Installation

The ZEB-HORIZON mounting base plate, damper and fixtures are pictured in the images below. With these accessories you can mount the solution directly under the DJI Matrice 600. The GeoSLAM UAV kit was developed specifically for the DJI Matrice 600, although through suitable mounting modifications it is possible to use any VTOL UAV platform as long as it lifts
3.7kg with adequate flight endurance.

Figure 1: ***Left picture:*** *Contents of UAV mounting kit. Mounting platform for the scanner head and datalogger, quick release lock, vibration damper, M600 mounting rails, safety cables.*
Right picture: Removal of the handle

The ZEB-HORIZON UAV mount comes with fittings to attach straight to the DJI M600 UAV.
Removing the rails fitted to the bottom of the UAV allows the damper to be fitted directly to the M600 (left picture). Alternatively, the 12mm tube clamps can be fitted to the damper and use the quick release system to attach to the bottom of the UAV (right picture).

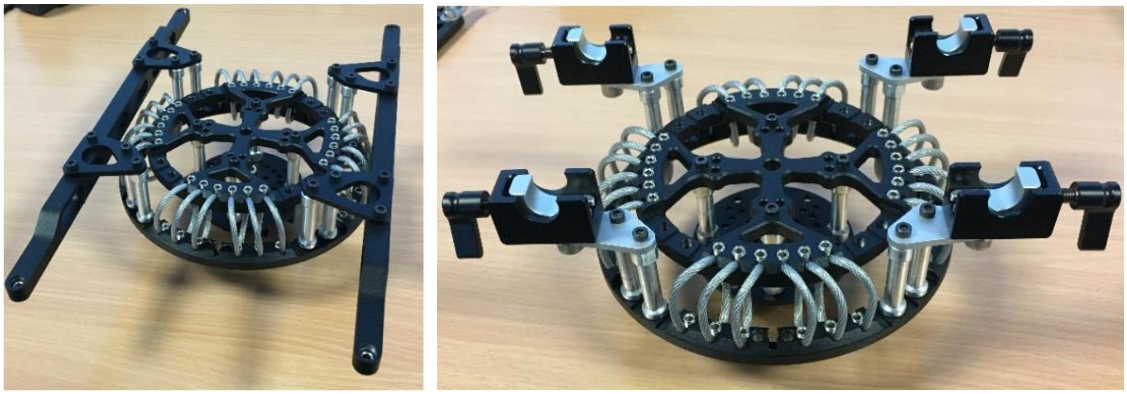


Figure 2: UAV mount options. ***Left picture****: mount to be attached directly to M600.* ***Right picture:*** *quick release system to be attached to the rails of M600*

When you configure the best fitting method for your UAV, follow those steps to complete the ZEB-HORIZON UAV installation:

- Remove the ZEB-HORIZON's handle by pulling the quick release button down and slide the handle out.
- ZEB-CAM should stay mounted on the same place as when used handled
- The ZEB-HORIZON and datalogger can be fitted to the baseplate using the eight M4x12mm countersunk screws and 2.5mm Allen Key provided.
- To assemble the baseplate and damper, slide the rail into the quick release clamp on the bottom of the damper. It can then be tightened by turning the clamp lever.
- Use the shorter 0.5m cable provided to connect datalogger with the scanner
- To remove the baseplate, loosen the clamp lever and slide the rail out, pushing down on the springloaded button to allow the rail to travel through the clamp

