



# **HONEYWELL** **ALTERNATIVE** **NAVIGATION**

For manned and unmanned aircraft and military surface vehicles

**Honeywell**

# INTEGRATED LAYERS OF RESILIENCY FOR ALL GNSS DEGRADED OPERATIONS

Aircraft and unmanned autonomous systems have relied on highly accurate navigation systems that combine the best of both worlds by blending an inertial navigation system (INS) with a global navigation satellite system (GNSS). But how do pilots or unmanned systems navigate when GNSS signals aren't available?

Honeywell's Alternative Navigation technology allows commercial and military pilots use alternative navigation technologies that use sensors like cameras, LiDAR, radar, radios and star-trackers to augment and improve INS data. These technologies can fill the void left when GNSS signals are jammed, blocked or simply unavailable. In a traditional INS-GNSS configuration, the GNSS signals are used to correct errors that cause inertial systems to 'drift' over time. Alternative navigation technologies can augment and aid the INS in a GPS-denied environment.

## WHAT IS ALTERNATIVE NAVIGATION?

Alternative Navigation System (ANS) is a collective term used to describe an alternative means of navigation using systems or sensors made up of cameras, LiDAR, radar, radios and star trackers to aid traditional navigation systems. Alternative Navigation enables vehicles and aircraft to navigate when the traditional navigation systems (INS or GNSS) is degraded or not available. With advancements in sensor technologies and the emergence of machine learning (ML), artificial intelligence (AI) and internet of things (IoT), it is now possible to reduce the dependency on GNSS and INS. Alternative Navigation is a subset of Alternative Positioning, Navigation & Timing (APNT) initiatives driven by FAA and other governmental institutions.

## WHY YOU NEED ALTERNATIVES TO GNSS

Position and timing signals from global navigation satellite systems (GNSS) have become the primary source of navigation for vehicles across air, land and sea. GNSS has seen a significant increase in intentional and unintentional disruptions including jamming and spoofing.

Intentional disruptions, caused by adversaries are meant to deny critical navigation systems in mission operating areas.

Unintentional disruptions, on the other hand, can be due to multi-path errors and are very common in urban environments. These disruptions can last from a few seconds to several hours.

Hence, it is imperative to understand and partner with our customers to engineer alternatives to GNSS based navigation to improve performance in civilian and military applications.

## VALUE TO YOU

### MAXIMUM PERFORMANCE –

With multiple systems onboard for increased navigational accuracy.

### CONSISTENT AVAILABILITY –

Navigation is critical to flight; this solution makes sure you have navigation available when you need it most.

### SYSTEM INTEGRITY –

Solution keeps you protected from spoofing and jamming so you can trust the integrity of what you are reading.

### UNRIVALED SIZE WEIGHT AND POWER –

All the power and effectiveness you need without the size/weight you don't.

## OUR PEDIGREE

Building on decades of leadership in inertial navigation systems for all kinds of aircraft and spacecraft, Honeywell engineers have made enormous progress in alternative navigation, aided by evolutionary advancements in sensors and other enabling technologies. Honeywell was one of the first companies to successfully demonstrate alternative navigation technologies in a GPS-denied environment.

## LARGE UAS/MILITARY AIRCRAFT SOLUTIONS

### Vision Navigation

Honeywell's Vision Aided Navigation system uses live camera feed (optical and/or IR) and compares it with maps to provide a passive un-jammable highly accurate absolute position. This was demonstrated on Embraer E170 and achieved a GPS like performance (i.e., horizontal position accuracy of 10m CEP50) during GPS denied conditions.

