PLUS+1® Autonomy

Danfoss Power Solutions presents – PLUS+1® Autonomy e-book

ENGINEERING
TOMORROW

Danfoss

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Start here

ACL Solutions

Same Building blocks for different application needs

LIBRARY GROUPS:

- Positioning
- Navigation
- Perception
- Partners

KEY FUNCTION HIGHLIGHTS:

- Path Follower
- Sensor Management
- Feature Detection
- Obstacle Avoidance
- Two Point Planner
- Position Filter
- Feature-based Localization
- Projected Path

APPLICATION EXAMPLES:

Roller & Compactor Use Cases

Ground Support Use Cases

Cattle Feeder Use case

Mowing Use Case

Spraying & Harvesting Use Case

ACL Library Groups

Positioning

One of the core functions of the Autonomous Control Library is to provide accurate positioning information to the Navigation sub-system.

Examples:

Relative Pos
UTM Conv
EKF Position
Wheel Odometry

Navigation

Once the position is determined, the next step of the Autonomous Machine is deciding where to go. This is where the Navigation function blocks become relevant.

Examples:

Path Follower
Two Point Planner
Projected Path
Obstacle Avoidance

Perception

The perception function blocks helps translate the sensor inputs from perception sensors to conceptualize surroundings and identify potential obstacles to avoid.

Examples:

Post Detection
Wall Detection
Obstacle Detection

Partners

The PLUS+1 Partnerships add different compliance blocks to help enable other components to work seamlessly into the GUIDE environment.

Examples:

Preco Radars
Ouster LiDARs

Key Function Highlights

Path Follower

Related Blocks: Two-Point Planner, Position Filter, Obstacle Avoidance

Function: The set of path blocks allow the machine to follow a given path provided through the path planner tool. Using path planner, the operator can create a path of up to 50 waypoints for the vehicle to follow. These three functions allow a vehicle to operate in a static environment or in an ever-changing environment.

Used for: Propel Navigation

Two Point Planner

Related Blocks: Path Follower

Function: The Two Point planner block sets up an application to follow a Dubins path. This enables a vehicle to do structural turns when reaching end of end of a row .

Used for: End of row turns, Orchard and Vineyard vehicles

Post Detection, Reflector Detection, Edge Detection, Wall Detection

Related Blocks: Feature Based Localization

Function: This block finds specific features in an environment and can used those markers for navigation. Based on what feature is selected and the sensor being used the feature identification can then be related back to the known location of that feature. This enables indoor and GPS denied navigation by providing a fixed reference point.

Used for: Positioning

Feature-based localization

Related Blocks: Post Detection, Reflector Detection, Position Filter, Position Filter

Function: The Feature Localization function block is used to update the location of a vehicle within a known environment. Given a map of detectable and known features, it compares the detected features to update the position. This way it can work as an alternative to GNSS in areas where the satellite signal is limited, such as for indoor applications.

Mostly used in indoor use cases, but not limited to

Used for: Positioning

Key Function Highlights

Lidar Drivers, Radar Drivers and other block for sensor inputs (Partner Compliance blocks)

Related Blocks: Post Detection, Reflector Detection, Edge Detection, Wall Detection, Obstacle Avoidance, Obstacle Detection, Projected Path

Function: The set of blocks can provide input to the decision level from any sensor on the vehicle. This includes wheel angle, wheel odometer, speed sensors, RADAR, LIDAR, etc.

Used for: Positioning, Obstacle Detection/Avoidance

Position Filter

Related Blocks: Yaw Estimate, Wheel Odometry, UTM Conversion, UTM Conversion Zone, Origin Function, Relative Position, Feature Based Localization, Path Follower

Function: The position filter fuses and combines multiple inputs and sensor data to determine a relative position. By combining multiple navigation inputs like GNSS, IMU and Wheel Odometry you can create a more accurate position than just one sensor can provide.

Used for: Propel Applications, indoor and outdoor positioning

Obstacle Avoidance, Obstacle Detection

Related Blocks: Projected Path, Path Follower

Function: This set of blocks uses information from LiDAR sensors, providing more certain information about the distance of the obstacle ahead and the general distance of the objects in the environment. Based on the settings the vehicle can then drive around the object or stop and wait for an operator.