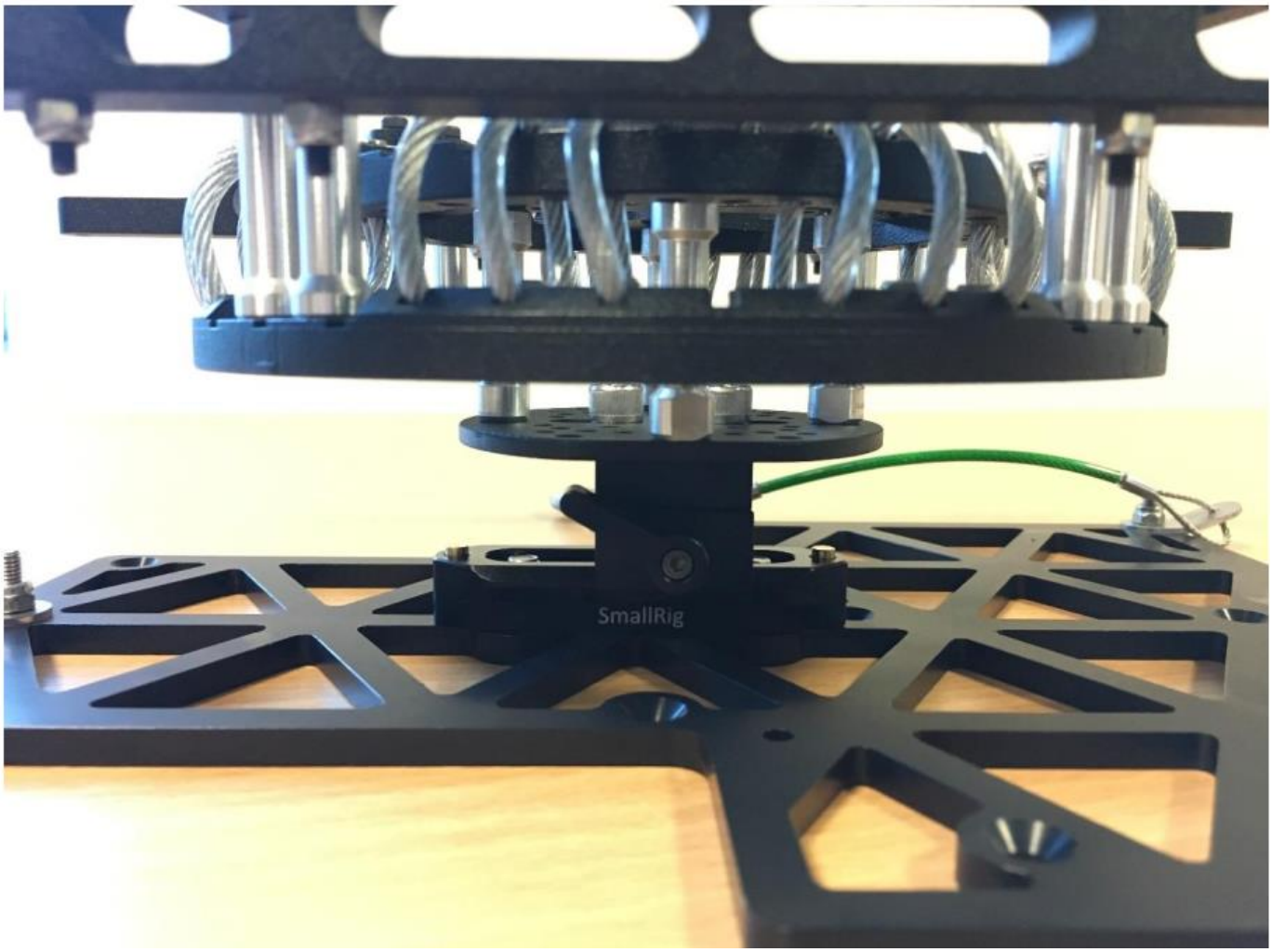


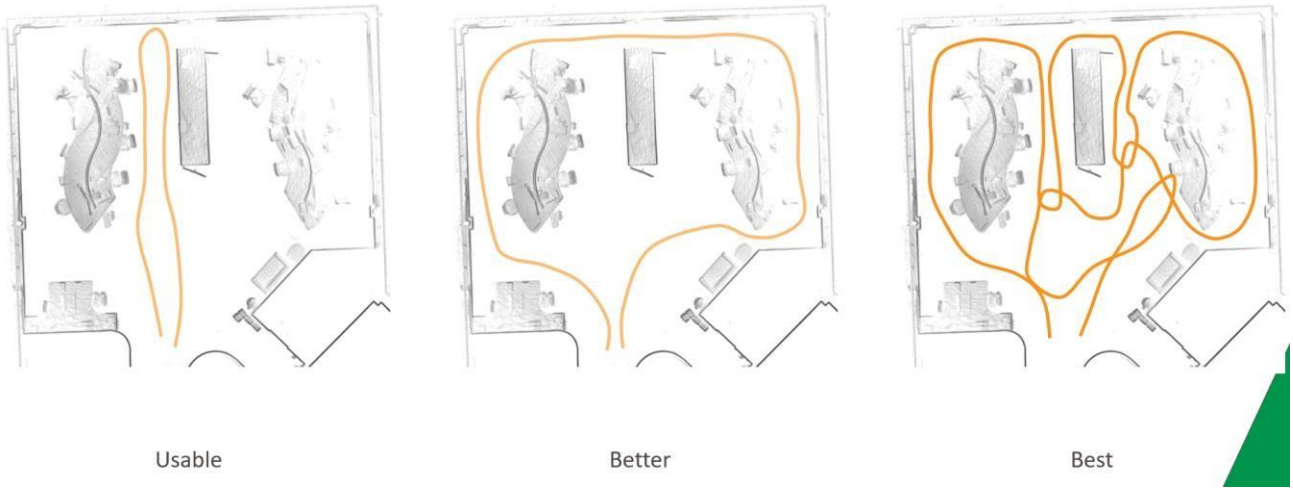
Figure 3: quick release clamp

Tip: Before flying operations and between every flight, check the centre of gravity; check that there is nothing in danger of hitting the propellers (i.e. hanging cables); check all fittings are tightly secured and thread locked (use Loctite). Just before take-off check again the primary sensor-to-UAV mount, battery mounting lock and that cable connectors are locked in. Always use the safety cables provided with the mounting kit.

