SAND2008-5951P

Overview of Video System Components

September 24, 2008

Dave Furgal

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Disclaimer

- All material in this module is unclassified
- In this module, photos of equipment are included as examples only
- Sandia National Laboratories does not endorse or recommend any specific equipment

Sandia National Laboratories

Module Objectives

- Identify the major components of a video system for alarm assessment
- Discuss analog and digital video systems
- Understand alarm assessment video system performance requirements
- Understand the assessment concepts of object detection, classification, and identification
- Understand differences between fixed and pan-tilt-zoom cameras
- Understand concept of far field resolution limitation

Module Outline

- Analog & digital video assessment systems
- Video alarm assessment system requirements
- Overview of system components
- Summary

Sandia National Laboratories

Analog to Digital Video System Comparison

Analog

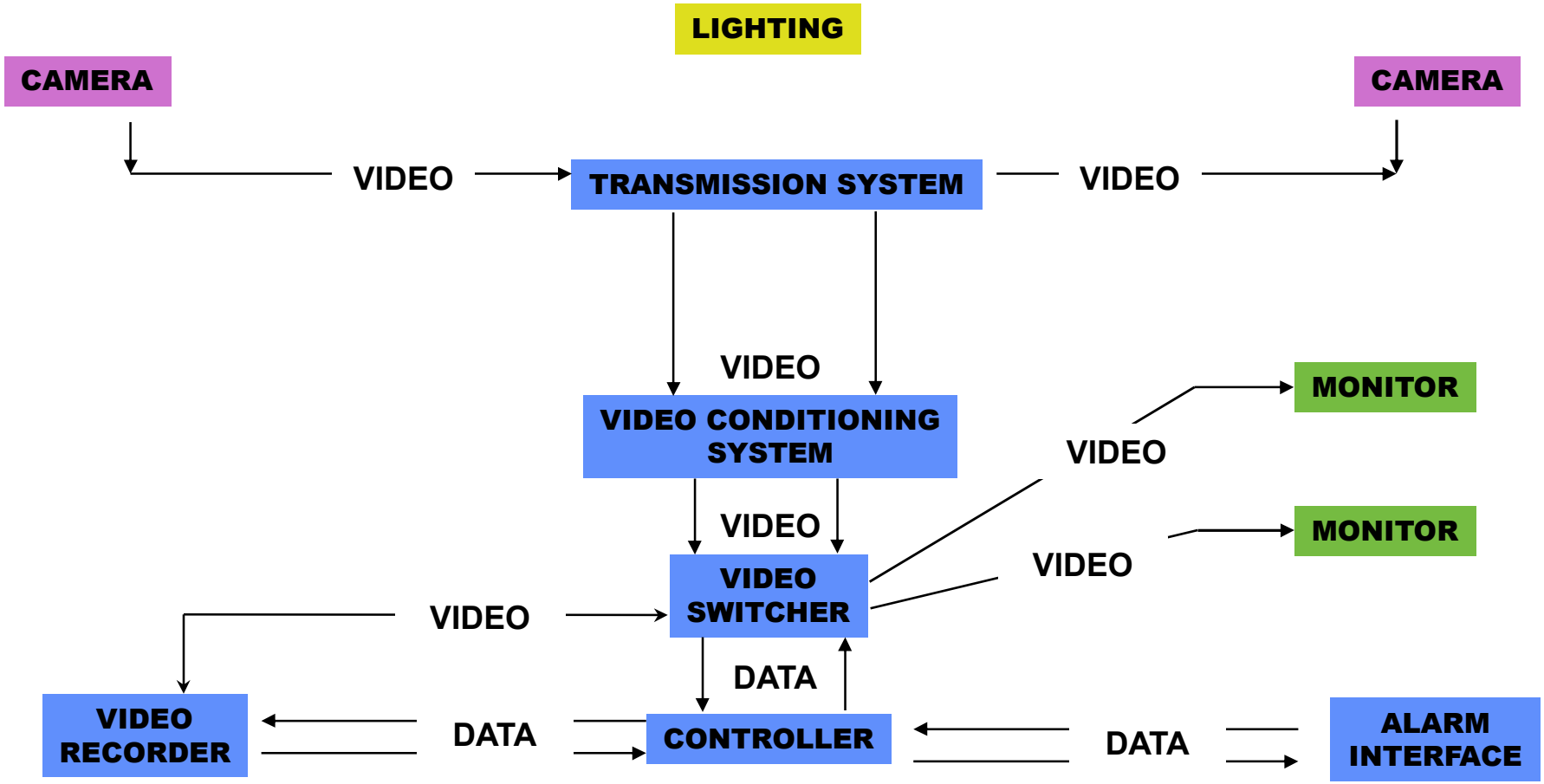
- Camera, mount, & lens
- Lighting system
- Video transmission
- Video conditioning
- Video switching
- Video recording
- Video monitor
- Video controller

Digital

- Network camera, mount, & lens
- Lighting system
- Network transmission
- Network conditioning
- Video / database software
- Network recorder
- Workstation
- Network server

