PRECISE POSITIONING FOR THE EVOLUTION OF AUTONOMOUS MOWERS

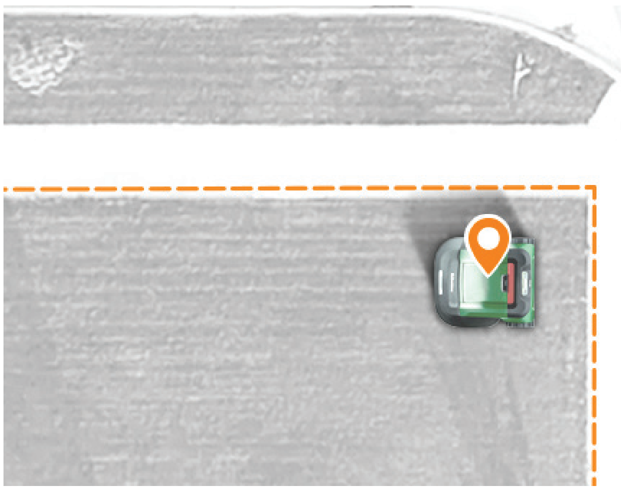
An Evolving Autonomous Robotics Landscape

Autonomous robotic applications are becoming a part of everyday life with sightings around our towns and homes. Examples include robots that deliver pizza to our front doors, aerial drones delivering packages to our yards and a growing variety of autonomous devices that save time and automate routine tasks such as vacuuming floors in the house and cutting the grass outside it. The possibilities seem endless with an autonomous mobile robot market size that is predicted to reach over $22 billion by 2030[1].

Such autonomy requires accuracy to ensure the safe and efficient operations of robotics. The ability to identify location becomes a critical component for such applications to both understand where they need to go and where they need to avoid. This is especially true for autonomous lawn mowers.

Lawn Mowing Limitations

The ability to autonomously cut lawns has numerous benefits and potential—with the global robotic lawn mower market projected to grow to $4.04 billion by 2028[2]—but it is not without its challenges. Not taking into consideration weather or terrain factors, many autonomous mowers currently lack striping ability[3] leaving random patterns across lawns, are unable to mow all the way to a lawn's edge and are not equipped to navigate around unplanned obstacles[4]. An additional issue autonomous mowers face is defining an operational area or geofencing.



Understanding Geofencing

The ability to identify areas of operation is made possible through geofencing, defined as providing a physical or virtual perimeter to a physical geographic area.

When paired with a location-aware device, geofencing triggers action from the device based on whether it has entered or left a defined geographic area of operation. When entering a defined operational area within the geofence, the device is operational and performs as intended and as programmed. When the device is no longer in the operable geographic area it ceases operation, ceases movement or is programmed to return to its "home" location.

There are many reasons a lawn mower must know its exact location for operation. The main purpose is safety. A lawn mower operating where it should not can cause injury to persons and damage to property. Another factor is performance. A lawn mower is only as good as its ability to mow a lawn. Ensuring that grass is what is cut instead of surrounding hedges, shrubs or flowers is an operational requirement.

Historical Approaches to Geofencing

PERIMETER WIRES

A common approach used to define areas is boundary or physical perimeter wires. Boundary wires—typically buried underground—work by creating a perimeter with an induction loop that creates a magnetic field to define the area in which the mower can operate. The mower can detect this magnetic current causing the robot to turn around and change course[5]. If the wire remains intact, it is a proven method of preventing the mower from operating in areas like flowerbeds or gravel paths. However, when improperly installed or when a single area on the perimeter is not intact—potentially damaged or altered by wildlife, other yard work or play[6]—the mower can work inaccurately or not at all. Perimeter wires also require considerable time and effort for installation, require one continuous circuit and must be connected to a power source—proving challenging for complex layouts and operations.

SINGLE BASELINE RTK APPROACH

A single baseline RTK (real-time kinematic) approach utilizes a GNSS (global navigation satellite system) base station that is setup on a point—or physical location—with known coordinates. This base receiver calculates required positional corrections and sends them to the robotic lawn mower resulting in highly-accurate, real-time location of the mower.

Once the position of the robotic lawn mower is accurately known, it is possible to utilize virtual geofences to define the area of safe operation. Unlike physical wires, a virtual geofence can handle complex layouts, can be changed easily and can not be damaged. While providing a better defined geofence and eliminating the need to install a physical perimeter, a single baseline RTK approach has its disadvantages.

