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Drone Testing and Education via Mixed Reality Simulation

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Abstract:

With the rapid advancement of drone technology and computer graphics, the applications of drones and virtual reality devices are expanding. Consequently, there is an urgent need for drone developers to test drones quickly, affordably, and realistically. This paper proposes a drone simulation system designed within the HoloLens 2 mixed reality environment, enabling developers to conduct more realistic tests. Additionally, this system can be applied in the fields of drone education and gaming, providing a versatile tool for both development and instructional purposes.

Keywords:

Mixed Reality; Drones; Hololens 2.

1. Introduction

Virtual reality has good interactivity, immersion, conceptual, intuitive and visual. This makes virtual reality devices can restore realistic scenes more easily and bring a new way of operation and display to the traditional testing, education industry. With the continuous improvement of computer CPU and GPU computing power, more virtual reality devices have been introduced. Different from the previous VR devices, AR, MR as a new generation of virtual reality concept, compared with VR has more portable, realistic and interactive characteristics.

In VR, AR and MR, MR can quickly combine the real environment and virtual things to interact with each other by introducing real scenes in the virtual environment and building a bridge of interactive feedback information between virtual time, the real world and the user, thus enhancing the realism of the user experience, due to the feature of being able to model the real environment in real time.

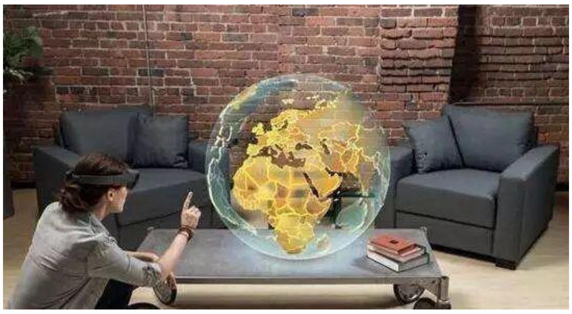

Fig 1. Virtual reality renderings

The development of UAVs is a highly systematic integration of several "independent" subsystems such as navigation, flight control, communications, telemetry and tele-sensing, and aircraft design, and is an interdisciplinary and comprehensive systems project. The emergence and development of drones will not only change the current mode of warfare, but may also change the way of life and survival of human beings in the future. As the scale of UAV development continues to expand, for developers, most of the existing virtual UAV test environments are tested on computers through monitors, with few virtual reality-based test simulation environments. In addition, for the educational environment of UAVs, if the use of real UAVs means not only the purchase cost of great UAVs, but also the need to pay for their later damage maintenance costs, making most of the current UAV education Institutions use simulators to achieve, and mixed reality-based drone simulation system can help them more realistic restoration of drone operation scenarios, and reduce the purchase and maintenance costs of drones.

2. System Scenario

2.1. Introduction of UAV Simulation System

This scenario requires the development of a basic drone simulation system. This system needs to contain a drone and control the interaction method, which can control the drone to move back and forth, up and down, and adjust the direction left and right. The drone will be affected by the external environment.

The system needs to be deployed to MR devices, and the current HoloLens 2 has a more comprehensive ecology and interaction than other devices, so the HoloLens 2 was chosen as the target mixed reality device here.

2.2. UAV Simulation System Analysis

First of all, the operating principle of the UAV is analyzed. The UAV flies by rotating the propellers and adjusts the speed of the propellers to lift and down, forward and backward, and adjust the direction. In order to simplify the problem, the UAV simulation system used here uses the current more popular quadrotor UAV. The UAV model is as follows.

