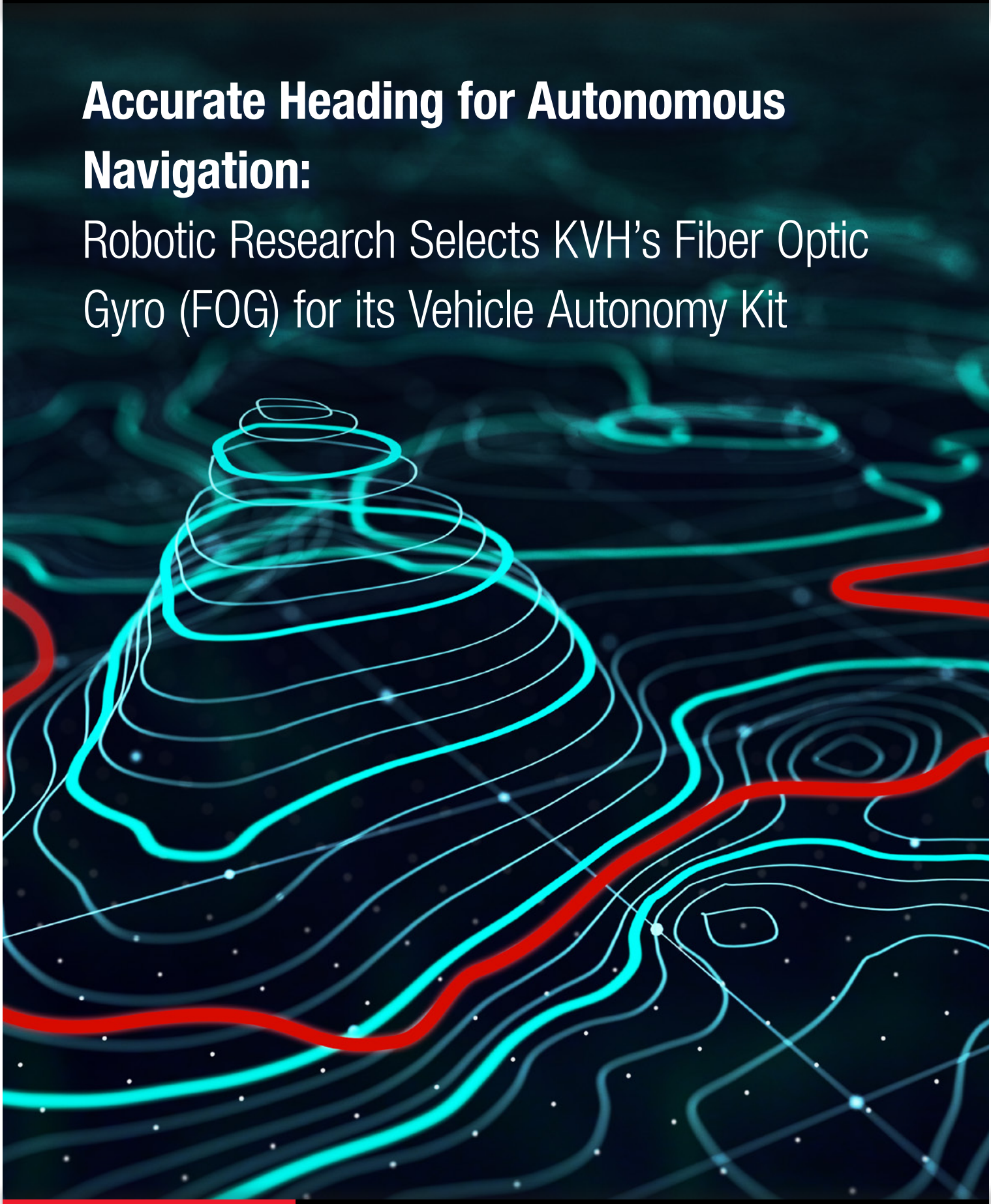
KVH®

Case Study

Accurate Heading for Autonomous Navigation:

Robotic Research Selects KVH's Fiber Optic Gyro (FOG) for its Vehicle Autonomy Kit



Robotic Research navigation software is found in almost all U.S. Army autonomous programs including the Leader-Follower program being tested by the Army for use in operational units. Leader-Follower provides the capability for a designated manned lead vehicle to lead a line of up to nine unmanned follower vehicles which are remotely operated by an operator in the lead vehicle.

