

Wayside, Track, and Onboard Measurement Systems

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Summary

What's inside the technology?

Overview of measurement systems.

What is the future of measurement?

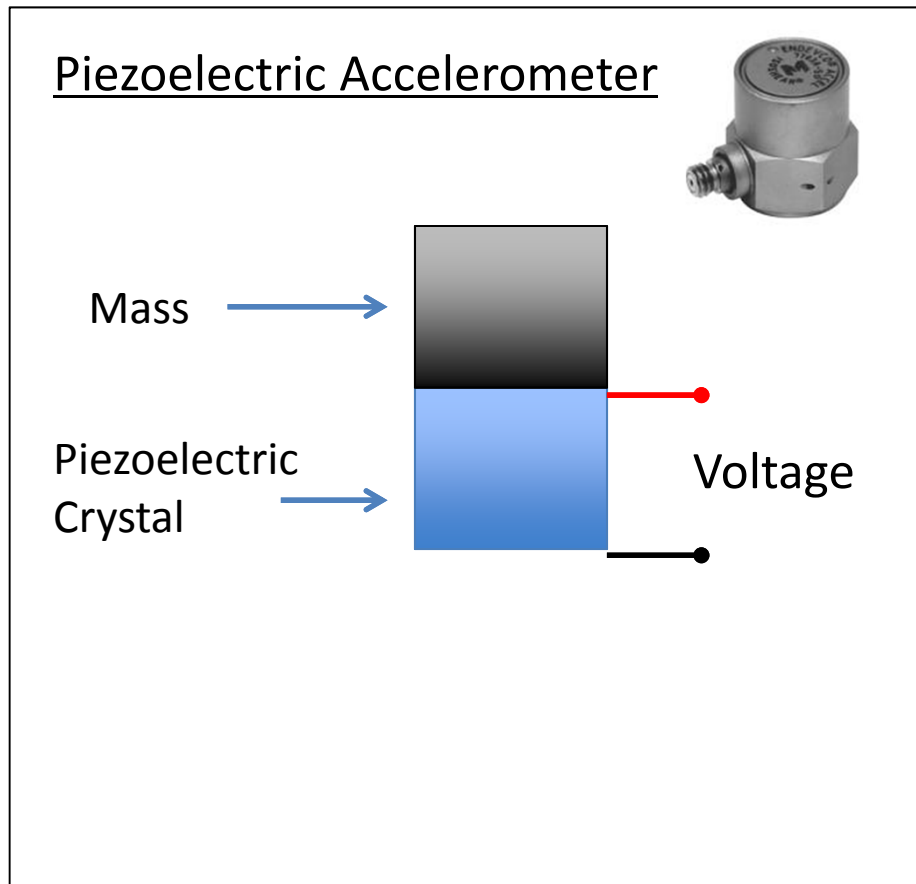


Background on Sensors



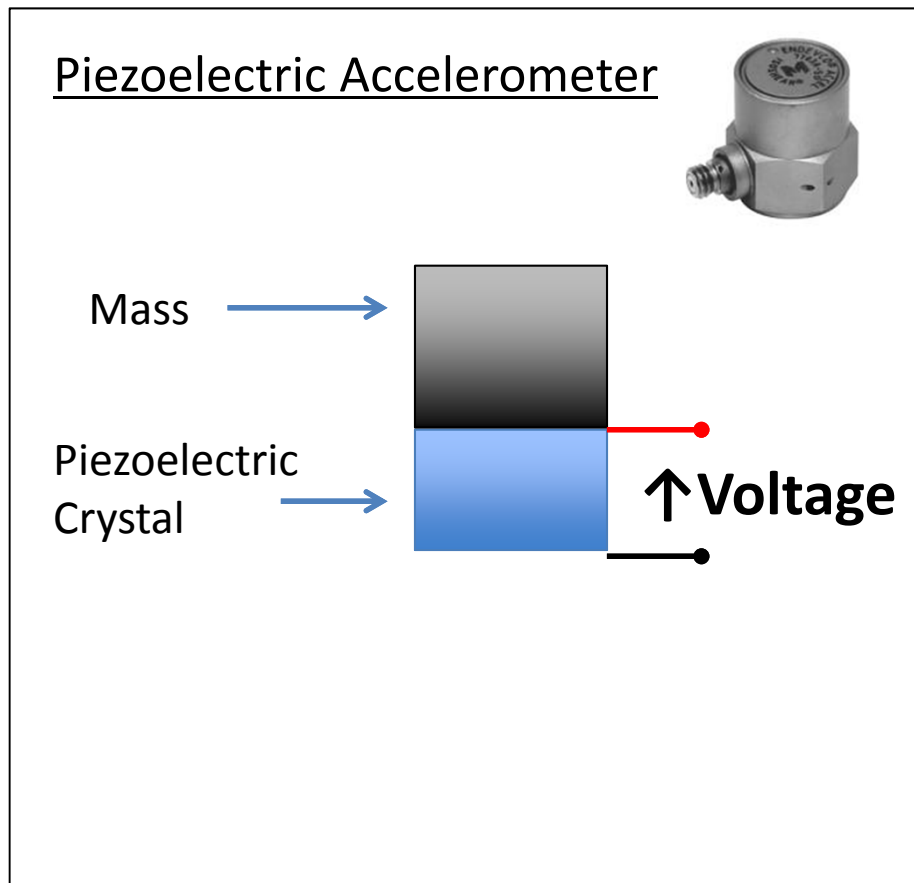
Accelerometers

- Directly measure acceleration
- Acceleration can be converted to Velocity, Distance, and Force



Accelerometers

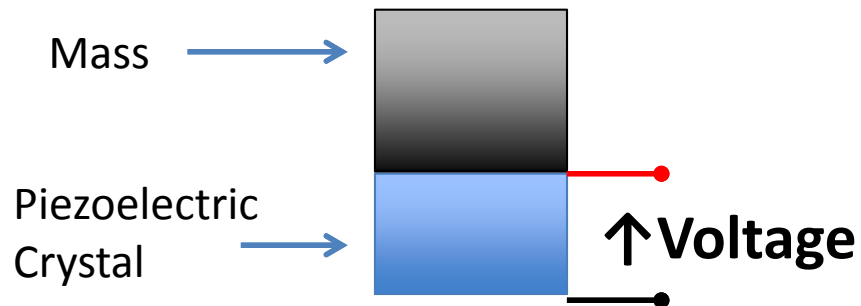
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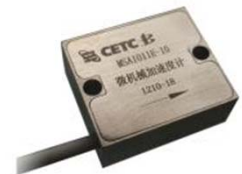
Accelerometers

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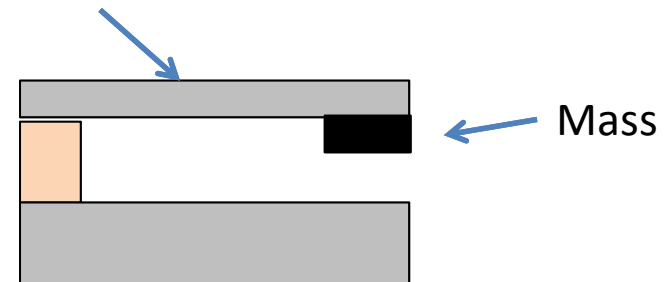
Piezoelectric Accelerometer



