

1. 实验名称及目的

1.1 实验名称

Olfati-Saber 集群算法（仅限完整版及以上版本）

1.2 实验目的

采用 Olfati-Saber 算法实现多无人机的避障、避碰、向目标点聚集。

1.3 关键知识点

具体实验原理请参考论文：“Flocking for multi-agent dynamic systems: Algorithms and theory”

2. 实验效果

6 个无人机起飞，穿越障碍物区域，达到目标点。途中会进行避碰、避障等行为。

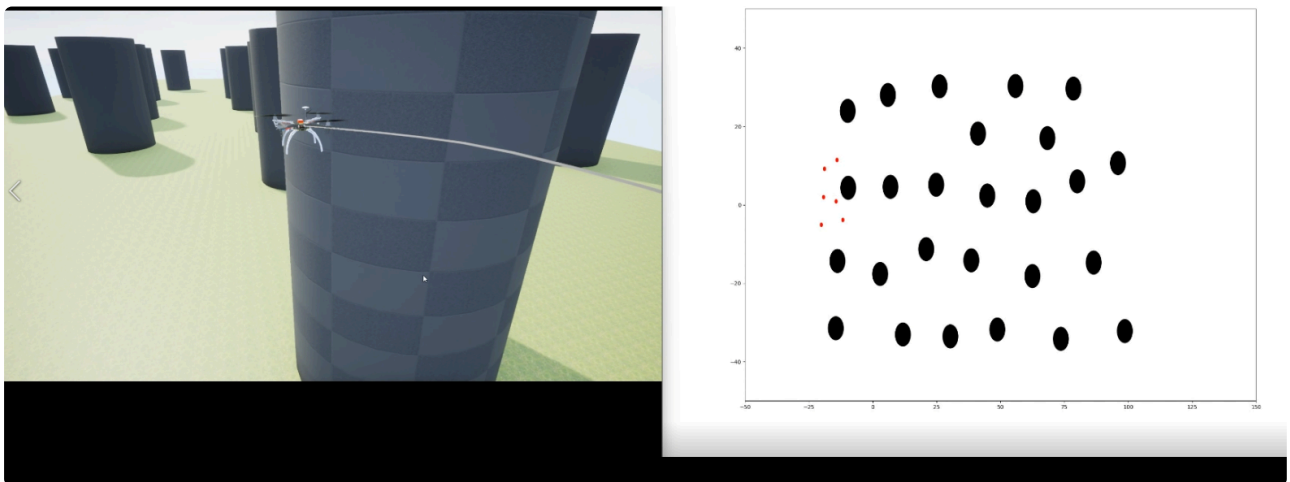


图 1 实验效果

3. 文件目录

例程目录：

[安装目录]\RflySimAPIs\10.RflySimSwarm\3.CustExps\e3.AISwarmCtrlExp\2.Olfati_SaberSwarmUAVObsAvoid

2.Olfati_SaberSwarmUAVObsAvoid](file:///C:\Users\uavcs\Desktop\1.SwarmLogGet)

表 1 文件目录

文件夹/文件名称	说明
Cylinder&Cylinder.xml	RflySim3D场景障碍物模型文件
Barrier.py	障碍物文件
CopySceToRflySim3D.bat	场景文件复制脚本
functions.py & params.py	参数配置文件
PathPlanningSITL.py	启动脚本
Python38Run.bat	Python环境启动脚本
sim_2d_avoid.py	启动文件
Readme.pdf	用户指南

4. 运行环境

表 2 运行环境

4.1 软件要求

Win 10/Win11系统；RflySim工具链。

①：若使用Pixhawk 6X飞控，平台安装时的编译命令为：px4_fmu-v6x_default，推荐PX4固件版本为：1.12.3。其他配套飞控及编译命令请见：

