

# Praneet Kumar Sahoo

Windsor – Ontario – Canada

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## Professional Summary

Human Factors researcher, AI engineer, and entrepreneur with over three years of progressive experience at the University of Windsor and as the founder of Orbit AI — an AI automation agency delivering intelligent semi-SaaS solutions for automotive and trade industries. Specializes in cognitive workload, situation awareness, automated driving systems, real-time machine vision, and full-stack AI product development. Adept at designing and executing end-to-end experimental studies — from ethics submission and physiological data collection (eye tracking, ECG, NIRS, EEG) through manual behavioral coding, statistical analysis, and peer-reviewed publication — with 10 publications across leading venues including *Applied Ergonomics*, *Scientific Reports*, *Transportation Research Record*, and *Theoretical Issues in Ergonomics Science*. Experienced in both controlled laboratory and high-fidelity on-road research environments, including naturalistic driving studies on active highway corridors (ON-401) using instrumented vehicles. Skilled in developing production-grade AI systems using deep learning architectures (1D-CNN-LSTM, Transformers), computer vision pipelines (MediaPipe, YOLOv8, OpenPose), and agentic AI workflows (LLM APIs, RAG, n8n), with hands-on experience deploying real-time inference on edge hardware and managing cloud infrastructure (AWS, DigitalOcean, Supabase). Proven track record leading multi-disciplinary research teams and delivering applied outcomes in collaboration with industry and government partners including Atlas Copco, TRQSS, the Ministry of Transportation Ontario, and the Windsor Police Department. Recipient of the Ontario Graduate Scholarship (2023 & 2024), Mitacs Award (2024 & 2025), and Dean's Honor Roll distinction. Passionate about advancing the science of human-machine interaction and building intelligent systems that bridge rigorous empirical research with real-world deployment to improve safety, efficiency, and user experience.

## Areas of Expertise

Human Factors, Human-Machine Interface (HMI), Automated and Semi-Automated Driving Systems, Cognitive Workload, Situation Awareness, Eye Tracking and Oculometrics, Neural Networks and Deep Learning, AI Automation and Integration, Machine Vision, Real-Time Physiological Signal Processing, User Experience (UX), Virtual Reality, Human-Centric Design, LLM Orchestration and Agentic AI Systems

## Work Experience

### Orbit AI — AI Automation Agency

Founder & Lead Engineer

Remote

2026 – Present

- Founded and built a production AI platform from zero to revenue (yourorbitai.com), serving real users across car dealership and export-import industries with end-to-end intelligent automation and client management tools.
- Architected a privacy-first system handling sensitive user data: end-to-end encryption (at rest and in transit), role-based access control, audit logging, and GDPR-aware design patterns.
- Built LLM orchestration workflows incorporating context management, multi-turn conversation memory, multi-step reasoning chains, and fallback handling for low-confidence AI responses — leveraging patterns analogous to LangChain.
- Designed a RAG-style architecture: user context retrieval from structured database → semantic relevance filtering → dynamic LLM prompt construction → response validation prior to delivery.
- Implemented AI safety guardrails including content filtering, hallucination detection via cross-validation, and graceful degradation when the model cannot provide reliable answers.
- Built an evaluation framework benchmarking 500+ AI interactions across consistency, accuracy, and safety violation metrics, establishing a continuous improvement feedback loop.
- Integrated an AI voice calling agent (Vapi) connected to n8n automation workflows for autonomous client outreach, lead qualification, and follow-up pipelines.
- Developed a fully functional CRM with custom dashboard, analytics, and per-user authentication leveraging Supabase's auth and database systems.
- Delivered full-stack implementation: Python/FastAPI backend, TypeScript/Node.js frontend (HTML, CSS, JavaScript), PostgreSQL with sub-100ms query optimization, Docker-based containerization for local testing and staging environments and cloud infrastructure on DigitalOcean — achieving zero critical failures over 3 months in production.
- Tech stack: Python, TypeScript, Node.js, PostgreSQL, Docker, OpenAI APIs, Anthropic Claude, Google Cloud Console, Firebase, Supabase, n8n, Vapi, DigitalOcean.

