INFRARED® TRAINING CENTER

Small Unmanned Aerial Vehicles and Optical Gas Imaging

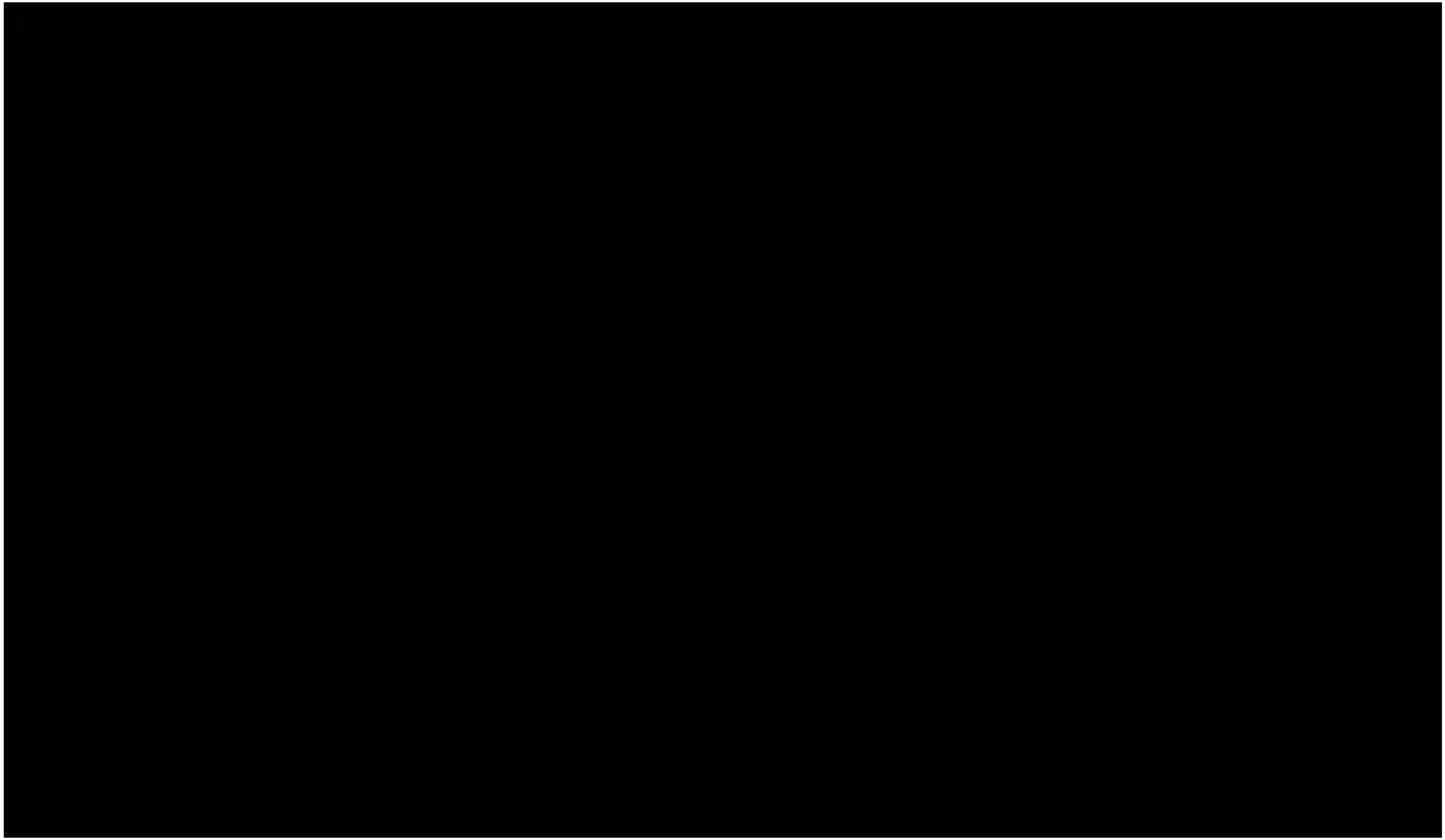
A look into the Application of Optical Gas imaging from a sUAS

NEEDS ANALYSIS

- Improving the ability to cover large areas for the detection of hydrocarbon leakage.
- Safety-locating gas leakage safely by identifying areas of leakage from the air.
- Connectivity-identifying and communicating gas leakage to personnel on the ground immediately.
- Productivity-increase productivity by inspecting larger areas and more components in less time.