Introduction

Military forces are typically among the earliest adopters of autonomous and unmanned technology. Following on the success of airborne drone platforms that have become valuable force multipliers in the modern, asymmetrical battlefield, ground platforms are now the focus of attention for their potential to bring added protection to the warfighter while increasing logistical capability. It's easy to understand why the military is interested. The successful deployment of autonomous platforms to lead convoys through treacherous urban environments, replenish critical supplies, or deliver soldiers in and out of war zones can reduce the number of humans required for these efforts, providing an increased number of soldiers available for other deployments or field operations.

In both commercial and defense applications, safety and precision are the focus of autonomous vehicle navigation. In addition, any of these vehicles deployed by the military cannot restrict or hamper the mobility of the warfighter. Autonomous ground platforms for military applications must be able to maintain the soldiers grueling requirements in the harshest of environments. Beyond survivability, the autonomous navigation system must also remain accurate and reliable when GPS is compromised or blocked by terrain or surrounding structures.

The many challenges of autonomous navigation include the ability to accurately navigate without GPS or in areas where GPS may be compromised

The Challenge

Robotic Research, LLC is an engineering firm that for the past 17 years has been involved in more than 20 different major unmanned systems programs. In fact, Robotic Research software can be found in almost all U.S. Army autonomous and unmanned systems. When Robotic Research needed to provide accurate, real-time navigation and localization solutions for wheeled or tracked ground vehicles in GPS-denied or compromised environments, they turned to KVH Industries, Inc.

The many challenges of autonomous navigation include the ability to accurately navigate without GPS or in areas where GPS may be compromised. One solution to this problem is to fuse multiple sensors into a navigation or positioning solution. Input from multiple sensors such as LiDAR, radar, inertial sensors, cameras, and GPS are integrated into a single system so that together they "fill in the gaps" in data to enhance the overall accuracy of the navigation and positioning solution. Inertial solutions such as Inertial Measurement Units (IMUs) and Inertial Navigation Systems (INS) provide precise localization without input from external systems, such as GPS, making these sensors unjammable as well as highly accurate.

According to Bryan Brilhart, Robotic Research Program Manager, the navigation system developed by Robotic Research required, "a robust and accurate heading

solution with minimal drift over time, while remaining cost effective." Mr. Brilhart added that, "accuracy in the roll and pitch solution was desired but was not weighted as heavily as the heading solution."

In the search for navigation and localization solutions, "Robotic Research engineers considered solutions that used MEMS inertial sensors, FOG inertial sensors, and a combination of both MEMS and FOG," said Mr. Brilhart.

Robotic Research's RR-N-140 Navigation System is designed specifically for use on unmanned ground vehicles and is heavily customizable to incorporate a wide variety of sensor inputs into the navigation solution.

The Solution

With cost being one of the driving factors in the decision, Robotic Research tested a MEMS Inertial Measurement Unit (IMU)-only solution, but the resulting heading solution did not provide the level of accuracy needed to effectively navigate in GPS-denied or compromised areas. As a result, Robotics Research paired the 6 Degrees of Freedom (6 DoF) MEMS IMU with KVH's high-performance, low noise DSP-1750 Fiber Optic Gyro (FOG), which measures the heading axis of rotation. "By pairing the DSP-1750 gyros with a MEMS IMU," Mr. Brilhart explained, "the RR-N-140 produces a heading measurement that is more accurate than a MEMS unit alone, while maintaining a competitive cost."

