CUSTOMER SNAPSHOT

OpenROV

Solving Complex Connectivity in Underwater Drones

OpenROV is a leading developer of powerful drones for marine intelligence and exploration. Their mission is, "to empower everyone to explore the world's oceans and waters." In 2012 the company launched the world's first affordable underwater robot kit, called OpenROV (open-source remotely operated vehicle). Since then, they have been working to evolve this robot into a device that was easy to use, ready to deploy out of the box, and able to perform in extreme underwater conditions. OpenROV is now preparing to launch their newest drone, Trident. Trident is the company's first high-performing, commercially-available underwater drone with a re-designed software and hardware architecture equipped for complex environments.

OpenROV launched their out-of-the-box, advanced underwater drone built on RTI's connectivity software to unlock access to the ocean for consumers, marine exploration, industry researchers and more. Trident has already shown promise as an alternative or problem assessment tool in areas traditionally served by larger more developed ROV technologies, such as ship maintenance, oil & gas and offshore inspection/survey. The Trident's compact size, low cost and ease of use has also proved to be beneficial to industries that aren't usually served by ROVs including aquaculture, eco-tourism, and search and rescue.

Figure 1. Photo of a shipwreck taken from the OpenROV Trident

Challenge

Designing the technology architecture for the Trident was no easy feat. The ocean habitat is one of the most unpredictable and harsh environments on earth. This created many communications and sensing challenges for the OpenROV team, including the fact that electromagnetic waves do not transmit well through water. On top of that, the requirements of the underwater robot include video and telemetry recording, Wi-Fi connectivity, user control from standard consumer mobile devices, stabilized motion, as well as customized waterproofing and material selection to ensure that the vehicle is able to operate at 100m depths, and in various natural and chemical environments. The device must also be intuitive and easy to operate by someone without specific technical training.

To achieve underwater video and recording, each OpenROV Trident is equipped with a built-in camera that produces multiple video streams. These streams are transmitted through the tether and then bridged to an operator's device via Wi-Fi. The vehicle's software is tasked with maintaining the balance between delivering low-latency, high-quality video, and working with the bandwidth and reliability constraints that the physical network imposes on the system. Additionally, due to the high-cost nature of underwater and maritime operations, reliability and robustness of both the physical vehicle and its software are of paramount importance. Even with traditional ROV equipment, which can cost hundreds of thousands to millions of dollars, the cost of the sensing equipment typically pales in comparison to the operational and personnel costs. In this context, Trident was designed to be cost-effective, fast and effective to deploy and use, and highly reliable when collecting valuable mission data. These requirements resulted in the need for an advanced connectivity solution.

Solution

The OpenROV team first heard of RTI and the Data Distribution Service™ (DDS) standard when a software engineer joined the company from NASA, where he had managed a successful implementation with RTI Connext® DDS. He was responsible for facilitating research in autonomous aerial vehicles and implementing a solid connectivity platform where all of NASA's complex systems were interoperable, reliable and secure. RTI Connext DDS was the only solution able to address these issues and work seamlessly across NASA's systems. Additionally, RTI was selected for its superior documentation and customer support. The engineer recognized similar connectivity challenges at OpenROV and immediately recommended implementing RTI Connext DDS due to its proven success.

Figure 2. A photo of the Trident captured during an underwater dive

Benefits

OpenROV successfully completed their initial implementation of Connext DDS in just two days. They immediately realized the value of the framework, and given the distributed nature of Connext DDS and its ability to enable automatic discovery between the various data streams and services in the vehicle, the engineering team was able to shift focus to their application data and business logic, and stop worrying about networking connectivity and performance. This opened up the ability for their developers to quickly analyze and iterate on the system's core software components, such as the vehicle's control system and video pipeline, and additionally create a wide variety of tools and monitors to aid in the company's production processes.

RTI's connectivity software enables OpenROV to ensure that all videos and telemetry captured by the Trident are simultaneously streamed live to the operator's device and recorded locally onboard the vehicle, as well. This means that the user always has a redundant source of mission data, in the event that the vehicle is lost or damaged while a mission is underway. Additionally, the flexibility of the pub-sub architecture allows the video delivery software to optimize the livestream's bandwidth for multiple operators, while delivering the most consistent, low-latency experience possible to the direct pilot. In industries like oil & gas, where it can cost millions of dollars a day to have a crew deployed to a site to perform a job, or where expensive assets may be at risk, loss of mission data and unreliable operation of the vehicle is not an option. In this context, OpenROV aims to distinguish Trident from other drones in its class with enhanced reliability, flexibility and robustness.

