Project synopsis:

Short Title: Discovery Drone

Title: Autonomous Discovery and Tracking Drone

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Suggested team size: 4-5

Logistics: On-campus.

Project description:

Unmanned aerial vehicles (UAVs) pose a significant security threat. Their ability to allow an adversary to remotely survey and attack targets cannot be ignored. There are several defense systems that exist to counter this threat. One of these defense methods is a drone discovery & intercept system. By discovering, intercepting, and subsequently following a target UAV, one can obtain valuable information about an adversary. While such a task can currently be accomplished manually, a comparable autonomous system could significantly reduce control overhead. Thus, in collaboration with the US Air Force academy at Colorado Springs, CO, a framework for an autonomous interception drone is being developed. The framework includes physical & simulated test platforms in addition to drone detection & flight control software. This framework will serve as the base for further development into autonomous interception drones.

The project being offered for CS Field Session Summer 2022 targets building a hardware and software framework for an autonomous interception drone. The students will have a hands-on opportunity to assemble and operate a cyber-physical system, and program it to have it autonomous flight capabilities. At the end of the project students will have chance to interact with faculty visiting Mines from Air Force Academy (AF-A) and demo their work.

Project components:

The project requires multiple components that uses existing open-source technologies to be stitched together and work coherently. The components are detailed below:

The hardware: The quadcopter is a Hexsoon EDU 450 using CubePilot as the flight controller. Depending on the purchase availability, the students may have a chance to build the drone from scratch or use an existing drone that is halfway assembled.

The software: The framework will use a combination of object detection and tracking algorithms. The students will be responsible for assembling the software pieces together to create a high-level control algorithm. The input is provided by Intellisense camera along with the depth information. Depending on the results of object detection and tracking, proper commands will be sent to the flight controller hardware via MavLink commands.

Simulation environment: The framework will first be operated on the gazebo simulation platform. Once initial testing is done hardware tests will begin.

Desired skills:

Following skills are a plus but not necessarily required:

- Familiarity with object detection and object traction algorithms
- Neural network execution frameworks (e.g., Tensorflow, tensorrt)
- Gazebo simulation framework
- MAVlink (https://mavlink.io/en/) or other drone-communication protocols
- 3D object design and printing

Devices available:

- Compute platform
  - NVIDIA Xavier NX
- Drone hardware
  - https://www.3dxr.co.uk/multirotor-c3/multirotor-frames-c97/hexsoon-edu450-new-v2-with-leds-p5008
  - https://www.3dxr.co.uk/autopilots-c2/the-cube-aka-pixhawk-2-1-c9/here-gnss-and-rtk-c11/cubepilot-bundle-here-3-cube-orange-std-set-istand-p4999

Expected Outcome:

At the end of the project, the team is expected make a demo to the AF-A faculty visiting Mines. The scenario will be based on tracking a toy adversarial drone autonomously in front Guggenheim Hall. The students who will make the demo will need to receive online hobby drone pilot certification (a 30m questionnaire).