Projected Path

Related Blocks: Obstacle Detection

Function: The purpose of this block is to detect obstacles along a projected path (curvature) and to determine if a machine can operate safely on the path. Path projection is determined by input command curvature. The path is divided into five zones which are equal in dimensions.

Used for: Propel Applications

Roller & Compactor Use Cases

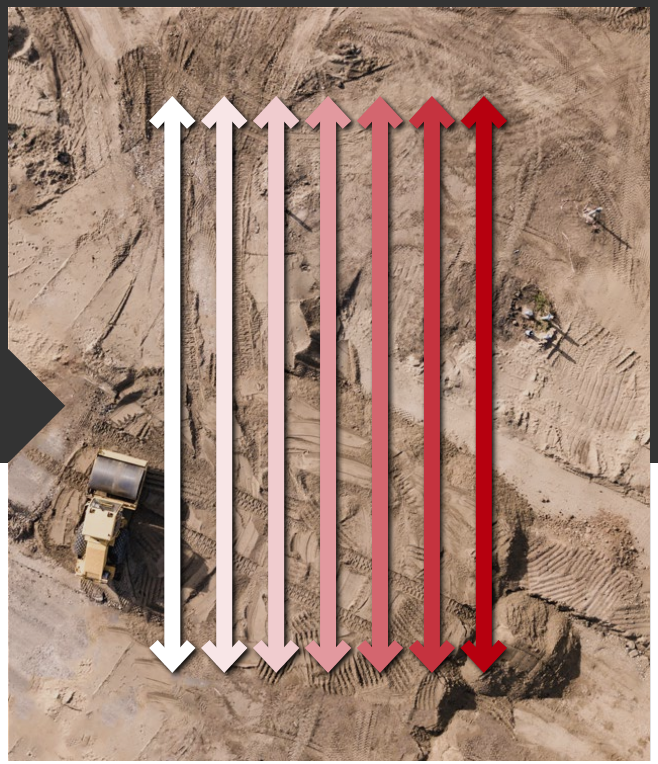
The average age of workers in the construction industry in the EU and North America has been increasing for the last several decades. As experienced workers who have been operating machines for 20, 30, or 40 years retire, less experienced workers take over the task. This has led to more rework and lower productivity on a project, at a time when there are more and more projects to do.

By using the positioning block, two point planner, and path following block a machine can compact soil or roll asphalt with proper overlaps and accuracy like an experience operator regardless of who is behind the wheel. By adding the obstacle detection block the operator in a tandem roller who has a limited field of view can be more aware of their surroundings.

Similar use cases: Paving, row crop harvesting

Roller & Compactor Use Cases

Drive soil compactor on the first pass and back, defining the beginning, end, and returning to the beginning, input vehicle width, overlap desired, number of rows to left or right, and number of passes per row.



Add a compaction detector to improve function and define when area is compacted as desired.

Ground Support Use Case

Ground support equipment is required to get close to airplanes while conducting its work. In many airports and airport service companies these is a lack of experienced drivers which can lead to the equipment bumping into the plane. In these cases, the plane must be inspected or repaired.

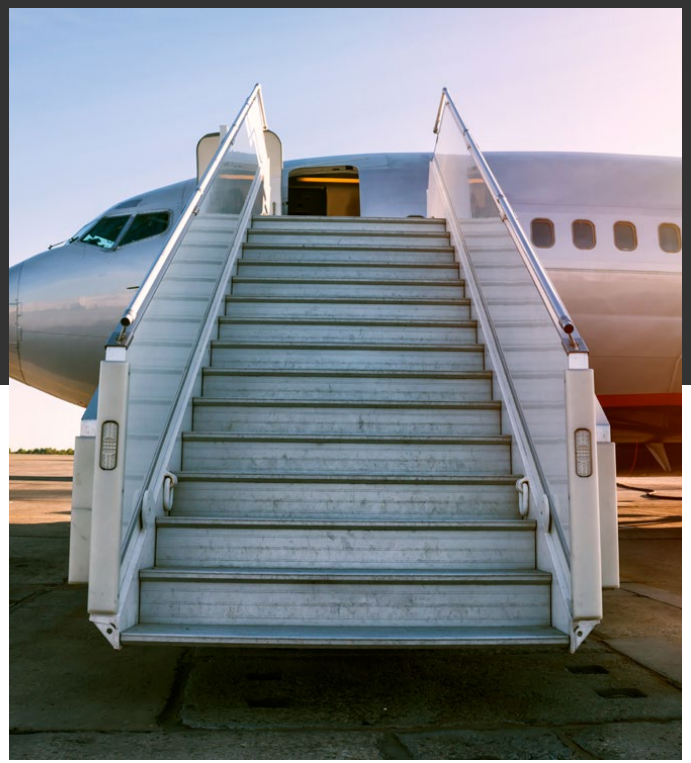
By using sensor management, steering, and feature identification ground support equipment can maneuver to the plane consistently without impacting the plane. In addition, much of this equipment has poor lines of sight as the cab is typically staged to best see the plane. By using a Collision Avoidance System or Collision Warning System your operator can increase their situational awareness of their surroundings.