### Celestial Navigation

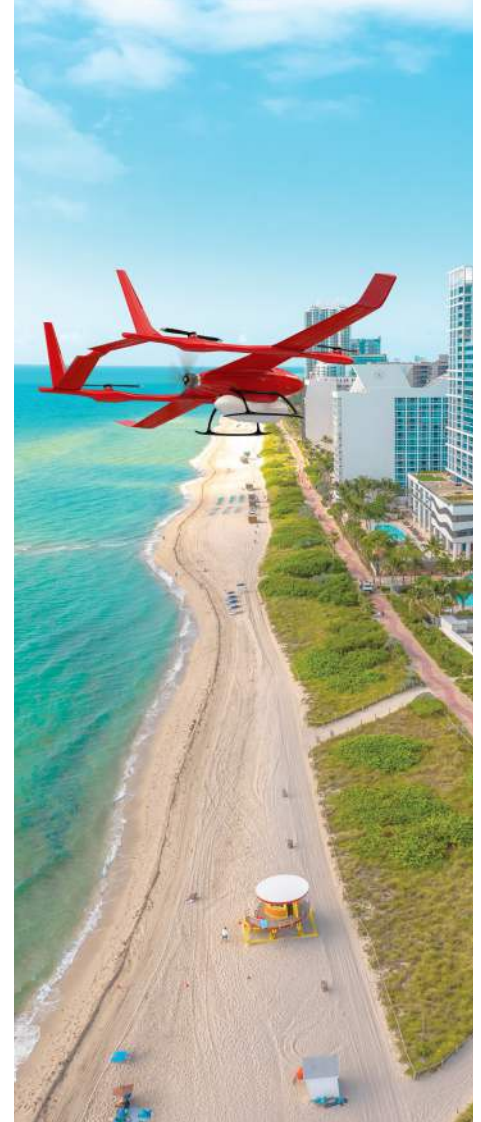
Honeywell's Celestial Aided Navigation system utilizes star tracker to observe stars and Resident Space Objects (RSOs) to provide a passive un-jammable solution with GPS-like accuracy in GPS denied or spoofed conditions. This was recently demonstrated on a land vehicle and achieved an accuracy of 30m CEP50.

### Magnetic Anomaly Aided Navigation

Honeywell's Magnetic Anomaly Aided Navigation system measures earth's magnetic strength and compares with magnetic maps to accurately identify the position of the vehicle. The technology was successfully demonstrated on Embraer E170 recently.

### Radar Aided Navigation

Honeywell's Radar Aided Navigation system uses radars to measure velocity and provide this information to INS. INS utilizes this information to improve its accuracy.



## SMALL UNMANNED AERIAL SYSTEMS (UAS)

### GPSdome by InfiniDome

GPSdome is a small sized, add on device that provides protection against GPS jamming, ensuring continuity of autonomous navigation and operation during jamming operations. GPSdome is compatible with any GNSS receiver on the market and with any off the shelf GNSS antenna. GPSdome does not include the GNSS receiver or the antennas.

### Honeywell Compact Inertial Navigation System

The size of a deck of cards, the Honeywell Compact Inertial Navigation System (HCINS) uses tactical-grade inertial sensors to provide centimeter-level accuracy to commercial and military customers. The HCINS outputs position, orientation and velocity data.

### Honeywell Radar Velocity System

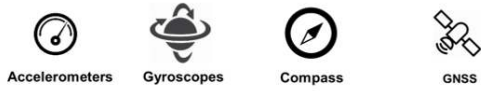
The Honeywell radar velocity system (HRVS) is a small, light weight, low power and low-cost radar-based, velocity aiding system for inertial navigation systems. The HRVS uses mmWave sensing technology (60-64GHz or 76-81 GHz) and outputs range, velocity and angle of objects.



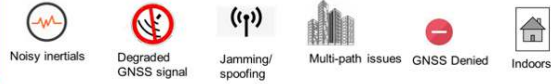
# HONEYWELL APPROACH

## TRADITIONAL NAVIGATION

### INS/GNSS Centric Solution

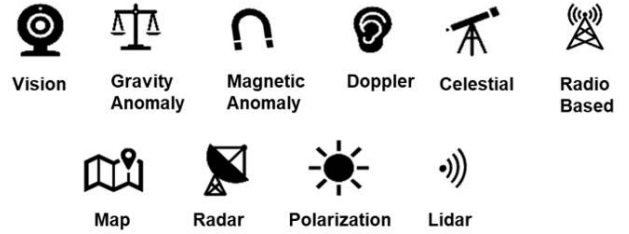


#### Limitations



## ALTERNATIVE NAVIGATION

### Mission Centric Solution



### Future Navigation Solution Improves:

Availability

Integrity

Performance

SWaP + Cost

## BUILDING A RESILIENT INFRASTRUCTURE

No single Alternative Navigation System can replace GNSS as each system has its own advantages and limitations. Our focus is on building a layered resilience architecture by fusing various navigation systems to create robust solutions that allow customers to mix and match multiple technologies to meet their operational requirements.

### For more information

To learn more visit:

[aerospace.honeywell.com/us/en/products-and-services/product/hardware-and-systems/sensors/alternative-navigation-systems](https://aerospace.honeywell.com/us/en/products-and-services/product/hardware-and-systems/sensors/alternative-navigation-systems)

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N61-3171-000-000 | 07/23  
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FUTURE  
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