Methods of air distant control for cadastral works in an agrocomplex

Abdulaziz Mamazhonov[1], *Sergey* Sobolkin[2,*], and *Olga* Kornyakova[3]

[1]South Ural State University, Polytechnic Institute, Electric Power Generation Stations, Networks and Supply Systems Department, 454080 Chelyabinsk, Russia
[2]Polytechnic Institute, Electric Drive, Mechatronics and Electromechanics Department, 454080 Chelyabinsk, Russia
[3]South Ural State University, Polytechnic Institute, Heat Power Engineering Department, 454080 Chelyabinsk, Russia

Abstract. The problem of air vehicle landing to carry out cadastral works in agro-complex under reduced air discharge remains an important task. By applying a neural network, the best results and fewer losses when performing the given tasks can be achieved due to the best optimization of work and flight trajectory. To do this, let's consider the technical-theoretical side of the work of neural networks on examples get acquainted with different methods of landing and understand their features, their possibilities and disadvantages compared to the standard methods of using manned vehicles. We will tell you about the method of improving the work of neural networks. We will introduce you to the features and importance of using air vehicles in rural industries and local supply organizations in order to improve the quality and speed of work.

1 Introduction

In recent years one of the most ambitious mergers of robotics and artificial intelligence has taken place in the context of aerial vehicles also known as quadrocopters used for land surveying. As the development of autonomous controllers for quadrocopters progresses, neural networks have been adopted as a reliable way to make control decisions in real-time. Today, drones are taking on more complex tasks such as surveying inaccessible territories and conducting search and rescue operations. Despite this extended range of applications opening up new opportunities, there is still much to be done in terms of problem-solving. Neural networks are especially useful for managing the movement of an aircraft during complex landing operations in high air density, such as during stratospheric or suborbital flight. Landing an aircraft in high air density is an extremely difficult task that requires navigation and control technologies that can accurately estimate the relative state of the aircraft in three-dimensional space. In this article, we will discuss the use of neural networks to solve this problem and look at how they can be used to improve the accuracy of drone landings. We will discuss the advantages of using this method, and finally, we will also look

* Corresponding author: pte2017pte@mail.ru

at how neural networks can be used to improve other aspects of drone navigation and operation.

2 Materials and methods. Theoretical part of embedding and basic concepts in neural network work

An unmanned aerial vehicle usually consists of a flight controller, power system, payload, propulsion system, navigation system and communication system. The flight controller is the brain of the quadrocopter and controls the other components. The power system provides the necessary power. The payload is the instruments or equipment that the vehicle carries. The propulsion system allows it to move and maneuver in space. The navigation system allows the quadrocopter to know where it is in space. Finally, the communication system allows it to send and receive messages from other systems [1].

The safest methods for drone landing remain the standard methods of aircraft landing under pilot control. The way to land a winged drone is to take it to an open space, gradually reducing altitude, and then turning off the engines. As soon as the drone slows down and approaches the ground, press the gas to soften the landing. For helicopter-type drones, horizontal, marked platforms are used, gradually reducing engine revolutions - the altitude decreases. In this way, we gradually turn off the engine and, at the same time, land the aircraft. For example, when an aircraft begins to approach the landing zone in high air density conditions, a neural network controller can receive data from onboard sensors and quickly process this information to determine the position and orientation of the aircraft relative to the landing zone. This allows the controller to configure the flight control systems of the aircraft to achieve a smooth and accurate landing. The combination of onboard sensors with the neural network controller can also help aircraft perform extended types of maneuvers that would otherwise be impossible in thin air. For example, the neural network controller can be used for rapid wind detection and rapid flight path correction to counteract its effects. This allows the drone to land safely in windy weather, making it ideal for high altitude missions [2].

The most common approach to navigation includes the use of Global Positioning System (GPS) satellites, but this is not suitable for missions that are conducted in sparse air, as the GPS signals are significantly attenuated in this environment. This means that for such a mission the aircraft must rely solely on onboard sensors and control systems. This is where neural networks come in. Neural networks are able to learn and react quickly to changes in the environment, making them unique for controlling an aircraft in sparse air conditions. An AI-powered drone is equipped with sensors such as computer vision cameras, and several visual positioning systems. When the drone is in flight, the image recognition software analyses the images and creates a 3D map of the surrounding terrain [3]. Using the maps created by the image recognition software, AI then calculates an optimal path for the drone's safe landing. The AI-powered aircraft also takes into account weather conditions, power levels and other external factors when constructing the best route to the landing zone. Before landing, the AI also constantly maintains a safe distance and altitude from the ground and obstacles. In the final stages of the landing process, the drone uses its rotary motors to slow down the drone to land safely and accurately.