Flight planning

Flight patterns

Flight patterns should incorporate horizontal “loops” similar to the operation of the handheld unit on the ground.



Example from indoor SLAM LiDAR scanning. Result is best when same features are “painted” around from all sides with maximum incident angle differences. Same principle applies to UAV SLAM flight planning.

If you want to capture data of a house, fly around the house or, if the capture area is very large, fly in a normal grid flight plan pattern covering it.

1. Round Flight Pattern

This can be used to fly around the single structures like house or towers. This way, the facades can be capture from the UAV and the loop can be closed vertically.

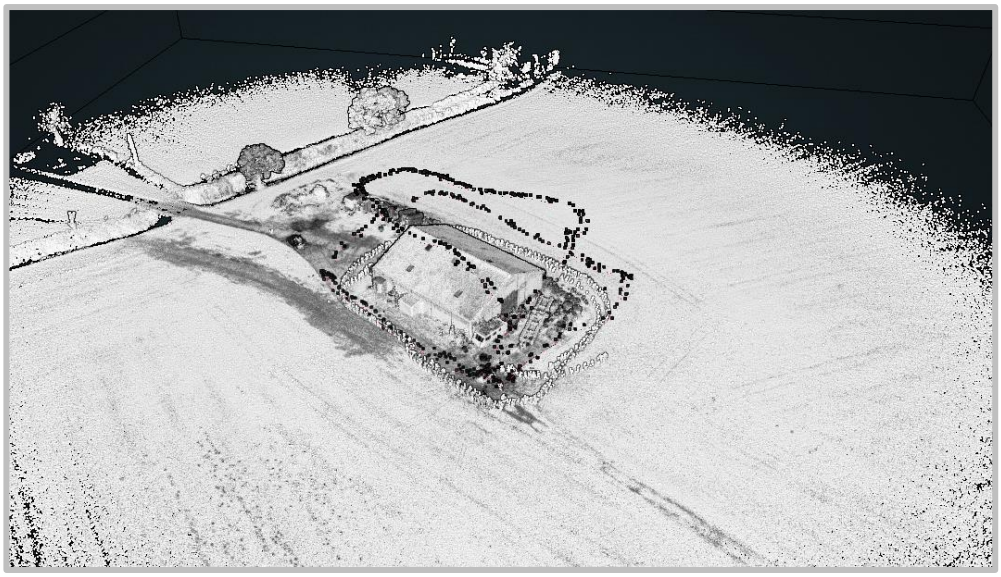


Figure 4: Round flight pattern.

2. Grid Flight Pattern

Grid pattern is suitable for covering large areas, using autamted missions. This way speed, altitude can be better controlled or point density and capturing smooth video footage for colourisation.

Tip: when creating automated missions, use course aligned flight with smoothed curves for each waypoint. It is also advisable to take off and land manually as the automated vertical speed can be fast for any smooth results.

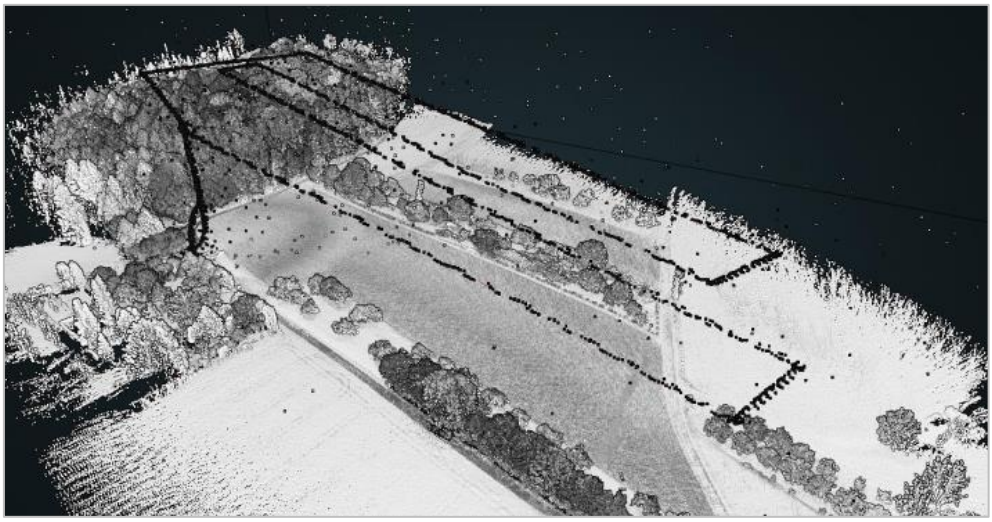


Figure 5: Grid flight pattern

3. Comb Flight Pattern

"Comb" pattern, for projects with scarcity of features. It represents a mix of area coverage and "around the house" patterns. Apply if features do not allow normal grid pattern, like in the case of corridor mapping. The manual comb flights can also result in a smoother flight capture.

