Université de Sherbrooke

(VAMUdeS)

1.Object Detection, Classification, and Localization:

1.1 System design:

- **Object Detection and Classification:**

  - Manual detection and classification will be performed using the custom MapUS software instead.

  - MapUS enables the distribution of images to team members for manual tagging, ensures no duplicate tagging, and handles image submission to the interoperability server.

- **Automated Software Consideration:**

  - The team's classification code, known as CNN drone (Convolutional Neural Network), has been trained with previous competition images.

  - It is currently not sufficiently reliable, especially in areas like color and letter classification, to be used in competition.

2.Mapping:

1.1 System design:

- **Software Selection** :

- Metashape by Agisoft is chosen for its compatibility with the team's needs.
- It has previously been used for mission debriefing and in other competitions.
- Metashape takes images and associated GPS positions to create 2D or 3D maps of the mapped area.
- It aligns batches of images to determine precise positions and angles, generating a mesh to represent the third dimension.
- An orthomosaic map adhering to the WGS 84 standard can be created and exported in JPEG format, cropable to a specified ratio.

- **Mapping Process**:

- Multiple batches of alignment are planned during the flight, focusing on this initial and time-consuming step.
- The generation of the mesh and orthomosaic map will occur either upon completion of the imaging task or as the drone returns to land.

3.Autopilot:

3.1 System design:

- **Autopilot Choice**:
- In previous years, the team successfully used the Pixhawk 2.1 on Orion as the onboard autopilot controller, and it met all the required specifications.
- **Tasks Performed by Autopilot**:
- The competition involves three tasks requiring the autopilot's capabilities.
- Obstacle avoidance can be performed directly from the ground control station using the autopilot.
- Autonomous waypoint navigation is implemented in the ArduCopter firmware running on the Pixhawk 2.1, allowing waypoints to be uploaded before the mission, enabling autonomous navigation during the flight.
- The final task involves autonomous flight, with various commands that can be added to waypoints, such as delays and orientation follow, providing effective off-axis target tracking, auto-takeoff, and auto-land capabilities.
- **Ground Control Station**:
- The chosen ground control station software is Mission Planner, which has been customized to meet the competition's specific mission requirements.
- Several features were added to the software, including sending UAV telemetry to the competition's interoperability server, automated flight planning with Companion, obstacle avoidance (SDA function), live position transmission via tracking antenna, display of speed and altitudes in imperial units, and the ability to show other teams' aircraft in the main UI.
- A shortcut for emergency braking of the drone during flight was also added to enhance safety.
- **PID Calibration**:
- The PID (Proportional-Integral-Derivative) settings have not changed since previous years, as the platform has remained consistent.
- This continuity in PID settings ensures that the autopilot's control algorithms remain well-calibrated and perform reliably.

4.Obstacle Avoidance:

4.1 System design:

- **Obstacle Avoidance - UAS Position Reporting**:
- To avoid obstacles like other aircraft, the UAS uploads telemetry data to the interoperability system.
- This allows other teams to know the UAS's position and adjust their trajectories accordingly.
- **Obstacle Avoidance - Stationary Cylinders**:
- To avoid obstacles like stationary cylinders, the UAS modifies its trajectory by calculating new waypoints.
- The obstacle avoidance algorithm smooths the path of the aircraft to align real behavior with planned behavior.
- If flying over obstacles is not possible, the avoidance plan is to navigate around the cylinder.
- Obstacle avoidance planning is done before takeoff, and the Ground Control Station Operator (GCSO) validates the new waypoints before uploading the mission to the aircraft.
- **Algorithm for Obstacle Avoidance**:
- The algorithm is recursive and continuously adds waypoints until the aircraft's path follows the outer circle around the cylinder.
- Key elements: green circle (the obstacle), inner red dotted line (inaccessible zone), and outer red dotted line (reference path).
- The process involves creating waypoints on the original path, then in the middle of the smallest arc of the outer circle.
- This repetition continues until the aircraft's trajectory is clear of the inner circle.
- The distance between the two circles increases by 2 feet with the creation of 5 new waypoints per obstacle to avoid slowing down the drone with an excessive number of waypoints.