The main obstacle is the installation of the base station itself. In addition to adding significant costs to the overall solution, a base station requires placement with a clear view of the sky—located away from buildings, trees and fences—which can be difficult depending on the layout of the property. Base stations also have aesthetic implications. A base station can be unsightly to property owners when placed in the ideal operational location in a clearing, away from plants or structures that could obscure its sky view.

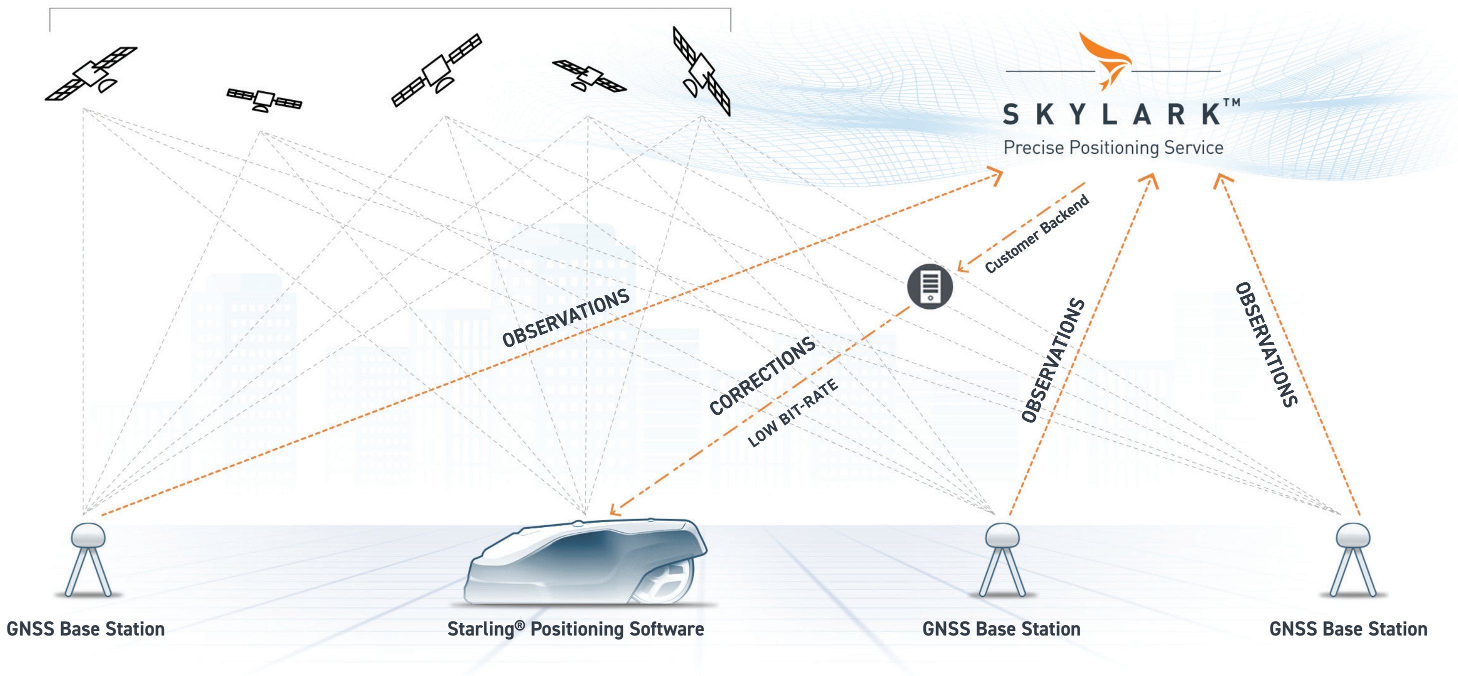
Evolving Approaches

Standard consumer GNSS accuracy has traditionally only been sufficient enough to detect the position of a robot lawn mower with meter-level accuracy[7]. Far too inaccurate to properly mow to and identify the edges of a lawn. Advances in GNSS technology that brings both accuracy and affordability to robotic applications have the potential to make a big impact for autonomous lawn mower manufacturers.

SWIFT NAVIGATION'S NETWORK-RTK APPROACH

Like a single baseline RTK approach, a network-RTK solution delivers highly-accurate positioning to a robotic lawn mower but unlike single baseline, it is not reliant on a local RTK base station. Instead, as the name suggests, it utilizes a network of base stations (located across a wide area or entire country) that calculate positional corrections and deliver them to the robotic lawn mower via Internet-based protocol called NTRIP (Networked Transport of RTCM via Internet Protocol). Robotic lawn mowers only require access to the Internet via a cellular modem (or other method) to utilize network-RTK geofencing.