3 Results. Improving the calculation method

Neural networks are a type of machine learning algorithm modeled on the human brain. They consist of a network of interconnected neurons, where each neuron receives input from several neurons and then transmits a signal to other neurons. A neural network can be represented as a simplest model is a predictive machine in Figure 1. After receiving some question, it performs an analysis and, based on its results, gives its conclusion (result) [4].

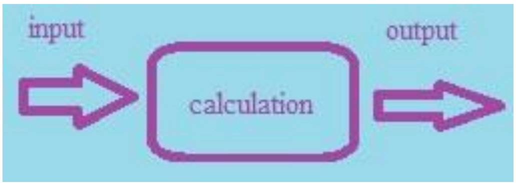

Fig. 1. Predictive machine.

Mathematically, signal transformations can be represented as the following expression:

$$y = \Phi(\sum_{i=1}^{n} \omega_i x_i - \theta) \tag{1}$$

where y is the output of an artificial neuron, ω_i, i = 1, …, n are the weights of the synapses of the artificial neuron; θ is the threshold level of the neuron's reaction to the total input signal

$$X = \sum_{i=1}^{n} \omega_i x_i \tag{2}$$

The activation function of the artificial neuron [5] is

$$\Phi(X - \theta) \tag{3}$$

A neural network learns by adjusting the weights between the neurons to accurately identify patterns in the input data. The neurons are organized in layers, with the first layer receiving the input data and the last layer producing the output data. Between them, a number of hidden layers process the data, using the weights to adjust the signals as they pass through the network in figure 2. The network continues to learn by adjusting the weights until it can accurately predict the expected result [6].

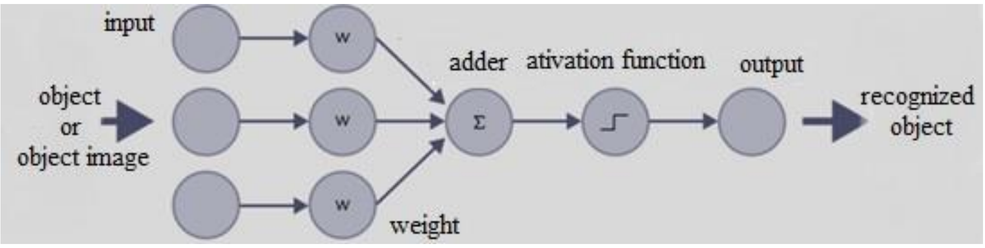

Fig. 2. General principle of neural network operation.

Increasing the number of training examples can help improve the performance of neural networks when attempting to land. This is because the network can learn more complex patterns and relationships as more data points are created, which can lead to more accurate predictions. For example, with a larger number of training examples, a neural network will be able to more accurately identify different shapes and attributes of a UAV, which can lead to more accurate landing predictions. Feedback is needed to modify the task and mission goals, to record results and intermediate calculations.

Communication with a quadrocopter and data transmission is the exchange of information between them and the ground station. This is usually done through a radio frequency link between the quadrocopters and the ground station, which allows for data to be sent back to the ground station in real time. The data is usually sent via a telemetry system which can include altitude, airspeed, location, and other data. This data is then used to control the aircraft, allowing for it to be remotely controlled. Additionally, data collected by the drone can be stored and sent back to the ground station, allowing for further analysis and recording [7].

This communication principle can be used for drone-to-drone communication, flight correction, and team coordination for priority setting.

Additional security protocols and cutting-edge methods should be set up to ensure a safe operation of the quadrocopter during its agricultural mission to prevent information leakage and transmission to third parties (malefactors). This complicates the production process but significantly increases their safety in work and everyday activities. The protocol should be designed so that only authorized personnel can access and transmit data. This is achieved through authentication and encryption. Authentication ensures that the user's identity is verified before allowing access to the system. Encryption is used to ensure the confidentiality of transmitted data. To ensure the security of the protocol, it must be regularly tested and updated. The protocol should be tested by personnel responsible for its maintenance as well as by external agencies [8]. This helps to ensure that all potential vulnerabilities have been identified and fixed, and that the protocol complies with the latest security measures. The protocol should also be monitored regularly to ensure that it is working properly. This can be done using automated tools for network traffic analysis and detection of any suspicious activity. It is important to ensure timely detection and elimination of all potential threats. Serious attention must be paid to the security of the communication protocol and ensure its compliance. This is done to ensure that the aircraft and its passengers are safe, protected, and can communicate safely with the ground.

4 Discussion

Unmanned aerial vehicles are gradually being introduced into our lives, replacing manned aircraft in favor of digitalization and technological development. Here are some of the common types of UAVs used in agriculture:

Fixed-wing UAVs are designed for long-distance flights and are ideal for agricultural tasks such as crop monitoring and spraying. They offer a range of features that make them perfect for use in agriculture, including extended autonomous operation, automated flight plans, payload carrying capabilities and enhanced sensors for crop monitoring and yield analysis. For this type of device, a takeoff and landing strip is required, which increases the computational load during takeoff and landing. However, it increases flight speed and processing area compared to multi-rotor.