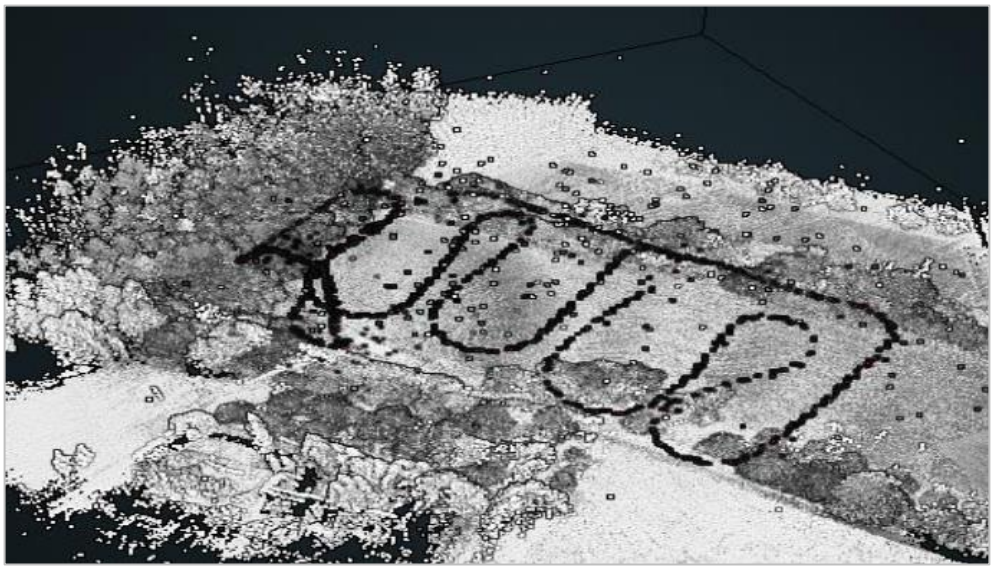


Figure 6: Comb flight pattern.

Methods of UAV flight

There is no need to fly dynamic IMU initialization routines like figures of eight before and after the data collection. All flight endurance can be used for collecting the actual project. On multiple flights, ensure 20% feature-rich overlap between adjacent pointcloud for matching the combined pointcloud using the Merge-function of the Hub software. This way even larger areas than allowed by LOS (Line Of Sight) can be covered on consecutive flights.

Because of the spherical 3D scanning pattern, ZEB-HORIZON does not mind which way it is pointing inflight. There is no need to match the air vehicle heading with the track-over-ground heading. In other words, you do not have to aim the "front" of the VTOL UAV platform to the direction where the platform is moving. This allows you to fly manually without having to fly "nose in" unless you want or the applied UAS requires you to. Stopping into hover and reversing are also OK when done smoothly. Try to avoid abrupt attitude and acceleration changes for best data, especially around vertical axis. When flying a semi-autonomous flight plan from waypoint to waypoint, platform should be moving smoothly throughout the flight to create even point distribution.

Height

Design the flight patterns with the following maximum distances in mind:

- 100m maximum scanning range
- > 40m away from features
- 30m AGL flying height will result in 60m swath
- 40m max AGL flying height for the ZEB-CAM colourization
- 40m max AGL flying height for an area with car-sized features
- 15m max flying height over LV powerlines
- 15m max flying height over GCP chequer signals of 40x40cm
- ZEB-CAM's FOV

For best possible results and if obstacles allow, consider flying the same project at two different flying heights above ground. This serves "painting" the same features from even larger range of incident angles of the laser pulses.

Speed

Groundspeed is currently tested up to 13 m/s. However, we recommend 5mps for smooth data capture.

SLAM features

Features mean any unique structures within 5 seconds of flight time seen by the SLAM algorithm. You should plan the flight so that you have some non-repetitive features well within the SLAM range during all stages of flight. Trees with their branches are perfect as there are lots of features to recognize. Urban environments in general are also good – indoors or outdoors. However, open fields are possible with large features within range. In borderline cases, consider artificial features like cars parked at open spaces.