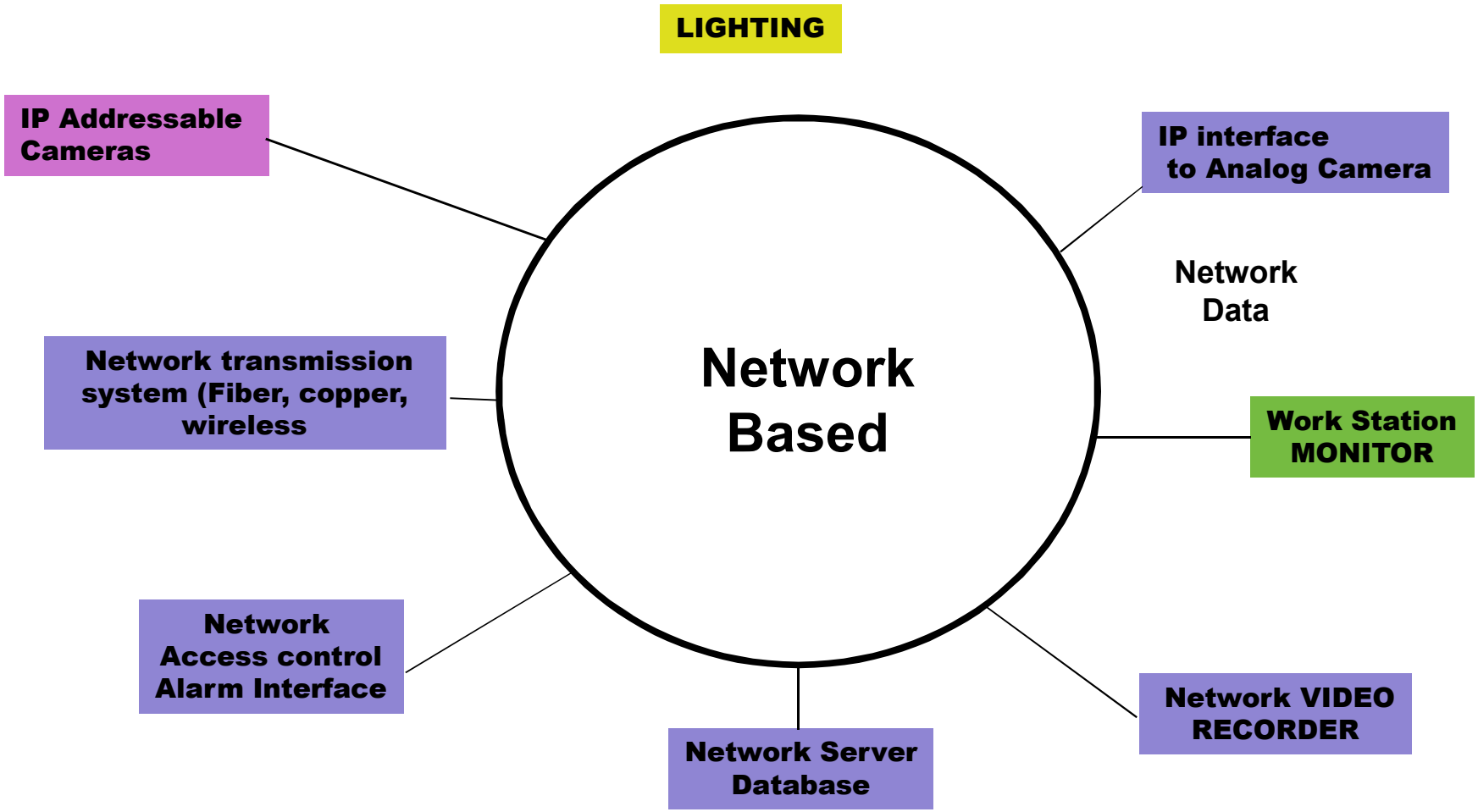
Sandia National Laboratories

Analog Video System Diagram



Sandia National Laboratories

Digital Video System Diagram



Video Assessment System Equipment

- Camera & Lens
- Communication System
- Switcher
- Recorder
- Monitor
- System Controller
- Man-Machine Interface (joystick)
- PTZ Control System
- Alarm Control & Display Interface

Sandia National Laboratories

Video Assessment System Equipment

(cont.)

- Camera Tower
- Camera Environmental Enclosure
- Video Isolation Devices
- Video Signal Amplifiers, Equalizers
- Power Supplies
- Lightning Protection
- Surge Protection
- System Grounding