- Conducting a comprehensive UX assessment of iNAGO’s Mutualism platform — an open, standardized automotive ecosystem integrating conversational AI, connected vehicle data, and third-party services to deliver next-generation in-vehicle experiences.
- Performing expert heuristic evaluations grounded in Nielsen’s 10 Usability Heuristics and cognitive walkthroughs of the in-vehicle HMI and conversational AI interface, identifying usability bottlenecks and interaction design gaps.
- Designing and executing usability testing sessions with participants to validate interaction flows and surface pain points across the platform’s end-to-end architecture.
- Delivering actionable interface and interaction redesign recommendations — producing annotated wireframes and design mockups in Figma — to improve discoverability, reduce cognitive load, and enhance the overall driver-facing user experience.
- Evaluating the platform-level interaction architecture, assessing how OEM and third-party services integrate into the in-vehicle experience and recommending design patterns for consistency and safety compliance.

- Serve as project lead across multiple concurrent applied and fundamental research projects in human factors, automated driving, and industrial ergonomics.
- Design and execute end-to-end experimental methodologies including participant recruitment, protocol design, ethics submissions, data collection, and statistical analysis.
- Develop and deploy AI and machine learning pipelines for real-time cognitive workload detection, driver behavior analysis, and posture monitoring using deep learning architectures (CNN, LSTM, Transformers) and computer vision frameworks (MediaPipe, YOLO, OpenPose).
- Author and co-author peer-reviewed journal articles, conference papers, and technical reports; contribute to grant applications and research proposals.
- Lead literature reviews and synthesize findings across automated vehicles, cognitive ergonomics, and machine vision.
- Manage and mentor junior research assistants and graduate students; oversee day-to-day lab operations.
- Collaborate with external industry partners including Atlas Copco, TRQSS, and the Windsor Police Department.
- Responsible for procurement, maintenance, and calibration of physiological measurement systems including eye trackers, NIRS, and EEG.

- Supported data collection across projects involving eye tracking, NIRS, physiological recording, and driving simulator studies.
- Conducted statistical analyses using SPSS, R, and Python; prepared figures and results for publications and lab reports.
- Assisted in experimental design, participant coordination, and ethics protocol preparation.
- Collaborated on literature reviews, methodology sections, and manuscript revisions.
- Contributed to VR environment development and simulator scenario design using Unreal Engine and CARLA.

## Projects

- Designed a full-stack real-time workload detection system on a mobile edge unit, streaming 200Hz eye-tracking data via a dual-threaded Python pipeline (Pupil Labs API) with inference times under 100ms.
- Built a robust preprocessing pipeline (NumPy/SciPy) involving blink artifact removal via cubic spline interpolation, Butterworth filtering, and extraction of saccadic/fixation features in 3-second sliding windows.
- Developed a hybrid 1D-CNN-LSTM architecture with self-attention mechanisms and Leave-One-Subject-Out (LOSO) validation, achieving high accuracy in distinguishing low vs. high cognitive load.
- Established a rigorous data protocol using the N-Back paradigm with millisecond-precise Unix timestamp synchronization and NASA-TLX validation to ensure ground-truth reliability.

- Developed a driver attention system classifying glances per NHTSA guidelines (safe vs. high risk) using MediaPipe Face Landmarker to extract head pose and gaze vectors via blendshape differentials.
- Engineered an optimized pipeline: FSRCNN super-resolution → feature extraction → EMA smoothing → threshold-based classification with specialized logic for blink rate and mouth openness detection.
- Built dual operational modes: a real-time interactive mode with OpenCV/Matplotlib visualizations and a headless batch-processing mode for analyzing large-scale naturalistic driving datasets.
- Integrated logic to detect secondary non-driving activities (e.g., talking, eating) and output detailed timestamped reports on zone durations, off-road bins, and fatigue metrics.

### **Driver Behavior Detection Using AI and Machine Vision**

*Human Systems Lab*

2025

- Engineered a CUDA-accelerated desktop application (PyQt5) for high-throughput analysis of driver behavior, automating the classification of Manual vs. Automated driving modes via HSV color filtering and ROI tracking.
- Orchestrated a parallel inference pipeline integrating YOLOv8 and MediaPipe to detect distractions (e.g., phone use, eating) based on real-time geometric proximity between objects and facial landmarks.
- Implemented multi-threaded batch processing and GPU-optimized morphological operations, enabling rapid analysis of large-scale naturalistic driving datasets without manual annotation.
- Integrated Tesseract OCR for millisecond-precise timestamp extraction to synchronize events, outputting detailed CSV reports correlating distraction frequency with automation levels.