MEMS Accelerometer



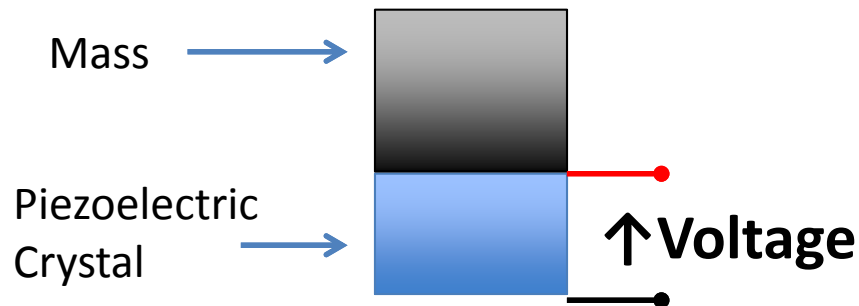
Cantilever Beam



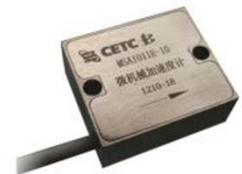
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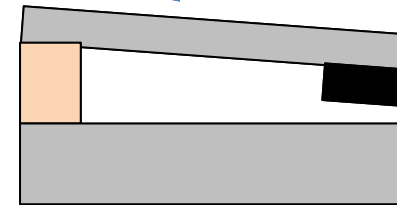
Piezoelectric Accelerometer



MEMS Accelerometer



Cantilever Beam



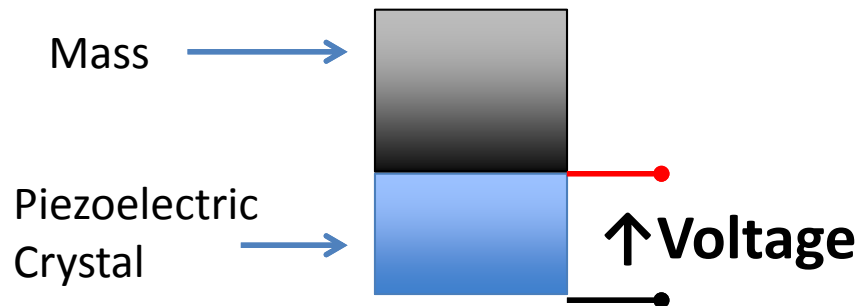
Mass



Accelerometers

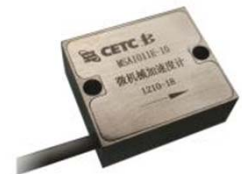
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Piezoelectric Accelerometer

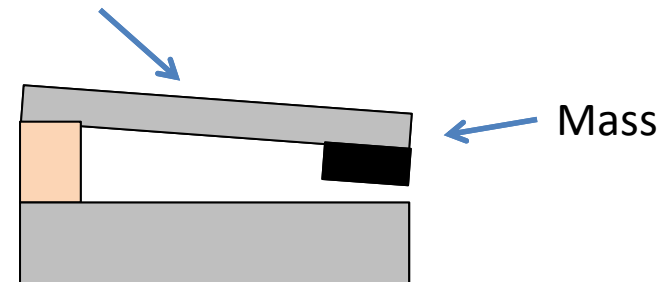


- Used for higher acceleration
- Used for higher frequency vibration

MEMS Accelerometer



Cantilever Beam

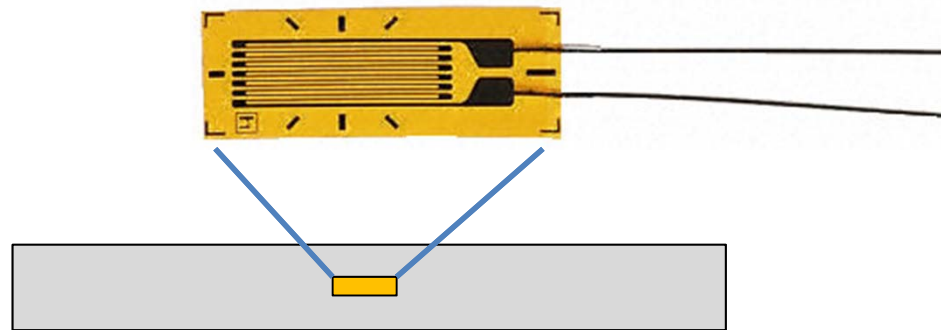


- Used for lower acceleration
- Used for lower frequency vibration
- Can measure "DC Response"



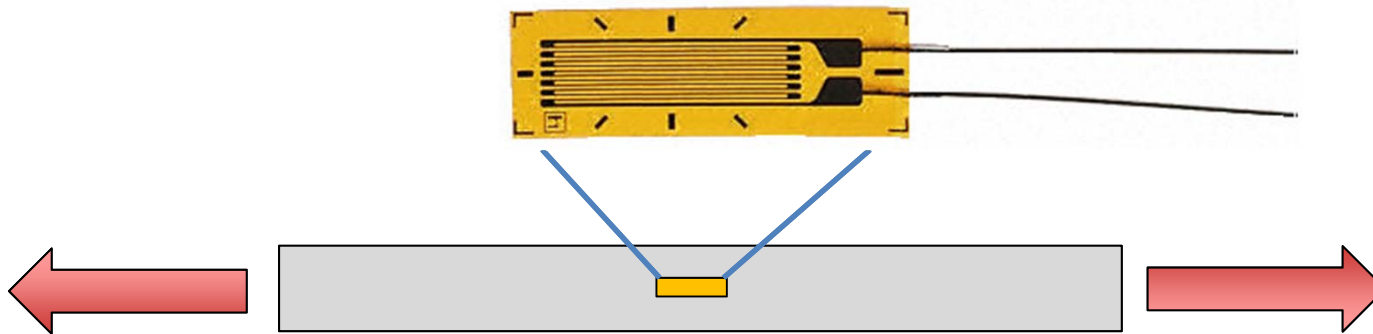
Strain Gauges

- Directly measures strain, which can be converted to stress.



Strain Gauges

- Directly measures strain, which can be converted to stress.



- Voltage change can be measured due to the strain gauge resistance change.
- There are various types and installation patterns of strain gauges.



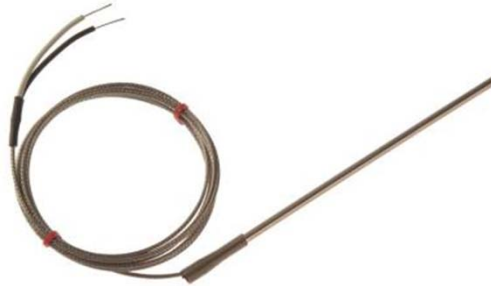
Temperature Sensors

Thermistors and RTDs



- Uses resistance change to measure temperature.
- Lower cost
- Lower temperature range

Thermocouples



- Uses voltage change between dissimilar metals to measure temperature.
- Higher cost
- Higher temperature range

