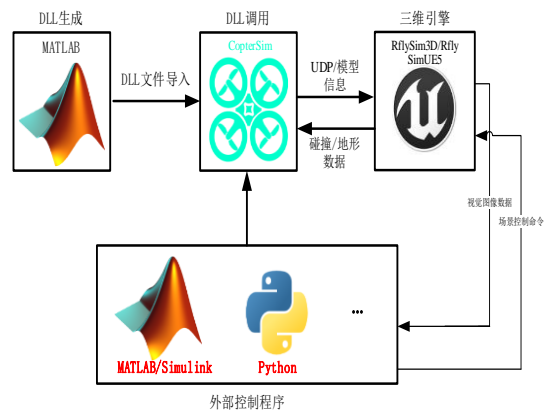

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3D Scene Modeling and Simulation

In the research and development process of unmanned systems, a large number of semi-physical real-time simulation experiments of motion control systems are needed. The motion trajectory display of traditional simulation interfaces is mostly in the form of two-dimensional curves, and the motion process and state are displayed through text data. With the increase of the amount of data, this method lacks intuitiveness, is difficult to observe, understand and analyze, and is not conducive to mining the essential characteristics hidden in the data. However, the information contained in a realistic image includes the information displayed by curves and text. Therefore, the application of 3D visualization simulation technology to the simulation of unmanned system can make the system data in a more natural and easier to understand image form display, realistically reproduce the entire operation process of unmanned system. The position of RflySim3D in the simulation platform



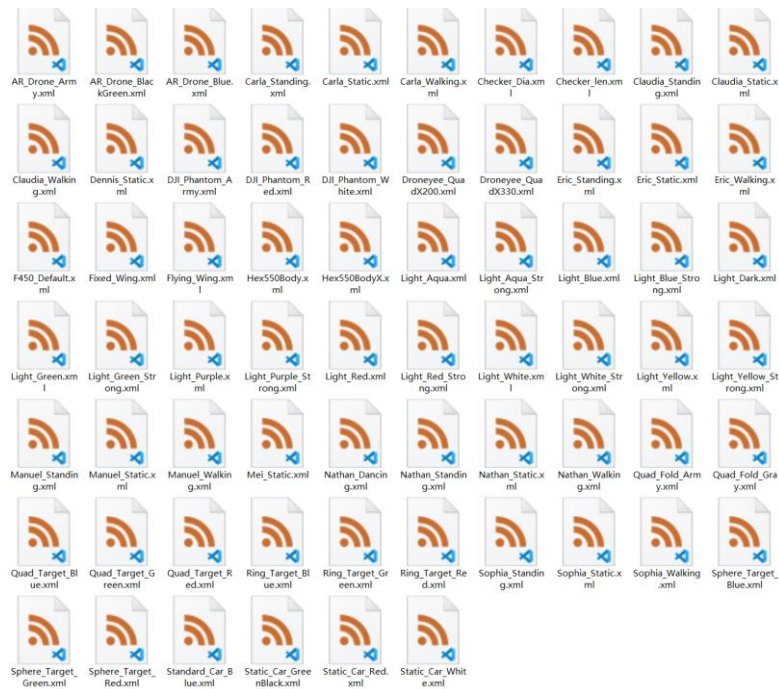
CopterSim calculates the current state of the UAV (mainly position and attitude data) from the motor control data incoming from Pixhawk (or PX4 SITL), and then sends this data to RflySim3D, which applies this data to the corresponding UAV in the scene. So that we can see the state of the UAV more intuitively.

RflySim3D uses UDP communication, can accept UDP commands from CopterSim, Python, Simulink, and return collision/terrain data as well as visual image data.