Similar use cases:
material handling, telehandlers, cargo handling

Groud Support Use Case

Operator selects docking mode

System identifies door and steers vehicle to dock with door while avoiding objects



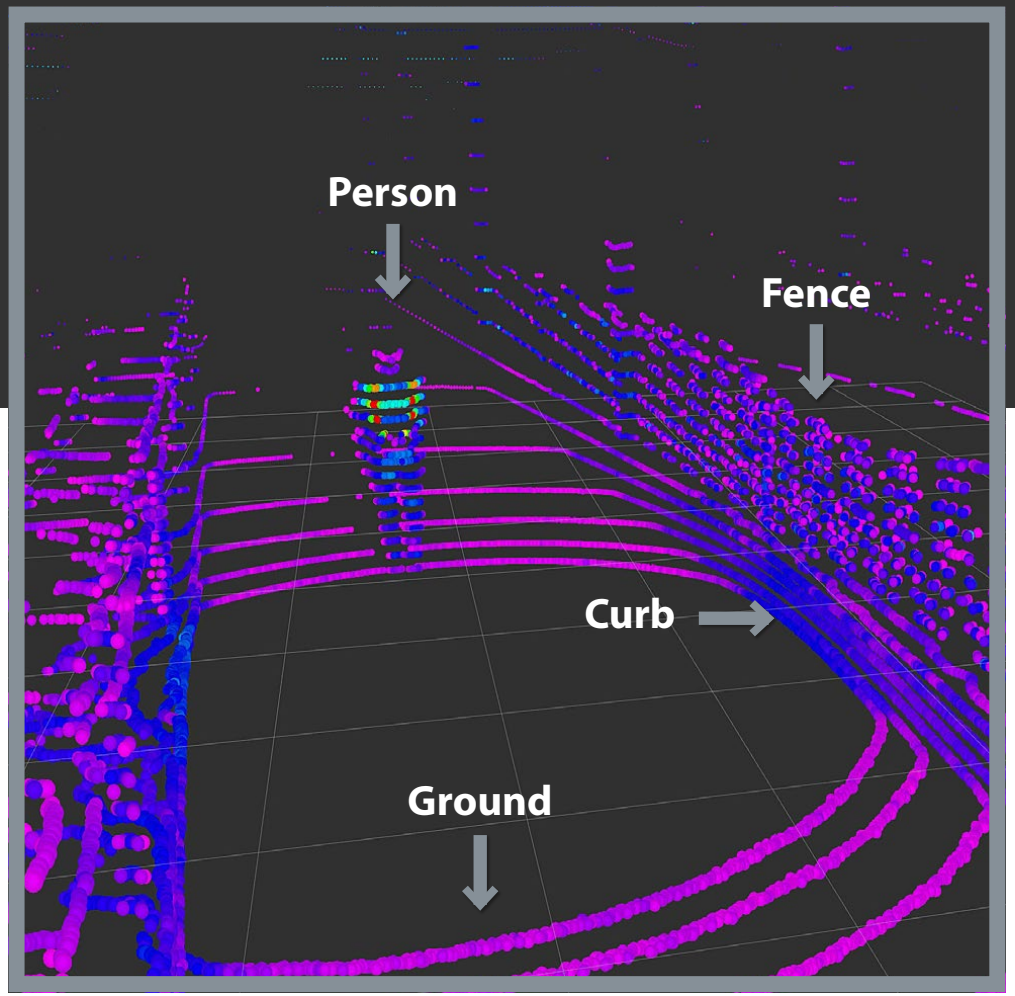
Ramp loader docks without incident and passengers can board plane