FLIR 300 A AUTOMATION CAMERA FOR GAS DETECTION

VIDEO FROM THE G300A VIPER DRONES



FLIR 300A FEATURES

- FLIR G300 a contains a cooled Indium Antimonide (InSb) detector that produces thermal images of 320 x 240 pixels.
- With its low F-number and high sensitivity, G300 a detects the smallest of leaks.
- The high sensitivity mode further enhances the detection level of the camera so that the smallest gas leaks can be detected.

GF 300A FEATURES

- The FLIR G300 a is available with a 23 mm (FOV: 24 ×18) or 38 mm (14.5 x10.8) lens.
- Telephoto lenses give you a narrower field of view so that you can detect gas leaks from further away !
- Full frame rate 60 Hz : The rate at which the infrared detector creates an image, 60 Hz indicates that the infrared detector creates images 60 times a second allowing it to react to fast changes in the incoming radiation.

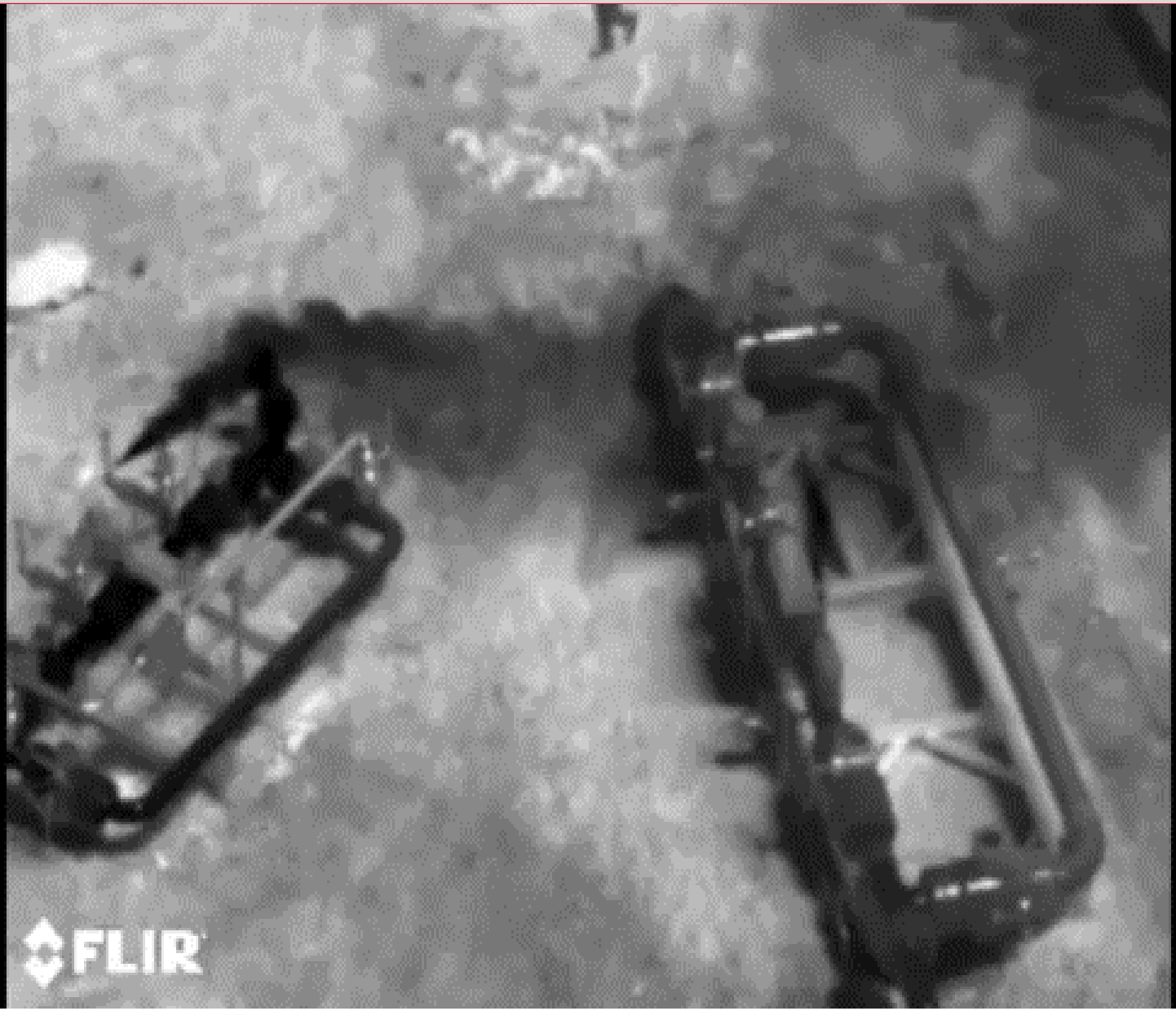
- IR resolution 320 × 240 pixels: this indicates that there a 76,800 pixels, each pixel contains information related to Thermography.
- Thermal sensitivity/NETD : <15 mK @ +30° C (+86° F) –the lower the mK the more sensitive the camera , the Noise Equivalent Temperature Difference determines how well the camera can determine small temperature differences.
- Field of view (FOV) : Standard 24 × 18° with 23 mm lens; 14.5 x10.8 with Optional : 38 mm lens-the more telephoto the greater distance you can see.

