INTERNATIONAL MARITIME FORUM "GLOBAL COMPASS" 2025

IntelliCelestial

Innovative Simulation Platform for Modern Astronavigation and AI-Augmented Star & Satellite Tracking

Presented by Zdravko Atanasov

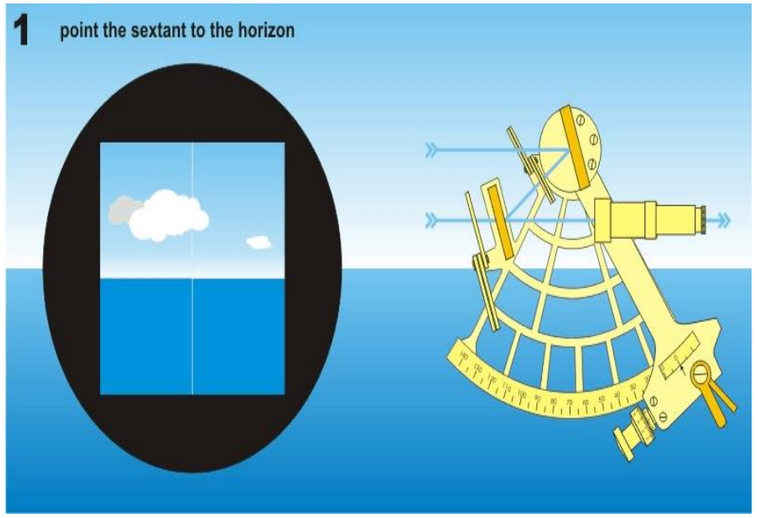
The Challenge We Address

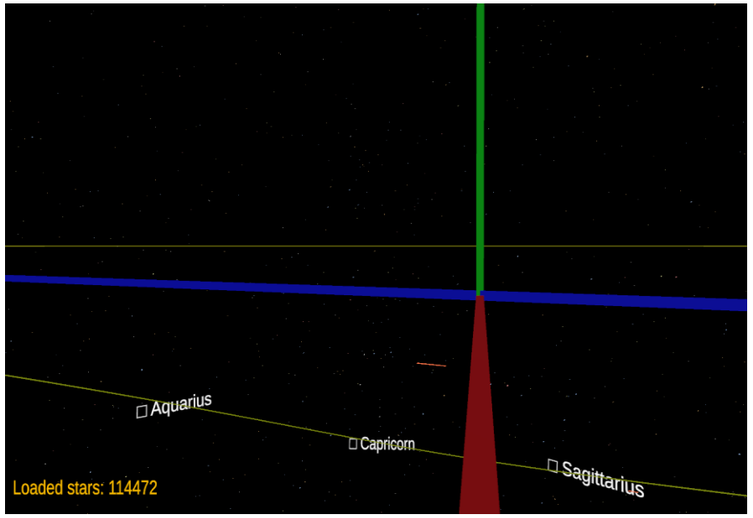
The Problem

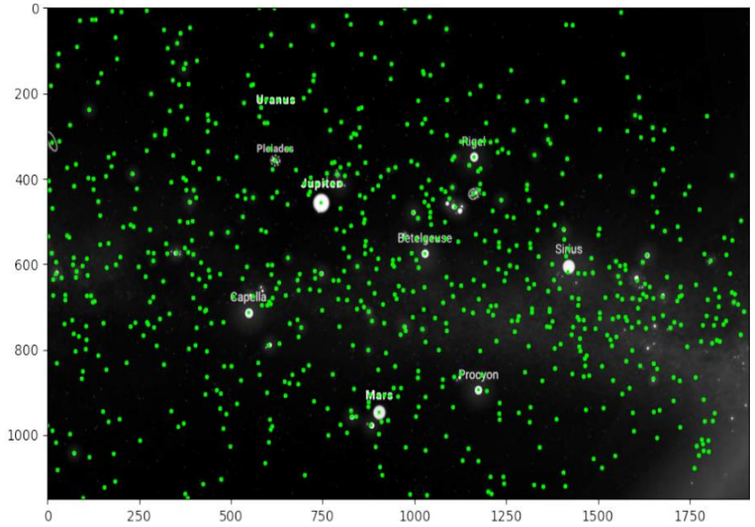
Today almost all ships use satellites to know where they are. This works well, but satellites can stop working, be jammed, or give wrong signals. If that happens, many seafarers will not know how to find their position. The old knowledge of navigating by the stars is disappearing, and younger generations of officers rarely practice it.