Infrared Sensors

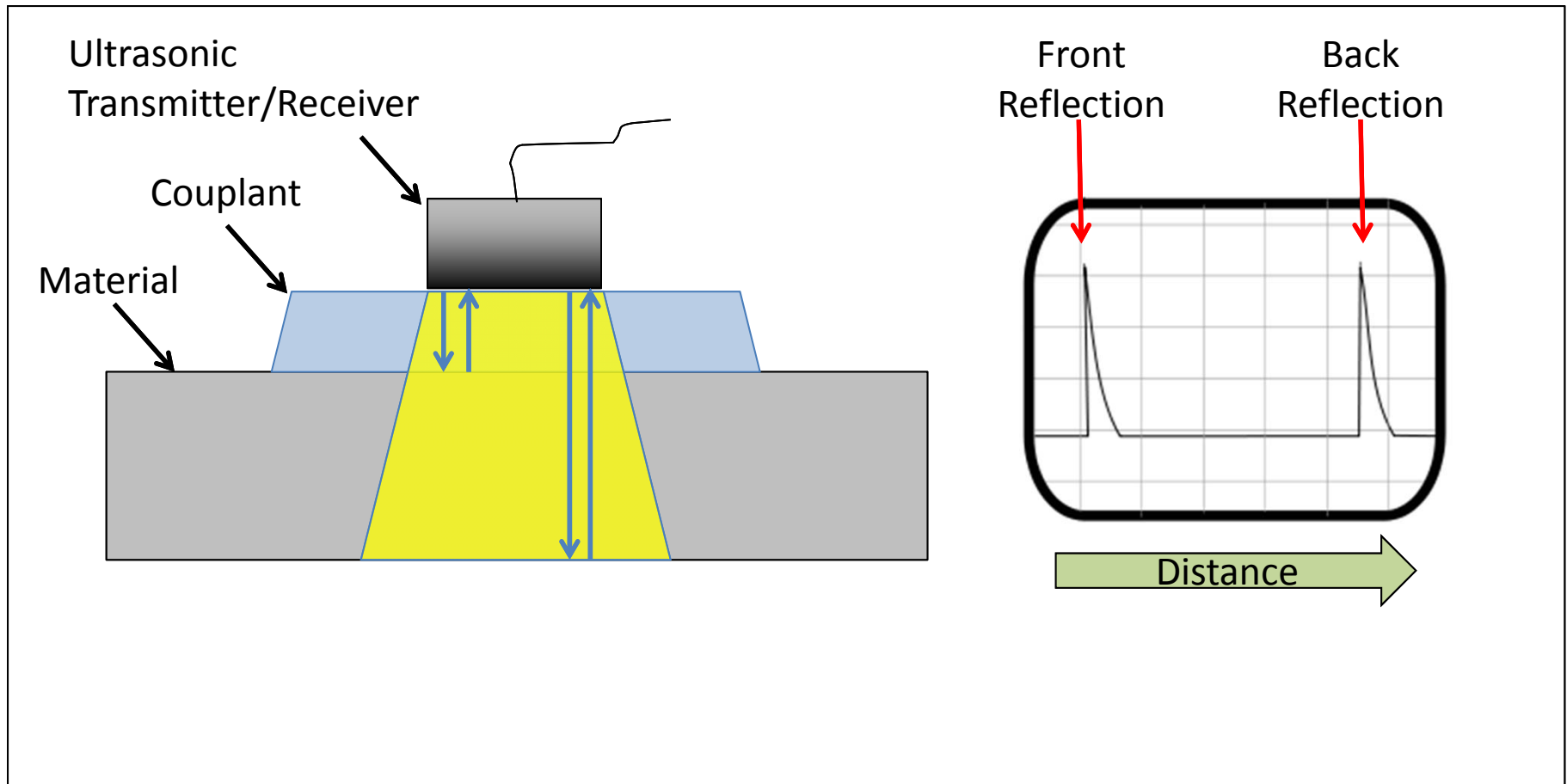


- Measures thermal radiation
- Non-contact measurement



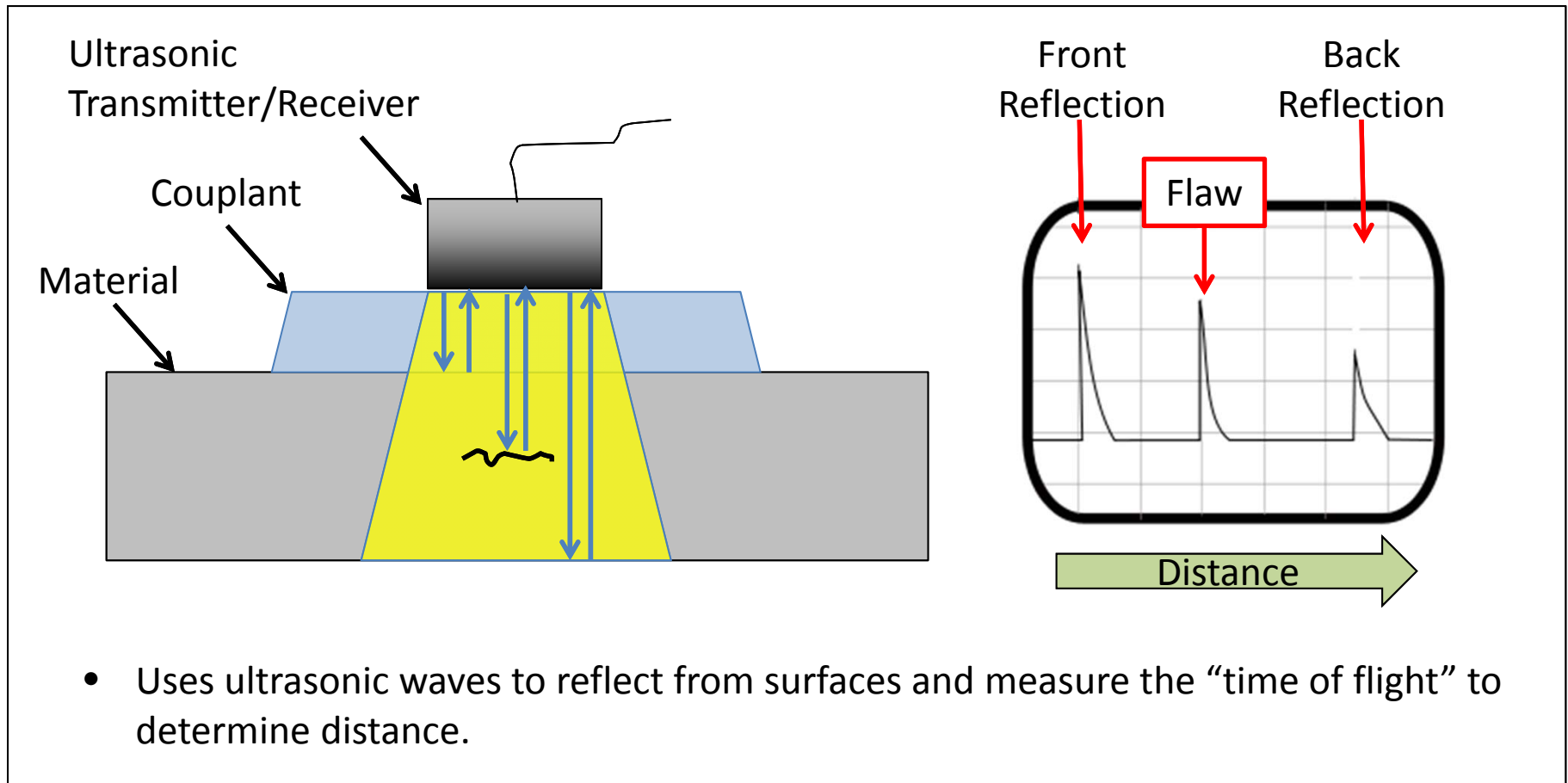