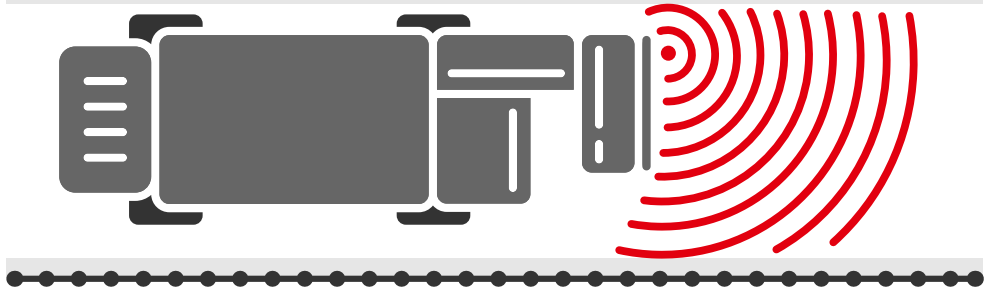
Cattle Feeder Use case

A cattle feeder is a machine that requires precision operation to ensure the feed is mixed properly, dispensed properly, and the cattle is fed the correct quantity at the correct time. Lack of skilled labor in this application can incorrectly dispense food, either dispensing the wrong amount or dispensing it too far from the cattle.

By using the wall following block, the vehicle can dispense food evenly and at the same distance from the wall every time. For coordinating the quantity of food dispensed per meter, indoor navigation can be used to ensure a junior operator does not over feed or under feed a pen of cattle.

Cattle Feeder Use case





Mowing Use Case

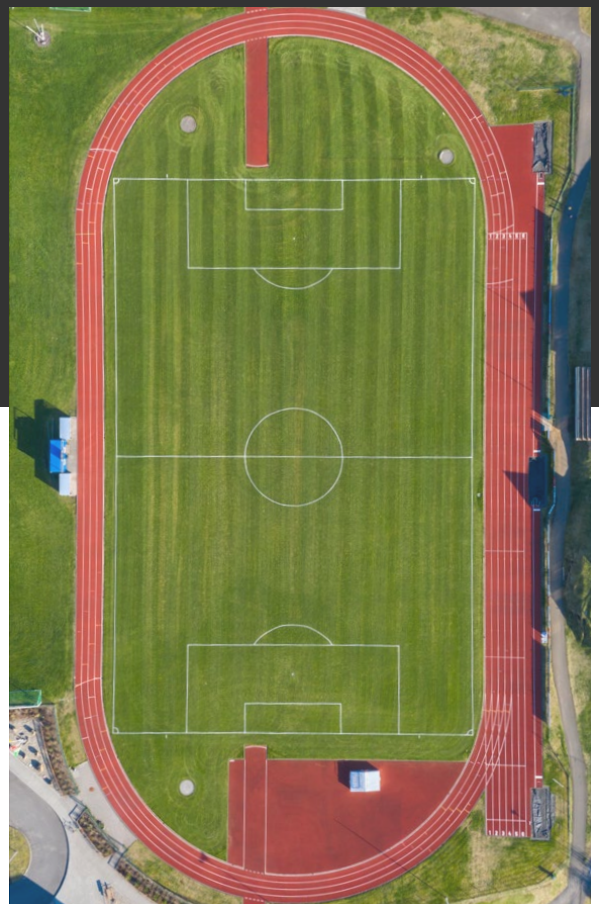
In this use case and industrial fairway mower or mower needs to mow an area defined by an operator. This can be done as an operator assist function, a platooning function, or a supervised autonomy function.

In industries like golf course management, departments of public works, and field management there is a lack of skilled and experience labor, solutions in this space increase Precision and Productivity.

A supervised mower can allow one worker to do the work of two, or by platooning two mowers you can have twice the mowing from the same operators. Using operator assist, a junior operator can ensure perfect coverage every time.

