Test Project

Module 3 – Autonomous Programming and Flight Planning

3 hours

Unmanned Aerial Systems

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1 Introduction to Test Project

Unmanned aerial vehicles (UAVs) are widely used in many practical fields, such as agriculture, inspection, delivery, and rescue operations. For a waypoint navigation task, the quadcopter is required to fly autonomously from one point to another. A navigation control system is essential to enable the UAV to track the desired waypoints effectively. In this work, the ArduPilot is utilized to navigate the quadcopter on waypoint tracking. The goal is to enable the quadcopter to track the desired waypoints. To support the use of ArduPilot, the Mission Planner software is used to monitor the position and configure the control parameters of the UAS. Simulation test flights can be conducted in the Mission Planner simulation environment to verify the effectiveness of the ArduPilot waypoint navigation control system of the autonomous flight.

In this Module competitors will use Mission Planner (sitl) to visualize vehicle data during flight and create autonomous flight plans specific to vehicle tracking. Software-in-the-Loop (SITL) is a simulation method where the ArduPilot firmware runs as a normal computer process, communicating with Mission Planner exactly as a real flight controller would. It allows full testing of configuration, missions, and flight behavior without any physical hardware.

Beyond mission planning, control software for UAS's offer an array of monitoring and analysis tools.

Users can effortlessly keep tabs on critical telemetry data, including altitude, speed, and battery status, in real-time. This real-time insight is paramount for ensuring safety and optimal performance throughout the mission. Furthermore, the software facilitates the analysis of detailed flight logs, aiding users in diagnosing issues, evaluating performance metrics, and refining strategies for future missions.

2 Description of project and tasks

Module 3 – Autonomous Programming and Flight Planning is expected to be completed within 3 hours.

2.1 Assessment Criteria

Module 3 will be objectively scored by a panel Experts.

Competitors should complete all tasks independently within the time allocated to the Module.

First, prepare according to requirements.

Second, complete the tasks listed below

Lastly, after all tasks listed in this Test Project are completed, Competitors should clean and organize their work area and submit the relevant materials and Record Sheets to the Experts.

READ THE ENTIRE DOCUMENT BEFORE PROCEEDING.

Workplace safety procedures and protocols must be always demonstrated.

If you are advised of a safety infraction during this module, there will be a percentage of marks deducted for each infraction. On the 3rd infraction, the Competitor will be stopped, and the evaluation will be based on work already completed.

Experts will not intervene unless there is a safety concern.

2.2 Module Task

In module 3 competitors will use Mission Planner to visualize vehicle data during flights and create autonomous flight plans specific to vehicle tracking.

Scenario

A local **consulting company has hired** you to map out the complete property for the school, as they want to plan for future expansions and building projects. We want to survey at least 2cm GSD.

They have asked you to provide aerial imagery that shows a comprehensive view of the site, aiding in the identification of potential delays or issues.:

- Documenting weekly progress. Captures aerial photographs for side-by-side comparisons.
- Comparing as-built conditions. Identifies discrepancies between plans and actual construction.
- Sharing visual updates. Provides stakeholders with real-time insights into project status.
- Monitoring of illegal activities (e.g., unauthorized dumping)

Task # 1 – Plan a Mission using Mission Planner

Study Area

The monitoring area is Chrysalis Academy school site to the east of M42 Metropolitan route and north of Tokai Rd. Table Mountain National Park is to the west, and an access road is on the north side.

1. Explore the study area using the images provided.
2. Load the Pre Cache Map data it into Mission Planner.
3. Takeoff & Landing Site - Select a dedicated, safe on-site takeoff and landing area for the drone. The location must be away from crowds, free of obstacles, pose no flight-safety hazards, and meet aerial photography operating requirements
4. Define the area for your flight and use the following initial parameters:
   Altitude: e.g., 80–130 m for clear imagery.
   Overlap: 60% side for mapping accuracy.
   Camera Specs: Sony A7R.
5. Camera Setup
6. How many flights do you need to cover this area?
7. Use the app to design the flights. Save the project so you'll be ready when you get to the site.