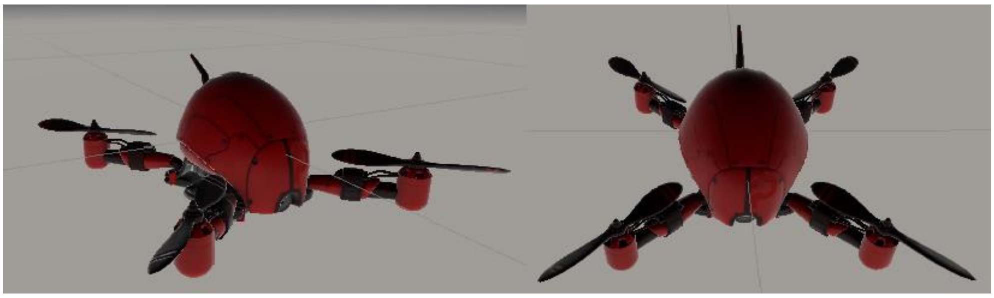

Fig 2. Experimental environment UAV model diagram

Consider the physics engine, in the case of using HoloLens 2, the device has more comprehensive support for Unity's physical environment, and Unity's physical environment development is quite comprehensive, the design of collision, external forces has been very real, so here use Unity as the physics engine support. Through the Unity physics engine, the system can support a variety of environmental effects, such as.

- Gravity
- Wind Power
- Collision

Consider the impact on the popularity of drones, taking the above three factors as the main environmental impact.

Interaction direction, because HoloLens 2 supports a variety of interaction methods, including buttons, gaze, voice more commonly used, in order to ensure that the drone can quickly access other interaction methods, here the operation of the drone and interaction decoupled, through the input system control, only by calling the input layer of the put to facilitate control of drone movement.

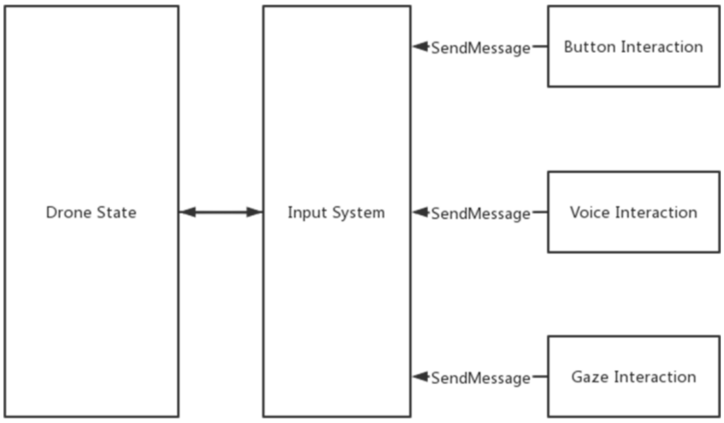

Fig 3. Drone operating system

3. Model Program Implementation

3.1. Drone State

The current system only considers the flight status of the UAV, environmental factors, and thestatus can be simplified to the following.

- Drone propeller status
- Whether the drone is adjacent to other collision bodies
- Flight resistance of the UAV in the event of a collision

The propeller state of the drone determines the current flight state of the drone, whether it is forward or backward, etc. If the UAV is adjacent to other colliding bodies, then the UAV will be subject to drag in the specified direction and change its flight path.

When the rotation speed of the drone's propeller increases, then the drone is subjected to a compelling force at the propeller position. In the Unity virtual environment, this needs to be achieved by adding Force, so here the size of Force is treated as a positive relationship with the rotation speed of the propeller, the larger the Force, then the greater the rotation speed of the propeller, and the direction of Force is always the same as the drone's The direction of Force is always in the same direction as the engine column of the UAV.

When the UAV collides with other collision bodies, two ways of handling are chosen here, the destruction of the UAV and the change of the UAV's trajectory. The destruction of the UAV needsto consider a variety of factors such as the internal structure of the UAV and the material stiffness, here the object is simplified and only the change of trajectory is considered, giving theUAV a reverse force to make it fly along the wall.

