INSITU PACIFIC
A Boeing Company

BVLOS RPAS Littoral Mapping - CASE STUDY

Amphibious support in beachhead mapping with Beyond Visual Line of Sight uncrewed aircraft

Proven Performance – Proven Delivery

Summary

The capture of highly precise, geospatial information without the need for ground control to identify terrain, vegetation density and non-natural structures was undertaken to demonstrate a highly relevant operational capability that can support amphibious operations to Defence. The demonstration was conducted utilising Insitu Pacific's Beyond Visual Line of Sight (BVLOS) Remotely Piloted Aircraft Systems (RPAS).

Aims/Objectives

The objective of this activity was to demonstrate an enhanced Concept of Operations (CONOP) for reconnaissance and assault planning activities to support Amphibious landing operations. Operational and environmental assessment of the Amphibious Operating Area (AOA) and surrounds is key to development and execution of effective assault and movement plans. Terrain capture has traditionally been achieved via satellite or high-altitude aircraft imagery, dedicated reconnaissance aircraft and/or intelligence data. Each of these mechanisms suffers from one or more limitations including low-resolution or obscured imagery, information latency, risk to assets, and alerting of adversary forces. This activity was undertaken to demonstrate the potential for BVLOS RPAS to deliver on-demand, high precision, low-risk data capture with on-vessel data processing and rapid post-flight information analysis.

What did we do?

The Insitu Pacific operations team worked closely with CASA to successfully integrate BVLOS RPAS operations into complex airspace north of Brisbane, Queensland between both Bribie and Moreton Islands to permit the data capture for the proposed amphibious activity in the vicinity of Bulwer and Cape Moreton. The total survey area covered approximately 38.63 km^2.

This survey activity demonstrated the effectiveness of High-Resolution, and High Accuracy Photogrammetric (HAP) data capture in a littoral environment without the need for pre-surveyed ground control points. Furthermore, this full cycle, capture-to-analysis toolchain – which can be completely self-contained within an Amphibious Task Force – highlights the significant reduction in lead time in comparison to non-organic third party geospatial data product generation and transfer. In addition, the ability to refresh data daily permits the application of a wide range of change detection algorithms and other deep learning techniques to further enhance the utility of the intelligence product.

Background/Context

The sequence of beachhead assessment methodology has a process whereby planning, embarkation, rehearsal, movement, assault and ultimately termination of an amphibious operation is completed. In working with defence organisations, Insitu Pacific has identified a unique and force-multiplying role for embarked ScanEagle and Integrator BVLOS RPAS that dovetail into this domain.

Providing the Commander-Landing Force and Commander-Amphibious Task Force with operationally relevant information on the Landing Zone, for environmental assessment and enemy force disposition, will assist in ensuring the AOA is free from interference by threat force surface, subsurface and land forces. Information gleaned from datasets provided by Insitu Pacific will allow amphibious planning teams to precisely plan assault locations, naval gunfire support targets, and/or ground targets for aerial support to be prosecuted prior to any landing fleet movements.

While conventional Full Motion Video provides a 'moment in time' view of the battlespace, high-resolution mapping imagery permits the use of Machine Learning to be applied over each image to significantly enhance the intelligence gained from the data collected. Having algorithms automatically detect items such as landform changes, equipment movements, shallow water/beach obstacles and any other pattern of life change over time, lessens the workload on data exploitation staff and may highlight changes not immediately obvious to the human eye.

Additionally, this type of operation requires up-to-date battle damage assessment operations and dynamic mapping tasks to support the continuous logistical support for the forces ashore.

Resources

Insitu Pacific undertook this demonstration with the proven ScanEagle BVLOS RPAS. This aircraft was fitted with additional technologies, including:

1. Airspace Access enabling technologies including Detect and Avoid (DAA).
2. Aerial spatial data capture High Accuracy Photogrammetry payload.

Insitu Pacific demonstrated a rapid data processing and visualisation GIS Tool, INEXA Surface, an Australian-developed software tool that is part of the Common Control software INEXA.

INEXA Surface was developed as a scalable photogrammetry processing system capable of transforming large-area, high-resolution image collections of hundreds of gigabytes of data into true orthomosaics, high-density point clouds and digital surface models (DSM). It is optimised for rapid processing on the tactical edge without requiring significant computing horsepower.

A single Tactical Edge Server can run INEXA Surface and host Machine Learning algorithms specifically targeting landform geometry change detection and non-natural structure identification/reporting. Combining these products delievers excellent insight into the battlespace, patterns of life monitoring and support preparation activities such weapons deployment analysis and line of sight for route planning and RF comms analysis.

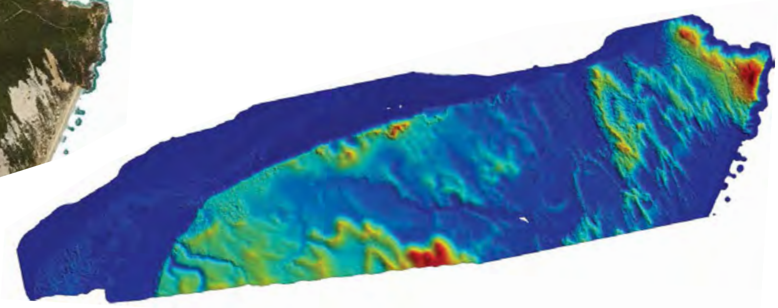
Evaluation

The flight operation demonstrated an ability to capture this area within a 3.4 hour sortie duration from launch to landing; the total capture timeframe for all 2192 images once transit has been completed was 2.5 hours.

Upon recovery of the aircraft and the captured onboard data, the completed time to provide geospatially correct and stitched data for both DSM and orthomosaic products through INEXA Surface to a resolution of =/< 0.1m, was 68 minutes (1 hour, 8 minutes).

This includes all steps involving feature detection and matching, camera data calibration, DSM fitting, orthomosaic rendering and reprojection.

By comparison, the same data set when processed through a Commercial Off the Shelf (COTS) software Package (PIX4D) to achieve the same number and types of output, was 1272 minutes (21 hours, 7 minutes).



Future Plans

This type of BLVOS RPAS payload and data processing technology is ideally suited for current near-term projects for the Australian Defence Force which seek to provide high resolution, temporal data capture and analysis through land, littoral and maritime campaigns.

Key Benefits Summary

Geospatial data capture benefits:

1. Artificial Intelligence / Machine Learning algorithms on HAP precision survey data for automated change detection.
2. Product classification for ground/vegetation/non-natural structures.
3. Environmental Coherent Charge Detection (CCD) including time of day change, structure and landform geometry update, approximate dimension reporting (e.g. infill ramp grade/road width/vegetation height).
4. BVLOS RPAS data can be augmented with hydrographic survey assessment to complete surface/subsea picture.

Airspace integration benefits:

1. Autonomous Aircraft operations undertaken in vicinity of Brisbane Controlled traffic region with close alignment to crewed systems.
2. INEXA Access DAA capability leverages a combination of onboard sensors and collision avoidance processing algorithms to provide a layered capability to minimise airspace collision risk. This capability can be utilised by the ADF across all domains to enable more flexible and safe BVLOS RPAS operations.

The effective employment of embarked BVLOS UAS is capable of not only undertaking maritime Blue Water ISR, but can extend support into the amphibious and land domain to deliver joint effects.

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