Safety & Reliability-Centered Maintenance
What We Do

Leveraging an Area of the Electromagnetic Energy Spectrum Beyond Our Eyesight

To Develop Imaging Solutions That Enhance Peoples’ Perception and Awareness

- See in Total Darkness
- See Through Obscurants
- Measure Temperature
- Enhanced Long Range Imaging
- Accurately Detect People & Animals

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SAFETY AND RELIABILITY

Key Dimensions for Industrial Operations

- Zero Injuries
- Uptime
- Quality
- Productivity

Profit and Growth
Health and Safety

Electrical, Mechanical, and Environmental
Hierarchy of Controls

NFPA 70E Hierarchy of Risk Control Methods
NFPA 70E

**APPROACH BOUNDARY**

<table>
<thead>
<tr>
<th>TABLE 130.5.C – ESTIMATE OF LIKELIHOOD OF ARC FLASH INCIDENT</th>
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<tbody>
<tr>
<td>• Infrared thermography and other non-contact inspections outside the restricted approach boundary <strong>DOES NOT increase</strong> the likelihood of an Arc Flash incident</td>
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<tr>
<td>However . . .</td>
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<tr>
<td>• Opening hinged doors or removing covers that expose energized components <strong>DOES increase the likelihood of Arc Flash</strong></td>
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How do we take advantage of IR thermography’s safety benefits?
Infrared Thermography Inspection

NON-CONTACT MEASUREMENTS

QUANTITATIVE DATA

VISUAL CLARITY

Reduced Hazard Exposure = Increased Safety
Handheld Thermal + Inspection Window

Which method is more efficient? Which method is less risky?
Cabinet Continuous Monitoring – AX8

Live Video, Alarming, Ethernet/IP and Modbus TCP, PLC/SCADA integration, Datalogging
Industrial Safety Considerations

HEAT, FIRE, EXPLOSION RISK

OPERATING EQUIPMENT AND VESSELS

WORKING AT HEIGHT

HAZARDOUS ENVIRONMENTS

CAUTION
HOT WORK PERMIT REQUIRED IN THIS AREA

CONFINED SPACE ENTRY BY PERMIT ONLY
Mitigating Industrial Hazards

Inspection at a safe distance – telephoto lens + laser-assisted autofocus
Mitigating Industrial Hazards

Intrinsically Safe Solutions
Mitigating Industrial Hazards

Automated Continuous Monitoring
Early Fire Detection

IR Camera Advantages

• Cover Large Areas
• Pre Fire and Pre Smoke Alarming
• Alarms during heat up stage
• All Weather Monitoring (Fog/Smoke)
Uptime

Reliability-Centered Maintenance
Cost of Unplanned Downtime

- Explosion at a stamping supplier caused 2-week F-150 disruption
- Lost Revenue
  - 35,000 trucks @ $46,900 ASP
  - $1.6 Billion
- Ford airlifted a 43-ton die from US to UK to resume production
- What if the explosion cause could have been predicted and corrected?
Case Study – IR Window Installation

Arkansas Paper Mill

- More than 700 3” IR Windows
- All 480 V and above switchgear
- > $200,000 window purchase

- Mill estimates **$667k annual savings**
  - Window inspection vs. open door inspection

Safer, more efficient inspections = Increased MTBF
Motors and Bearings
Predictive Maintenance

HOT SPOT DETECTION

VERIFYATION AFTER REPAIR

High temperature delta revealed trouble, lower delta verified repairs aligned with historical measurements
Thermography vs. Vibration Analysis

**BEFORE BEARING REBUILD – 459 F**

**AFTER BEARING REBUILD - 102 F**

Vibration analysis showed no anomalies
Case Study – Data Center Substation Monitoring

Continuous Monitoring = increased MTBF, decreased insurance premium
Productivity

Doing More with Less
Productivity

**DOING MORE WITH LESS**

- Retiring workforce, growing skills gap
- Need for Faster, Safer Inspections

**REDUCING DUPLICATION OF EFFORT**

- Data transfer and/or keyed entry
- Possibility for human error at each interface
Training Resources

- Regional Certification Courses
- Online Courses & Tutorials
- YouTube Channel
- Onsite / Custom Classes
Complete, Reliable Solution

FLIR Thermal Studio Pro

FLIR Inspection Route Creator

FLIR Thermal with Inspection Route Camera Software

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Multiple points to inspect (taking too long to finish)