- Detector type: Focal Plane Array (FPA), cooled to 77 K , 196 C or -321 F in 7-8 min.

- Spectral range: 3.2–3.4 µm (wavelength) with a cold filter.

- Automatic image adjustment: Continuous/manual; linear or histogram based

FLIR A 300 VIPER DRONES SKY EYE



GF 300A SPECIFICATIONS

- FLIR G300 a detects the following gases:

- Benzene, Ethanol, Ethylbenzene, Heptane, Hexane, Isoprene, Methanol, MEK, MIBK, Octane, Pentane, 1-Pentene, Toluene, m-xylene, Butane, Methane, Propane, Ethylene and Propylene.

sUAS Infrared and Radiometric Cameras

- The following Infrared Cameras are suited for use on a sUAS Platforms
- These cameras are not Gas Detection cameras, however have Oil and Gas Applications such as tank levels, overheating components, etc. some cameras have Infrared and Radiometric values.
- We will look at the specifications and values for these cameras.

FLIR DUO PRO R

FLIR DUO™ PRO R
HIGH-RESOLUTION THERMAL AND VISIBLE-LIGHT IMAGER FOR sUAS

- High resolution thermal and 4K visible-light imaging and recording in a rugged, compact package
  - *Capture video & still imagery in both thermal and video simultaneously for improved understanding of every scene*
- Fully-integrated thermal and visible airborne mapping system
  - *Get accurate metadata, including GPS, temperature, and altitude, for every image*
- Flexible, powerful camera control and configuration options
  - *Multiple thermal resolution and lens options give you the optimal configuration for your missions*

DUO PRO™ R SPECIFICATIONS

Overview	Duo Pro R 640	Duo Pro R 336
Thermal Imager	Uncooled VOx Microbolometer	
Spectral Band	7.5 – 13.5 µm	
Thermal Sensitivity	< 50 mK	
Thermal Sensor Resolution Options	640 x 512	336 x 256
Thermal Lens Options	13 mm: 45° x 37°	9 mm: 35° x 27°
	19 mm: 32° x 26°	13 mm: 25° x 19°
	25 mm: 25° x 20°	19 mm: 17° x 13°
Thermal Frame Rate	30 Hz	
Visible Sensor Resolution	4000 x 3000	
Visible Camera FOV's	56° x 45°	56° x 45°
Radiometry		
Measurement Accuracy	+/- 5 C or 5% of readings in the -25°C to +135°C range +/- 20 C or 20% of readings in the -40°C to +550°C range	
Physical Attributes		
Size	85 × 81.3 × 68.5 mm 85 × 86.5 × 68.5 mm (640/25 mm lens only)	
Weight	325 g 375 g (640-25 mm only)	325 g