Our Goal

We want to bring back star navigation, but in a modern way. With our simulator, people can learn how to use the Sun, the Moon, and the stars to find their way at sea. At the same time, we add artificial intelligence and new tools, so tradition and modern technology work together. This makes navigation safer and gives seafarers more confidence.







Our Vision: A Resilient Navigation Ecosystem

Bridging classical starlight navigation with modern AI and satellites, IntelliCelestial creates a resilient platform that preserves traditional skills, empowers immersive training, and ensures reliable positioning even in a GPS-denied world.

1

Astronavigation Simulator

Training and education in classical celestial navigation.

2

Digital Planetarium

Immersive, realistic night sky simulation for diverse applications.

3

Star & Satellite Recognition System

AI-powered positioning independent of GNSS.

Astronavigation Simulator: Mastering the Art of Celestial Navigation

Key Features:

- Realistic sky visuals with data from the Sun, Moon, stars, and planets
- Calculation of altitudes, azimuths, and lines of position (LOP)
- Visualization of sextant use and star domes in 2D and 3D
- Supports training, automated assessment, and AI-based star recognition

Objectives:

- Preserve and modernize the skill of celestial navigation
- Provide an accessible educational tool for students and professionals
- Enable VR and interactive experiences for immersive learning

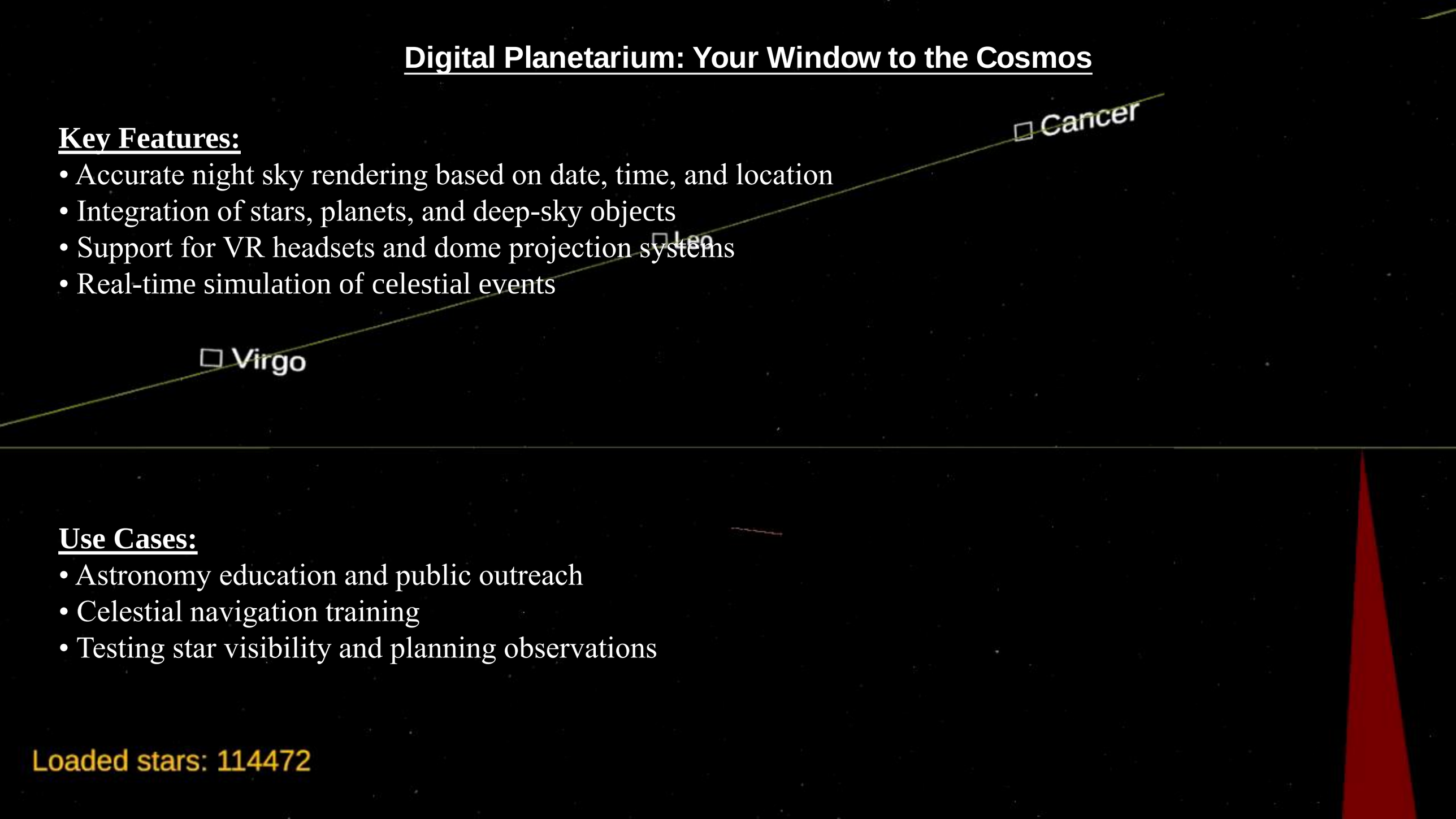
Digital Planetarium: Your Window to the Cosmos