Ultrasonic Sensors

- Can measure depth, size, and orientation of internal flaws in a material

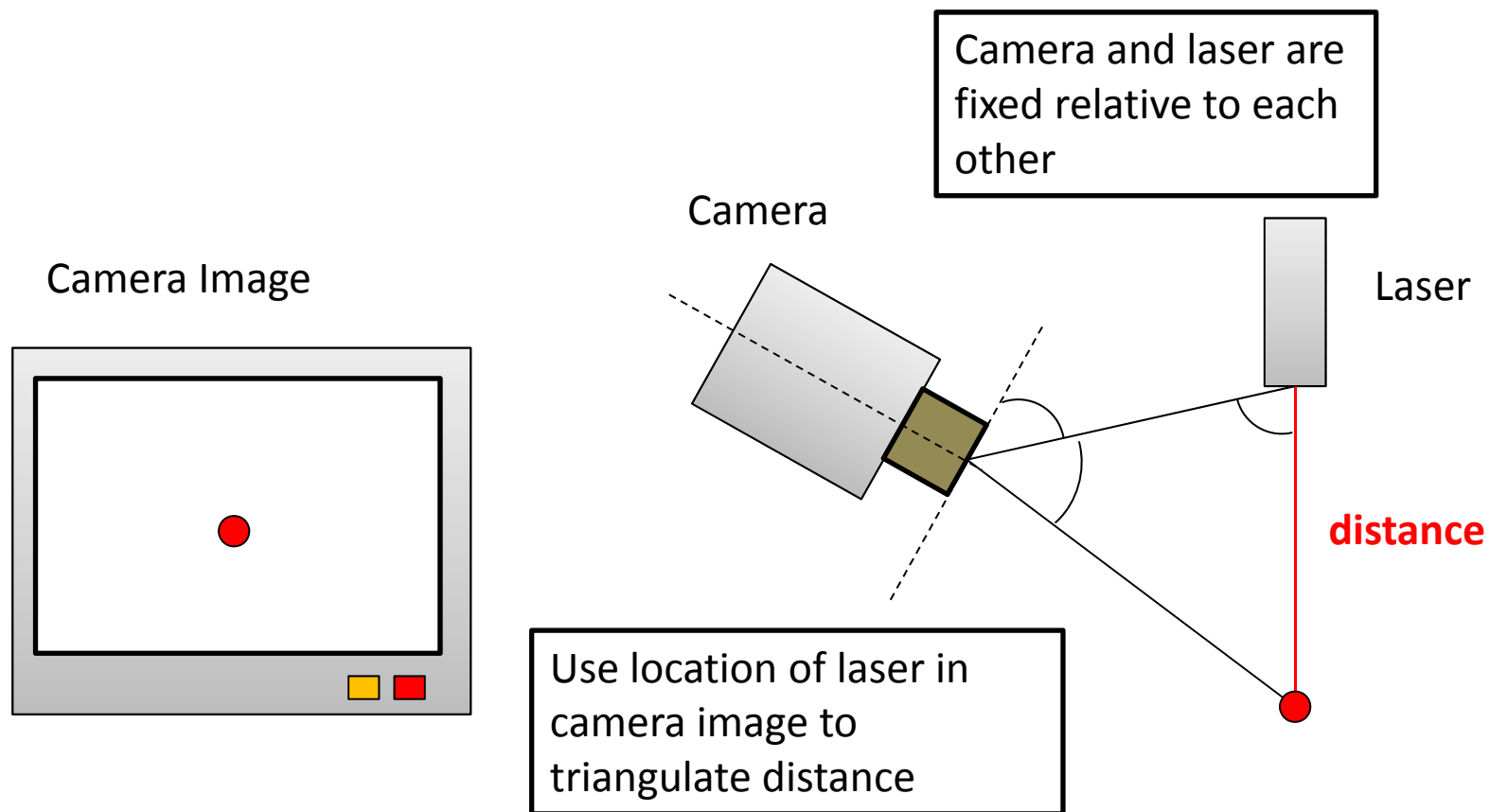


Ultrasonic Sensors