KVH's DSP-1750 FOG is the smallest high-performance fiber optic gyro in the world. The DSP-1750 FOG uses KVH's unique 170-micron E•Core ThinFiber, the smallest D-shaped optical fiber which is capable of delivering extremely low noise with very high bandwidth.

Robotic Research chose the KVH DSP-1750 FOG as the heading and localization solution in its RR-N-140 Navigation System because it provides a high degree of accuracy at the desired price point, according to Program Manager Brilhart. The RR-N-140 Navigation System provides accurate absolute and relative 3D or 6 DoF localization information for ground vehicles and is designed to be customizable so that a variety of sensor inputs can be incorporated into the navigation solution.

The DSP-1750 FOG, in addition to delivering fast input rates and outstanding Angle Random Walk (ARW) and Bias Instability, features a flexible two-piece design in which the 1.7" diameter optical sensor is separate from the control electronics. This two-piece design allows the sensor to be installed directly above the sensitive axis, while the control circuit cards can be integrated elsewhere. This innovative design makes the DSP-1750 especially easy to integrate into platforms where space and payload weight are at a premium.

The Results

With the KVH DSP-1750 gyro integrated into the Robotic Research navigation solution, Mr. Brilhart reported, "The RR-N-140 with the DSP-1750 gyro outperforms navigation systems at the same, or up to double the price point in localization solutions in GPS-denied or compromised areas."

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>
> – **Bryan Brilhart,** Robotic Research Program Manager - Robotic Research, LLC

By choosing the KVH DSP-1750 FOG, Robotic Research ensures that its navigation and localization solutions receive accurate and reliable position and heading data even when GPS and other satellite-based navigation systems are blocked, jammed, or otherwise compromised.

About Robotic Research, LLC

Robotic Research, LLC is a small engineering firm located in Gaithersburg, MD, founded by Alberto Lacaze and Karl Murphy in 2002. Since that time, Robotic Research has been involved in more than 20 different major unmanned systems programs, and the company's software can be found in almost all U.S. Army autonomous unmanned systems. The company delivers timely, high-quality, innovative engineering solutions and services, including autonomy, navigation, and GPS-denied localization. The firm also offers customers path planning for on- and off-road autonomous vehicles, as well as prototyping and simulations. Visit https://www.roboticresearch.com to learn more about Robotic Research and its products.

Learn more about KVH's comprehensive family of gyros and inertial systems, download papers and watch videos about our solutions at: www.kvh.com/unmanned

About KVH Industries

KVH Industries is a leading manufacturer of high-performance sensors and integrated inertial systems for defense and commercial navigation, positioning, and stabilization applications. KVH has produced over 100,000 fiber optic gyros (FOGs), both as standalone systems and fully integrated within KVH's high-performance inertial systems. These systems play a vital role in such diverse applications as robotics, mapping and surveying, guidance and localization, and a host of emerging unmanned and autonomous technologies including driverless cars. KVH is also a premier manufacturer of TACNAV,® a high-performance tactical navigation system for military vehicles operating worldwide. Founded in 1982, the company's worldwide headquarters is in Middletown, RI with research, development and manufacturing operations in Middletown, RI and Tinley Park, IL, and more than a dozen offices around the globe. Visit kvh.com/unmanned to learn more about KVH and its solutions for autonomous and unmanned platforms.

Learn more about KVH's new photonic chip technology and prototype photonic gyros, now in testing with leading autonomous platform developers at: www.kvh.com/photonicgyro

Product Profile

The DSP-1750 offers numerous configurations to meet the needs of a wide range of stabilization, guidance, precision pointing and navigation applications. Available in dual and single axis configurations with digital or analog outputs, the flexible, adaptable design of the DSP-1750 gyro is ideal for defense and commercial applications in which low payload weight, compact size and high performance are critical to success. This gyro provides cost-effective solutions for a vast number of precision pointing, stabilization, and navigation applications including stabilization of weapon and equipment platforms, navigation and stabilization for autonomous vehicles for land, sea and air, stabilization of longer-range optical and sensor systems, high-speed gimbals, tactical missiles and more.

KVH FOG
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