Key Features:

- Accurate night sky rendering based on date, time, and location
- Integration of stars, planets, and deep-sky objects
- Support for VR headsets and dome projection systems
- Real-time simulation of celestial events

Use Cases:

- Astronomy education and public outreach
- Celestial navigation training
- Testing star visibility and planning observations



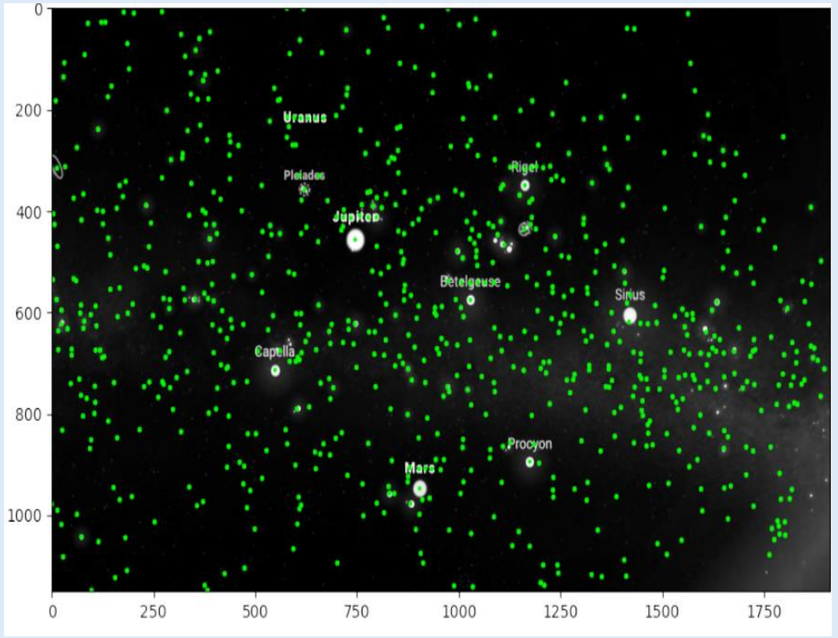
AI-Augmented Star Recognition: Navigation Beyond GNSS

