# RUGGED PAYLOAD COMPUTERS FOR COMMERCIAL DRONE APPLICATIONS

## BACKGROUND

Commercial drone technology has increased significantly in recent years. Many of the uses for commercial drones rely on image capture and processing using standard camera technology from companies like GoPro for professional photography, video and filmmaking.

Increasingly though, commercial drones are also being used in conjunction with more advanced imaging camera systems utilizing technologies such as Hyperspectral imaging, short-wave infrared (SWIR) and LiDAR (light detection and ranging). For environmental and damage surveys, SWIR has the distinct advantage of being able to "see through" fog, rain, haze particles and other challenging atmospheric conditions to provide high-contrast views of objects of interest. The picture below demonstrates a naked-eye view of the San Francisco Bay bridge side-by-side with the matching SWIR image.

Figure 1:NASA – SWIR image of San Francisco Bay Bridge.[1]

Whereas SWIR deals with the infrared range of the electromagnetic (EM) spectrum, hyperspectral imaging is capable of capturing many more bands of the EM spectrum. Hyperspectral image files are often referred to as data cubes and are comprised of spatial data in the x,y dimension with EM wavelength data in the 3rd dimension (Figure 2). Depending on image resolution and other factors a data cube can be in the 100's of megabytes in size. Originally developed for oil and mining exploration, uses now include agriculture monitoring (disease, plant species detection, and maturity) as well as physics, astronomy, historical research, leak detection and security and surveillance.

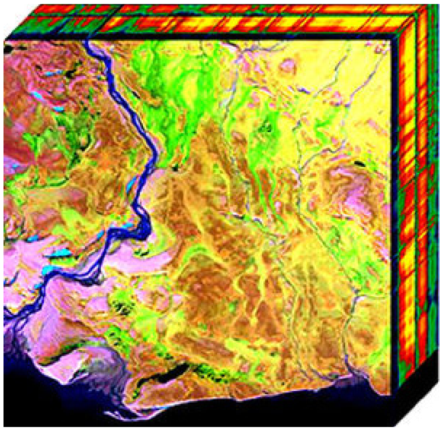

Figure 2: Wikipedia - Hyperspectral 3D Data Cube[2]

Unlike SWIR and hyperspectral imaging, LiDAR uses laser technology and inertial measurement units (IMU) to generate high-resolution maps for geology, seismology, forestry, laser guidance and other uses. Traditionally done with high-altitude military avionics or commercial airplanes, LiDAR technology has now matured and "shrunk" to the point that drones are now being deployed in many cases.

## DESIGN CHALLENGES

All of these commercial imaging technologies put a huge burden on the payload computer with respect to datalink speed, storage, and processing power. Depending on the use scenario, it can also require operation in rugged stress or temperature environments.

Common interface datalinks for these applications include Cameralink (2 Gb/s base rate), CoaXPress (up to 6.25 Gb/s), USB3.0 (5 Gb/s) or Ethernet (1Gb/s and 10Gb/s).

Commercial drones also have very real limits with respect to size and weight capacity. There is a direct correlation between cost, weight carrying capacity and battery life as can be seen from the table below for some commonly available commercial drones:

| Drone Model | Cost | Max Flight Time w/ No Load (min) | Operating Range (m) | Payload Capacity (Kg) |
|---|---|---|---|---|
| AEE F100 | $58,000 | 70 | 10,000 | 2.5 |
| Yunecc HX3 | $3,000 | 45 | 2,000 | 2 |
| Allied Drones HL48 "Chaos" | $20,000 | 45 | 20,000 | 6.8 |
| StediDrone Vader X4 | $19,995 | 50 | 1,500 | 4.3 |
| DJI Matrice 600 | $4,600 | 16 | 5,000 | 6 |

Source: drones.specout.com [3]

All of these factors result in a challenging set of requirements for a commercial payload computer:

- Mechanically rugged
- Extended operating temperatures
- Small size and weight
- High-performance processing
- High-bandwidth camera interfaces
- High-capacity storage

## PAYLOAD COMPUTER DESIGN

Figure 3: ADL, Intel Core-based Payload Computer

ADL recently collaborated with a client developing next-generation SWIR sensor technology requiring a drone test platform for demonstration purposes. The client's experimental SWIR camera interfaces to the payload computer via USB3.0 with plans to interface via Cameralink at a later time.

Figure 4: ADL Payload computer with SWIR camera and DJI Ronin MX Gimbal assembly. Drone model used is DJI Matrice 600. [4,5]

Using Solidworks™ design software, DJI mechanical drawing for the Ronin MX Gimbal assembly and customer input, ADL Embedded Solutions, Inc. successfully designed a custom payload computer with features including:

- ADLQM87PC Intel Core i7 CPU
- Rugged milled-aluminum chassis design
- Thermal design for wide operating temperature range
- Low size and weight with mounting holes for both DJI Ronin MX gimbal and SWIR camera system
- 802.11 Wifi connectivity
- 2x High-speed Cameralink ports for future use
- 2x USB3.0 ports for current experimental SWIR camera

## CUSTOMER RESULTS

The client was able to utilize their DJI drone test platform and experimental SWIR camera within a short 3 weeks of receiving the payload computer. Including the 6 weeks of consulting and development period, the overall development time from concept to operational use was less than 10 weeks for this rugged payload computer.

The initial test results for this new SWIR technology have been very successful with the client's press release expected in late Q4 2016 to announce this significant milestone.

# ABOUT ADL EMBEDDED SOLUTIONS, INC.

*ADL Embedded Solutions Inc., is a leading provider of high-performance embedded systems targeting demanding thermal and rugged environments for industrial and military applications. ADL Embedded Solutions excels at collaborating with customers to design quality, reliable embedded system solutions in a timely fashion to exacting customer requirements. ADL Embedded Solutions boasts a broad portfolio of COTS/MCOTS enclosures, modular systems, and long-lived SBCs, ranging from low-power Intel® Atom® architecture through high-performance Intel® Core™ i5/i7 processors that ensure access to the latest processor technology and long life product availability.*

## REFERENCES

1. NASA Spinoff - SWIR: https://spinoff.nasa.gov/Spinoff2010/ip_2.html
2. Wikipedia - Hyperspectral Imaging: https://en.wikipedia.org/wiki/Hyperspectral_imaging
3. Drone Comparisons: http://drones.specout.com/
4. DJI Matrice 600 drone: https://www.dji.com/matrice600
5. DJI Ronin MX gimbal: https://www.dji.com/ronin-mx