the study. The experiment involved 28 1st-2nd year cadets studying at the UI GA in the direction of training 25.03.03_04 "Organization, support and maintenance of unmanned aerial systems flights". The efficiency of specialists is affected by many unfavorable factors associated with emotional stress, adverse weather conditions, high physical activity, monotonous monotonous work with maintaining a working posture, etc. Sociological methods (survey, questionnaire), analysis and synthesis, and a competitive method were used.

Results and conclusions. With the involvement of specialists from the Department of Human Biology and Fundamentals of Medical Knowledge of the Federal State Budgetary Educational Institution of Higher Education "UlGPU named after I.N. Ulyanov" identified the human muscles involved in controlling an unmanned aerial vehicle by acting on the remote control sticks (see table).

The main device for controlling the UAV is the remote control (transmitter). The UAV remote control usually has two sticks: the left one is responsible for moving the aircraft up and down, as well as yaw; the right one is for roll and pitch. In this case, 2-4 fingers work; as a rule, the little finger is not involved in the control. There are two ways to hold and act on the sticks:

Muscles involved in the action of the fingers on the sticks

Muscle	Function
Brachioradialis muscle	Supinates the forearm in a pronated position; pronates the supinated forearm; flexes the arm at the elbow joint
Flexor carpi ulnaris	Flexes the wrist, flexes the elbow joint
Extensor carpi ulnaris	Extends the wrist; extends the arm at the elbow joint
Flexor carpi radialis	Flexes the wrist and pronates the forearm, flexes the elbow joint
Pronator teres	Pronates the forearm
Pronator quadratus	Synergist of the pronator teres
Palmaris longus muscle	Tenses the skin of the palm and participates in flexion of the wrist, flexes the elbow joint
Flexor digitorum superficialis	Flexes the middle phalanges and participates in flexion of the wrist, flexes the elbow joint
Extensor carpi radialis longus	Extends the wrist
Extensor carpi radialis brevis	Extends the wrist
Flexor pollicis longus	Flexes the nail phalanx, as well as the entire thumb
Deep flexor digitorum	Bends the nail phalanges and partly the hand
Extensor digitorum	Extends the fingers and hand; extends the arm at the elbow joint
Supinator (forearm muscle)	Supinates the forearm and hand
Longus abductor pollicis muscle	Abducts the thumb and hand
Flexor pollicis brevis	Flexes the thumb
Extensor pollicis brevis	Extends and abducts the thumb
Extensor pollicis longus	Extensor pollicis longus
Extensor of the index finger	Extensor of the index finger
Abductor pollicis brevis	Abducts the thumb
Adductor pollicis muscle	Adducts and partially opposes the thumb

1) pinching the sticks the aircraft is controlled with two fingers of each hand: the thumb and index finger. With this method, the outer pilot “pinches” the stick. In this case, the middle and ring fingers are on the front edge of the remote control and can press the buttons and toggle switches located there (Fig. 1).

2) thumbs – only the thumbs work, and the index and middle fingers are on the front edge of the remote control and can also press the levers and buttons (Fig. 2).

Fig. 1. Pinch action

Fig. 2. Impact with thumbs

The choice of the method of holding and acting on the sticks depends on the development of fine motor skills of the hands and personal preferences of the remote pilot. A survey of cadets studying at the UI GA showed that pinching the sticks provides more precise control, while the action with the thumbs is faster. The method of acting by pinching the sticks is used by 70% of the surveyed cadets. It should be noted that UAVs can be light and heavy, respectively, they have different speeds and flight characteristics. Light (small) UAVs are more difficult to control: they are high-speed, maneuverable, and require a quick reaction from the remote pilot to perform various maneuvers. Heavy UAVs have a certain inertia in flight. Different categories of UAVs impose corresponding requirements on the strength, endurance, dexterity and coordination of the small muscles of the operator. Based on this, the work of an external pilot is a new type of work activity that requires the development of certain muscle groups and professionally important physical qualities.

For the experimental group (12 cadets), exercises were selected and used during the fall semester to develop fine motor skills of the hands. The exercises were classified as follows: physical exercises with small objects, coordination and dexterity exercises, sensory exercises, and exercises on special simulators. Such simulators included interactive tables and sensorimotor panels for performing certain tasks. The panels have a set of different surfaces, buttons, and switches with which the palms and fingers of the students must interact. At the same time, the muscles of the back, neck, and chest are strengthened.

An important aspect of training external pilots is the use of modern information technology to develop fine motor skills. Among the numerous applications and interactive games (for personal computers and smartphones), we have identified specially developed tools for training coordination and correcting finger movements. During physical training, the training effect is transferred, increasing the ability to withstand extreme factors of UAV control.

Thus, physical training for the work of unmanned aerial vehicle operators seems to us to be a very important factor in the development of skill. Improving the performance of the external pilot is possible under the condition of using training effects that exceed the level of capabilities to which the body is adapted and force it to new adaptive reactions [3]. In this case, two problems are solved: the level of functional capabilities of the body is increased and morphological changes in the musculoskeletal system are activated. The solution to these problems was implemented in the course of experimental work.

Conclusions. The conducted study allowed us to determine the current state of unmanned aviation in Russia and its personnel support, to develop a strategy for long-term physical and professional competitive training of external UAV pilots. The use of specially developed sets of exercises in the educational process of the Civil Aviation Institute, based on the main methods of developing fine motor skills, made it possible to obtain a certain result: successful performance in the competition in the skill of controlling unmanned aerial

vehicles by a team consisting of cadets of the experimental group (1st place).

The cadets of the control group took 6th place out of 10 participating teams. The competition was held within the framework of the national project "Growth Point". In March 2024, the staff of the Department of Physical Education and Sports of the Faculty of Training of Aviation Specialists of the Civil Aviation Institute published a teaching aid "Development of Fine Motor Skills of Hands of Unmanned Aircraft System Operators" intended for students of all areas and profiles of training, as well as teachers of physical education of educational institutions of civil aviation, and a textbook "Physical Education and Sports in Civil Aviation Universities" was published. Thus, the development of fine motor skills of UAV operators is a very important element of professional and applied physical training of cadet pilots.

Methods and means of developing fine motor skills can and should be integrated into physical education classes for students at different stages of the educational process. Such classes not only improve physical condition, but also contribute to better assimilation of educational material, fill leisure time, and allow you to acquire professionally important motor skills. This becomes possible with constant practical work, which improves the fine motor skills of the hand muscles.

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