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CERADON SYSTEMS LLC
CAPABILITY BRIEF

VANTAGE
Passive Through-Wall Human Sensing System

Awareness Without Detection — Passive Human Sensing via Commodity WiFi CSI

Patent Pending: US #63/844,044 (filed July 15, 2025)

Distribution Statement A: Approved for public release; distribution unlimited.

SYSTEM OVERVIEW

Vantage is a passive through-wall human sensing system that exploits WiFi Channel State Information (CSI) to detect, classify, and track human subjects through standard construction materials without emitting a detectable RF signature. Unlike active radar systems that transmit energy and risk compromise, Vantage operates by analyzing per-subcarrier amplitude and phase data from ambient 802.11n/ac/ax WiFi traffic, providing covert situational awareness in contested environments.

Built on commercial off-the-shelf (COTS) hardware with a system cost under \$50, Vantage delivers military-grade intelligence using commodity components. The system provides real-time classification of human presence, pose, movement, location, and behavioral patterns through walls, enabling tactical decision-making prior to entry or engagement.

Operational Gap Addressed: Current through-wall sensing solutions require active RF transmission (detectable by adversaries), employ expensive proprietary hardware (\$30,000+), or expose operators to ionizing radiation. Vantage eliminates these limitations through passive sensing, COTS affordability, and edge-deployable architecture suitable for Special Operations Forces (SOF) size, weight, and power (SWaP) constraints.

KEY CAPABILITIES

Vantage provides five pillars of through-wall intelligence:

1. Presence Detection

Binary occupied/unoccupied classification with 97.3% accuracy. Enables rapid structure assessment without physical entry.

2. Pose Classification

Real-time identification of human postures: standing, sitting, prone, crouching, arms raised. Machine learning pipeline (CNN-LSTM/RGANet architecture) achieves 91.6% classification accuracy, enabling threat posture assessment and hostage/hostage-taker differentiation.

3. Movement Analysis

Vector-based tracking of human movement: walking, running, stationary, transitional states. Velocity estimation supports pattern-of-life analysis and activity classification.

4. Location Determination

Room-level localization via multi-access point triangulation. Achieves ~1.2m spatial accuracy, enabling precise subject tracking across multi-room structures.

5. Behavioral Analysis

Temporal pattern recognition identifies behavioral signatures: sleeping, pacing, sentry behavior, erratic movement. Supports intelligence preparation of the battlefield (IPB) and threat assessment.

TECHNICAL SPECIFICATIONS

Parameter	Value
Detection Range	~12 meters through 2x standard drywall
Operating Frequency	2.4 / 5 GHz (802.11n/ac/ax)
System Power Draw	5.1W (full system)
Bill of Materials	~\$50 (COTS components)
Hardware Platform	Intel AX210 NIC + GPD Win 4 / Raspberry Pi 5
Inference Latency	~82ms (real-time classification)
Operational Modes	Passive (primary) / Active LPI/LPD (fallback)
Output Format	JSON / ATAK integration / Link 16 compatible

Machine Learning Pipeline

Raw CSI data undergoes Hampel outlier rejection and Butterworth filtering, followed by Principal Component Analysis (PCA) for dimensionality reduction. Feature extraction combines spatial Angle-of-Arrival (AoA) and temporal Doppler profiles, feeding a Convolutional Neural Network–Long Short-Term Memory (CNN-LSTM) classifier based on Residual Gated Attention Network (RGANet) architecture.

Dual-Mode Operation

Primary (Passive Mode): Exploits ambient WiFi infrastructure without transmission. Zero RF emission profile ensures operational security (OPSEC) compliance in denied or contested environments.

Fallback (Active Mode): Transmits Low Probability of Intercept/Low Probability of Detection (LPI/LPD) probe frames mimicking commercial router beacons when ambient WiFi is unavailable. Maintains covert profile while enabling sensor operation in RF-sparse environments.

DEPLOYMENT CONCEPTS

Vantage supports four primary employment scenarios:

Static Surveillance Node

Persistent monitoring of structures, border crossings, or high-value areas. Battery or solar-powered operation with remote data exfiltration via cellular or mesh networking.

Robotic Platform Integration

Mountable on Unmanned Ground Vehicles (UGVs) or small Unmanned Aircraft Systems (sUAS) for remote reconnaissance and standoff intelligence collection.

Operator-Carried Handheld

Lightweight, portable configuration for Close Quarters Battle (CQB) and structure clearing operations. Provides pre-entry intelligence to maneuver elements.

Perimeter Mesh Network

Distributed sensor array providing wide-area coverage. Multi-node triangulation enhances localization accuracy and enables pattern-of-life mapping across large facilities or compound structures.

OPERATIONAL EMPLOYMENT

Target Users: USSOCOM units (JSOC, 75th Ranger Regiment, Special Forces Operational Detachment-Alpha), Federal Bureau of Investigation Hostage Rescue Team (FBI HRT), Special Weapons and Tactics (SWAT), Customs and Border Protection Border Patrol Tactical Unit (BORTAC).

Mission Applications:

- **Hostage Rescue:** Differentiate hostages from hostage-takers via pose classification prior to dynamic entry.
- **Structure Clearing:** Pre-entry intelligence reduces risk to assault elements by identifying subject count, locations, and activity.
- **Perimeter Security:** Persistent monitoring of facilities, forward operating bases, or sensitive sites without detectable sensor signature.
- **Counter-IED:** Detect human activity near suspected IED emplacement locations.
- **Border/Tunnel Monitoring:** Continuous surveillance of cross-border tunnels or illicit crossing routes.

COMMAND AND CONTROL INTEGRATION

Vantage outputs structured JSON data compatible with Android Team Awareness Kit (ATAK) and Nett Warrior tactical networks. Plug-in architecture enables direct integration into existing Common Operating Picture (COP) systems. Future development roadmap includes Link 16 tactical data link compatibility for joint interoperability.

Companion Tool: Phantom Scout — Android mobile application providing RSSI-based WiFi signal intelligence and access point mapping. Enables pre-mission site surveys and sensor placement optimization.

COMPETITIVE POSITIONING

Feature	Vantage	Lumineye	Xaver Series
Detection Method	Passive WiFi CSI	Active UWB Radar	Active UWB Radar
Detectability	Zero RF emission	Active transmission	Active transmission
System Cost	~\$50	\$30,000+	\$30,000+
Radiation Exposure	None	None	Ionizing (UWB)
Hardware	COTS	Proprietary	Proprietary
SWaP Profile	SOF-optimized	Heavy/bulky	Heavy/bulky
Deployment	Edge/offline	Cloud-dependent	Proprietary backend

TECHNOLOGY MATURITY

Current Status: Minimum Viable Product (MVP) demonstrated. Technology Readiness Level (TRL): 4-5 (laboratory validation progressing toward relevant environment testing).

Development Roadmap:

- **Q2 2026:** Field prototype testing with operational units
- **Q3 2026:** Military environmental qualification (MIL-STD-810H)
- **Q4 2026:** Production engineering and supply chain establishment

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- **Q1 2027:** Initial production run and first article delivery
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STRATEGIC VALUE PROPOSITION

Vantage delivers asymmetric advantage in contested environments by providing undetectable situational awareness at a fraction of competitor cost. COTS-based architecture enables rapid scaling, field maintenance with commercial components, and technology refresh aligned with consumer electronics cycles. Passive sensing eliminates RF signature, preserving operational security while enabling intelligence collection in denied areas where active systems risk detection and mission compromise.

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