### **Real-Time Ergonomic Posture Detection & IoT Feedback System**

*Human System Labs*

2025

- Engineered a bio-mechanics monitoring system using OpenPose and OpenCV, calculating spinal deviation angles via vector geometry to identify musculoskeletal risks.
- Developed an IoT-based feedback loop on an Arduino Uno R4 WiFi, programming an embedded C++ web server to trigger haptic alerts upon receiving HTTP requests.
- Implemented non-blocking state machine logic on the microcontroller and multi-threaded request handling in Python to ensure zero-latency feedback without interrupting video processing.

### **Cognitive Workload Analysis of AR Operator Guidance Systems**

*Human Systems Lab & Atlas Copco*

2025

- Partnered with Atlas Copco to assess next-generation operator guidance systems, specifically comparing projection-based AR against standard software interfaces for high-precision manufacturing.
- Designed and executed an experimental protocol measuring physiological responses (pupillometry, gaze behavior) to identify cognitive bottlenecks during simulated EV battery assembly.
- Delivered data-driven recommendations for optimizing Human-Machine Interfaces (HMI), identifying specific conditions where AR projection minimizes error rates and accelerates operator training.

### **In-Situ Workload Analysis of Tier-1 Automotive Assembly Lines**

*Human Systems Lab, TRQSS & Atlas Copco*

2025

- Orchestrated a comprehensive in-situ field study on the live assembly floor of a Tier-1 automotive safety systems manufacturer (TRQSS), capturing real-world operator data without disrupting production flow.
- Deployed wearable sensors to monitor cognitive workload (eye tracker & motion sensors) and behavioral patterns across multiple shifts, establishing a baseline for worker fatigue and cognitive load.
- Analyzed workload variability across specific workstation profiles, identifying high-risk task sequences and providing data-driven recommendations for line balancing and shift scheduling to mitigate operator burnout.

### **Comparing Cognitive Workload Across Different Modalities of Assembly Instruction**

*Human Systems Lab*

2024

- Engineered a high-fidelity VR assembly simulation in Unreal Engine, implementing custom scripts to interface with the SRanipal SDK for real-time extraction of raw eye-tracking data from the HTC Vive Pro Eye.
- Designed a multi-factorial experiment manipulating instruction modality (AR Laser vs. Pictorial vs. Video) and cognitive load (via an auditory 1-Back task) to stress-test operator performance.
- Evaluated the efficacy of AR laser projection in mitigating the cognitive costs associated with high-load assembly tasks, providing empirical evidence for next-gen smart manufacturing.

### **Transportation Safety: Driver Distraction in BIAs and School Zones**

*Human Systems Lab & Windsor Police Department*

2024

- Conducted a naturalistic observational study in collaboration with the Windsor Police Service to quantify the prevalence of driver distraction in high-risk zones (BIAs and School Zones).
- Analyzed frequencies of secondary task engagement (e.g., handheld device use, eating) relative to traffic density and pedestrian presence.
- Delivered spatial risk profiles and data-driven recommendations to inform municipal traffic enforcement strategies and safety policy updates.

### **Blink Detection AI for Fatigue Monitoring**

*Human Systems Lab*

2024

- Engineered a lightweight CNN architecture optimized with NVIDIA TinyCUDA to detect blink events in real-time on edge devices with minimal latency.
- Curated a custom dataset from Pupil Labs infrared (IR) eye-tracking feeds, performing temporal annotation of blink onset and offset to capture dynamic eye closure duration.
- Trained the model to robustly distinguish between natural blinks and fatigue-induced microsleeps, creating a viable prototype for driver drowsiness detection systems.

### **Stabilization Time after Mode Switch in Conditionally Automated Driving**

*Human Systems Lab*

2024

- Designed a high-fidelity CARLA simulation to investigate cognitive stabilization during automated-to-manual mode switches.
- Orchestrated a study with participants collecting multimodal data—Eye Tracking (fixation duration), NIRS (hemodynamics), and DRT (reaction time)—across bidirectional handover conditions.
- Identified critical safety buffers for AV design, finding that drivers require 10–15 seconds to stabilize after manual takeover and 5–10 seconds after relinquishing control.