FLIR VUE PRO - WWW.FLIR.COM/SUAS/VUEPRO/

Overview	Vue Pro R 640	Vue Pro R 336
Thermal Imager	Uncooled VOx Microbolometer	
Resolution	640 × 512	336 × 256
Lens Options (FOV for Full-Sensor Digital Output)	9 mm; 69° × 56° 13 mm; 45° × 37° 19 mm; 32° × 26°	6.8 mm; 45° × 35° 9 mm; 35° × 27° 13 mm; 25° × 19°
Lens Options* (FOV for NTSC Analog Output)	9 mm; 62° × 49° 13 mm; 45° × 35° 19 mm; 32° × 24°	6.8 mm; 44° × 33° 9 mm; 34° × 26° 13 mm; 24° × 18°
Spectral Band	7.5 - 13.5 µm	
Full Frame Rates	30 Hz (NTSC); 25 Hz (PAL)	
Exportable Frame Rates	7.5 Hz (NTSC); 8.3 Hz (PAL)	
Measurement Accuracy	+/-5°C or 5% of reading in -25°C to +135°C range +/-20°C or 20% of reading in -40°C to +550°C range	

FLARE TIP INSPECTION

FLIR ZENMUSE XT

- The most highly-integrated thermal imaging solution for commercial drones – only from DJI and FLIR
- Available in either 640 × 512 or 336 × 256 resolutions, the Zenmuse XT has multiple lens options to make sure you'll have the right combination of situational awareness, magnification, spot size, and area coverage to suit your mission requirements

ZENMUSE XT LENS OPTIONS

Lens Models		6.8 mm	7.5 mm	9 mm	13 mm	19 mm
17µ 640×512	FoV iFoV	/	f/1.4 90° x 69° 2.267 mr	f/1.4 69° x 56° 1.889 mr	f/1.25 45° x 37° 1.308 mr	f/1.25 32° x 26° 0.895 mr
17µ 336×256	FoV iFoV	f/1.4 49.1° x 37.4° 2.519 mr	/	f/1.25 35° x 27° 1.889 mr	f/1.25 25° x 19° 1.308 mr	f/1.25 17° x 13° 0.895 mr
Min Focus Distance		2.3 cm	2.5 cm	3.2 cm	7.6 cm	15.3 cm
Hyperfocal Distance		1.2 m	1.2 m	2.1 m	4.4 m	9.5 m
Hyperfocal Depth of Field		0.6 m	0.6 m	1.1 m	2.2 m	4.8 m
Spot Size Ratio (D:S) (10x10 pixels)		~40:1	~44:1	~53:1	~76:1	~112:1