<https://rflysim.com/doc/zh/1/Hardware.html>

4.2 硬件要求

笔记本/台式电脑① 1台。

①：推荐配置请见：<https://rflysim.com/>

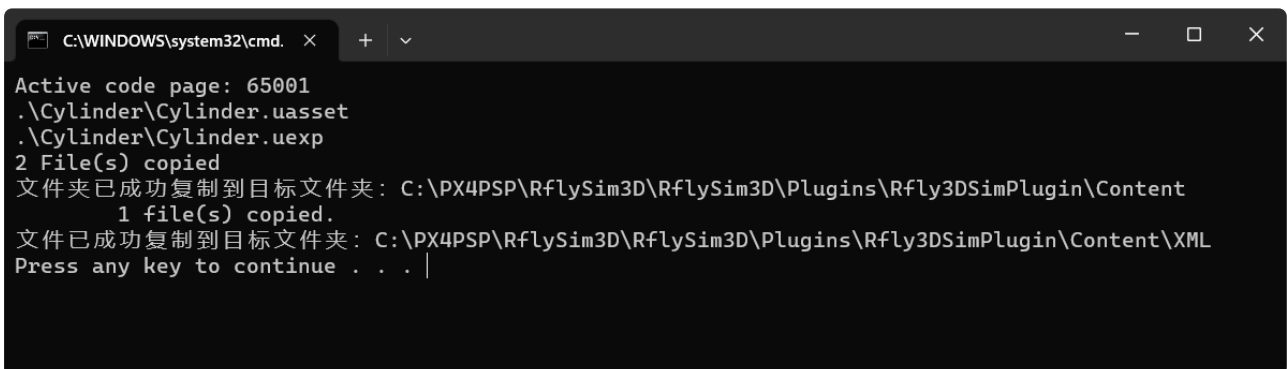
1. **：**推荐配置请见：<https://doc.rflysim.com/1.1InstallMethod.html>

5. 实验步骤

5.1 必做实验

Step 1: 障碍物配置

配置障碍物文件，双击运行CopySceToRflySim3D.bat文件，该文件运行过程中会将文件夹Cylinder和文件Cylinder.xml复制到RflySim3D对应的路径下。



```
C:\WINDOWS\system32\cmd. x + v
Active code page: 65001
.\Cylinder\Cylinder.uasset
.\Cylinder\Cylinder.uexp
2 File(s) copied
文件夹已成功复制到目标文件夹： C:\PX4PSP\RflySim3D\RflySim3D\Plugins\Rfly3DSimPlugin\Content
1 file(s) copied.
文件已成功复制到目标文件夹： C:\PX4PSP\RflySim3D\RflySim3D\Plugins\Rfly3DSimPlugin\Content\XML
Press any key to continue . . . |
```

图 2 障碍物配置

注：本步骤只需在RflySim平台首次运行本例程时进行，后续运行可跳过本步骤。本步骤是将文件夹Cylinder放

在..\PX4PSP\RflySim3D\RflySim3D\Plugins\Rfly3DSimPlugin\Content路径下；将Cylinder.xml文件放在..\PX4PSP\RflySim3D\RflySim3D\Plugins\Rfly3DSimPlugin\Content\XML路径下。也可手动进行复制。

Step 2: 仿真初始化

双击运行PathPlanningSITL.bat脚本，观察RflySim3D左上角出现“CopterSim/PX4 EKF 3DFixed: 6/6”即表示初始化完成，在RflySim3D中会显示6架飞机。



图 3 仿真初始化

Step 3: 启动仿真

在文件夹下，双击Python38Run.bat，打开集成好的python环境，在该环境下运行sim_2d_avoid.py文件，输入

```
python
```

sim_2d_avoid.py，接着按回车，等待程序进行迭代，Python38Run弹出“起飞了”，即表示算法迭代完成，开始进行仿真。

```
C:\windows\system32\cmd.exe
You can use pip or pip3 command to install other libraries
Put Python3Run.bat into your code folder
Use the command: 'python XXX.py' to run the script with Python

D:\10.RflySimSwarm\3.CustExps\e3_AISwarmCtrlExp\2.0lfati_SaberSwarmUAVObsAvoid>python sim_2d_avoid.py
sigma_d=6.1245154965971, sigma_r=11.447610589527217
simulation olfati saber flocking algo
[[, []]
[[-9.77930949552725, -13.501138167573176, -12.01147489849374, -14.439941532132302, 8.571084632485205, 7.55938327116167,
5.147133136287918, 7.8063960834039365, 24.32760270196796, 22.500042059306452, 26.23179216265504, 25.918600643130763, 40.
926548878023986, 42.06310627113789, 41.67109040510766, 43.519942897639204, 55.63269427905333, 59.297548037404844, 58.466
439898349996, 61.51571815066941, 72.80137936634841, 74.93480609458302, 73.83476600085794, 79.30357403108572, 92.67695973
31301, 91.27781587056792, 91.83122849802093, 95.10201084357006], [-31.91878333161988, -14.614213399055021, 3.92435155298
88517, 22.02596630889179, -26.063667637976422, -9.530593623218806, 9.625014018785713, 28.270156467923073, -31.5675860437
61356, -15.487991893932865, 0.18124149775134946, 16.55122258089792, -32.93580531467097, -13.205819075712178, 5.720040571
6206975, 22.06205661993578, -25.90859229939706, -7.549477628672495, 8.752714073677673, 26.866818424904615, -32.762466748
67552, -16.689460757061394, 2.0835029799947775, 23.62974512559577, -32.073528849049765, -10.319016803221812, 8.532972055
967265, 27.803926664247108]]
[[ -9.7793095  -13.50113817 -12.0114749  -14.43994153   8.57108463
  7.55938327   5.14713314   7.80639608  24.3276027   22.50004206
  26.23179216  25.91860064  40.92654888  42.06310627  41.67109041
  43.5199429  55.63269428  59.29754804  58.4664399  61.51571815
  72.80137937  74.93480609  73.834766   79.30357403  92.67695973
  91.27781587  91.8312285   95.10201084]
[-31.91878333 -14.6142134   3.92435155  22.02596631 -26.06366764
 -9.53059362   9.62501402  28.27015647 -31.56758604 -15.48799189
  0.1812415   16.55122258 -32.93580531 -13.20581908  5.72004057
  22.06205662 -25.9085923  -7.54947763   8.75271407  26.86681842
 -32.76246675 -16.68946076  2.08350298  23.62974513 -32.07352885
 -10.3190168   8.53297206  27.80392666]]
[0, 4, 4, 4, 8, 8, 8, 12, 12, 12, 16, 16, 17, 20, 20, 23, 24, 24, 27, 28]
Simulation Start.
Enter Offboard mode.
起飞了
```