### **Semi- Naturalistic Driving Study: Driver Attention in Manual vs. Automated Modes**

*Human Systems Lab & Ministry of Transportation, Ontario*

2023

- Conducted an on-road naturalistic study on the ON-401 highway in collaboration with the Ministry of Transportation, Ontario, where participants drove a Tesla Model 3 for two hours under both manual and automated (Autopilot) driving modes.
- Equipped participants with a multi-modal sensor suite including eye tracking, ECG, and Detection Response Task (DRT) to continuously capture visual attention, physiological arousal, and cognitive load.
- Manually coded driver glance behavior from video recordings into discrete regions of interest: infotainment system, rearview mirror, left/right side mirrors, and out-the-windshield forward gaze.
- Segmented driving data by automation mode (manual vs. automated) and construction zone phase: pre-construction (approach zone), active construction, and post-construction (recovery zone), enabling fine-grained analysis of attention reallocation across driving contexts.
- Analyzed how driving automation and construction zone proximity influence driver attention allocation, situational vigilance, and cognitive workload — contributing empirical evidence for AV safety policy and highway design guidelines.

### **VR Autonomous Driving Simulation & Situation Awareness Assessment**

*Human Systems Lab*

2023

- Developed a high-fidelity "Human-in-the-Loop" driving simulation using DReyeVR (CARLA x Unreal Engine) integrated with physical driving controls (steering wheel/pedals) to study Level 4 automation.
- Programmed custom scripts within the VR environment to execute the SAGAT protocol, automating simulation freezes and real-time query display to objectively measure Situation Awareness.
- Synchronized multimodal physiological data streams (eye metrics, cerebral hemodynamics, response times) with simulation events to analyze the dissociation between cognitive workload and driver vigilance.

### **SAE BAJA: Off-Road Vehicle Design & Technical Leadership**

*NIT Durgapur & SAE BAJA*

2019 – 2021

- Advanced from Team Member to Vice-Captain (leading a 25-person multidisciplinary team) to Technical Advisor, overseeing the end-to-end product lifecycle from CAD concept to manufacturing and endurance racing.
- Engineered the suspension and steering geometry to optimize ride quality and handling, minimizing driver fatigue during 4-hour endurance events.
- Designed a custom driver cockpit based on anthropometric data (5th–95th percentile accommodations), validating reach zones and visibility using RULA/REBA assessments.
- Performed Finite Element Analysis (FEA) on the roll cage and chassis using Ansys to ensure structural integrity and compliance with rigorous SAE safety standards.

## **Publications**

- Sahoo, P., & Biondi, F.N. (2026). "On the effect of using an augmented reality laser projection operator guidance system on cognitive workload and assembly task performance." *Applied Ergonomics*, 130, 104662.

- Li, Y., Sahoo, P., Vasta, N., & Biondi, F. (2025). "Stabilization Time after Mode Switch in Conditionally Automated Driving: Focusing on Drivers' Cognitive Load and Visual Attention." *Transportation Research Record*, 2679(7), 208–221.
- Biondi, F., Sahoo, P., & Jajo, N. (2025). "The distraction potential of driving a partially automated vehicle through a construction zone." *Scientific Reports*, 15(1), 8539.
- Sahoo, P., Bain, A.J., & Biondi, F.N. (2025). "Investigating the interplay between cognitive workload and situation awareness during full driving automation." *Theoretical Issues in Ergonomics Science*, 26(4), 457–477.
- Sahoo, P.K., & Biondi, F. (2025). "On the Effect of Laser Projection Operator Guidance on Cognitive Workload and Task Performance." *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 69(1).
- Biondi, F., Sahoo, P., & Jajo, N. (2024). "Tesla Autopilot Through Constructions: Investigating the Effect of On-Road Partially-Automated Driving through Construction Zones." *Springer Science and Business Media LLC*.
- Sahoo, P.K. (2024). "Exploring the Potential for Metrics of Cognitive Workload to Measure Situational Awareness." Master's Thesis, *University of Windsor, Canada*.
- Biondi, F., Sahoo, P., & Strayer, D. "Temporal Changes in Secondary Task Engagement and System Use During Partially Automated Driving: A Hybrid Naturalistic Study." *SSRN 6052611*.
- Biondi, F., Sahoo, P., & Li, Y. "Can speed cameras curb distraction? Exploring the added road safety benefits of automated speed enforcement."
- Sinha, B., Sengupta, C., Sahoo, P.K., Nath, T., & Mukherjee, O. (2022). "Genetic regulations of microbial biofilm." *A Complete Guidebook on Biofilm Study*, 35–58.

