# Raptor

### No GPS? No limits.

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First-of-its-kind software suite delivering nextgen GPS resilience for autonomous systems

INTELLIGENCE

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From contested battlefield environments to urban canyons, loss of GPS through jamming, spoofing, or interference has become an operating reality.

GPS is a single point of failure that dramatically impacts drone navigation and sensemaking.



GPS interference in Europe over the course of a single week



We need new, resilient technologies to make sure autonomous systems work just as well in this new reality as they do in a GPS-powered world.



US / MEXICO BORDER Precision3D base layer

For a drone carrying out critical surveillance or tactical operations, losing position isn't just inconvenient– it's mission failure.

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KALGOORLIE MINE Precision3D base layer

For drones delivering materials or inspecting critical infrastructure in remote areas, weak signal isn't just a detour– it's a job incomplete.



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For drones delivering materials or inspecting critical infrastructure in remote areas, weak signal isn't just a detour– it's a job incomplete.



#### **Introducing Raptor**

A suite of vision-based software products that use Maxar's unique global 3D data to deliver a breakthrough terrain-based positioning system for drone navigation and sensemaking in GPS-denied environments.



MILITARY SURVEILLANCE

TACTICAL OPERATIONS



**ENERGY INFRASTRUCTURE** 



**CIVIL ENGINEERING** 



SEARCH AND RESCUE

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#### **×** Raptor core products

AERIAL POSITION

#### **Raptor Guide**

Vision-based positioning software loaded directly onto an autonomous platform to determine its aerial position at a demonstrated absolute accuracy of <10 m RMSE, enabling precise navigation in the absence of GPS.



#### Raptor Sync

Software that georegisters the full motion video feed from the drone's on-board camera with Maxar's 3D terrain data in real-time, enabling intelligence fusion, multi-domain interoperability across different sensors and accurate ground coordinate extraction at a demonstrated absolute accuracy of <3 m.



#### Raptor Ace

Software solution installed on commodity laptop equipment that works alongside drone controllers, enabling operators to extract real-time target ground coordinates from full-motion aerial video feeds with a demonstrated absolute accuracy of <3 m.









#### Raptor draws from 90M+ sq km of highly accurate 3D terrain data



## Raptor

by the numbers

#### **Global 3D datum**

**90M+ sq km** of highly accurate Precision3D<sup>™</sup> terrain data regularly updated for a reliable view of the operational terrain

#### Global 3D terrain data accuracy 3 m SE90 accuracy for Maxar's Precision3D terrain data

### **Precise aerial positioning**

Demonstrated absolute accuracy of <10 m root mean square error (RMSE) when determining UAS aerial position

#### Accurate coordinate extraction

Demonstrated **absolute accuracy of <3 m** for ground coordinate extraction



#### Maxar's global 3D data delivers a true operational terrain

Many other vision-based positioning solutions rely on 2D maps, requiring downward-facing cameras that aren't effective in low altitude, high-relief terrain situations.



Maxar's 3D terrain data (Precision3D<sup>™</sup>) provides a real-world view that ensures high performance with forward and side-looking cameras, including at low altitudes, making it the visual-based positioning solution for many flight conditions.





# Raptor GUIDE

# AERIAL POSITION





#### × Raptor Guide

## Precise navigation in GPS-denied environments

- Vision-based positioning software loaded directly onto an autonomous platform to determine its aerial position at a demonstrated absolute accuracy of <10 m RMSE.
- Works with commodity on-board camera systems, using the camera's live video feed, Maxar's 3-meter accurate 3D terrain data and proprietary algorithms to determine the drone's position.

#### Relevant use cases

- Tactical operations, including loitering munitions
- Surveillance drone operations
- Commercial drone operations



**Sample Results** 



#### **×** Deployable on any drone platform



## Smaller multi- and single-rotor drones

Mapping, surveillance, reconnaissance, tactical operations, emergency response, infrastructure inspections, civil engineering, agriculture



Hybrid VTOL and

heavy-duty multi-rotor





#### **Fixed wing drones**

drones Mapping, surveillance, reconnaissance, tactical operations, emergency response, cargo delivery, infrastructure inspections, civil engineering, agriculture

Mapping, surveillance, reconnaissance, tactical operations





#### **Raptor Guide Key Advantages**

#### Accurate



## Positional accuracy

Has demonstrated better than 10 m absolute positional accuracy without GPS or GNSS.



#### Industry-leading 3D reference included

No additional reference data licensing required. Maxar has a unique foundation of global high-resolution 3D terrain data with 3 m accuracy. We own the satellite source data and update base layers regularly.

#### Deployable



## No specialized hardware

Maxar software and data runs on commodity COTS hardware that is low-power, accessible and economical. Works with standard calibrated cameras.



