Developing a New Breed of Industrial Inspection Drone Using the NI RIO Platform

"Using LabVIEW as our software development environment gives us the ability to design, prototype and deploy software within a single development environment saving us significant time."

- Ashley Bryant, VTOL Technologies

The Challenge:
Creating tight-deadline simulation and flight control for a breakthrough remotely piloted aircraft system (RPAS) design using hardware in-the-loop testing that can operate in a real-time environment and handle significant data communications including telemetry data logging and processing.

The Solution:
Using the myRIO device with FPGA and real-time capabilities, LabVIEW software, the LabVIEW Control Design and Simulation Module, and the LabVIEW MathScript RT Module to achieve the high-speed data analysis necessary to control our “fly-by-wire” Vertical Take-Off and Landing (VTOL) Flying Wing.

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VTOL Technologies

VTOL Technologies is at the forefront of developing light (<20 kg) low-altitude, beyond visual line of sight (BVLOS) aerial-inspection remotely piloted aircraft systems, also known as drones. We develop and provide services for the automated inspection of network-based industry assets and infrastructure including, but not limited to, electricity and gas transmission and distribution, rail networks, water utilities, offshore maritime electricity generation, agriculture, and forestry.

As economies grow, more and more capital infrastructure is being built and, as a consequence, infrastructure needs more frequent and precise inspections with the resultant captured data compared over time. Today, customers either use manned helicopters, short-duration multirotor platforms, or foot-based personnel for many asset and infrastructure inspection tasks. The challenge for the deployment of light RPAS (or drones) is currently limited by range and endurance as well as not being able to repeat the inspection process safely, accurately, and consistently. If we could do this, we would establish trend data to deliver higher quality inspection information and reduce the overall inspection costs.

Today’s asset inspection techniques are often expensive, associated with safety considerations, and lack the required levels of consistency that could open up opportunities for advanced data processing techniques. With the availability of cheap multirotor platforms, companies have started to use such

devices operating within visual line of sight (VLOS) for low-altitude aerial inspections. Unfortunately these platforms have endurance, precision flight, and range limitations. To achieve our goal of low cost, fully automated, and repeatable inspection processes, we needed a change in RPAS or drone design and paradigm.

We solved two key problems prior to delivering BVLOS solutions. First, we established whether there was a clear return on investment. Second, we established concepts of operations that can meet civil aviation authorities (CAA) BVLOS RPAS regulatory frameworks. Finally, VTOL Technologies patented the VTOL Flying Wing platform that can deliver up to six times the endurance of an equivalent multirotor platform (such as a quad, hex, or octocopter), as well as dramatically extending endurance when hovering into wind compared to conventional multirotor platforms or rotorcraft.

VTOL Flying Wing from Think Allowed on Vimeo.

VTOL Flying Wing

We needed to incorporate three critical technologies (high-precision GNSS, miniature collision avoidance, and persistent BVLOS communications) into a new, long endurance, precision flight, flexible, and “deployable anywhere” drone or RPAS platform. This new breakthrough platform that incorporates these technologies is the VTOL Flying Wing.

Figure 1. The VTOL Flying Wing

The breakthrough concept behind our unique RPAS architecture consists of the following elements:

- An advanced aerofoil for high lift at low speed with low drag at high speed
- Thrust vectoring mechanisms that require minimal energy to rotate
- Extensive redundant control authority for high-precision flight
- Unique flight maneuvers such as turning without banking, rapid acceleration and deceleration, and hovering into wind

VTOL Flying Wing Control

We selected the myRIO device as a baseline technology for our flight control system development and used LabVIEW software to develop our flight planning and flight operations ground control station tools. LabVIEW features unique rapid-prototyping capabilities and can handle large volumes of real-time telemetry and payload data coupled with an ability to tightly integrate the FPGA with other real-time hardware and software. This includes interfacing with inertial systems, laser altimeters, collision-avoidance technologies, and precision GNSS to help us achieve our goals. Currently, the VTOL Flying Wing is in the development state and has successfully performed test flights.

Our application uses myRIO hardware with LabVIEW software and incorporates several toolkits including the LabVIEW Control Design and Simulation Module and the LabVIEW System Identification Toolkit. Furthermore, we also use NI-VISA and DLL integration capabilities to communicate with third party software and devices such as electronic measurement devices, virtual reality environments, and hardware characterisation test rigs.

Using LabVIEW as our software development environment gives us the ability to design, prototype, and deploy software within a single development environment and save significant time. We can also quickly develop and deploy customisable, user-friendly software interfaces, and demonstrate to prospective customers with the ability to quickly upgrade based on feedback, if required.

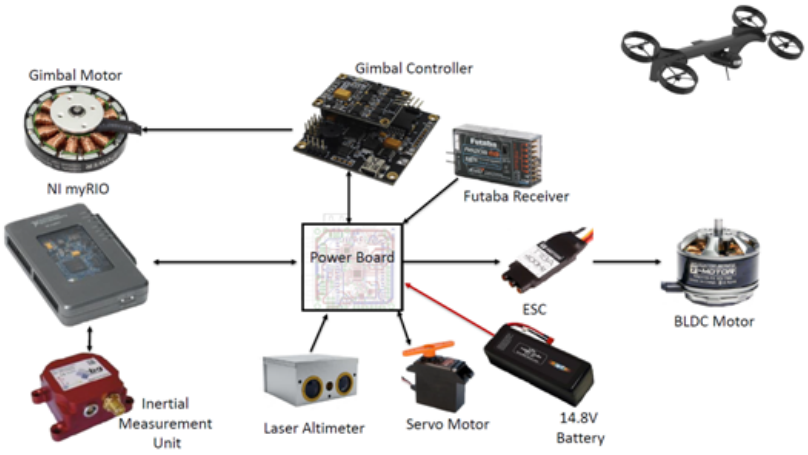

Figure 2. VTOL Flying Wing Avionics Architecture

Prior to starting this project, some of our engineers had experience with LabVIEW along with CLAD certification. However, we chose to send our entire software development team to a personalised LabVIEW training programme, which brought all staff up to a standard LabVIEW programming skill level. To meet our tight programme development schedule and gain greater training flexibility, our engineers also signed up for the online training videos.

We continue to work very closely with the NI professional services team that reviewed our combined preliminary hardware and avionics software and flight control systems architecture to provide positive design feedback. Additionally, NI technical support has been an important ongoing factor in addressing

software development issues as they occur.

The reliability and speed of the NI FPGA and real-time solution helped us develop robust flight-control system architectures with LabVIEW, which are critical for BVLOS operations. The myRIO device exceeded our expectations with its capability of running custom code with good deterministic performance (less than 1 μs loop cycles in real-time). The flight control system successfully uses the time-critical loop to ensure deterministic data acquisition and control loop with no latency or jitter on a complex controller.

Overall, the NI solution continues to meet our objectives. Our future plans include moving to the NI System on Module (SOM), which will be smaller, lighter, and allow us to have, where appropriate, a higher level of customization without requiring changes in the software due to the seamless platform approach.

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Next Steps

See Other Applications Using myRIO

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