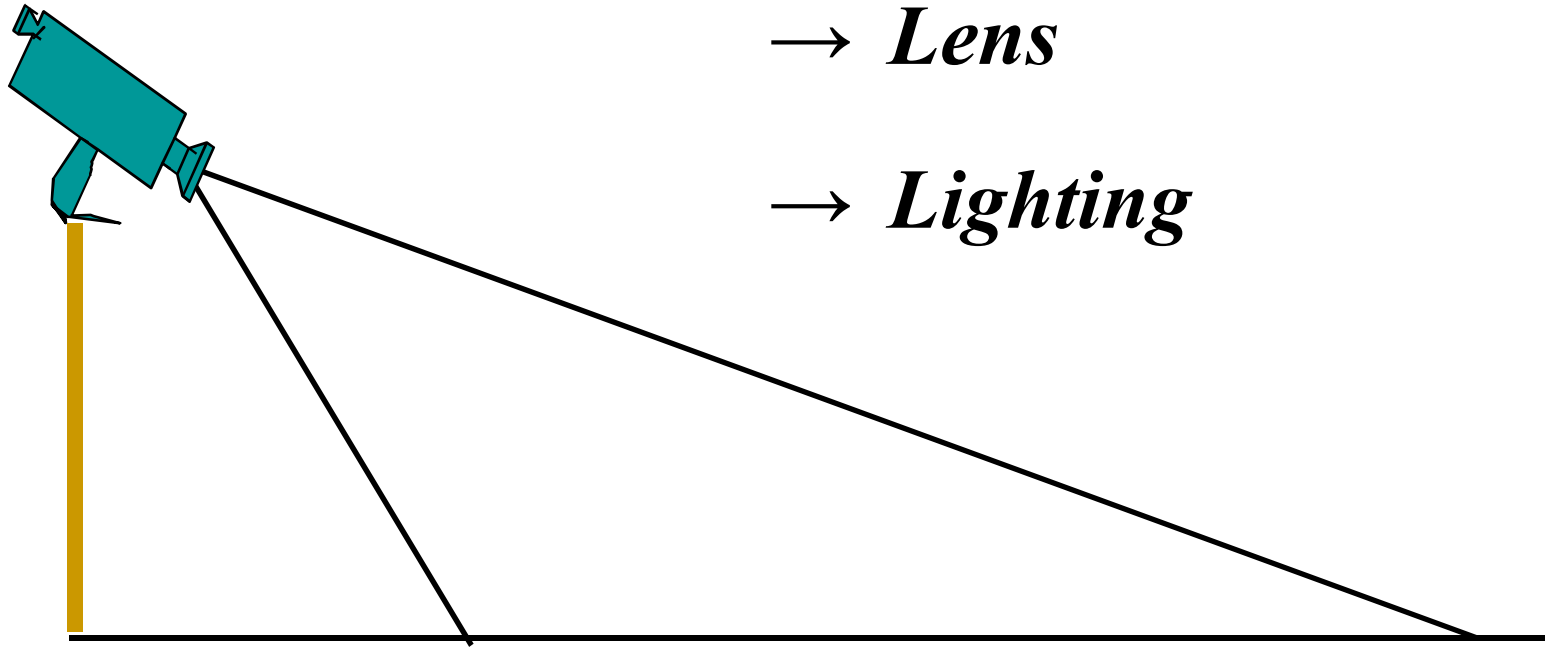
Sandia National Laboratories

The Three Major Video Assessment Elements

→ *Camera*

→ *Lens*

→ *Lighting*



Sandia National Laboratories

Camera and Lens

- Camera converts visual image to an electrical signal for communication to control room equipment
- Camera is placed at proper location & installed with appropriate lens type to adequately assess a defined area, zone or sector
- Camera and lens selection determined by video resolution needed to meet assessment requirements

Cameras

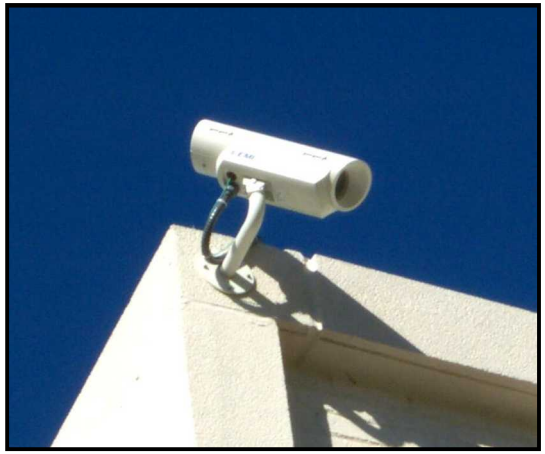
Sandia National Laboratories

Camera and Lens

- The camera converts a visual image to an electrical signal for transmission to the security system control console
- Major types
  - Solid state imagers
  - Thermal (specialty camera)
- Camera placement depends on appropriate lens selection to adequately assess a defined area, zone, or sector

Fixed and PTZ Cameras

- **Fixed camera**
  - Non-motorized mount
  - Fixed or variable focal length (zoom) lens
- **Pan-Tilt-Zoom (PTZ) camera**
  - Motorized mount
  - Motorized zoom lens



Sandia National Laboratories

Fixed and PTZ Camera – Factors to Consider

- **Fixed Camera**
  - + Always pointed at area to be assessed
  - + With video recorder, captures pre-alarm and post-alarm video
  - - Requires more cameras for complete coverage
- **Pan-Tilt-Zoom Camera**
  - + Requires fewer cameras for complete coverage
  - - Low probability it will be pointed at the location that must be assessed when alarm occurs
  - - Cannot provide video for two simultaneous alarms in different portions of the camera coverage area

Desirable Camera Characteristics

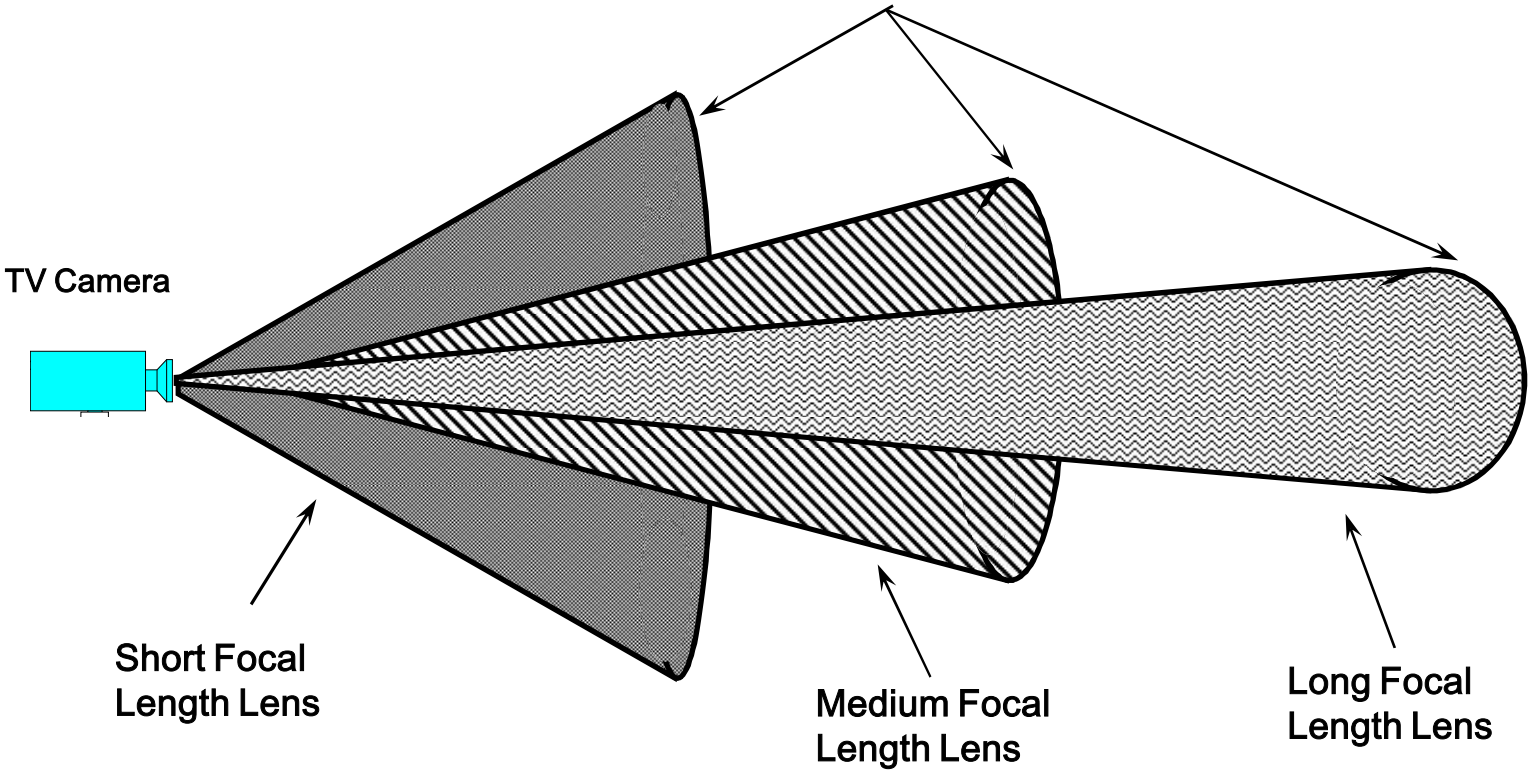
- High sensitivity to provide best video image with lighting conditions present
- Control circuits (AGC, auto iris) to maintain video image quality over range of day/night lighting conditions
- Maintains picture quality while motion is present
- Long life, durability, reliability & resistant to environmental effects