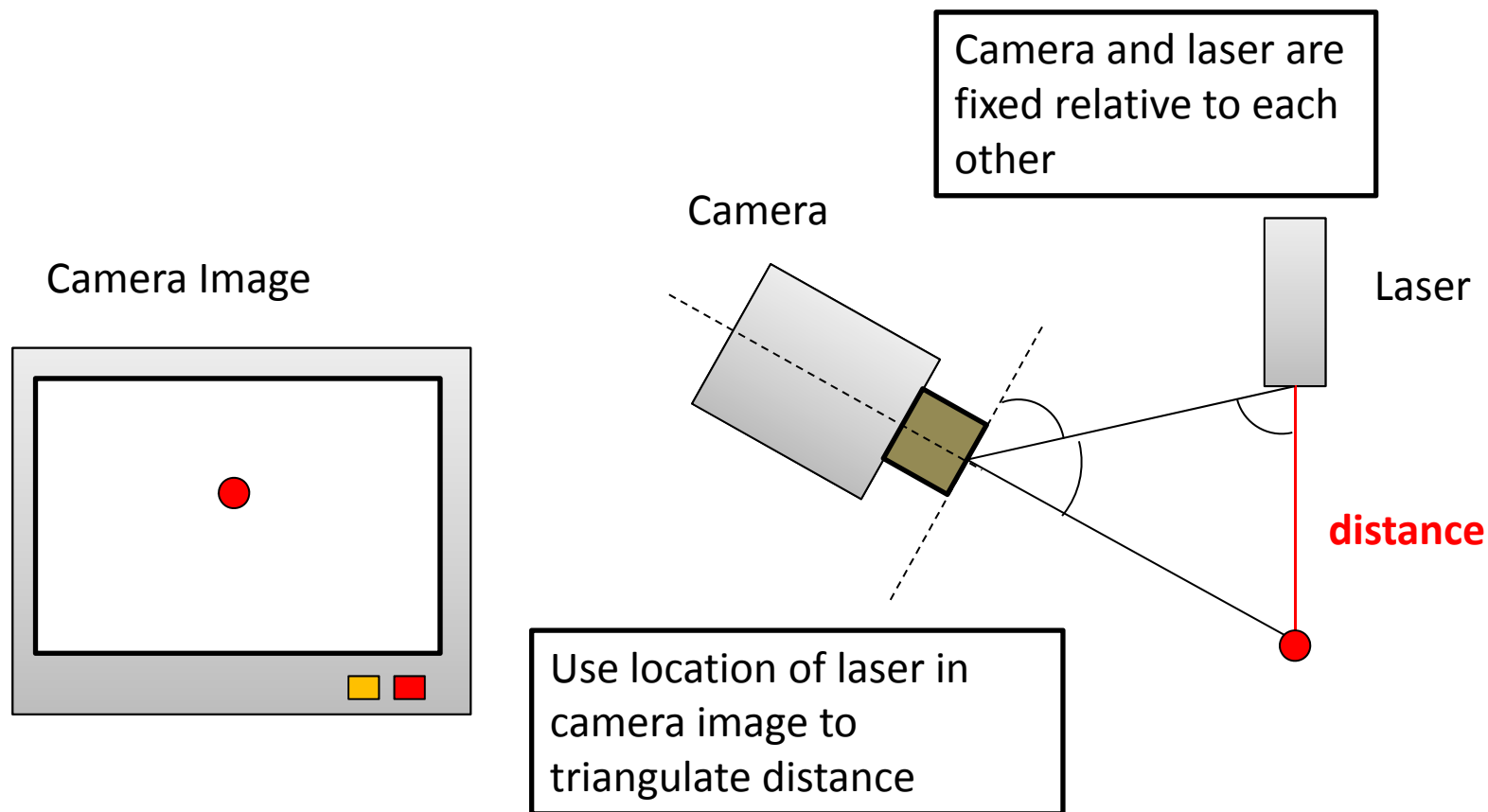
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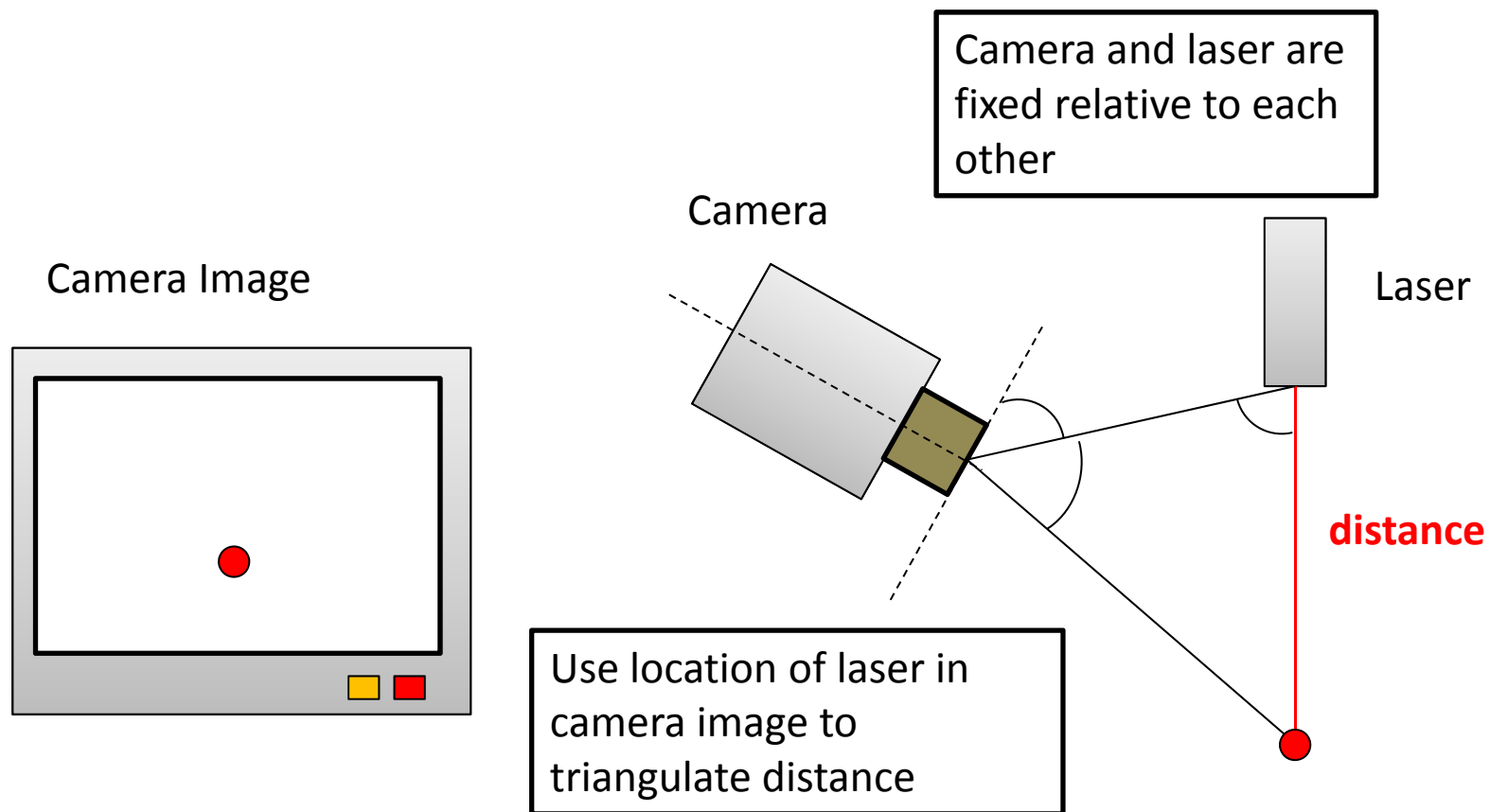
Laser Triangulation Measurement



