N-DRIVE™

Neya's full-stack autonomy solution tackles unconstrained, off-road terrain, head on.

Neya's N-Drive autonomy stack has been developed over the past 16 years specifically for off-road ground vehicles. Off-road autonomy solutions face many unique challenges in comparison to on-road applications. Unlike on-road autonomy, which can take advantage of existing infrastructure like well-defined roads and predictable traffic patterns, off-road autonomous systems must navigate through dense brush, avoid cliffs, ford water features, and traverse rough, complex ground surfaces. These unique and unpredictable off-road challenges require autonomous systems to explore in real time, navigating unstructured and variable terrain under all weather conditions using robust sensors and dynamic mapping.

N-Drive takes a modular, open-systems approach to provide a full-stack, vehicle agnostic autonomy solution, with best-in-class autonomous navigation in any off-road environment. Its comprehensive suite of capabilities spans from standard Teleoperation and Guarded Route Following to Go-to-Point navigation and full autonomous Exploration.

Key Features of N-Drive:

— Modular Open Systems Approach (MOSA) compatible

— Cutting-edge Obstacle Detection & Avoidance (ODOA) capabilities

— Operation with minimal to no GPS dependency

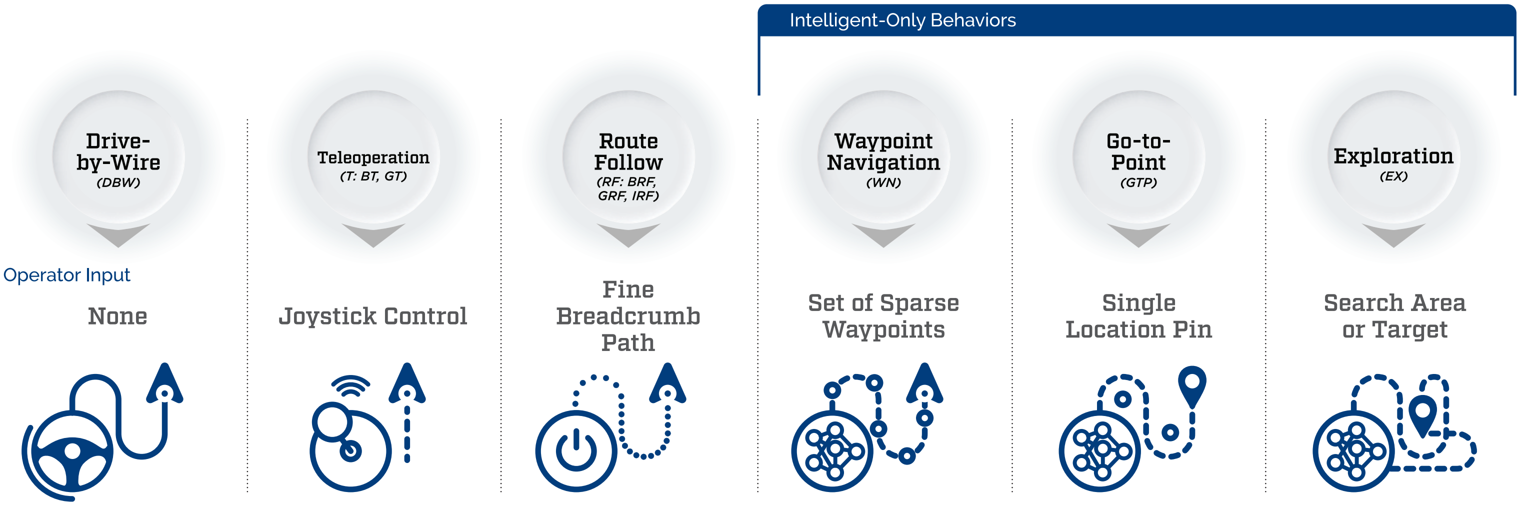
— Optimized for operation in cluttered, dense environments

— Extendable plug-in architecture to support specialized vehicle and environment-specific behaviors

— Configurable vehicle kinodynamic model to take advantage of novel vehicle driving characteristics

— High modularity and rapid integration with drive-by-wire platforms and perception sensors

N-Drive Autonomy Behaviors



Behavior variants include Blind (B), Guarded (G), and Intelligent (I). Blind implies perception is NOT active. Guarded implies See-and-Stop style behavior. Intelligent implies See-and-Avoid style behavior.