Mission specification (To be provided in the Morning Briefing)

Requirement	Example Specification
Home position	SITL default location
Takeoff	AUTO_TAKEOFF to 20 m AGL
Boundary Waypoint 1	
Boundary Waypoint 2	
Boundary Waypoint 3 etc.	
Return	RTL command at end of mission
Waypoint Radius	
Fence Areas	

Tip: remember that the estimated flight time generally does not include the time to get to the first way point.

Required parameter configuration (sample)

Parameter	Required value	Candidate value	Notes
FRAME_CLASS	1		Quad
FRAME_TYPE	1		X configuration
FS_THR_ENABLE	1		RC failsafe: RTL
BATT_LOW_VOLT	14.0		Low battery RTL (4S)
BATT_CRT_VOLT	13.2		Critical battery land
RTL_ALT_M	20		RTL altitude: 20 m
WP_SPD	5		Waypoint speed: 5 m/s
WP_ACC	3		Waypoint acceleration
LAND_SPD_MS	.25		Landing descent: 25 m/s
PILOT_TKO_ALT_M	10		Auto takeoff: 10 m

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Task #2 – Save your Simulation Mission Parameter File on the supplied USB stick in the following format:

XXX_MISSION_SIM.param where XXX is your country

Task # 3 – Save and submit your simulated flight on the supplied USB

XXX_MISSION.waypoints where XXX is your country

3 Instructions to the Competitor

3.1 Competition Requirements

Competitors will use the computer supplied and will be provided with mapped cache data.

Image files and a USB stick to save data will also be provided. Save the files into the Module 3 folder inside the main country folder.

Instructions

1. Competitors should not bring any device irrelevant to the Competition to the workstation.
2. Tools, electrical components and materials for the Skill are all provided at the workstation or in the shared work area for Competitor access.
3. During the Competition, for matters irrelevant to the Competition contents, such as use of the washroom, or report of equipment, facilities, tooling, or tool faults, Competitors can seek help from the Experts.
4. Competitors may refer to the reference documents for the Skill provided.

Operation Safety Rules

1. Put on proper personal protective equipment according to operation requirements;
2. Take site safety protection measures and confirm them;
3. Before performing operations with power off, confirm that the batteries are disconnected;
4. Before performing operations with power on, connect the battery after confirming that no safety hazards exist;
5. Do not operate in an unsafe manner;
6. All the tools or materials used during operations should be stored properly after use.

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4. Equipment, Machinery, Installations, and Materials Required.

4.1 Equipment provided by the Competition Organizer

One laptop installed with core programming tools will be provided to all Competitors on C-2.

Mission Planning

Cached Map Data.

One laptop installed with core programming tools including but not limited to:

- Mission Planner
- Raspberry PI Imager
- VS Code
- Drone OS Image
- WS500 Documentation
- WinSCP

All equipment, tools, and materials listed in the Infrastructure List –see the WorldSkills Forum and Technical Description;

Personal Protective Equipment (PPE) and tools must be provided by Competitors.

Testing equipment for fault finding module;

Objects required for manipulation during the performance and testing.

Test arena for the performance evaluation tasks

UAS with faults and instructions for the fault-finding module.

Common UAS and components for the design and prototyping module.

Parts and tools required to complete the design and prototyping modules.

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4.2 Equipment and Materials not Permitted

Non – Supplied laptops or portable computers.

Tablets, such as Android, IPAD, etc.

Memory stick /digital storage devices.

Portable radios/ Music players.

Electronic organizers/diaries.

Wireless communication devices, including mobile phones.

Any other software not provided by the Competition Organizer without the approval of Experts.

Pre-programmed Raspberry Pi images not approved; teams will be required to delete any images under the supervision of Experts during the familiarization period and will then receive a pre-approved version.

During the Competition, no tools, equipment, stationery, components, parts, raw materials, manuals, drawings, electrical devices, or digital storage devices may be taken out of or brought into the Competition venue without the approval of the Skill Competition Manager.

4.3 Items to be Provided by Teams

Each team must provide and wear team identification indicating their region. These must be always worn during the Competition.

5. Notes on Schedule

If Competitors complete a module ahead of schedule, they may use the time to practice other modules.

Competitors may modify (build) parts of their UAS during the Competition.