Lumenera's Industrial USB 3.0 Lt965R Cameras Selected as Imaging Solution in UAV System Designed to Monitor Vegetation Health

Two of Lumenera's Industrial-Grade Lt965R Cameras Replace Consumer-Level Point and Shoot Cameras in an Unmanned System Used to Monitor Vegetation Health from the Air.

Background: The Need for Remote Sensing of Soil Moisture

Saving water, using less pesticide & fertiliser, and increasing yields are three key aspects that those in the agricultural industry strive for to produce healthier plants and reduce negative impacts on the environment.

The founders of AggieAir, members of the Utah State University's Water Research Laboratory, set out to do this in 2006 by implementing a remote sensor system to monitor soil moisture content. The director of the Lab, Dr. Mac McKee, wanted to accomplish this by utilizing Unmanned Aerial Vehicles (UAVs), but he stipulated that "the aircraft had to be inexpensive, they had to be easy to use, and processing of the imagery acquired from the aircraft had to be relatively simple". With this mission statement in mind, the team set out to build a cost effective, easy to use, UAV system to monitor vegetation health from the sky.

Solution: UAV System to Monitor Vegetation Health from the Sky

The initial system, using consumer-grade cameras, worked quite well at first. It was far more cost effective than using manned aircraft, it could achieve a much better resolution than using satellites in orbit, and was unaffected by cloud cover. It quickly surpassed more labour intensive methods such as blimp-based photography – which could cover roughly 1km in half of a day, with their first model, capable of covering 25km of ground in a morning.

Why was Lumenera's Lt965R the Perfect Fit?

- Ultra-light weight cameras with rugged aluminum body weighing 175g each
- High bit depth of 14bits/pixel
- Lt965R has a dynamic range of 65dB
- No anti-aliasing filter which results in sharper and higher resolution images
- GPIO hardware trigger ability, which reduces triggering delay to microseconds
- ~20cm of resolution at an altitude of 1km above ground

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About the System

The system works by first determining the resolution required for the application, which dictates the altitude at which the aircraft must fly to accurately capture the data. Once the altitude is calculated, one or multiple flight paths are set, depending on the required coverage area. The flight path is then uploaded to the UAV's onboard flight computer.

Flight Altitude (Above Ground)	Swath Width		Ground Resolution	
	Lt965R	Lt1265R	Lt965R	Lt1265R
200m	156m	164m	5cm	4cm
500m	390m	411m	12cm	10cm
1000m	780m	822m	23cm	19cm

A team of only two people are required to oversee the flight – a backup safety pilot with a remote control, who can take over the flight if necessary and a ground control station operator to monitor the aircraft's onboard instrumentation. As the plane flies overhead, it takes one image every three seconds. Once the flight is complete, the images are collected and post-processed to create a single georectified mosaic image that is turned into a very accurate map.

If the video above does not load, click here to view on YouTube

AggieAir Requires Technology Beyond what Point and Shoot Can Offer

As applications diversify and their complexity intensifies, a need for higher quality imaging arose. AggieAir was using off the shelf, point and shoot style cameras, which can be heavy, difficult to interface with, and offer less than repeatable results. Many point and shoot cameras also use anti-aliasing filters which reduce the effective pixel count of the sensor. Since high frequency patterns aren't typically present in nature, AggieAir sought a solution that removed the anti-aliasing filter from the equation, as well as addressed their concerns for a lighter, higher quality device. In addition to this, they were looking to simplify their interface between the camera and the plane, and improve their triggering mechanism to achieve higher precision between image intervals.

Two Light-Weight, Industrial-Grade Lt965R Cameras Replace Consumer-Level Point and Shoot

AggieAir replaced their original point and shoot camera with two 9 Megapixel Lt965R USB 3.0 cameras, weighing in at a mere 175g each. Since Lumenera offers both colour and monochrome variants, the colour model was naturally selected to photograph the colour spectrum and the monochrome model was selected to capture Near Infrared (NIR) as well as the red edge of the scene. This wealth of highly accurate, broad spectrum data allows for excellent computation of the Normalized Difference Vegetation Index (NDVI) – which can determine the health of vegetation by measuring different wavelengths of light absorbed and reflected by the plants and soil.

Aerial view of a vineyard surveyed. Image captured with Lumenera's Lt965RM (Monochrome).

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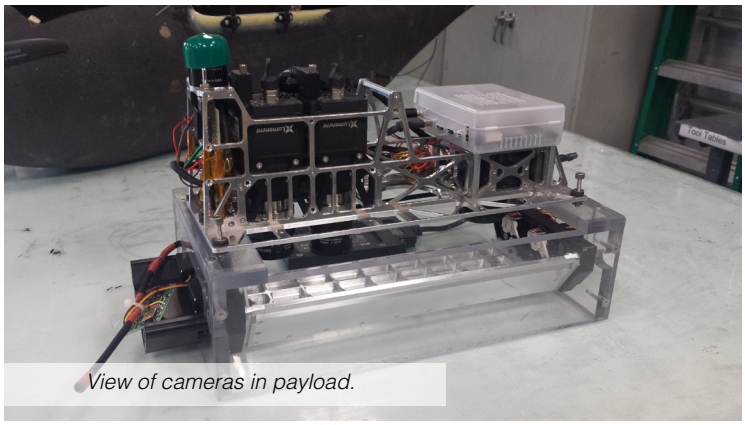
Continued: Two Light-Weight, Industrial-Grade Lt965R Cameras Replace Consumer-Level Point and Shoot

They were also able to achieve a higher resolution with fewer pixels, as they transitioned from a 10 megapixel point and shoot to the 9 Megapixel Lt965R that does not require an anti-aliasing filter for UAV applications. As such, each pixel is now able to capture raw data instead of assigning a subset of pixels to perform unneeded filtering operations. In addition, the removal of the filter allows for sharper images as the blurring it causes is no longer an issue. The Lt1265R was then added to AggieAir's portfolio of sensors to offer extra resolution at 12 megapixels. Both the Lt965R and Lt1265R offer 14 bits of information per pixel with a respective dynamic range of 65dB and 59dB, which is output in unaltered raw format to maximize the usable data. This results in a significant increase in data quality to software.

Aerial view of a vineyard surveyed. Image captured with Lumenera's Lt965RC (Color).

The move from a consumer-grade point and shoot camera to a robust, industrial-grade camera introduced new features and functionality that come with commercial-grade equipment. The General Purpose Input-Output (GPIO) port of the cameras were used to reduce their inconsistent triggering delay from around one second to the order of microseconds. This allowed AggieAir to deterministically control and trigger both cameras simultaneously to ensure near-seamless image overlay of the color and monochrome frames. Lumenera also provided AggieAir with their Linux API and SDK as well as technical assistance to facilitate the integration with their existing Linux operating system aboard the plane.



View of cameras in payload.

Performing white balance in the field.

Conclusion

AGGIE AIR The upgraded camera system, along with other enhancements, has allowed AggieAir to expand from the Agriculture domain to four other key areas of UAV imaging and analysis. They have recently had advancements in the Civil Domain – assessing roads and bridges, in Riparian Studies such as hydraulic modeling, in Wetlands Management to address invasive agricultural species, and in Emergency Response where flooded land can be quickly imaged and mapped out.

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