Lenses

Sandia National Laboratories

Camera Lenses

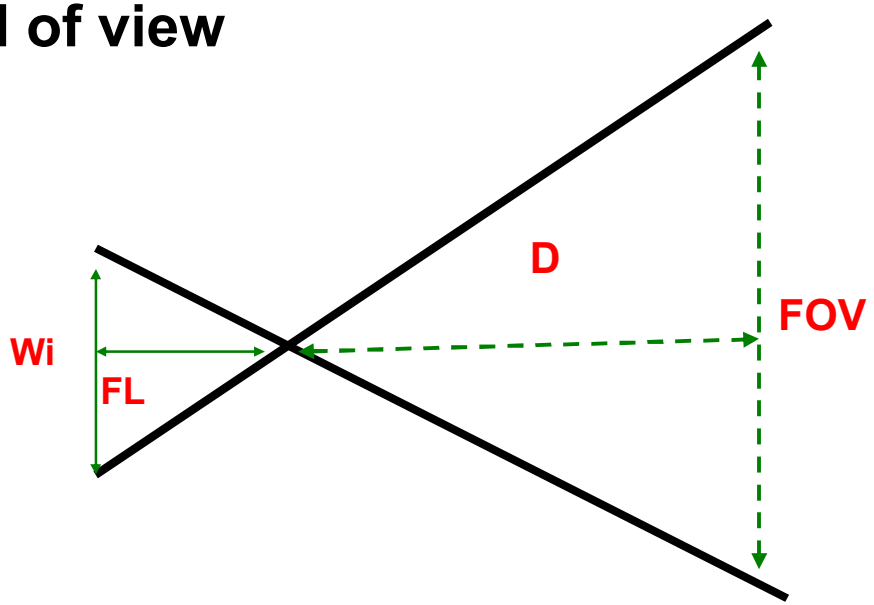
Focal length limits imposed by resolution requirement



Sandia National Laboratories

Lenses

- **Format must match camera format**
  - **Equal or larger format on lens than camera**
- **Focal length (8mm, 25mm, 75mm)**
  - **Relative magnification of an object and width of field of view**



Lens Attributes

- **Format**
  - **Size (1/2”, 1/3”, etc.)**
  - **Spherical / aspherical**
- **Focal length**
  - **Relative magnification of an object**
- **F-stop (F-number)**
  - **Measure of the ability to gather light**
- **Transmittance (T-number)**
  - **Amount of light that can pass through the lens**