Night Mode – Star Navigation
- Camera detects stars → pattern recognition (plate solving)
- Calculate altitudes & azimuths
- Lines of Position (LOPs) → Position Fix

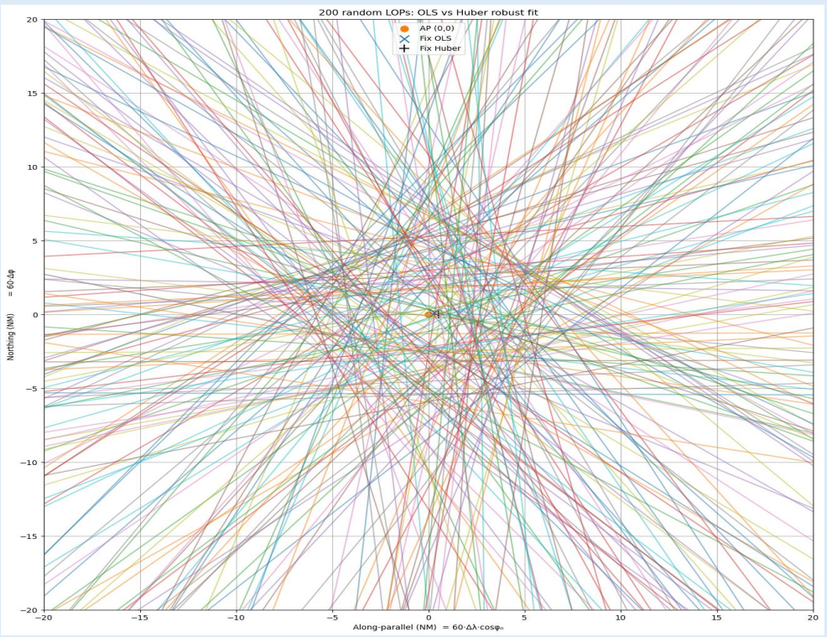
Day Mode – Satellite Tracking
- RF Angle-of-Arrival & Doppler measurements
- Track visible satellites (e.g. Starlink, GPS, Galileo)
- Position Fix even without stars

Fusion
- Combine celestial + satellite data with Dead Reckoning
- Smart filtering ensures stable and accurate position

