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## Remote Sensing: Natural Gas Detection with Infrared (IR) Spectrum

### Objectives

- Detection of Natural Gas Leaks in Wide Area Surveillance
  - Particularly for Pipeline Management
- Minimize Required Personnel
- Minimize Personnel Interaction
  - Push Towards Full Automation
- Maximize Detected Leaks

### Challenges

- Limited Data
  - Most Data is Proprietary
- Very Low Resolution
  - Often 320x240 pixels for Hundreds of Square Feet or More
- Irregular Behavior of Gas Due to Environment
  - High or Low Winds
  - Thick or Thin Density
- Varying Levels of Leaks
  - Due to the Wide Area Surveillance Objective this Project Focuses Primarily on Heavy Leaks
- Moving Target and Moving Background
  - Also Potentially Fast Moving Frames

### Proposed System

- IR Camera
  - Range: 3 $\mu$ m to 4 $\mu$ m or 7 $\mu$ m to 9 $\mu$ m
  - Natural Gas Peaks: 3.3 $\mu$ m and 7.6  $\mu$ m
- Aircraft
  - Maned or Unmanned

### Implementation

- Current Implementation
  - Blended Algorithm of Feature Detection and Foreground Detection
  - Implemented in MATLAB®
- Future Additions
  - SVM (or similar) Classifier
  - Implement in C++ for Speed

### Algorithm

1. Train Foreground Detector with 20 Frame Groups
  - Foreground Detection using Gaussian Mixture Models
2. Extract Individual Frame from Video
3. Extract Foreground Binary Mask of Image
  - This Creates an Image the Same Size as the Frame with Foreground Regions as Binary 1; Background is 0.
4. Extract MSER Feature Regions
  - MSER Regions are Areas of Similar and continuous intensity.
  - All Regions are Compared and Only the Strongest Regions are Saved
5. Construct Binary Mask from Regions
6. Combine Foreground and MSER Mask
  - Logical AND Operation
7. Process Mask with Blob Detector
  - Analyzes Mask for Connected Binary Components of Large Size
8. Display Image with Bounding Boxes around detected Binary Blobs

### Experimental Results