Lighting

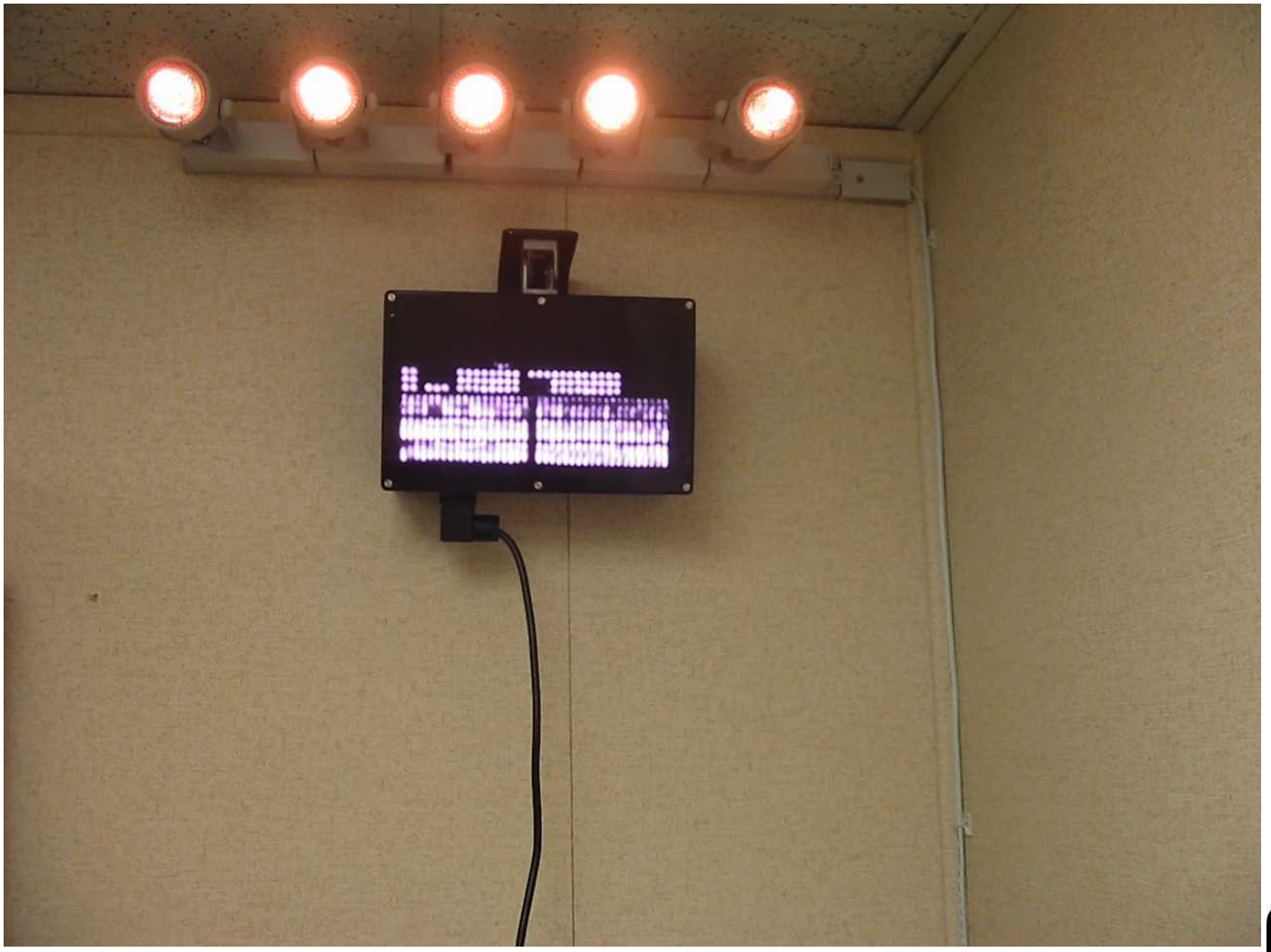
Sandia National Laboratories

Lighting Function and Types

- **Function**
  - Illuminate scene for nighttime operation
- **Major types**
  - Incandescent
  - Mercury vapor
  - High pressure sodium
  - Low pressure sodium
  - Near infrared