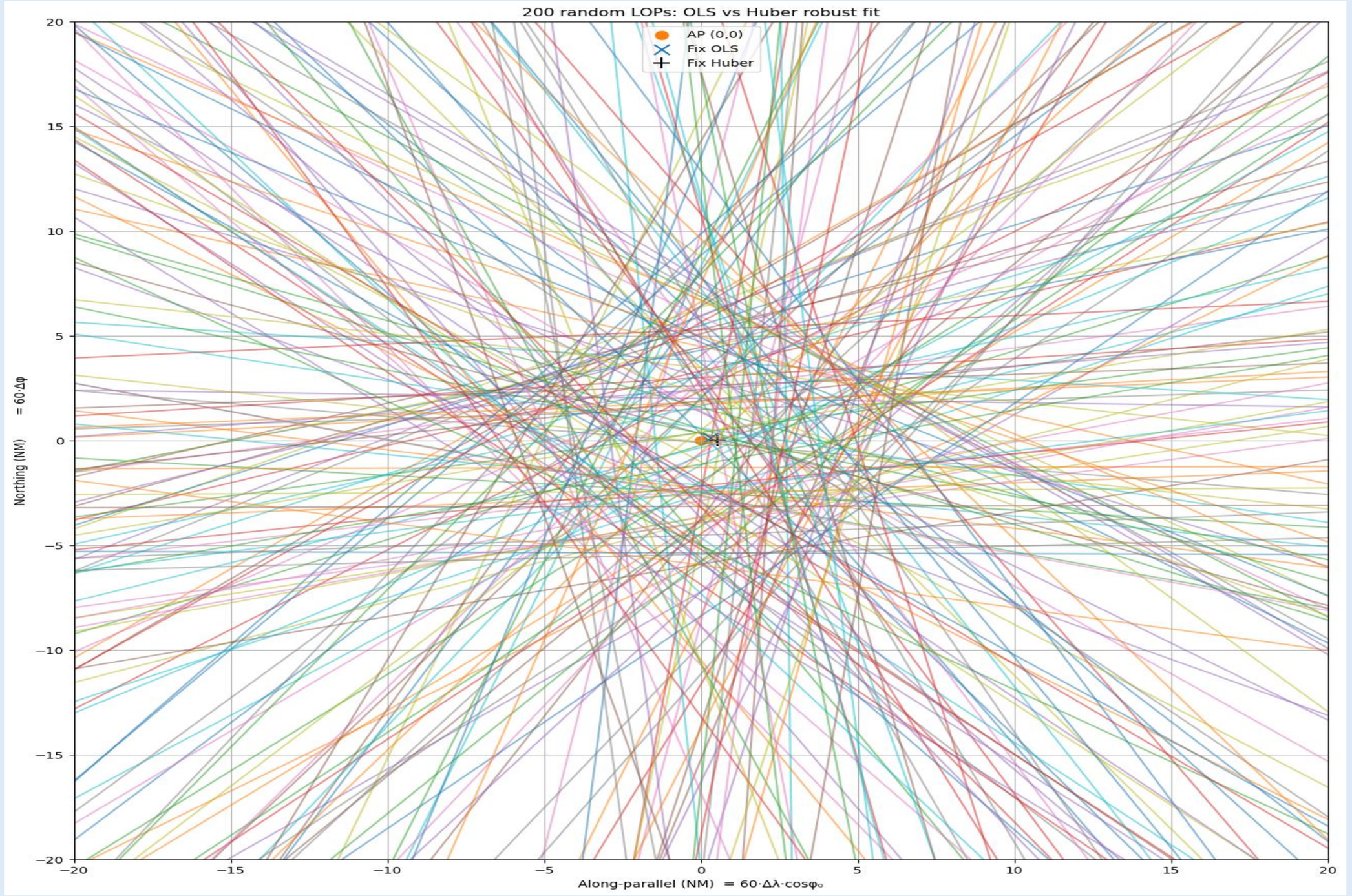
Real picture



AI Detection



Precision Positioning


200 random LOPs: OLS vs Huber robust fit
AP (0,0)
Fix OLS
Fix Huber
Northing (NM) = 60·Δφ
Along-parallel (NM) = 60·Δλ·cosφ₀
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Mixed Celestial-Satellite Navigation: All-Weather Resilience

Our hybrid system seamlessly integrates celestial navigation with satellite tracking, ensuring robust positioning day and night.

Night Mode: Star & Planet Recognition

- Automatic star pattern recognition using the Hipparcos catalog
- Precise azimuth and altitude measurements for stars, planets, Sun, and Moon
- Position fixing through Lines of Position (LOPs) with high accuracy using advanced algorithms and AI.

Day Mode: Satellite Tracking

- Passive RF Angle-of-Arrival (AoA) arrays track satellites even in daylight and cloudy skies
- Tracking bright low-orbit satellites like Starlink at twilight, when stars are hard to see.
- Delivers reliable navigation fixes even when stars are not visible

Why IntelliCelestial Matters: Value and Impact

IntelliCelestial is more than a backup system; it's a foundational tool that cultivates deep understanding and enhances resilience in navigation.

Education & Core Skills

Revives foundational knowledge by linking modern methods to the timeless art of astronavigation.

Enhanced Security

Delivers a GNSS-independent backup, essential protection against jamming and signal denial.

Professional Identity

Connects navigators with centuries of tradition and exploration, enriching professional culture.

Future Integration

Bridges classical astronomy with modern AI, strengthening resilience and insight in a high-tech world.

IntelliCelestial: Building resilient, intelligent navigation by uniting the timeless stars with modern satellites.

In collaboration with the Master's Program in Simulation Engineering
at Nikola Vaptsarov Naval Academy.

Thank you for your attention!

Capt. Zdravko Atanasov

Founder, IntelliCelestial