图 4 启动仿真

Step 4: 实验效果

进入RflySim3D窗口，实验仿真开始后，即可在RflySim3D中看到6架无人机起飞，并开始避开障碍飞行。

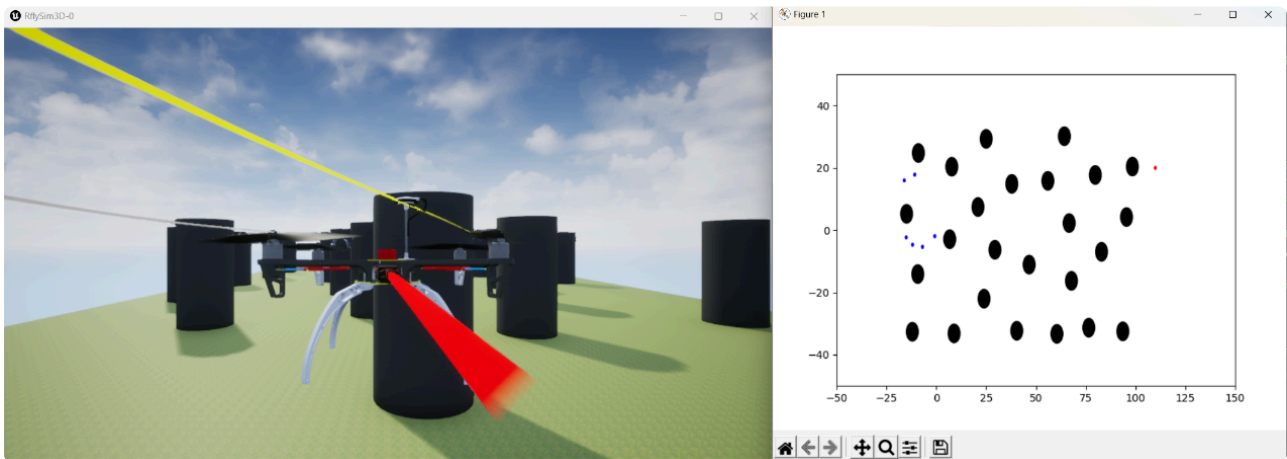


图 5 实验效果

5.2 选做实验（VS Code调试运行）

Step 1: 准备工作

先确保已经按

[\[RflySim安装目录\]/RflySimAPIs/1.RflySimIntro/2.AdvExps/e3.PythonConfig/Readme.pdf](#)