http://www.dji.com/zenmuse-xt/info

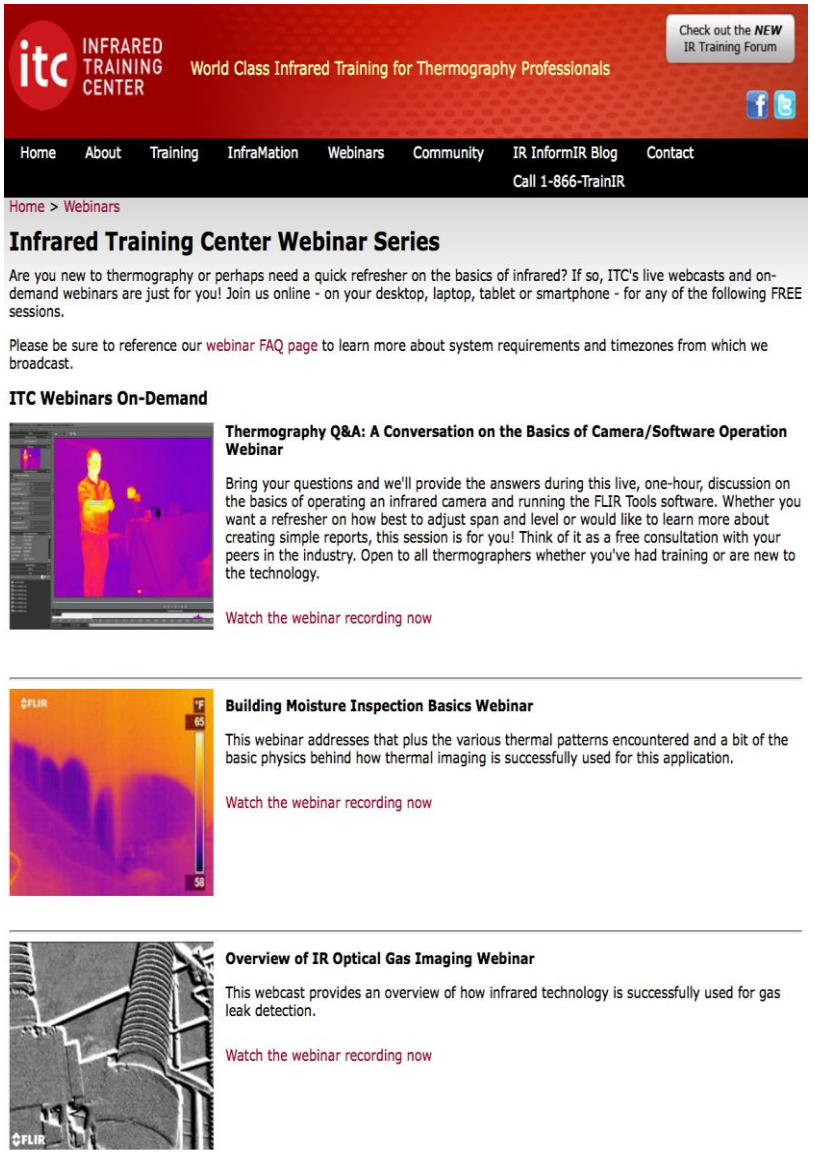
FLARE INSPECTION

WHICH CAMERA IS FOR ME ?

- 336 or 640?
  - 336 : Good price / performance in most applications, FPV
  - 640 : 4x pixels provides more FOV, required for mapping to reduce number of passes
- Which Optic?
  - Narrower FOV : Subjects are distant or small. Improved uniformity across image
  - Wider FOV : When flying lower, object locations are unknown, more situational awareness is important. Thermographic performance can suffer in the corners. Distortion can aid in 3D mapping

- 9Hz or 30Hz?
  - 9Hz : No effect on radiometry. Exportable to most countries. Great for mapping
  - 30Hz : Preferred in dynamic FPV flying. Restricted to US and STA countries
- Standard or Radiometric?
  - Standard: Relative information provides sufficient contrast to drive actionable results. Building inspection, energy audits, SAR, fire, disaster response, agriculture
  - Radiometric: ACTUAL temperature of the subject is critical to the workflow. Industrial process control & inspection, precision agriculture

- FLIR Vue web pages
  - http://www.flir.com/suas/content/?id=70733
- DJI Zenmuse XT web pages
  - http://www.dji.com/product/zenmuse-xt
  - http://www.flir.com/suas/content/?id=73063
- Infrared Training Center
  - http://www.infraredtraining.com
  - USA 1-866-TrainIR (866-872-4647)
  - Canada 1-800-613-0507 Ext. 24
  - Latin America +55 15 3238 8075
  - Europe +46 (0) 8 753 25 91



ACKNOWLEDGEMENTS

- Viper Drones-www.viper-drones.com

QUESTIONS ??

The Infrared Training Center wishes to Thank You for your attendance and we look forward to any questions that you may have.

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