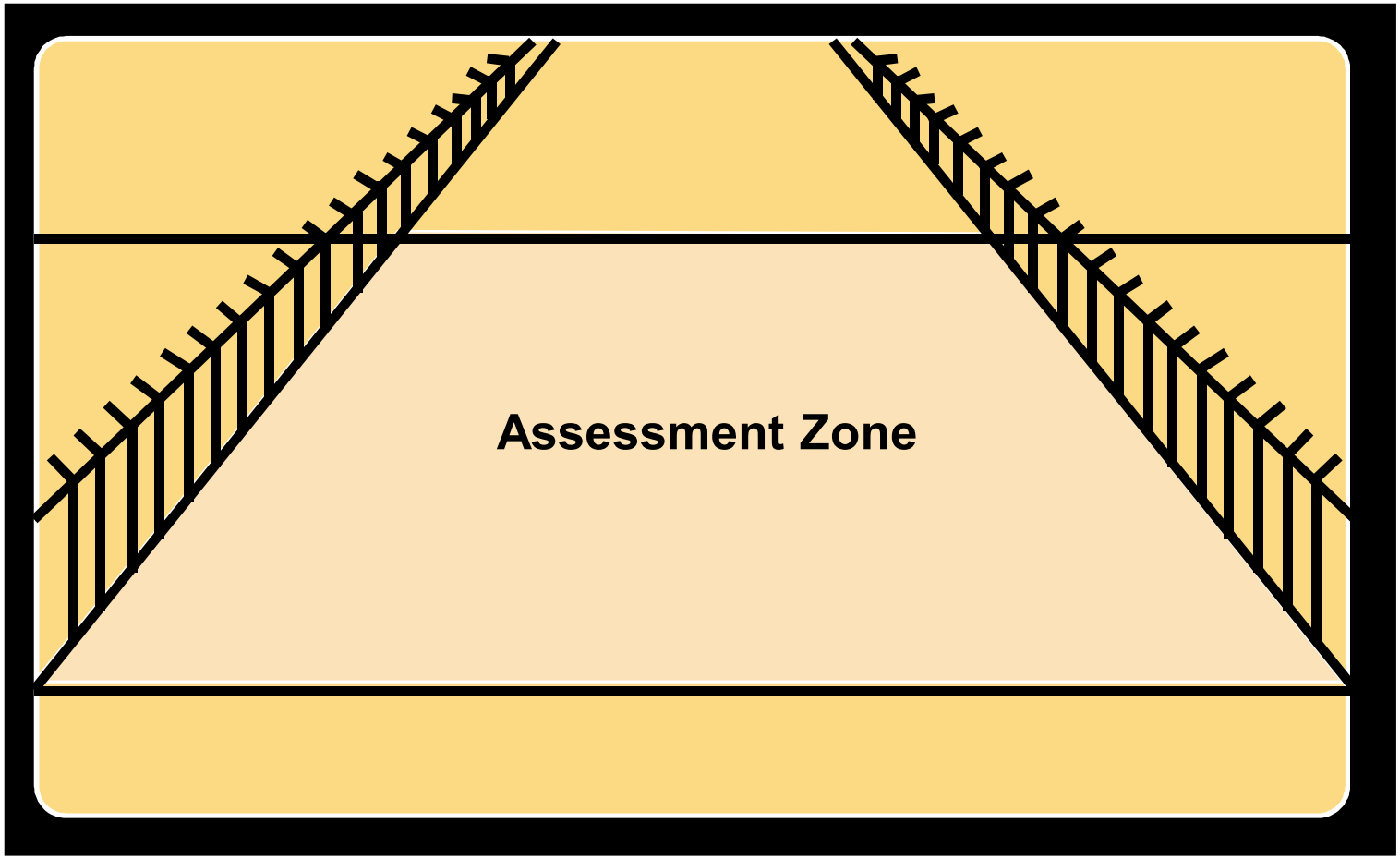
Sandia National Laboratories

Incandescent and Near-Infrared Lamps



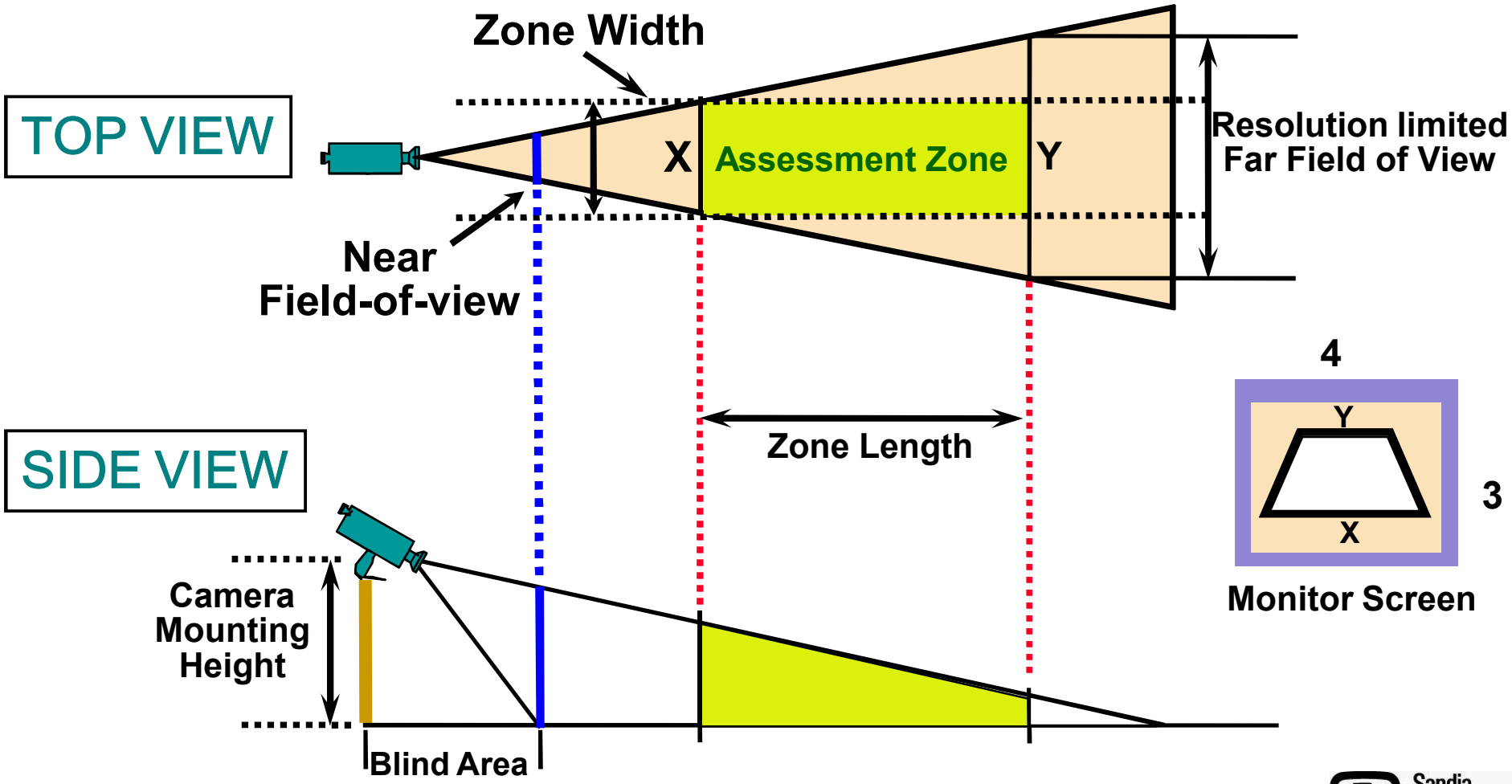
Sandia National Laboratories

Monitor Picture of Camera Field-of-View



Sandia National Laboratories

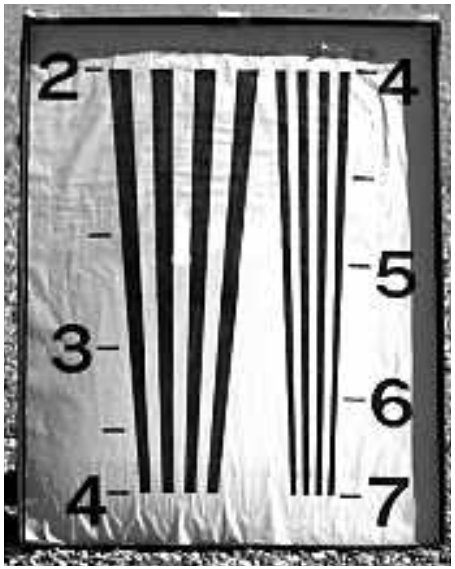
Geometry of Assessment Zone

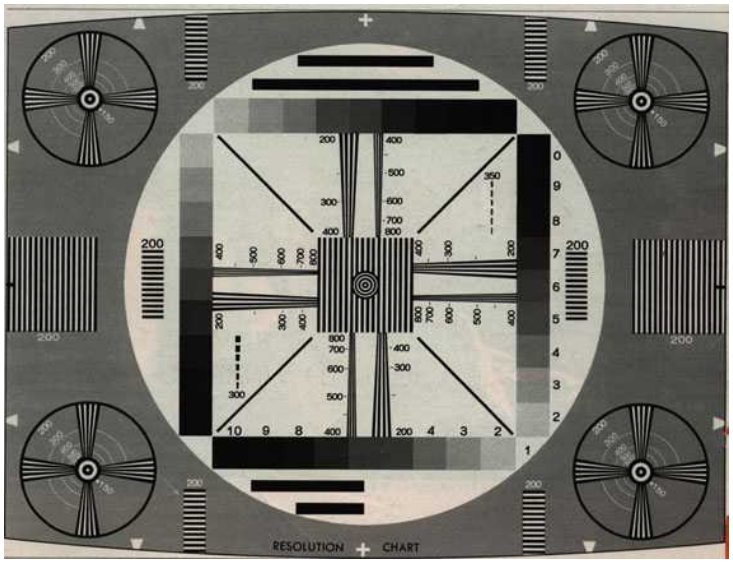


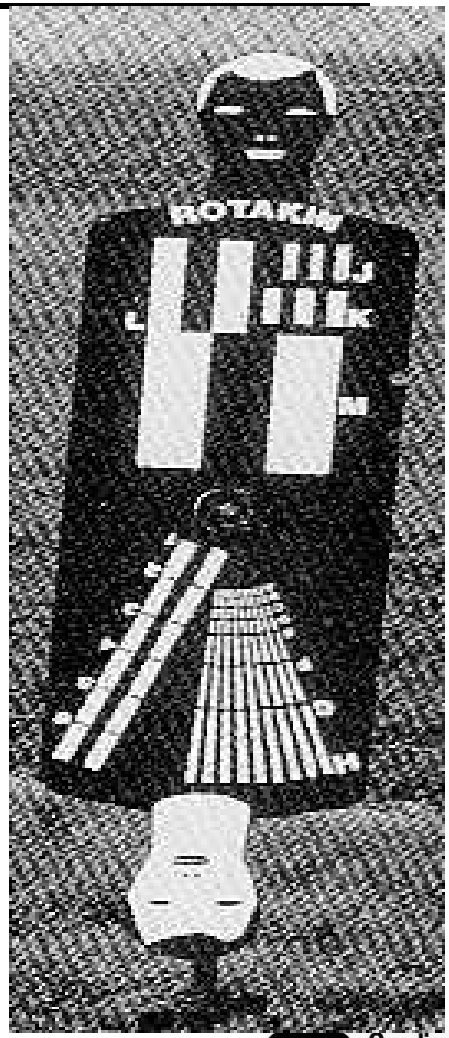
Sandia National Laboratories

Resolution

- Degree to which you can see fine details in viewed image
- Measured using resolution chart





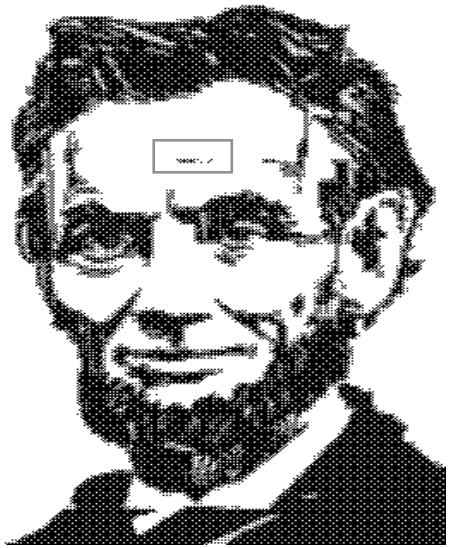


Sandia National Laboratories

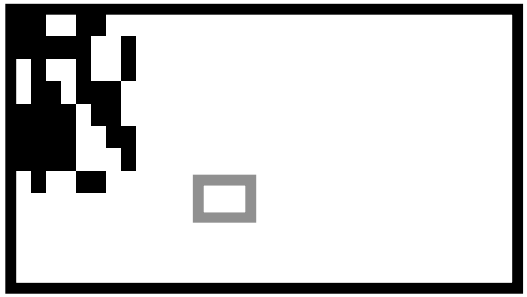
Resolution (cont.)

Number of independently resolvable elements in picture

Pixel - The smallest resolvable detail that can be detected in a TV screen



Full Picture



Zoomed-in Forehead

One Picture Pixel

Sandia National Laboratories

Levels of Resolution

Detection	Classification	Identification
		
Determine Presence of Object	*Determine Class of Object*	*Determine Identity of Object*

Levels of Resolution (cont)

For assessment, we consider 3 levels of resolution:

Detection	**able to identify presence of an object in video image**
Classification	**able to identify whether human, animal or blowing debris**
Identification	**ability to identify a person not just a human**

	Approx # of Pixels
Detection	2 to 3
Recognition	6 to 9
Identification	10 to 16

Important factors are *Contrast & Motion*

Sandia National Laboratories

Assessment Resolution

- Assessment resolution depends on camera resolution, lens FOV, & closeness of object to camera
- We want to distinguish (classify) between an animal crawling and a person with his/her head facing camera
- We can better determine if it is a human when in standing position

Assessment Resolution (cont)