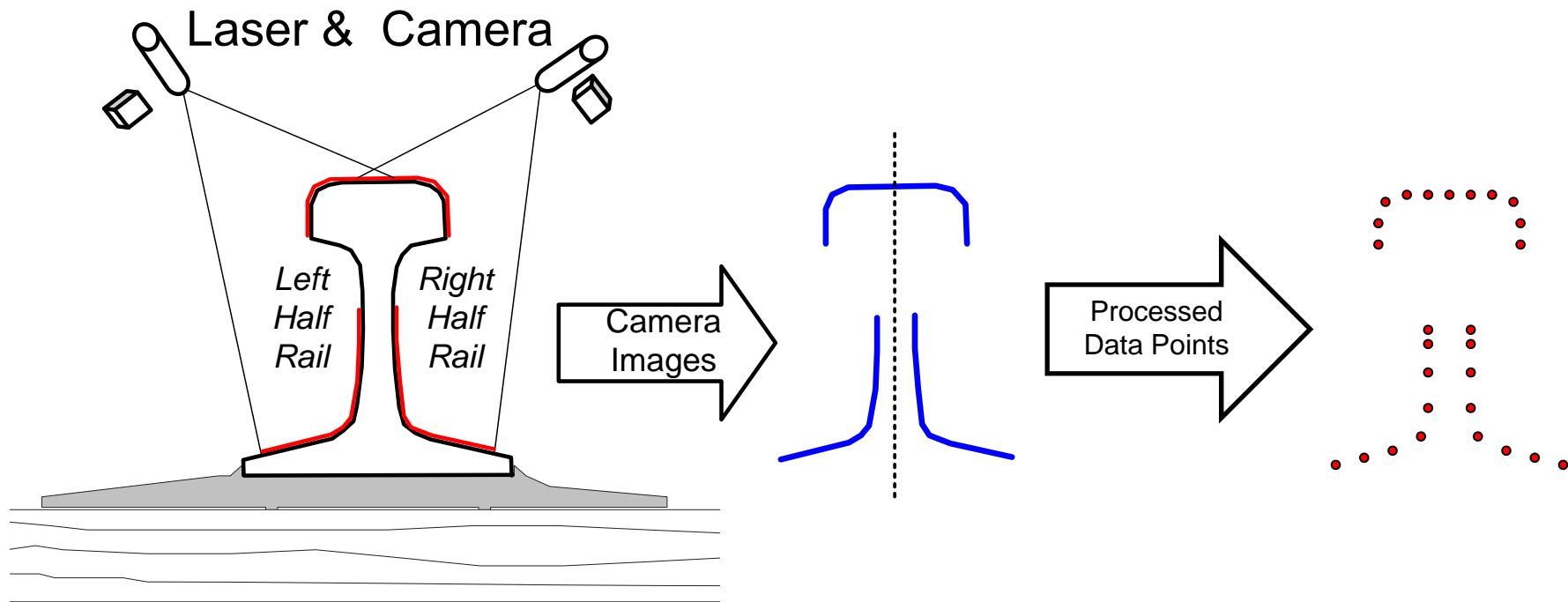
Laser Triangulation Measurement



Laser Triangulation Measurement



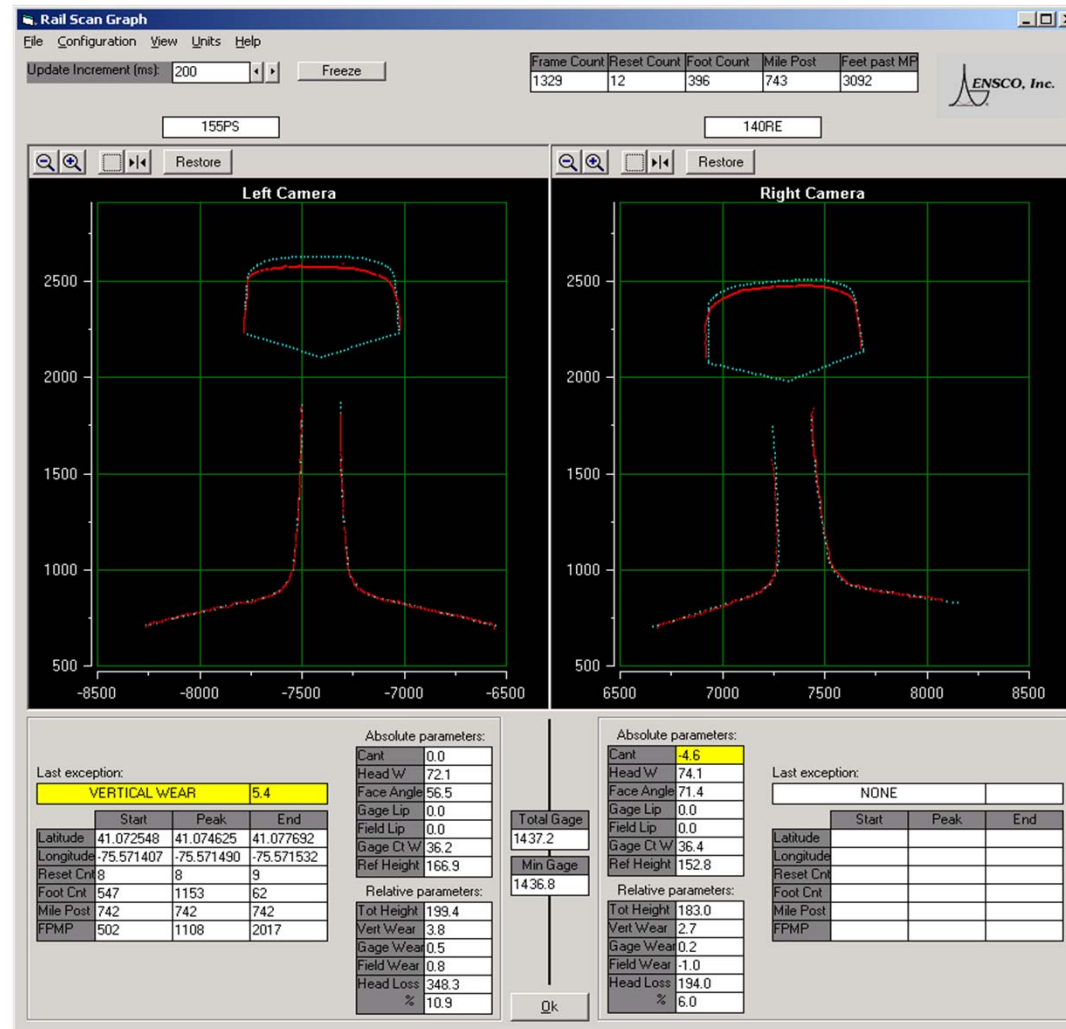
Laser Triangulation Measurement



Ref 1



Laser Triangulation Measurement



Cameras

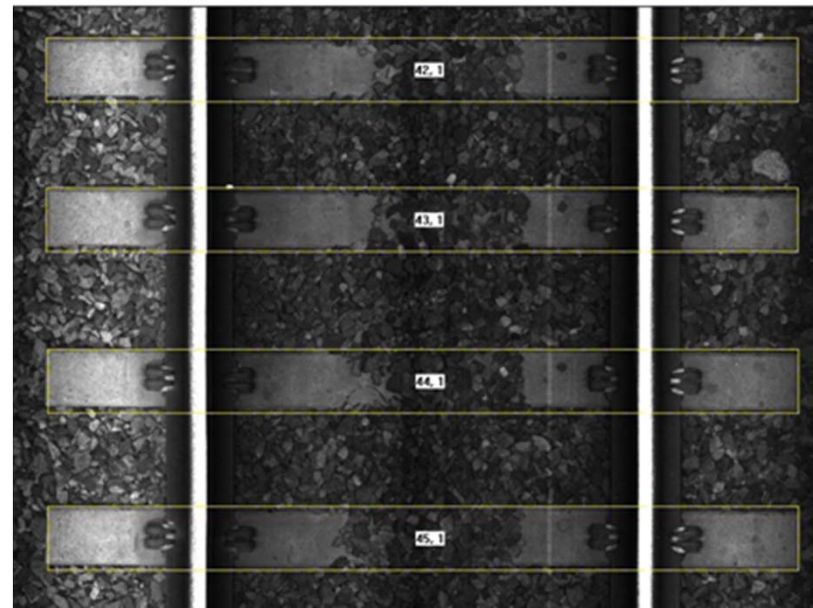
“Area Scan” Cameras

- Works like your phone camera
- Works well for angle shots
- More difficult to take measurements from



“Line Scan” Cameras

- Works like your document scanner
- Works when camera is perpendicular to the direction of travel
- Easier to take measurements from



Ref: Edwards J.R., “Development of Machine Vision Technology for Railcar Safety Appliance Inspection”



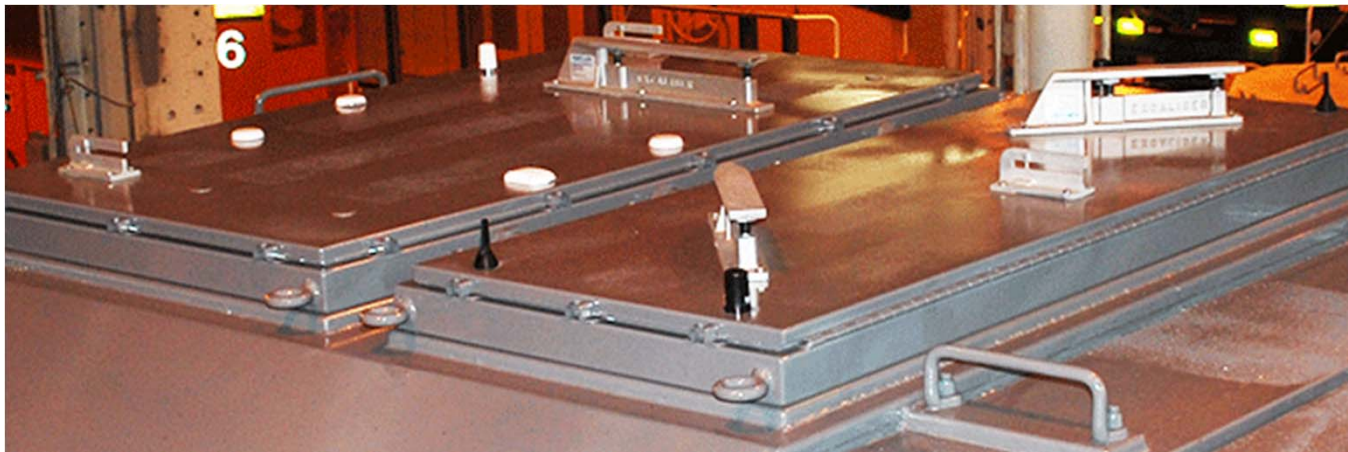
Distance/Location Measurement



Wheel Sensor



Tachometer



GPS Antenna



Overview of Measurement Systems

There are five basic categories of measurement system.



Categories of Measurement Systems

1) Mounted on Vehicle to measure the Vehicle.