Teleoperation (Remote Control)

Teleoperation is synonymous with a remote control style of operation. In Teleoperation mode, there is an operator who sends commands for steering and throttle to the vehicle over a local communications link (e.g., tactical networked radios). In base teleoperation mode, control remains completely in the hands of a human operator. The operator is responsible for the safe operation and navigation of the vehicle through direct sight or remote video feeds.

Communication latency is a primary requirement in base teleoperation with an objective latency of <150 ms for operator drive camera feeds and controls. Communication distances for teleoperation are generally dependent on the tactical radios, which typically provide coverage up to 2 km Line of Sight (LOS). Mesh networks can be used to extend this communication range.

Guarded Teleoperation (GT)

As in Teleoperation, there is an operator who sends commands for steering and throttle. However, in Guarded Teleoperation, the vehicle senses its environment and determines when obstacles are present in its path. When an obstacle is detected and collision is possible, the vehicle will autonomously apply brakes and ignore unsafe commands from the operator. The operator may drive around obstacles or engage “Push-Through” mode which can be used to drive directly through obstacles such as barricades or thick vegetation.

Communication range is still dependent on the tactical radios, but guarded teleoperation can support higher latencies, since perception will stop the vehicle from driving into obstacles.

Assisted Teleoperation (AT)

With Assisted Teleoperation, our system integrates a robust path planning module that goes beyond simply stopping for obstacles or applying the brakes. It seamlessly ties into autonomous steering control, enhancing safety and precision. For instance, if the user pushes the joystick and the left side of the vehicle approaches a tree, the perception stack detects the risk and reports it. The path planning module then adjusts the path slightly to the right, steering the vehicle away from the tree and overriding the user’s input to prevent potential contact. This ensures smoother navigation and greater protection in real-time scenarios.

Person Follower

Person-Following behavior enables a vehicle to follow a person or squad, reducing the significant cognitive load required for teleoperation. Like a dog on a virtual leash, the Person-Following behavior uses remote sensing via LiDAR and/or cameras. While following a person or squad, this capability estimates the traversability of the surrounding terrain. Using this terrain model, the vehicle will chart its own path through the environment and around obstacles to follow at a requested gap distance.

Leader Follower/Convoying

In Leader Follower mode, the autonomous vehicle will follow a “lead” vehicle. The lead vehicle must be equipped with GPS-positioning and radios to communicate path details to the autonomous vehicle. Gap distances can be configured by the operator, and autonomy will automatically increase and decrease vehicle speeds to maintain this gap. If an obstacle blocks the leader path, the vehicle will plan a path around it and continue operation.

Guarded Route Follow

Guarded Route Follow (GRF) autonomy behavior requires the operator to provide a GPS-based route of coordinates for the vehicle to follow. GRF detects obstacles within its assigned path and stops to allow the operator to safely navigate around the obstacles. The operator draws the routes for the vehicle to drive using satellite tiles and elevation data.

Intelligent Route Follow

A "See and Avoid" package can be added to the Leader Follower and Guarded Route Follow behaviors, enabling Intelligent Route Follow (IRF). See and Avoid behavior enables the vehicle to autonomously navigate around these obstacles instead of stopping. The operator defines how far from the path the vehicle is allowed to deviate.

Waypoint Navigation

Waypoint Navigation allows a vehicle to execute a series of consecutive geographic points, called waypoints. Unlike Route Following, Waypoint Navigation gives the vehicle freedom to chart its own path through the environment. This allows the operator to task the vehicle faster by relying on higher levels of autonomous path planning.

Go-to-Point Behavior

The Go-to-Point (GTP) behavior allows the operator to assign a single destination point. The vehicle autonomously chooses the path between its current location and the end point and will see and avoid obstacles in its path without operator intervention.

Autonomous Exploration

Autonomous Exploration expands the set of missions N-Drive-enabled vehicles can execute by allowing the operator to specify a search area instead of a route or set of waypoints. Simply by drawing an area on a satellite image, N-Drive will determine the most efficient paths to take to explore and map an uncharted area. This can be fused further with specialized detectors for people, other vehicles, or objects of interest to highlight desired object locations within the search area.