## Education

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|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>University of Windsor</b>                                                                                                       | <b>Windsor, Ontario, Canada</b>    |
| <i>Master of Science in Kinesiology (Human Factors), Grade: 90/100</i>                                                             | <i>September 2022 – April 2024</i> |
| ○ <b>Thesis:</b> <i>Exploring the Potential for Metrics of Cognitive Workload to Measure Situational Awareness</i>                 |                                    |
| ○ <b>Supervisor:</b> Dr. Francesco Biondi                                                                                          |                                    |
| ○ <b>Focus Areas:</b> Human Factors, Cognitive Workload, Situation Awareness, Eye Tracking, NIRS, Automated Driving, VR Simulation |                                    |
| <b>National Institute of Technology Durgapur</b>                                                                                   | <b>West Bengal, India</b>          |
| <i>Bachelor of Technology in Biotechnology, CGPA: 8.98/10</i>                                                                      | <i>August 2018 – May 2022</i>      |
| ○ <b>Focus Areas:</b> Biotechnology, Genetic Engineering, Microbiology, Biomechanics                                               |                                    |

## Technical Skills

- **Programming Languages:** Python, R, C, C++, Java
- **Deep Learning & AI Frameworks:** PyTorch, TensorFlow, Keras, YOLO, OpenPose, MediaPipe, FSRCNN, 1D-CNN-LSTM Architectures, Bidirectional LSTMs, Transformers, Self-Attention Mechanisms
- **AI Automation & Integration:** Agentic Engineering, LLM Orchestration, LLM APIs (OpenAI, Anthropic, Gemini), Retrieval-Augmented Generation (RAG), AI Workflow Automation (n8n), Prompt Engineering
- **Computer Vision:** OpenCV, MediaPipe, YOLO, Real-Time Video Processing, Gaze Estimation, Head Pose Estimation, Blink Detection, Super-Resolution (FSRCNN), Blendshape Analysis
- **Cloud & Infrastructure:** AWS, DigitalOcean, Cloud Deployment & Management, Edge Computing, Android Mobile Computing
- **Scientific Computing:** NumPy, SciPy, Pandas, Matplotlib, Signal Processing (Butterworth Filtering, EMA Smoothing, Cubic Spline Interpolation), Feature Engineering, Time-Series Analysis
- **Research & Physiological Measurement:** Eye Tracking (Pupil Labs Neon, Tobii), NIRS, EEG, NASA-TLX, Detection Response Task (DRT), RULA, REBA, SPSS
- **Simulation & Design Tools:** CARLA Simulator, Unreal Engine, Figma, CATIA, Ansys, GIMP
- **Hardware & Embedded Systems:** Arduino Uno R4 WiFi, NVIDIA TinyCUDA, Sensor Integration & Calibration
- **Other Tools:** MATLAB, Git, LaTeX

## Achievements & Awards

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- **Mitacs Award (2024 & 2025):** Awarded for outstanding research collaboration and innovation in partnership with industry.
- **Ontario Graduate Scholarship (2023 & 2024):** Competitive provincial scholarship awarded for demonstrated academic excellence and high research potential.
- **Dean's Honor Roll (2023):** Recognized for exceptional academic performance in graduate coursework at the University of Windsor.
- **Ignite Scholarship (2023):** Awarded for leadership contributions and active engagement with the academic community.
- **University of Windsor Entrance Scholarship:** Merit-based scholarship awarded upon admission in recognition of academic excellence.

## Volunteering

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- **Food Distribution for the Homeless**

Volunteered to distribute food to homeless individuals in the Windsor community, contributing to community welfare and social support.

- **FIRST Robotics Competition**

Provided on-field technical assistance to competing teams; troubleshoot engineering issues and offered real-time guidance during competitions.

- **Windsor Symphony Orchestra**

Volunteered in operational and outreach capacities to support live performances and community engagement across the Windsor-Essex region.

## Hobbies & Interests

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- Reading
- Listening to Podcasts
- Mixed Martial Arts
- Calisthenics
- Cube Solving
- Coding