Fast import of multiple types of 3D model files



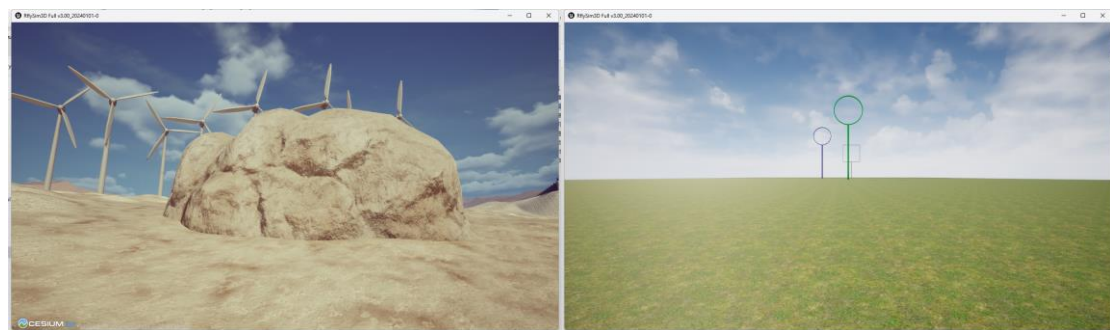
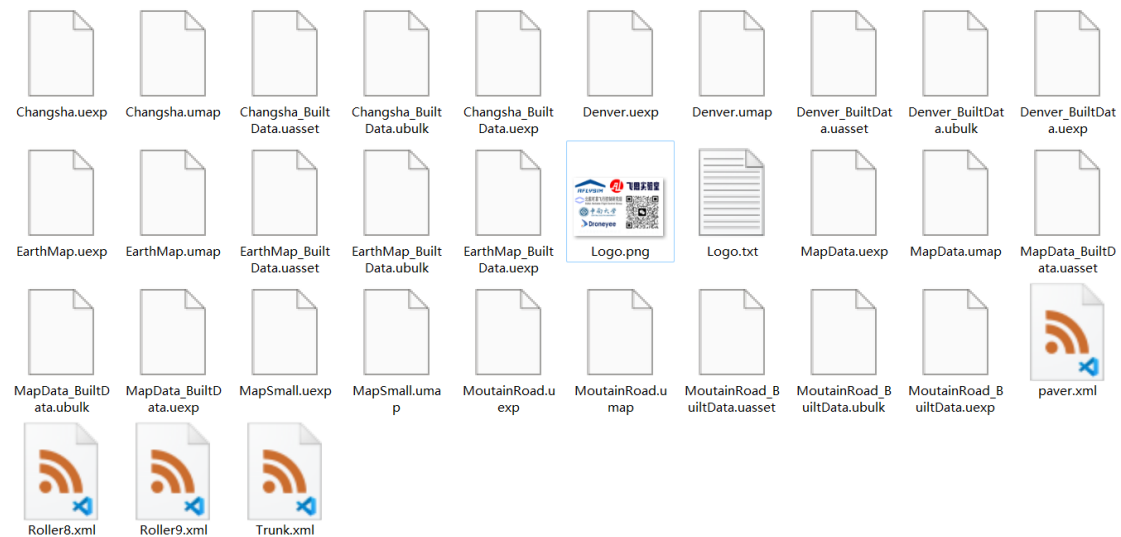
- **XML files:** The RflySim platform has a large number of 3D model XML files built in, which can be switched between different model files (at present, in addition to various types of vehicle simulation models, it also includes helicopter landing ground, ring plane, satellite, satellite receiver, balloon, ring and other examples to quickly arrange the required simulation scene). At the same time, it supports the custom development of XML files (defining the relative position and size of the grid body, material path, etc., to generate the required instance), just copy the file to the specified position of RflySim3D for simulation.



- **Static mesh body splicing model:** After importing the actuators that need to be controlled and the body that does not need to be controlled into UE, the assembly and material replacement are carried out. After the packaging is completed, the model is imported into RflySim3D, and the external program can give simple animation effects.
- **Model with Blueprint program:** The model with blueprint logic created in the Unreal Blueprint, only need to define the [ActuatorInputs interface and ActuatorInputsExt](#) interface according to the format in the Blueprint Actor event chart, you can use the corresponding interface to trigger the corresponding blueprint animation and effect.
- **Vehicle AI Model:** A project created based on Unreal Engine's vehicle template, which defines the vehicle model with its own AI behavior

Fast import of multiple types of 3D scene files

RflySim built-in scenes: The platform built-in simulation scenes can be found in the following platform installation directory, including from indoor to outdoor, from small-scale buildings to large-scale buildings, from large urban scenes to high-fidelity dynamic natural environments, and even real-time global large scenes with digital twin to real environment.