- Structured inspection route
- Camera guides the operator

User can define up to six (6) levels
Not sure what is next on the list to inspect

- Desktop-produced inspection route
- Workflow flexibility

Description and/or comment available for the inspection point.
**Improvement vs. Pencil + Paper Data Acquisition**

- Tabulated data acquisition
- Images and Measurements tagged with Asset Information
Centralized Data

- Thermal data, Visual image, Asset information in a single JPG file
- Organized in desktop software
Outdoor Visibility

- Eyepiece Viewfinder & Vibrant 4” touchscreen LCD
- Allows user to view route, whether indoors or outdoors in bright sunlight
A- product used as sensor (built in analyse) with software clients

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Our SDK allows for custom integrations

**SDK FUNCTIONALITY**

- **Live**
  - View and control stream

- **Image processing**
  - Edit IR Images
  - Fusion (MSX)
  - Palettes
  - Level & span

- **Measurements**
  - Live data
  - Log files from meters

**Radiometric JPEGs**
CONTINUOUS MONITORING WITH FLIR CAMERAS

Viper Imaging
Questions to be asked- You have to break the CODE

• **Connectivity**
  - What information do you want and how do you want to receive it?

• **Object**
  - How hot? How big? What’s it made of? How much of it do you want to see?

• **Distance**
  - How far is the target away? Distance to control room?

• **Environment**
  - How dirty is it? Special considerations?
It all starts with Connectivity...

• It’s the data that matters

• This drives the camera format that you need

• Types of outputs
  • Visualization of the Thermal image (A300, Vue, Tau, Quark)
  • Discrete alarming on-board (Ax8, A310, FCR-Series, A310pt)
  • Email alarm messaging on-board (Ax8, A310, FCR-Series, a310pt)
  • Analog and/or digital data stream, go-no go (Ax5, A3xx, A6xx)
  • Data communications via OPC, ModBus, ProfiNet, etc. (Ax5, A3xx, A6xx, A310, A66xx)
  • Database (A310, Ax5, A3xx, A6xx, A66xx)

• Software example- link to ViperVision
The Object drives the camera set-up

- Size of object- Lens
- Minimum spot size required- Resolution
- Emissivity of object- Wavelength
Distance

• Distance to target will determine the lens needed
  • What could be in the way? smoke, steam, human traffic, mechanical structure, etc.
  • Loss of signal due to distance
  • Field of View Calculator

• Distance from camera to control room
  • Standard limits for electrical connections
    • USB
    • HDMI
    • Cat5/6
    • Fiber (MM)
    • Coax
Environment

- Ambient temperature
- High EMI
- Access due to Voltage considerations
- Hazardous classification (A310ex, Viper Enclosures)
- Smoke/Steam
- Spray- from molten metal to waste sludge, both have to be accounted for
Case Study- Alabama Power

- Wholly owned subsidiary of Southern Company.
- 1.47 million customers served.
- 84,564 miles of line.
- 1301 active substations.
- 88,022 active pieces of substation equipment.
Alabama Power’s CODE

• Connectivity
  • Need to continuously monitor Various components on the transformer to ensure that components do not overheat individually or phase to phase. This information needs to be transferred via OPC to the customer’s PI data historian

• Object
  • Each Transformer is 230-115kV Autobank Installation and is approximately 12’ wide & 15’ tall with a variety of components inside and outside of this envelope

• Distance
  • There is limited distance between the transformer & the pole to be used for mounting the camera requiring a wide angle lens. The system is less than 300’ from the control room (PC).

• Environment
  • The cameras will be located in an outdoor location in the Southeastern US (read hot & humid)
System Installation

- Includes three (3) A65 cameras in IP 67 enclosures with sun-shades
- Each camera is powered via a central PoE switch located in a centrally located panel near the base of the pole
- The Central Cabinet is connected to the control room via a Cat6 Ethernet connection.
- Each Substation has a PC running ViperVision software with OPC and Time-Lapse modules (capable of adding more cameras for additional transformers)
Benefits of the Viper System

• Continuous monitoring of the transformer provides security and the ability to run at maximum capacity

• Temperature measurements provide insight into their process allowing them to extend transformer life and better control the system during peak loads

• Software allows for Time-Lapse recording and replay for further diagnostics and future planning