#### EAR-99 compliant

No burden of export license or lengthy compliance screenings required, making the software ready-to-deploy sooner

#### Applicable



## Low altitude, day and night

3D approach supports low profile, terrain avoiding missions. Provides accurate position estimates down to 120 m flight altitudes. Works on visible (EO) and infrared cameras



## Non-dedicated camera

Operates optimally with frontfacing, 45 degree off-nadir camera, allowing co-use with existing visual monitoring and automatic target recognition cameras



#### Raptor Guide registers video from an existing forward-mounted camera using 2D to 3D phase correlation

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Using points from the video frame image correlation, Raptor Guide uses Perspective and Point (PnP) algorithms to solve for the drone's 3D position in real-time

#### **POSITION ESTIMATES**

Latitude: 39.7540332° Longitude: -105.2380540° Altitude: 103.2m AGL

#### **KEY SPECIFICATIONS**

- **Sensors**: Passive EO or IR, fixed, 45 degrees forward looking
- Altitude: 50 20,000+ m AGL
- Outputs: Sensor Location and Heading
- **Frequency**: 1Hz
- Drift Correction: ± 1,000m
- **Export Controls**: EAR99
- Absolute accuracy metrics:
- Precision3D: 3 m SE90 in X, Y, and Z
- Absolute Positional Error: <10 m (90<sup>th</sup> percentile)
- **Compute**: Commodity SBC with GPU



Raptor Guide provides position updates every second to the navigation system to maintain position without GPS

**×** Raptor Guide – Operating View



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INTELLIGENCE

# Raptor SYNC

#### **UNIFY YOUR VIEW**





## × Raptor Sync

## Georegister full-motion video for real-time data fusion and interoperability

- Software that georegisters the full motion video feed from the drone's onboard camera with Maxar's 3D terrain data in real-time, enabling intelligence fusion, multi-domain interoperability across different sensors and accurate ground coordinate extraction at a demonstrated absolute accuracy of <3 m.</li>
- May be used to complement Raptor Guide for many mission sets, enabling consistent coordinate extraction without GPS information or ground control points.

#### **Raptor Sync:**

- Is proven in operational environments
- Accuracy benefits from the 3 m SE90 accuracy and global coverage of Maxar's Precision3D<sup>™</sup> data.
- Supports oblique look angles and low-altitude aerial vehicles
- Includes an open-source full-motion video (FMV) software development kit (SDK) to support integration





#### Accurate

- Enhance full-motion video (FMV) absolute positional accuracy to 3 m SE90
- Enables accurate coordinate mensuration without ground control points
- Optimal alignment with highly-accurate foundational 3D data
- Consistent global accuracy



- Real-time sensor fusion
- Georegistration of both nadir and oblique imagery and video
- Automates georegistration without manual intervention
- Integrates with single frames and full-motion video feeds



- Facilitates interoperability between unmanned systems and end user applications by anchoring multi-source sensor data against a common foundation.
- Regardless of which hardware or software platforms are deployed, Raptor coordinates can be exchanged across system boundaries, delivering scalable cross-system architecture.
- Proven in operational environments; adapts to specific workflows and mission needs
- Customizable installation for immediate or archived image processing
- Operates optimally with front-facing, 45 degree off-nadir camera, allowing co-use with existing optics.



#### Raptor Sync: Georegistered in real-time

Building 4 Building 6

lon:-81.8169580 lat:32.0729280 hgt:+16.79m



Building Z

#### **×** Better together: Raptor Guide and Raptor Sync

#### **Raptor Sync**

- Registers satellite imagery or aerial video to Maxar's 3D data
- Allows users to determine precise <u>3D ground</u> <u>coordinates</u> of objects in 2D imagery & video

#### **Raptor Guide**

- Uses Maxar's 3D data and aerial video content to estimate the <u>3D coordinates of the aerial platform</u>
- Allows users to determine the aerial platform's location in real time without GPS information







#### **Raptor Sync and** Raptor Guide work in harmony to provide resilience for a range of critical autonomous drone missions.



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#### **Raptor Guide + Raptor Sync Operating View**



Maxar License Server

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# Raptor

# NAVIGATE **EXTRACT** COORDINATES OPERATOR







## Putting the full power of the Raptor suite into the hands of the operator

- Software solution installed on commodity laptop equipment that puts the full power of the Raptor suite into the hands of the operator.
- Operating alongside existing drone controllers, Raptor Ace enables operators to locate ground features/objects to extract real-time ground coordinates from full-motion aerial video feeds with a demonstrated absolute accuracy of within 3 m.
- Delivered as an aftermarket kit that can be installed on any laptop, no additional hardware required.
- Tested and demonstrated in multiple countries.





#### **Raptor Ace Key Advantages**

#### Accurate

## Positional accuracy

Highly accurate localization. Testing demonstrates better than <3 m TCM accuracy without GPS/GNSS.



#### Industry-leading 3D reference included

No additional reference data licensing required. Maxar has a unique foundation of global high-resolution 3D terrain data with 3 m accuracy. We own the satellite source data and update base layers regularly.

#### Deployable

## No specialized hardware

Software solution runs on commodity low power COTS hardware. Works with standard calibrated cameras.

#### **Multi-Mission**

Facilitates precise navigation for Search and rescue operations around collapsed buildings, infrastructure inspections in urban environments, agriculture mapping in remote fields and in defense operations that requires resilience to GNSS jamming

#### Applicable



#### Low altitude, day or night

3D approach supports low profile, terrain avoiding missions. Provides accurate position estimates down to 120 m flight altitudes. Works on visible (EO) and infrared cameras



## Leverage existing optics

Operates optimally with frontfacing, 45 degree off-nadir camera, allowing co-use with existing mission cameras – no need for a dedicated downward looking camera



File View New Add Help



**Raptor Ace supports** critical tactical autonomous drone



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operations and missions.

**×** Raptor Ace Operating View

#### **Raptor Ace solution in context**







#### > Demonstrated performance in a flight test with Inertial Labs



In testing with Inertial Labs, Raptor Guide enabled an Inertial Labs Navigation System and Visual Inertial Unit (VIU) on a Cessna 172 Skyhawk to fly without GPS for 55 km with an average absolute accuracy of less than 10 m root mean square error (RMSE) throughout the flight.







































































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