- **Unreal Store Scenes:** Unreal Store features dozens of pre-built, highly detailed environments, from the Moon to Mars, and everything in between. Alternatively, if you look under the "Learn" TAB of Epic Game Launcher, you'll find many free samples you can use.
- **Twinmotion Near-ground Scene:** This enables simultaneous indoor and outdoor layout design and rendering optimization of architectural scenes. Twinmotion supports all major CAD, BIM and modeling solution file formats ([Twinmotion plug-in - Twinmotion](#)) and enables one-click synchronization with most of them. In addition, it is also possible to further develop Twinmotion projects in Unreal Engine.
- **Cesium Real-time Global Big Scene:** With the Cesium for Unreal plugin, a geo-accurate and detailed virtual earth model can be created in Unreal Engine. The plug-in can obtain high-resolution data on the shape and image of the Earth from Cesium Ion services in real time, as well as data on 3D buildings around the world, which are then rendered in a virtual environment.
- **CityEngine Urban Scenes:** CityEngine is a programmatic modeling application and uses CGA rules (the only programming language used to generate 3D content for buildings). After collecting the required geographic information data and importing it into Esri CityEngine software, the written CGA rules can be used to generate urban building models

on corresponding roads and plots based on vector data and other inputs (such as building styles, etc.), thus quickly integrating relatively realistic urban scenes.

Rich external interaction interface

RflySim3D exposes the following program interface, so you can programmatically interact with the RflySim3D unmanned system 3D simulation model in the simulation. When you install the RflySim platform, the required python library files will be installed automatically, and the corresponding interface files will be integrated at the following locations in the installation path. At present, the supported interfaces are divided into two ways: Python/MATLAB: scene control interface, such as: create/update model, broadcast control commands in the LAN, trigger extension blueprint interface and other functions. Terrain service interface, such as: analyzing scene terrain data, generating map height data, sending console commands.

More comprehensive computer vision interfaces

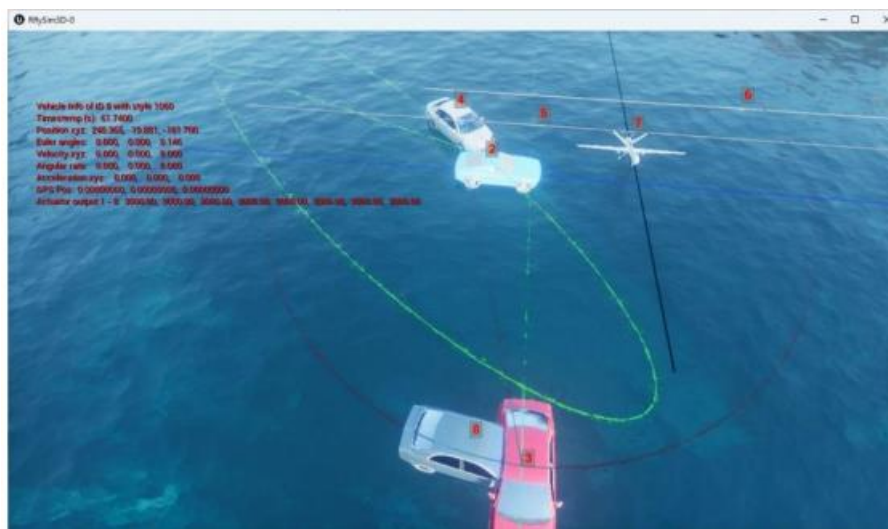
RflySim3D provides a comprehensive image API for retrieving synchronized images from multiple cameras as well as ground truth, including visible-light RGB, grayscale, depth, segmentation maps, lidar and heatmaps, plus range sensors for collision detection. Send via [imageHeaderNew \(image data structure\)](#), [UE4CommMemData \(image parity data\)](#), and receive [image-related data via VisionSensorReq](#) structure. You can set camera property parameters such as sensor data type, FOV in [Config.json](#). Learn more about.. [\8.RflySimVision\API.pdf](#).

