

# Multi UAV simulator in Unity

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## Abstract

This paper describes a simulator application specifically designed to calculate the multi-agent motion of Unmanned Aerial Vehicles (UAVs) during spraying/mapping missions. This simulator has the main purpose to simulate UAV movement through waypoints from a centralized multi-agent application. Currently, some simulators are presented in different papers. However, the lack of multi-UAV simulators, designed to simulate behaviour of the UAV flock for agriculture purposes motivated this work. The main requirement for this framework is to simulate real physics and dynamics, likewise, the same precision should be provided about collision data. Moreover, simulation should be flexible for adjustments and stress-resistant for manual changes during the process.

*Keywords:* UAV, simulation, Unity, agriculture, unmanned aerial system

## 1 Introduction

In recent years, the problem of automatization of UAV piloting seems intense. UAVs have enough superiority in front of traditional ways of detecting and spraying large agricultural areas. Our project is focused on solving the agricultural problem of spraying fields. This paper is a part of the entire project as a simulator. According to paper [1] authored by Che Mat et al, game engines such as Unity (fig. 1) can provide commercial strength and well-supported 3D development environments that enable fast and safe simulation development. In this paper, we present a basic collision and test simulator for multiple UAVs with adjustable settings for each agent.



FIGURE 1. Flock of 3 UAV agent in Unity environment simulator

In The key explanation is that the majority of simulation systems on the market are unable to meet our project's requirements.

Tested simulators are described in the next part.

## 2 UAV path planning system

In this approach we suggest a centralized multiple-UAV path planning system. Some different mission types should be implemented in the simulator. As input values simulator get waypoints array from path planning algorithm (fig 2).

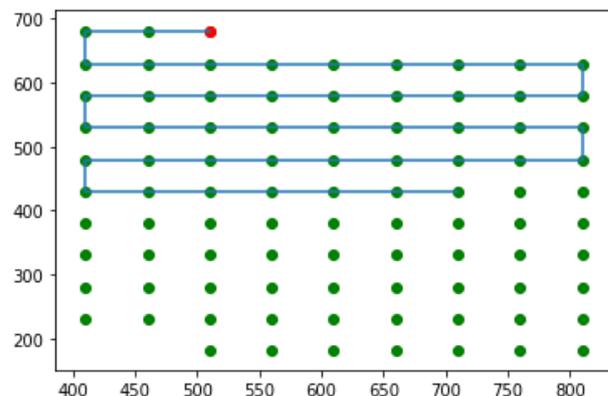


FIGURE 2. Waypoints array appearance.

Challenging part of simulating the process of spraying drones is short battery life-time and limited lifting power (for spraying substance) of agents, which leads to necessary refilling manipulations during the mission. The bottleneck of multiple UAV spraying is the process of launching and refilling the drone, because all agents have to visit the same point. By the same token we got a mobile ground station which helps drones to solve refilling problems, meanwhile stops of the mobile station can be optimized as well. Besides refilling of the substance tank is going to be manual, so this timing system has to be stress-resistant enough.

Simulator general tasks:

- Test fly before executing the real process of mapping and spraying.

- Simulate physical bodies of UAVs to prevent collisions in a physical environment.
- Make time optimization in moving paths for UAVs and mobile station.

### 3 Overview

Several authors have proposed simulator algorithms, nevertheless, the most of the simulation systems available are not unable to meet all requirements for solving our needs. The paper after Yuchao Hu and Wei Meng [2] described a developed simulator, which can successfully simulate multi-unmanned aerial vehicle local planning. Nevertheless, that simulator was developed for LIDAR UAVs. That is one of the limitations of our system.

UAV flight algorithm described is sufficient details in work [3] by Massimiliano De Benedetti et al. They suggested a multi-agent simulator using C++ and QT5 library. That approach has not been designed for simulation of movement through prepared waypoints to verify calculated paths. Besides, this team made a UAV simulator described in [4] developed using AgentSimJs for web-based simulations. They meet a close problem of plant inspection by the flock of UAVs. Furthermore, they include machine learning for optimization purposes. Another success realization was presented by Amjed Al-Mousa et al [5]. That paper described details of simulator architecture created in Unity. As well they show success bandwidth communication speed inside that system.

Overviewed papers were implemented with various programming languages and simulators. However successful simulations were demonstrated as results of described works.

Based on reviewed works Unity has been selected for developing simulation framework. The proposed simulator is developed in Unity game engine. One of the benefits is that it can be used to develop cross platform applications.

### 4 Unity

Unity is flexible and powerful tool for creating multiplatform games and interactive experiences. Besides game developments, Unity3D could also be employed by academic research [3, 6]. Based on reviewed works Unity

has been selected for developing simulation framework. One of the benefits is that Unity can be used to develop cross platform applications.

### 5 Decision

As we know, simulation technologies can verify planned routes for UAVs and identify potential problems in bottleneck parts of the spraying process.

For better simulation we need to follow some requirements:

- UAV agents can be heterogeneous
- Simulation should be accurate enough to make decisions about real launches
- Collision detection system
- LIDAR sensing excluded
- Real-time changes in simulation should be available

### 6 Conclusion

Simulator for verifying multiple UAV paths for agricultural needs is described. Overviewed papers show that simulations can verify safe routes for UAVs and predict collisions inside a virtual environment.

### 7 Future works

Final simulator work has been divided in 3 steps:

- Making UAV agents follow prepared waypoints, imported from another script. Main purpose to give information about collision (this paper describes the first phase).
- Optimize launching and landing time for agents to go in series with each other.
- Learning ML-agents in Unity simulator for spraying

Future works are going to reach the next steps of final simulator realization.

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