

HCAS — Human Collision Avoidance System Detailed Whitepaper on Micromobility Safety Challenges and Embedded AI Rider-Risk Intelligence

**Analysion Inc.
www.Analysion.com**

The rapid global adoption of micromobility platforms including e-bikes, scooters, motorcycles, and other lightweight electric transportation systems has introduced significant new safety challenges for riders, municipalities, insurers, and transportation agencies. Recent transportation safety discussions increasingly highlight the need for better rider awareness systems, structured telemetry analytics, real-time hazard intelligence, and predictive safety technologies capable of reducing collisions and improving rider situational awareness. HCAS (Human Collision Avoidance System), developed by Analysion Inc., was created to address these emerging challenges through embedded AI perception, depth sensing, telemetry analytics, and rider-risk intelligence infrastructure.

1. The Growth of Micromobility and Associated Safety Risks

Micromobility transportation has experienced rapid expansion worldwide due to increasing urban congestion, sustainability initiatives, delivery services, and consumer demand for flexible transportation options. The adoption of:

- E-bikes
- Electric scooters
- Delivery mobility platforms
- Shared transportation systems
- Electric motorcycles
- Personal mobility devices

has significantly accelerated over recent years. However, public safety organizations and transportation studies increasingly report concerns related to:

- Rider injury rates
- Increased collision incidents
- Limited rider awareness
- Inexperienced operators

- Urban traffic interaction
- Vulnerable road-user exposure
- Night-time visibility limitations
- Lack of advanced safety systems

Unlike automotive platforms that increasingly benefit from advanced driver-assistance systems (ADAS), many micromobility systems still rely almost entirely on rider reaction time and passive safety mechanisms.

2. The Lack of Structured Rider-Risk Intelligence

One of the most important gaps identified across transportation safety studies is the lack of structured and standardized rider-risk telemetry. Current mobility ecosystems generally lack:

- Near-miss telemetry datasets
- Real-time rider-risk analytics
- Hazard event classification
- AI-based situational awareness
- Structured GPS-linked safety telemetry
- Rider-behavior intelligence
- Embedded collision-risk estimation

Most existing systems focus primarily on:

- Passive rider protection
- Camera recording
- Basic warning systems
- Manual reporting

while lacking integrated analytics capable of supporting future mobility intelligence, insurance assessment, fleet analytics, and predictive safety infrastructure.

3. Insurance and Liability Challenges

Insurance providers and transportation stakeholders face increasing challenges associated with micromobility adoption. Current challenges include:

- Limited rider-behavior visibility
- Lack of structured incident telemetry
- Difficulty assessing rider risk profiles
- Limited predictive analytics

- Incomplete collision context data
- Lack of objective near-miss information

As micromobility adoption continues to grow, insurers and fleet operators increasingly require more sophisticated risk-intelligence infrastructure capable of generating objective, timestamped, and GPS-linked telemetry data.

4. HCAS — Human Collision Avoidance System

HCAS (Human Collision Avoidance System) is an embedded AI-powered safety and rider-risk intelligence platform developed by Analysion Inc. The system was designed to provide:

- Real-time situational awareness
- AI-based hazard recognition
- Rider-risk telemetry
- Structured event analytics
- Mobile telemetry integration
- Insurance-oriented safety analytics
- Future mobility intelligence infrastructure

HCAS combines multiple embedded technologies into a unified platform architecture capable of supporting real-time mobility intelligence.

5. Embedded AI Architecture

The current HCAS prototype architecture integrates:

- NVIDIA Jetson Nano edge AI processing
- Intel RealSense depth sensing
- ESP32-S3 telemetry subsystem
- IMU sensor fusion
- UART communication architecture
- GPS-linked mobile telemetry
- Real-time analytics dashboard
- Structured telemetry pipeline

The architecture was intentionally designed as a modular embedded platform capable of future scalability across multiple mobility applications.

6. Real-Time AI Perception and Hazard Analysis

HCAS currently supports embedded AI-based object recognition using OpenCV DNN processing and SSD MobileNet COCO models. Current recognition capabilities include:

- Person detection
- Bicycle detection
- Motorcycle detection
- Vehicle detection
- Bus and truck recognition
- Traffic-light recognition
- Stop-sign recognition
- Obstacle awareness

The system performs:

- Real-time object classification
- Depth-aware hazard analysis
- Relative distance estimation
- Time-To-Collision (TTC) estimation
- Event prioritization
- Risk-score generation
- Structured event telemetry

7. Rider-Risk Analytics and Structured Telemetry

A major differentiator of HCAS is its emphasis on rider-risk intelligence and analytics infrastructure. The platform generates structured telemetry capable of supporting:

- Near-miss analysis
- Rider-behavior analytics
- GPS-linked event tracking
- Historical ride analysis
- Rider-risk scoring
- Fleet intelligence
- Insurance-oriented analytics
- Mobility safety research

The HCAS dashboard infrastructure already supports:

- Interactive analytics
- Event visualization
- GPS mapping

- Risk charts
- Rider-profile scoring
- Severity analysis
- Historical telemetry analysis

8. Mobile Connectivity and Real-Time Telemetry

The HCAS mobile application supports:

- Real-time telemetry monitoring
- GPS ride tracking
- Rider-event visualization
- Live communication with embedded systems
- CSV export and structured logging
- Wi-Fi telemetry infrastructure

This mobile integration enables future expansion toward:

- Cloud analytics
- Fleet monitoring
- Insurance integration
- Remote telemetry analysis
- Rider safety reporting

9. Current Development Status and Achievements

HCAS has successfully progressed from concept stage into a fully integrated embedded AI prototype platform. Completed milestones include:

- Embedded AI perception operational
- RealSense depth integration operational
- ESP32 telemetry subsystem operational
- Mobile telemetry application operational
- Unified telemetry schema completed
- Dashboard analytics operational
- Stable reboot-safe startup operational
- Investor and IRAP documentation completed
- Public website and technical presence established
- YouTube and LinkedIn public channels launched

The project is currently entering:

- Real-world e-bike deployment
- Rider dataset collection
- Field validation
- Commercialization preparation

10. Future Vision and Commercialization Potential

HCAS is designed as a scalable embedded mobility intelligence platform. Potential future markets include:

- E-bikes
- Scooters and e-scooters
- Delivery fleets
- Smart helmets
- Electric wheelchairs
- Industrial mobility systems
- Worker safety systems
- Future automotive integration

Long-term strategic opportunities include:

- Rider-risk intelligence platforms
- Insurance analytics
- Fleet analytics
- Mobility telematics
- Smart-city integration
- Embedded mobility AI systems

11. Conclusion

Micromobility adoption is accelerating globally while rider-safety infrastructure remains limited. HCAS addresses this growing challenge by combining:

- Embedded AI perception
- Depth-aware hazard analysis
- Real-time telemetry
- Sensor fusion
- Rider-risk analytics
- GPS-linked event intelligence

- Insurance-oriented reporting

The platform represents a next-generation approach toward embedded mobility safety and rider-risk intelligence infrastructure. HCAS is currently entering real-world validation and commercialization preparation stage under Analysion Inc.

CONFIDENTIAL AND PROPRIETARY — PROPERTY OF ANALYSION INC.
HCAS — Human Collision Avoidance System — Patent Pending
www.Analysion.com