The OpenROV team also leverages RTI's debugging and monitoring tools to identify any failing sensors or potential connectivity issues as the vehicles move through the production line. Tools like Admin Console and Recording Console are routinely used by production engineers to take snapshots of system state when issues arise and collect other valuable data and statistics. This data can then be forwarded on to the engineering team for analysis, troubleshooting, and optimization.

As an additional feature, because OpenROV customers have access to RTI Connector which supports the rapid development of DDS applications using scripting languages, such as Python, technically savvy users can quickly write their own plugins or tools for working with the vehicle. This makes the platform easier to experiment with in the context of adding new software features, such as autonomous control, data processing, artificial intelligence, and also new hardware components, such as additional sensors and manipulators. As an example, OpenROV has internally used this plugin approach to quickly integrate and test a new inertial measurement unit alongside the existing one without having to modify the vehicle or its core software. They are also working on an experimental Python plugin, built on top of Connector, which allows you to connect the vehicle with popular live streaming services and allow viewers to interact with and direct the vehicle in a limited capacity through a chat interface.

This ability to rapidly test new ideas and integrate with existing technologies and libraries is core to OpenROV's future plans for the vehicle as a platform for innovation in underwater applications.

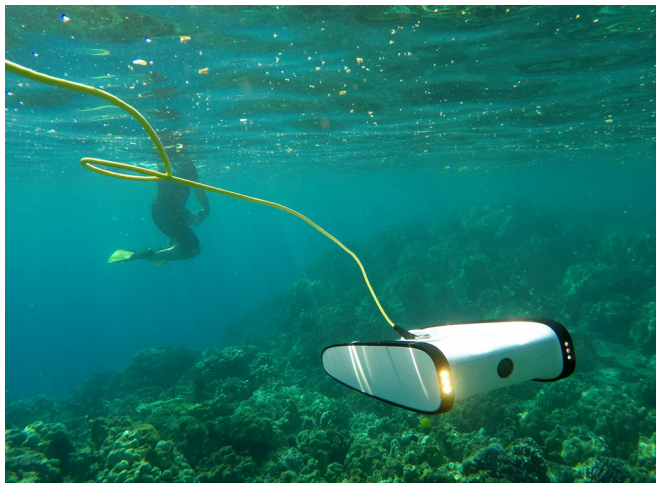

Figure 3. The Trident's tether is used to transmit the live video streams from the built-in camera to the user's mobile device.

"Ease of use, reliability and the technology's proven success were among the many critical factors in selecting RTI to provide the connectivity platform for our underwater drones. The Connext DDS framework enables us to rapidly enhance interoperability between the technical aspects of our products, improving the way we utilize multiple vehicles at once and the way we expand the capabilities of each individual vehicle. We are currently working on expanding our systems into more industrial applications and we believe that RTI's vast industrial experience will serve as a strong basis for this growth."

Charles Cross, Software Engineer at OpenROV

With RTI's leading connectivity software, OpenROV was able to provide a high-performance underwater drone for consumers, researchers and professionals. In the future, the company plans to continue to advance this technology and expand into larger, industrial markets building off of the Connext DDS framework. Together, OpenROV and RTI are enabling the development and widespread expansion of technologically-advanced underwater drones via enhanced and reliable connectivity solutions. RTI will continue to support OpenROV as the company deploys new devices for the intelligent Industrial IoT systems of the future.

About RTI

Real-Time Innovations (RTI) is the Industrial Internet of Things (IIoT) connectivity company. The RTI Connext® databus is a software framework that shares information in real time, making applications work together as one, integrated system. It connects across field, fog and cloud. Its reliability, security, performance and scalability are proven in the most demanding industrial systems. Deployed systems include medical devices and imaging; wind, hydro and solar power; autonomous planes, trains and cars; traffic control; Oil and Gas; robotics, ships and defense.

RTI lives at the intersection of functional artificial intelligence and pervasive networking℠.

RTI is the largest vendor of products based on the Object Management Group (OMG) Data Distribution Service™ (DDS) standard. RTI is privately held and headquartered in Sunnyvale, Calif.

Your systems. Working as one.

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