PX4 Autopilot Task Planning with LLM & MAVSDK

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Date: 03.23.2025

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1. Introduction

This report outlines multiple task templates designed for realistic drone experiments. In a scenario where the drone uses YOLO-based object detection and is controlled via MAVSDK on PX4, these templates help validate and showcase the drone's motion, navigation, and autonomous capabilities. Each task template lists specific missions that a user might request (for example: "take off to 10 m", "move forward 10 m", "hover", etc.), covering the full range of operations from takeoff through object engagement, surveying, and safe landing.

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2. Task Templates Overview

2.1 Pre-flight & Takeoff

This category focuses on initializing the system and achieving a stable hover. These tasks ensure that the drone's sensors are calibrated and that it can safely transition from ground to flight.

Mission Task	Description	Parameters/Examples	User Request Example
System Check	Perform pre-flight system checks and sensor calibrations.	Run calibration routines; check GPS, IMU, magnetometer.	"Run pre-flight checks and calibrate all sensors."

Takeoff	Arm and lift off to a set altitude.	Takeoff to 10 m altitude.	“Take off to 10 meters.”
Hover	Stabilize in mid-air for a set duration.	Hover for 5 seconds.	“Hover for 5 seconds.”

2.2 Navigation & Waypoint Missions

These tasks test the drone’s ability to navigate to specified locations, follow defined paths, and adjust its trajectory during flight.

Mission Task	Description	Parameters/Examples	User Request Example
Go-to Location	Navigate to a specific GPS coordinate or relative position.	Move to coordinate (47.397742, 8.545594, 10) or 10 m forward.	“Go to location (47.397742, 8.545594, 10)” or “Move forward 10 m.”
Waypoint Navigation	Follow a sequence of waypoints for complex missions.	Define multiple waypoints (e.g., (10 m, 0 m), (10 m, 10 m)).	“Follow these waypoints: start at point A, then B, then C.”
Directional Movement	Execute precise lateral or rotational movements.	Move left/right 5 m; turn 90° left/right.	“Move left 5 meters and then turn 90 degrees to the right.”

2.3 Object Detection & Target Engagement

Integrating YOLO-based object detection, these tasks instruct the drone to detect, approach, and interact with objects in the scene.

Mission Task	Description	Parameters/Examples	User Request Example
Detect & Approach Object	Use onboard vision (YOLO) to detect an object then navigate toward it.	Detect red car; navigate to its coordinates.	“Find the red car and fly towards it.”

Hover Near Object	Once near the target, maintain a steady hover for observation.	Hover for 5–10 seconds at a safe distance.	“Hover next to the detected object for 5 seconds.”
Circle Around Object	Perform a circular flight pattern around the detected object for inspection.	Circle with a 5 m radius, complete a full 360° rotation.	“Circle around the object.”
Track Moving Object	Continuously adjust the drone’s flight path to follow a moving target.	Update flight path in real-time based on object movement.	“Follow the moving vehicle.”

2.4 Area Survey & Inspection

These tasks are designed for systematic surveys, mapping, or structural inspections.

Mission Task	Description	Parameters/Examples	User Request Example
Grid Survey	Fly in a grid pattern over a defined area for mapping or inspection.	Define grid with 10 m spacing.	“Survey the area in a grid pattern.”
Waypoint Inspection	Navigate through a series of waypoints to inspect specific locations.	Multiple waypoints with predefined coordinates.	“Inspect these points: A, B, C, and D.”
Altitude Variation	Vary the flight altitude during the survey to collect multi-level data.	Ascend to 20 m, descend to 5 m between waypoints.	“Adjust altitude during the survey for better data capture.”

2.5 Return-to-Launch & Landing

This category ensures safe mission completion with controlled descent and landing.

Mission Task	Description	Parameters/Examples	User Request Example

Return-to-Launch (RTL)	Automatically navigate back to the starting point.	Use RTL command via MAVSDK.	“Return to launch point.”
Controlled Landing	Descend smoothly and land at a designated location.	Land with a gradual descent.	“Land slowly at the current position.”
Disarm	Safely shut down the motors after landing.	Execute disarm command post-landing.	“Shut down the drone after landing.”

2.6 Emergency Handling

Emergency tasks ensure safety by triggering fallback routines when needed.

Mission Task	Description	Parameters/Examples	User Request Example
Low Battery Return	Automatically trigger RTL if battery level falls below a threshold.	Monitor battery; trigger RTL if below 20%.	“If the battery is low, return to launch immediately.”
Immediate Emergency Landing	Execute an immediate landing if critical failures occur.	Trigger emergency landing command.	“Emergency landing now.”
Failsafe Activation	Activate predefined failsafe protocols on sensor or system error.	Trigger failsafe routines upon sensor failure.	“Activate failsafe if any sensor fails.”

Key Findings

- MAVSDK covers nearly all drone mission skills needed for PX4 integration.
- Tasks like arm(), takeoff(), goto_location(), return_to_launch(), and land() are fully supported via Python API.
- YOLOv8 provides object position (x, y, depth), which can be converted to relative/NED coordinates or GPS for use with MAVSDK.
- VLMs (like LLaVA) help convert object detection results into rich scene descriptions for the LLM.

- LLMs (like LLAMA or GPT) can generate valid MAVSDK mission code if prompt-engineered with system capabilities.

Next Step: Task Validation Phase

Before LLM integration, we will validate each MAVSDK skill independently using PX4 SITL. This includes:

Takeoff & Hover
Navigate to GPS / Relative Positions
Waypoint Missions
Land / RTL
Emergency RTL / Failsafe Tests
Object-Centric Navigation via Relative Position, Each test will include:

- Connection to SITL
- Execution of command
- Logging of result
- Pass/fail status

Once validated, we will proceed to build the LLM Code Planner and close the loop with full automation.

3. Conclusion

This report provides a comprehensive set of task templates for testing and validating the full range of drone capabilities using PX4 with MAVSDK. Each template covers key mission types—pre-flight, navigation, object engagement, survey, and emergency handling—ensuring that the drone can be evaluated in realistic scenarios based on typical user requests.