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MODELING OF A DRONE CONTROL SYSTEM BASED ON VR TECHNOLOGY

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Introduction

Nowadays, virtual reality (VR) technologies are developing at a rapid pace in the fields of engineering, aviation, medicine, and education.Their use in aerial surveillance, filming, cargo delivery, geodetic measurements, and search operations in disaster areas demonstrates the effectiveness of the technology. However, drone control largely depends on the operator's experience, reaction speed, and real-time spatial awareness. In this context, the use of virtual reality (VR) technology takes the process of drone control to a new level.

Virtual reality is a computer-generated three-dimensional space in which the user feels as if they are interacting with the real world. The most common VR devices are VR headsets (e.g. Meta Quest, HTC Vive, Oculus Rift). They accurately track a person's head movements, gaze direction, and sometimes hand movements, creating a fully immersive environment through visual and audio effects.

Theoretical part

VR is one of the key technologies in the interconnected space of reality and virtuality. In this regard, it is distinguished from other digital visualization solutions, such as augmented virtuality and augmented reality. Virtual reality is one of the key technologies in the space that demonstrates the seamless connection between reality and virtuality, and it is distinguished from other digital visualization solutions, such as augmented virtuality and augmented reality. Modern virtual reality systems are based on the use of headsets or multi-projection environments that create realistic images, sounds and other sensory effects to make the user imagine that he is physically present in a virtual space. In most cases,

virtual reality systems include audiovisual feedback, and some also provide sensory and tactile (hand-feeling) effects through special technologies.

1. Basic principles of virtual reality

VR systems consist of three main components:

1.Visual Display (Visual Display) is a screen for the user's eyes, displaying separate images to both eyes, creating a stereo effect.

2.Tracking System — calculates head and body movements using gyroscope, accelerometer, and infrared sensors.

3.Interaction System — allows you to interact with virtual objects using controllers and wearable sensors.

The main advantage of VR technology is the ability to realistically experience movement in space and work with three-dimensional models. This is especially important in engineering and flight simulations.

The main elements of a VR system:

- VR headset (Head-Mounted Display)– a screen that covers the user's entire field of view, displaying 3D video.
- Motion Tracking– records a person's head, hand, and body movements and displays them in a virtual environment.
- Interactive interface– provides interaction between the user and the virtual environment.
- Audio and haptic systems– produces sensory effects such as sound and vibration.

VR technology enhances the user's spatial awareness and creates a real-life environment. This allows the operator to make accurate and safe decisions when controlling the drone.

2. Drone and its control system

A drone (Unmanned Aerial Vehicle — UAV) is an unmanned aerial vehicle. The main types of drones are:

•Quadcopter (four-engine);

•Hexacopters and octocopters (6 or 8 engines);

•Fixed-wing drones.

The drone control system includes:

•On-board controller,

•GPS module,

•Gyroscope and accelerometer,

•Camera or video broadcasting system,

•Includes remote control interface.

Today, drones are widely used not only for amateur photography, but also in geodesy, construction, ecology, military reconnaissance, and agriculture.

The role of VR technology in drone control.In traditional drone control systems, the operator controls the device by looking at a monitor or using a remote control. In this case, the viewing angle is limited, and the orientation in space is not accurate. When using VR technology, the operator sees the world through the "eyes" of the drone, that is, he gets the impression that he is directly observing the events taking place in the flight path with his own eyes.

The main advantages of driving through VR:

- Increases spatial awareness;
- Reaction time is reduced;
- Flight accuracy and safety will increase;
- Allows you to control multiple drones from one center;
- Provides conditions for safe testing for practical and educational purposes.

For example, if the operator is wearing a VR headset and turns his head to the right, the drone's camera will turn in that direction. The drone's speed and altitude are controlled by hand gestures. This creates a natural, intuitive way of controlling it.

3. The principle of combining VR and drones

The main goal of integrating VR technology with a drone is to improve the operator's control experience and create simulations in a safe environment. VR goggles allow you to view the video from the drone's camera in real time, or simulate the drone's movement in the form of a virtual model.

The main elements of such systems are:

•Unity or Unreal Engine are programs for creating three-dimensional environments;

•VR SDK (Software Development Kit) — Oculus SDK or OpenXR libraries;

•Physical algorithms that calculate the modeled motion of the drone (e.g., engine thrust, aerodynamic stability);

•Real-time communication via controller and motion sensors.

Project description

In this work, a virtual drone model was created on the Unity platform and controlled using the Meta Quest 2 VR headset. The user's head movement and the controller's tilt angle affect the direction and speed of the drone. In the VR environment, the flight dynamics, movement trajectory, and altitude of the drone are based on a real physical model.

This way, the user can fully experience the process of controlling the drone in a safe virtual space and get the impression of a realistic flight.

Areas of application and practical significance

Advantages of controlling a drone via VR:

•Safe training process – no risk of damaging the drone;

•Effectiveness as a simulator – operators gain experience similar to real-life situations;

•Interactive visualization – you can learn to navigate in 3D space while flying;

•Educational and research opportunities – used in engineering and programming courses.

Conclusion

In conclusion, the combination of VR and drone technologies is a promising direction in digital engineering and modern education. Through this project, students will have the opportunity to gain hands-on experience with flight physics, motion models, and control algorithms, and test real-world engineering solutions in

a virtual environment. Such systems will pave the way for future improvements in air vehicle control, testing of unmanned systems, and safety simulators.

VR technology opens up new opportunities in the field of drone control. It improves the operator's spatial thinking, increases reaction speed, and increases control accuracy. Simulation of drone control systems based on virtual reality is one of the innovative directions that will form the basis for the development of autonomous and remotely controlled devices in the future.

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