Hybrid aircraft combine the advantages of airplanes and helicopters. They are capable of hovering like helicopters, as well as having the speed and range of airplanes. This makes them well suited for use in thermal and electrical networks, as they can be used for quick access to remote sites.

Unmanned helicopters have the following layout configurations: classical single-rotor, coaxial double-rotor, transverse double-rotor, longitudinal double-rotor, synchro-copter, reactive, rotor-wing, auto-gyro, convertible plane and multi-copter [9].

The most widely used configuration for drone helicopters is the multi-copter. It also has several different sub-configurations, the main difference between which is the location and number of rotors. In helicopter type machines, the lift is generated by rotating rotors with blades and not wings, which either do not exist or play only an auxiliary role.

Such machines can stay in one place for a long time and maneuver easily, which allows them to be used as unmanned systems. They have better maneuverability than aviation type machines [10].

Hybrid aircraft are also capable of transitioning from vertical to horizontal flight. This allows them to take off from a fixed position and then transition to forward flight. This makes them ideal for use in confined spaces such as urban areas, as they can take off and land in a limited space.

Hybrid aircrafts can revolutionize aviation, combining the best features of both helicopters and fixed-wing aircrafts. They can take off and land vertically, hover, and fly long distances at high speeds. Additionally, they are more fuel-efficient than traditional aircrafts, reducing their environmental impact.

Autonomous airships are lighter-than-air vehicles powered by electric motors and capable of making long-distance flights without the involvement of a human operator. They have high maneuverability and can be used for observation, crop monitoring, and other agricultural work.

Autonomous drones have a number of advantages over other types of aircraft. They are cheaper to operate than traditional piloted aircraft and require less maintenance. They can also fly at lower altitudes and at lower speeds, allowing them to cover larger areas with greater accuracy and detail. Autonomous drones can also be used in remote locations where other types of aircraft cannot operate.

The technology used in autonomous dirigibles is still in its infancy, and many designs are still experimental. Nevertheless, they can revolutionize the use of unmanned aerial vehicles. Autonomous dirigibles are being developed for various applications, including surveillance, search and rescue, and communication.

Safety is an important factor when operating autonomous airships, as they are not equipped with the same level of safety measures as traditional piloted aircraft. The use of autonomous airships is strictly regulated by the Federal Aviation Administration, and operators must adhere to all applicable rules.

Data collection and mapping drones in agriculture are Unmanned Aerial Vehicles (UAVs) used to collect data and create maps of agricultural areas. They are usually equipped with cameras and sensors that measure temperature, humidity, and other environmental factors. Drones can be used for a variety of tasks such as assessing crop health, detecting diseases, monitoring soil moisture, and tracking livestock. They can also provide valuable information on crop quality and quantity, allowing farmers to make more informed decisions. Drones can be used to create detailed maps of fields which can be used to identify areas with the highest yields as well as areas that may need more attention due to poor soil quality. Drones also offer potential for precision farming which can help farmers optimize their resources and maximize yields [11, 12].

The advantages of using drones in farming include: increased efficiency and accuracy of crop and irrigation monitoring, cost-effectiveness - drones are cheaper than renting a piloted aircraft, ability to cover larger areas more quickly, ability to collect data more frequently, ability to access hard-to-reach places with a piloted aircraft, reduced risk of crop and property damage due to precise flying and ability to capture high-resolution images and videos for analysis [13, 14]. The features of drones used in farming include: long-term autonomy, collision avoidance systems, automated flight patterns, payload capacity, real-time data analysis, high resolution images and videos, enhanced sensors for monitoring and crop analysis [15, 16].

The issue of landing under reduced pressure is also relevant to space. Currently, drones used for landing on other planets and data collection from them use thrust propulsion. This landing method is considered the most reliable and stable. For landing a UAV on the moon, the soft landing method is used. The method includes a number of stages, including the use of rocket boosters, parachute descent, the use of aerodynamic forces and the use of braking devices. The soft landing process allows reducing the energy and acceleration of the UAV to a certain level for safe landing [17, 18].

Safety is an important factor when operating autonomous drones, as they are not equipped with the same level of safety measures as traditional piloted aircraft. The use of autonomous drones is strictly regulated by the Federal Aviation Administration and operators must comply with all applicable rules.

5 Conclusion

In summary, by increasing the number of training examples, increasing the number of layers and neurons, using optimizers, and introducing regularization techniques, neural networks can be made more accurate and efficient when used in small aircraft. In addition, more research needs to be done to further improve the accuracy and efficiency of these neural networks. Research should also explore the use of various techniques such as Convolutional Neural Networks and Recurrent Neural Networks to improve performance. This will allow the use of aircraft with little or no intervention from controllers, which will increase autonomy and structure their work.

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