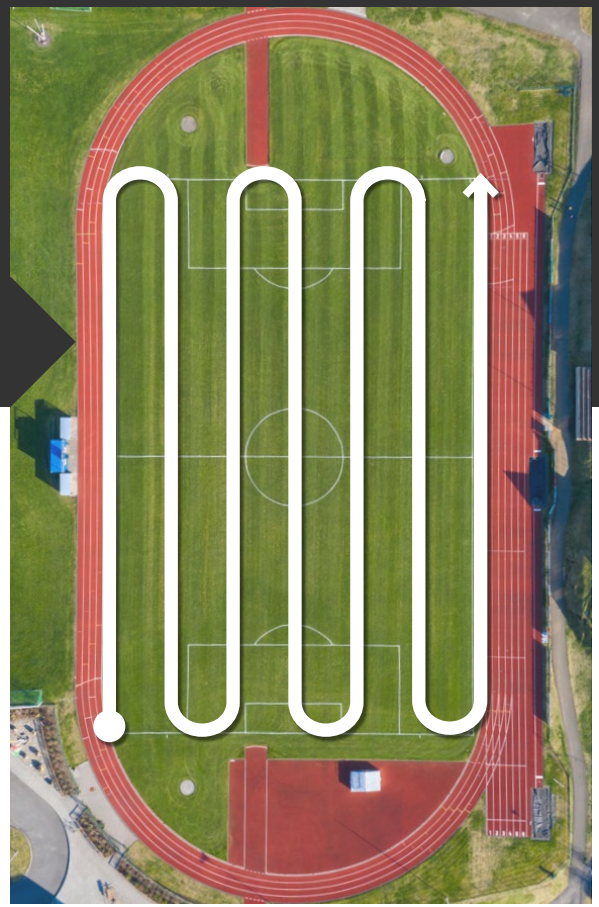
Similar use cases:
Snow Grooming, Snow Blowing/plowing

Mowers Use case



Field to be mowed

Drive outside of field
or define the field



Mower does field in straight lines while
Operator can focus on surroundings
or other tasks from vehicle

Vineyard Use Case

No industry is impacted more by the lack of experienced workers than the specialty orchard and vineyard agriculture industry. This industry requires a significant amount of precision and productivity to harvest the quality crops that the world needs.

Using the Obstacle Avoidance block, Obstacle Detection block, Two Point Planner block, and positioning functions a vehicle can improve its productivity and precision ensuring the crop is properly planted, sprayed and harvested without the need of a skilled operator.

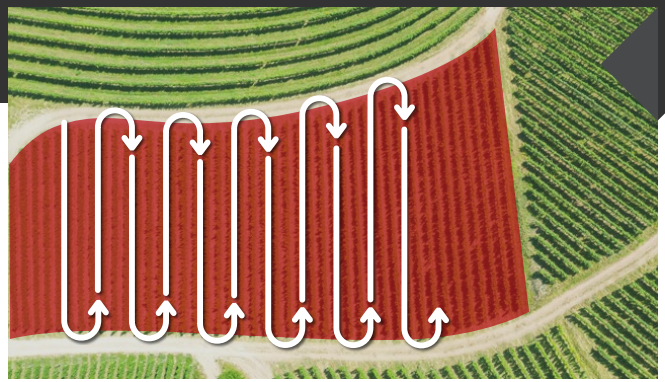
Similar use cases: Material handling

Vineyard use case

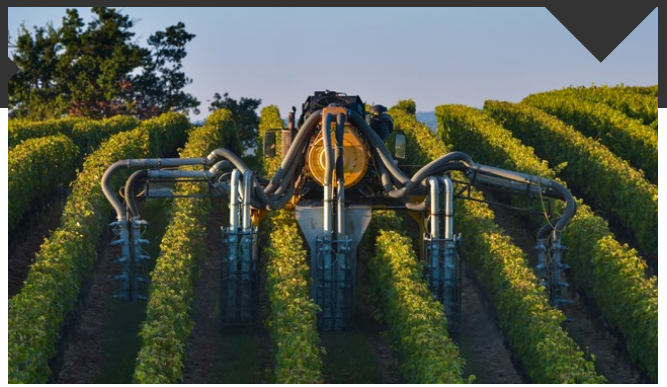
Position vehicle at start point

Vehicle looks for most clear path to travel

Job completed with high precision and optimal time for the vehicle.



Vehicle turns at end of row



Vehicle drive perfectly down center at speed

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Contact information:

» Helpdesk

» Distributor contacts list

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