AI Recovery Module

N-Drive's AI Recovery Module enables an autonomous vehicle to detect and respond to problems during operation without human intervention. It uses AI to recognize issues like vehicle blockage, sensor errors, or loss of positioning and then plans and carries out actions to fix them. This allows the vehicle to recover from unexpected situations, maintain safety, and continue its mission with minimal human intervention.

N-Drive is being developed to achieve zero human intervention in off-road environments, setting a new standard in autonomous performance and reliability.

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Advanced Autonomy Capabilities

Advanced autonomy capabilities are essential for enhancing the performance, safety, and reliability of autonomous systems. These capabilities can enhance navigation by enabling systems to follow existing paths and adapt to terrain changes. They also support autonomous navigation in the presence of unique obstacles, such as water, negative obstacles, airborne particulates, or hidden objects such as rocks concealed by vegetation. These capabilities allow autonomous systems to function effectively in diverse and challenging environments, ensuring consistent performance and extending the system's operational life.

Trail Detection and Following

Trail Detection is a perception package that can be added to both Intelligent and Guarded Route Follow. In addition, with intermittent GPS due to obscurants like tree canopies or even jamming, the system will accumulate errors over time. Trail Detection enables the vehicle to compensate for various sources of GPS drift during Guarded Route Follow routes. It does this by identifying the trail in LiDAR or camera data and keeping the vehicle centered or aligned to one side of the trail.

Negative Obstacle Detection

Positive obstacles like rocks, trees, and other vehicles occupy positive physical space. In contrast, negative obstacles are voids such as cliffs, potholes, ravines, or anti-tank ditches. While positive obstacles provide a signature response in LiDAR and cameras, negative obstacles do not. Rather, they are gaps in the data. With Negative Obstacle detection, N-Drive can detect these gaps by evaluating the real-time, local elevation map produced by the autonomy stack against positive obstacle range shadows to identify and avoid negative hazards.

GPS-Denied Localization

Typical waypoint missions rely on GPS for localization and route planning. However, degraded GPS signals are common due to terrain, vegetation, or signal jamming. As a result, it is not always possible to rely on GPS for navigation. N-Drive fuses traditional localization sensors like IMUs and wheel encoders with perception sensors to perform Visual and LiDAR-based Inertial Odometry (VIO and LIO, respectively). These state-of-the-art VIO and LIO solutions combined with traditional localization sensors allow N-Drive to maintain absolute localization to meter-level accuracy over multi-km GPS-denied missions. As a significant bonus, they also allow real-time dynamic adjustment of sensor calibrations, minimizing required vehicle maintenance and simplifying the sustainment of autonomous systems.

Vegetation Filtering

Vegetation Filtering is a critical capability for ensuring robust perception in outdoor environments. Without it, fields of tall grass, dense shrubs, and large bushes are erroneously interpreted as positive obstacles in LiDAR and camera data, impeding autonomous navigation. Neya's vegetation filtering module intelligently analyzes the density and spatial distribution of objects within the scene, distinguishing sparse or semi-transparent obstacles, such as grass or weeds, from genuinely impassable structures. By classifying these elements as traversable terrain instead of rigid obstacles, this module significantly enhances the system's ability to navigate complex, natural terrains while reducing false positives and improving path planning efficiency.

Dust Filtering

Dust Filtering plays a pivotal role in ensuring reliable perception in environments with airborne particulates, such as as mining or construction sites. Off-road vehicles frequently encounter dust clouds that, much like vegetation, produce positive returns in LiDAR and camera data. Without effective filtering, these dust clouds are misinterpreted as dynamic, positive obstacles moving unpredictably through the scene, obstructing the vehicle's path and hindering mission success. Our advanced Dust Filtering algorithms, initially developed for demanding commercial mining applications, excel at mitigating this issue by filtering transient dust particles while preserving true positive obstacles. This ensures safe and efficient navigation even in the most dust-laden environments, maintaining high levels of operational reliability and performance.

VEHICLE AND SENSOR AGNOSTIC AUTONOMY

Neya's N-Drive autonomy stack is highly modular, simplifying integration with new platforms, new sensors, and new planning algorithms. Our autonomy can be integrated into various types of vehicles, offering universal applicability across multiple platforms. This approach not only reduces development costs but also accelerates time to deployment.

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For more information or to schedule a demo, please contact us.

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