High precision 3D engine collision detection interface

You can enter collision mode by pressing P in RflySim3D. This mode will return reqVeCrashData (crash data) and Ue4RayTraceDrone structure (sent to CopterSim of each Copter). These two structures not only contain the information of whether a collision has occurred, It also contains information such as collision location, surface normal, penetration depth, etc.

Multiple ways to drive 3D models

RflySim3D supports trajectory control and actuator adjustment of a variety of unmanned systems. It can realize trajectory control, actuator animation adjustment, real-time control formation of multiple homogeneous and heterogeneous unmanned vehicle clusters,



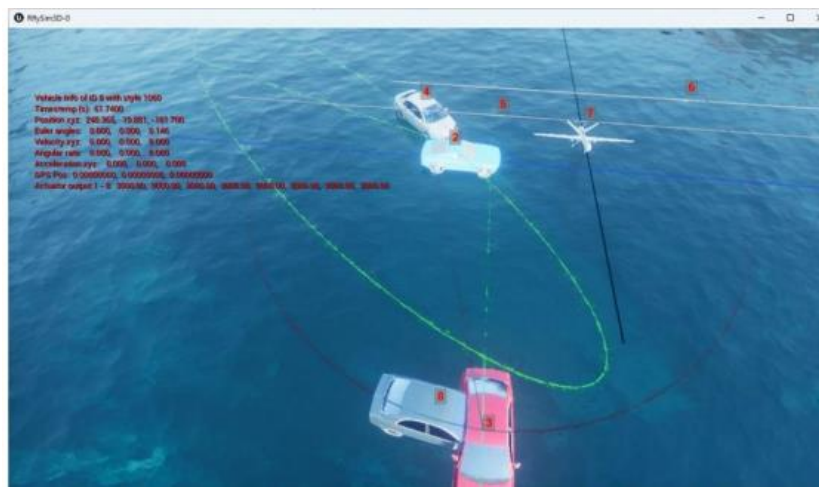
Real-time simulation of time, weather and other environmental variables in the scene

If you want to switch between different simulation environment variables in the scene in real time, you can download the UltraDynamicSky plug-in in UE and quickly import it into RflySim3D to help you achieve a more realistic dynamic simulation environment.

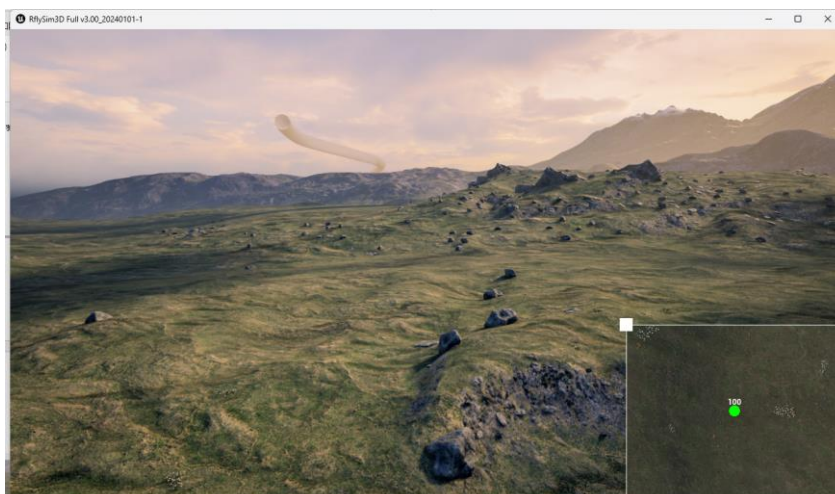


It supports a variety of simulation effects to achieve cool simulation effects

- Display model label: you can customize the simulation model ID, text annotation and so on in RflySim3D by shortcut keys or command line.
- Display track: the movement track of the simulation model can be customized style, such as: track thickness, color, to help you more clearly observe the running state of the vehicle.
- Display vehicle motion information: it can display the position, attitude, speed, acceleration, GPS and other information of any vehicle in the current scene.



- Global small map: the small map display of the global simulation environment can judge the spatial position of the vehicle more intuitively.



- Explosion effect: The extended blueprint interface can trigger the damage effect of the corresponding blueprint model.