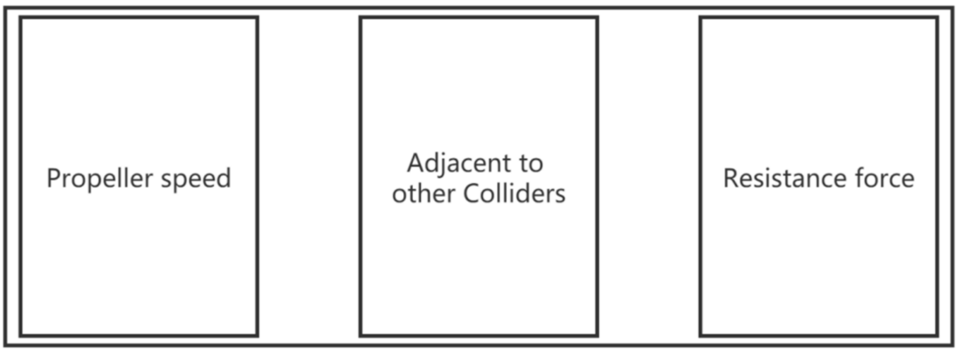

Fig 4. Force section in UAS

When implemented in Unity, the system uses a power component placed on each engine of the UAV to control the propellers. The engine will get the commands from the input system every second, and if there is a command, then it will update the current motion state, and if there is no command, then it will stay in the default state. The drone requires a total of four propeller engines, because each propeller engine does not resolve commands the same way when completing the same operation, and its calculation formula is different.

3.2. Input System

The input system is responsible for adjusting the state of the drone, when it receives a forward command, then it will adjust the state of the drone, i.e., adjust the direction of rotation and rotation speed of the drone propellers, by which the Force on the four engines is changed to make the drone move.

The system should support the basic drone operation methods, such as: forward, backward, left, right, up, down, adjust direction to the left, adjust direction to the right, a total of eight states, here you can use a two-dimensional vector Cyclic to represent the plane movement of the drone, with a floating point number throttle to represent the drone lifting state, with another floating point number pedals to represent the drone's Drone State will keep reading these numbers to make a response.

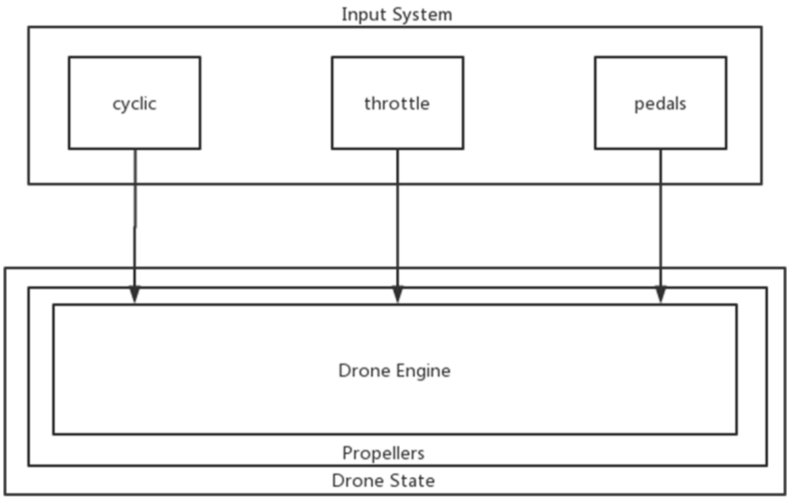

Fig 5. Drone input system

3.3. Interaction

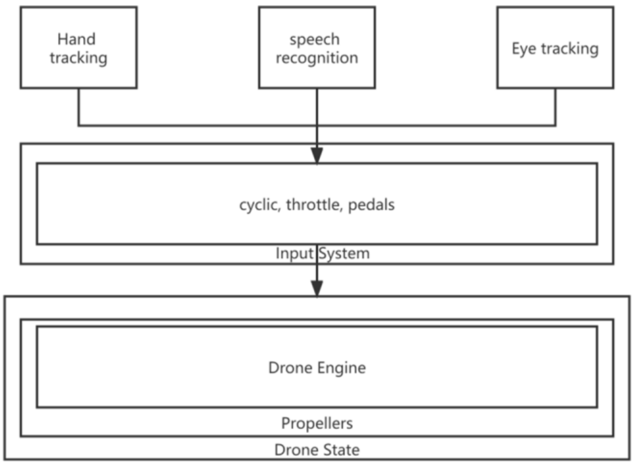

Fig 6. Drone interaction system

The system is deployed as a HoloLens 2 UAS device. HoloLens 2 supports three operations: hand tracking, voice recognition, and eye tracking. Whichever operation method is used, the drone can be controlled by sending information to Input System.

4. Summary

This paper designs a mixed reality-based UAV simulation system, which allows developers and related organizations to easily test and display UAVs. In addition, this system incorporates Input System to decouple UAV control from device input, which is convenient for subsequent secondary development.

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