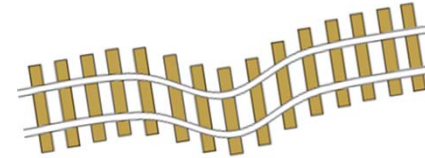
Examples:

- Event Recorder
- Locomotive Health Monitor
- Railcar Health Monitor
- Asset GPS Tracking



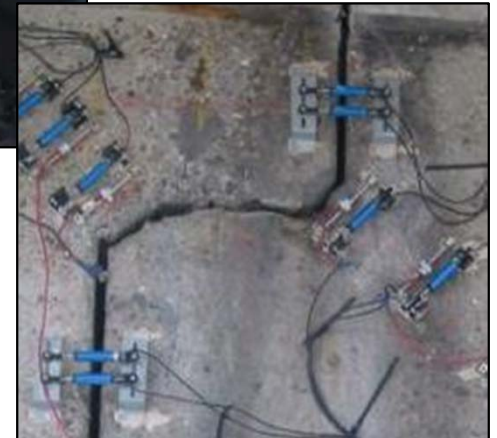
Categories of Measurement Systems

2) Mounted on Track to measure the Track.



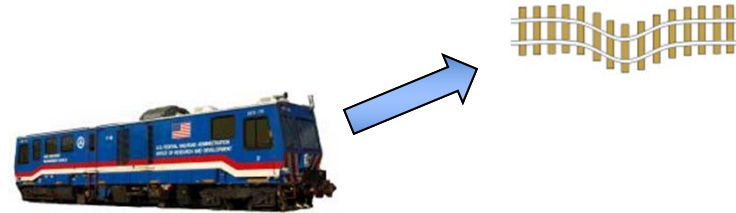
Examples:

- Rail Stress/Temp Monitor
- Bridge Monitoring
- Landslip Monitoring
- Flood Monitoring



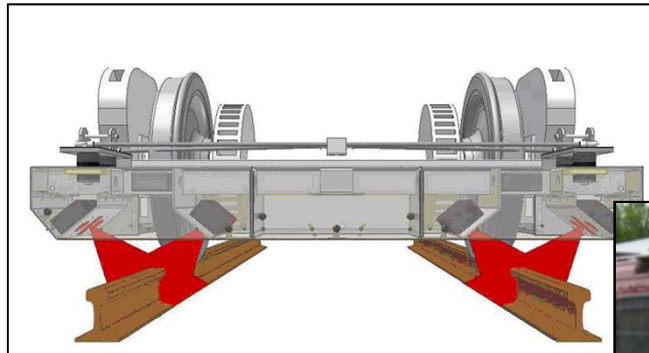
Categories of Measurement Systems

3) Mounted on Vehicle to measure the Track.



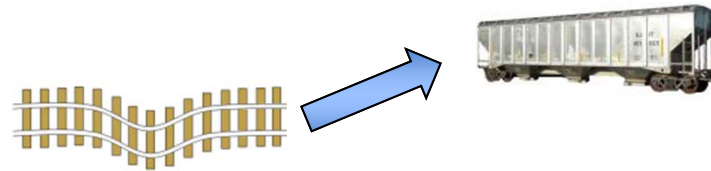
Examples:

- Track Geometry Measurement System
- Rail Profile Measurement System
- Ultrasonic Rail Flaw Detection
- Ground Penetrating Radar
- Track Bed, Joint Bar, and Rail Head Machine Vision
- V/TI Monitors
- Corrugation Measurement
- Track Modulus Measurement



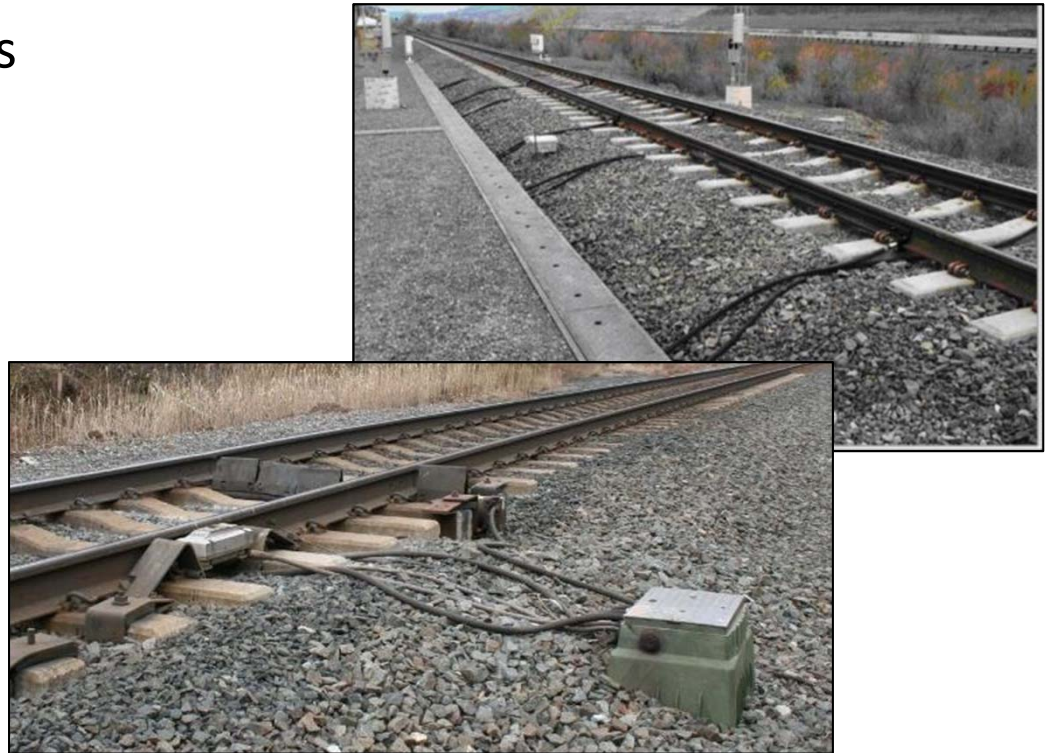
Categories of Measurement Systems

4) Mounted on Track to measure the Vehicle.



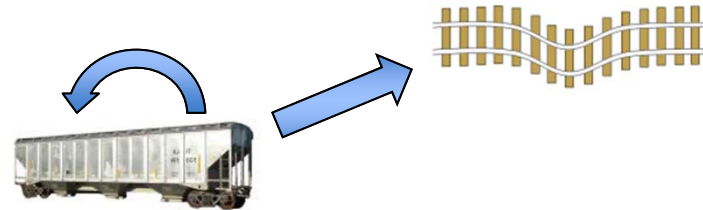
Examples:

- Dragging Equipment Detectors
- Hot Bearing Detectors
- Hot/Cold Wheel Detectors
- Wheel Impact Load Detectors
- Truck Performance Detector
- Truck Condition Detector
- Acoustic Bearing Detectors
- Wheel Profile Detectors
- Safety Appliance
- Cracked Wheel Detector
- Machine Vision



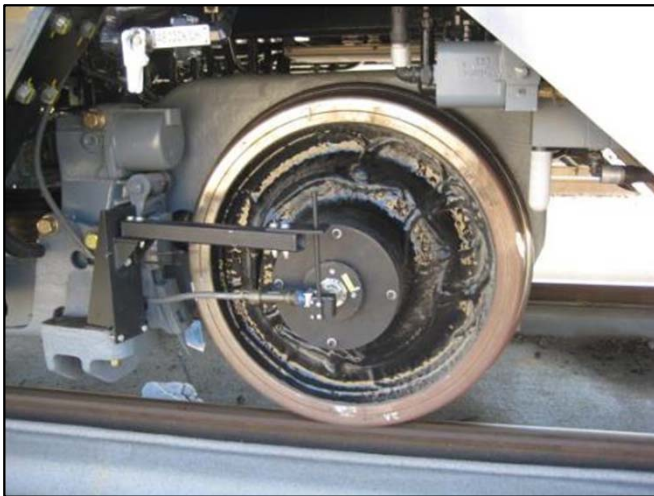
Categories of Measurement Systems

5) Mounted on Vehicle to measure the Vehicle & Track.