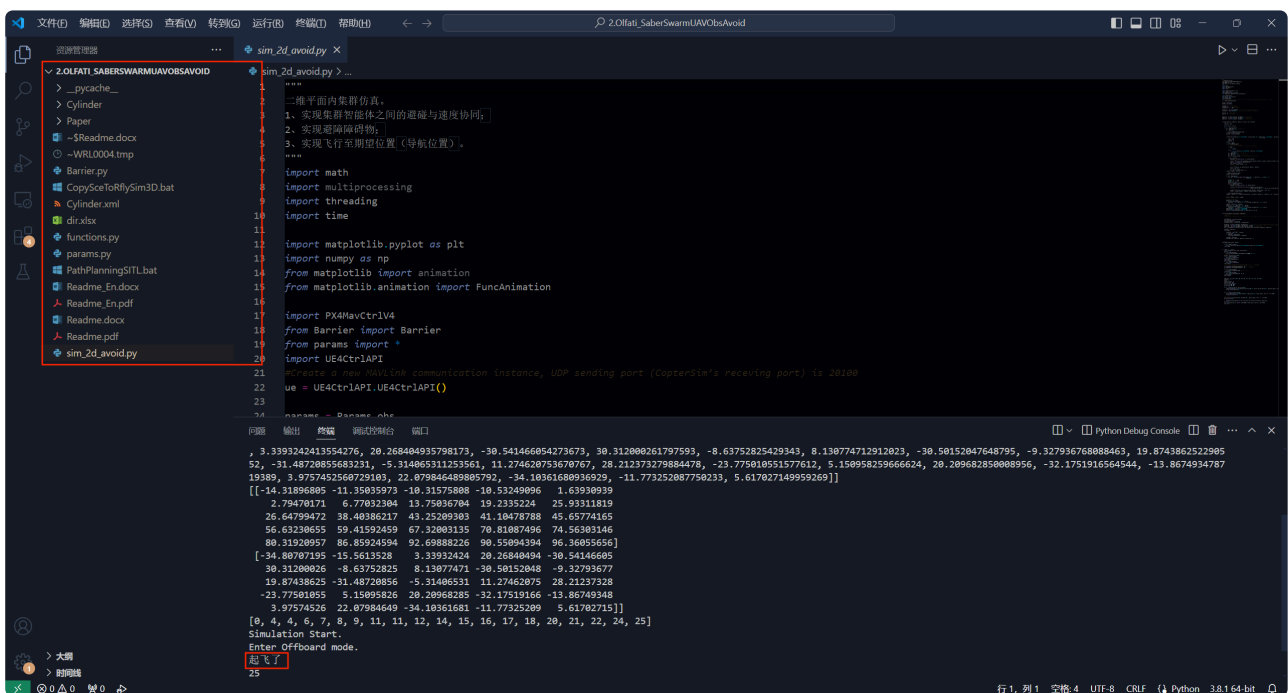
步骤，正确配置VS

Code环境。或者配置了自己的Pycharm等自定义Python环境。

Step 2: VS code调试运行

其他步骤与上文相同，在Step 3启动仿真时，打开VS

Code，找到本实验的路径文件夹，运行程序sim_2d_avoid.py，等待程序进行迭代，VS code弹出“起飞了”，即表示算法迭代完成，开始进行仿真。



```
21 create a new MAVLink communication instance, UDP sending port (Copter's receiving port) is 2010
22 ue = UE4CtrlAPI.UE4CtrlAPI()
23
24 params = Params()
25
26 , 3.3393242413554276, 20.268484935798173, -30.541466854273673, 30.312000261797593, -8.63752825429343, 8.138774712912023, -30.58152847648795, -9.327936768888463, 19.8743862522965
52, -31.48728855683231, -5.314865311253561, 11.274628753678767, 28.212373279884478, -23.775818551577612, 5.158958259666624, 28.2896828590088956, -32.1751916564544, -13.8674934787
19389, 3.975745250979183, 22.879844489885792, -34.18361688936929, -11.773252887758233, 5.617827149959269]]
[[[-14.31888885, -11.35835973, 18.31575888, -10.53248896, 1.63838839]
2.79478171, 6.77832384, 13.75836784, 19.2335224, 25.93311819]
26.64799472, 38.48386217, 43.25289383, 41.18478788, 45.65774165]
56.63238655, 59.41592459, 67.32883135, 78.81887496, 74.56383146]
80.31920957, 86.85924584, 92.69888226, 90.55894394, 96.36853656]
[-24.88787195, -15.5612528, 3.33932424, 20.26848494, 30.54146685]
30.31200026, -8.63752825, 8.13877471, -30.58152848, -9.32793677]
19.87438625, -31.48728856, -5.31486531, 11.27462875, 28.21237328]
-23.77581855, 5.15895826, 28.28968285, -32.17519166, -13.86749348]
3.97574526, 22.87984649, -34.18361681, -11.77325289, 5.61782715]]
[0, 4, 6, 7, 8, 9, 11, 12, 14, 15, 16, 17, 18, 20, 21, 22, 24, 25]
Simulation Start.
Enter Offboard mode.
起飞了
25
```

图 6 VS code运行示例

6.参考资料

7. Olfati-Saber R. Flocking for multi-agent dynamic systems: Algorithms and theory[J]. IEEE Transactions on automatic control, 2006, 51(3): 401-420.

7. 常见问题

Q1：发生碰撞

A1：可能是算法参数设置不恰当、障碍物过大的原因