The benefits of utilizing network RTK include the implementation of geofencing capabilities without the added cost of on-site installations. Swift's solution delivers high-accuracy positioning without requiring any physical changes to one's property. Ideal for the manufacturers of autonomous mowers, Swift's solution is easy to implement and the utilization of Swift's Skylark™ precise positioning services allows manufacturers of autonomous mowers to offer a solution to customers that works consistently across continents across the globe. Another advantage of precise navigation is that it allows a mower to be more efficient in how it mows the lawn. Replacing the random mowing pattern of mowers currently on the market, new mowers can deliver a systematic approach making it possible to cut a larger area with a smaller mower.

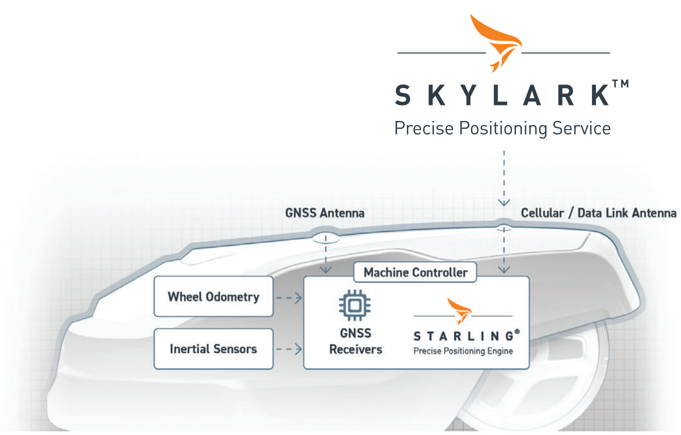


Easily Evaluate & Implement Into Your Equipment

Swift's engineers know how important it is to be able to easily evaluate and test a new solution or platform. Swift offers its Precision GNSS Module (PGM) Evaluation Kit, making it possible to quickly install on a target platform and test performance in the field.

PGM features STMicroelectronics' TeseoV chipset in a Quectel LG69T-AP module. The PGM was designed specifically for running Swift's Starling® positioning engine and delivers maximum precision when paired with Swift's Skylark corrections. Once evaluated, Swift's solution can easily be integrated into robotic applications and create a quick path to production.

By offering the receiver-agnostic Starling positioning engine and the PGM module in an mPCIe format for rapid volume deployment or high-volume applications, Swift provides options allowing your application to achieve high-precision positioning performance.



Get Started Optimizing Your Operations

Swift's precise positioning makes it possible to easily and affordably implement Network RTK into your autonomous robot applications to deliver seamlessly efficient mowers.

GET STARTED TODAY BY CONTACTING SWIFT AT SALES@SWIFTNAV.COM.

References

[1] Research and Markets. February 4, 2022. *Global Autonomous Mobile Robot Market (2022 to 2030) - Opportunity Analysis and Industry Forecasts.* GlobeNewswire, https://www.globenewswire.com/news-release/2022/02/04/2379278/28124/en/Global-Autonomous-Mobile-Robot-Market-2022-to-2030-Opportunity-Analysis-and-Industry-Forecasts.html

[2] Fortune Business Insights. (n.d). *The global robotic lawn mower market is projected to grow from $1.48 billion in 2021 to $4.04 billion in 2028 at a CAGR of 15.5% in forecast period, 2021-2028.* Fortune Business Insights. https://www.fortunebusinessinsights.com/robotic-lawn-mower-market-106531

[3] Whisner, Ryan. January 29, 2021. Pros and Cons of Robotic Mowers. *Green Industry Pros.* https://www.greenindustrypros.com/mowing-maintenance/mowing/article/21220683/pros-and-cons-of-robotic-mowers

[4] Müller, Matthias. (n.d.). *10 Problems With Robotic Mowers You May Not Be Aware Of.* Robolever. https://robolever.com/10-problems-with-robotic-mowers-you-may-not-be-aware-of/

[5] Müller, Matthias. (n.d.). *Robotic Mower Boundary Wires: How They Work.* Robolever. https://robolever.com/robotic-mower-boundary-wires-how-they-work/

[6] Broadbent, Carl. (n.d.). *Do All Robot Mowers Need A Boundary Wire?* Gardenia Organic. https://gardeniaorganic.com/do-all-robot-mowers-need-a-boundary-wire/

[7] My Robot Mower. (n.d.). *Is There A Robot Lawn Mower Without Perimeter Wire?* https://myrobotmower.com/is-there-a-robot-lawn-mower-without-perimeter-wire/