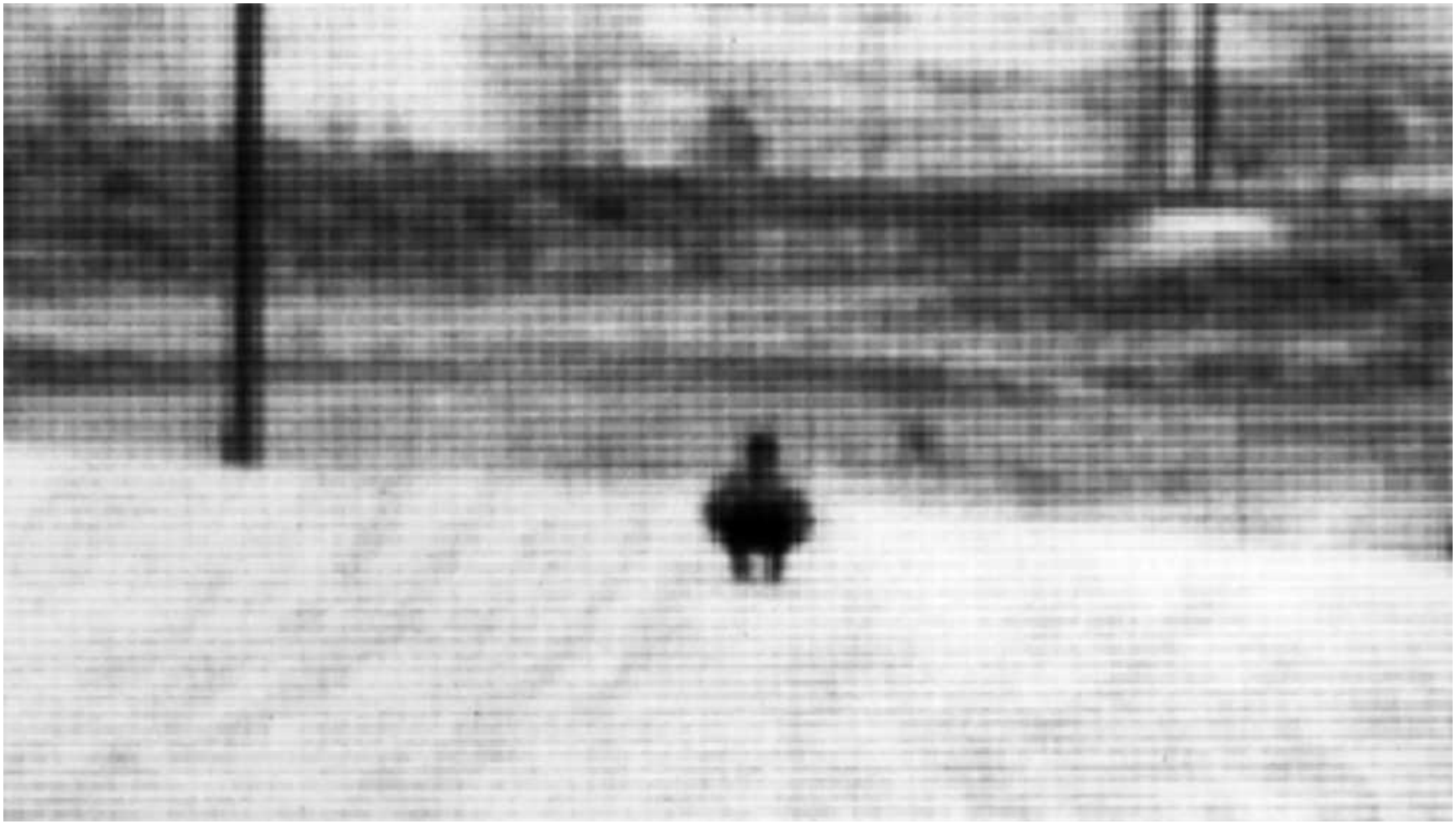
- Tests at Sandia showed that 6 horizontal TV lines (8 pixels) on a 1-ft target at a 100-ft far field width was minimum to classify human shape
- This affects number and placement of cameras
- Recommendation: Test cameras for specific application
  - Don’t rely on manufacturers’ data

Sandia National Laboratories

Assessment Resolution - *Detection*

Sandia National Laboratories

Assessment Resolution -
Classification



Sandia National Laboratories

Assessment Resolution - *Identification*

Sandia National Laboratories

Performance Requirements for Video Assessment

- Minimum time between sensor alarm and video display
- Complete area coverage of intrusion detection zone / sensors
- Classify 1-ft target at far edge of detection zone
- Field of view at far edge of sensor zone (height/ width)
- Continuous operation 24/7
- Minimal sensitivity to adverse weather conditions

Preferred Camera Assessment Layout Conditions

- One fixed camera per area to be assessed
- Camera resolution limitation where camera can see about 100 feet in width
- Outdoor perimeter zone length 300 feet maximum
- Outdoor perimeter zone width 45 feet maximum
- Illumination source at least 10 feet above camera height
- No illumination sources in the camera field of view
- Perimeter areas that are straight and flat
- No obstructions (places to hide) in camera field of view
  - Control or junction boxes, walls, furniture, cabinets or equipment

Preferred Camera Assessment Layout Conditions (cont)

- Fence separation constant and parallel – both fences in camera field of view
- Sensors and associated equipment in camera view
- Cameras high enough and tilted down so horizon is not in camera field of view
- Camera mount and tower stable in wind
- Camera tower does not interfere with detection sensor operation
- Camera tower does not obscure view of assessed area
- Cameras not on wooden pole

Assessment Example Pictures

A perimeter that is not straight and flat

Sandia National Laboratories

Aim the camera down to avoid horizon

Sandia National Laboratories

A camera mounted on a sturdy tower

Sandia National Laboratories

Examples of towers that flex

Sandia National Laboratories

Wooden poles can bend and twist

Sandia National Laboratories

Module Objectives

- Identify the major components of a video system for alarm assessment
- Discuss analog and digital video systems
- Understand alarm assessment video system performance requirements
- Understand the assessment concepts of object detection, classification, and identification
- Understand differences between fixed and pan-tilt-zoom cameras
- Understand concept of far-field resolution limitation