Examples:

- V/TI Monitors
- Instrumented Wheel sets



System Background

Estimated Number of Detector/Monitor Systems in North America

Mechanical (Car)

- Dragging Equipment Detectors (~6000)
- Hot Bearing Detectors (~2000)
- Hot/Cold Wheel Detectors (~700)
- Wheel Impact Load Detectors (~147)
- Bogie Steering Performance (~30)
- Acoustic Bearing Detectors (~20)
- Wheel Profile Detectors (~10)
- Brake Shoe Thickness (~3)
- Safety Appliance (~2)
- Cracked Wheel Detector (1)
- Component Monitors (?)

Engineering

- V/TI Monitors (270)
- Ultrasonic Hyrail (~125)
- Hyrail Track Geometry (~48)
- Railbound Track Inspection Vehicles (~23)
- Misc Hyrail (~11) [Joint Bar, GPR, LIDAR]
- Remote Rail Temp Monitors (?)

Mechanical (Locomotive)

- Locomotive Operations Monitor (~8000)



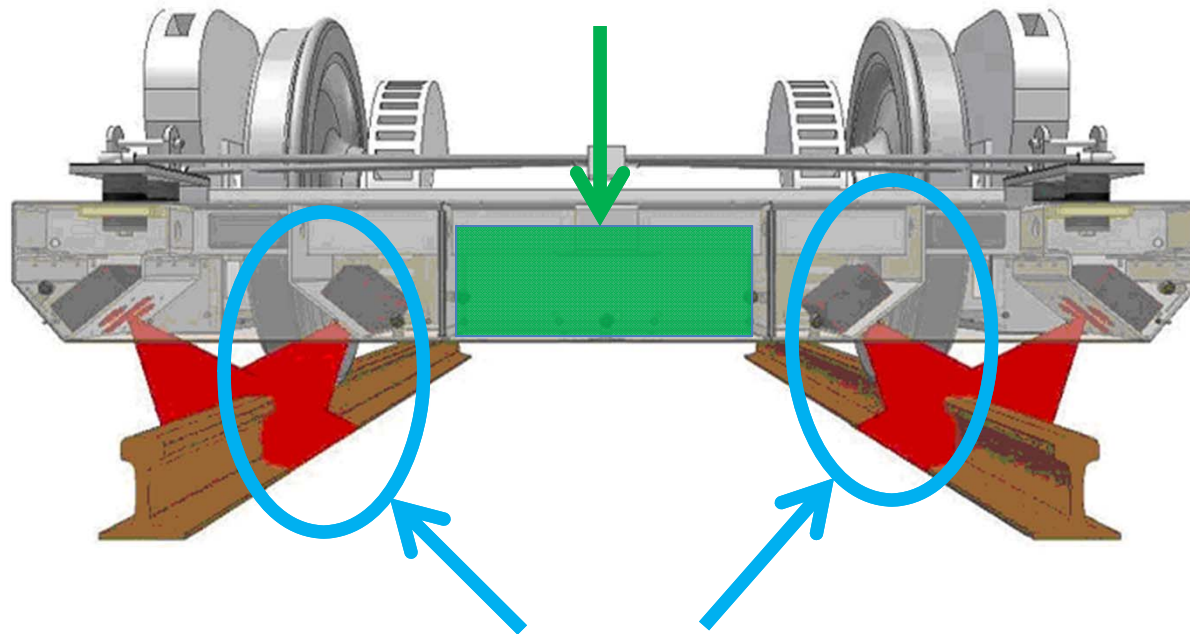
Detailed Discussion of Measurement Systems



How does a Track Geometry Measurement System Work?

Inertial Package

“Measures the beam location in three dimensional space”



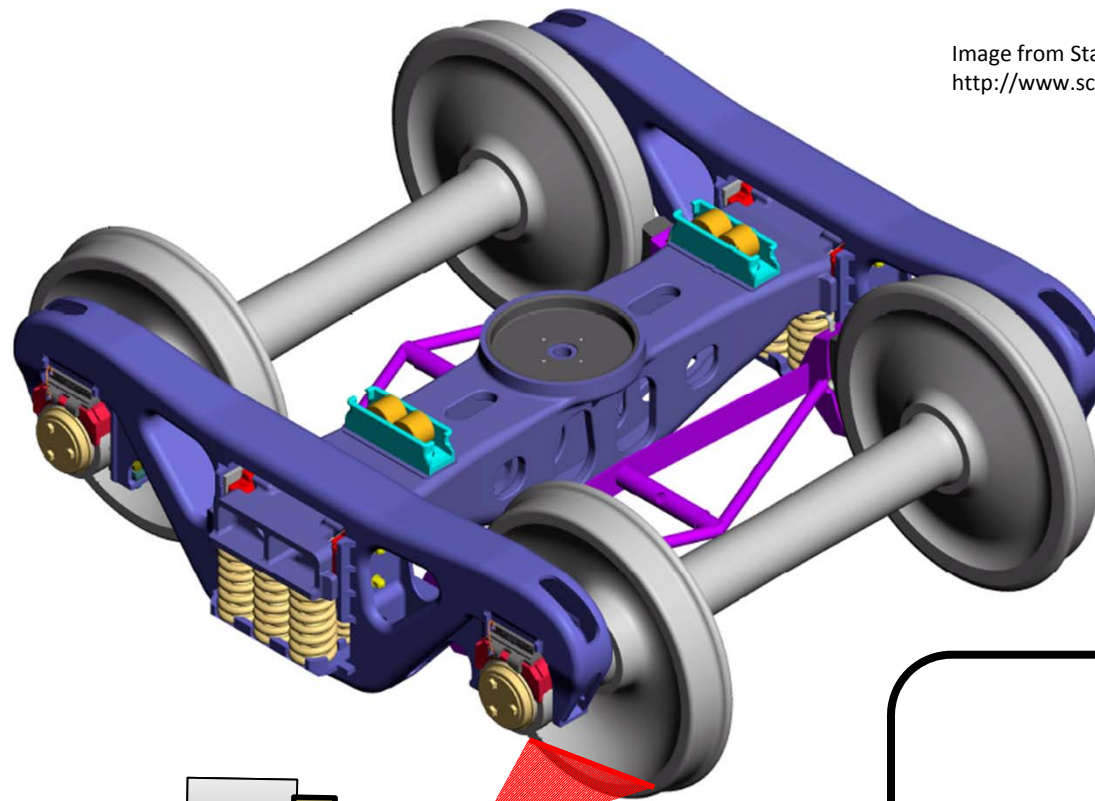
Laser/Cameras

“Measures the relative positions between the rails and the beam”

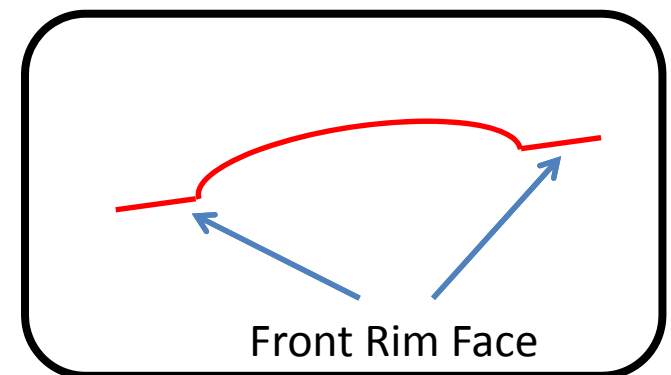
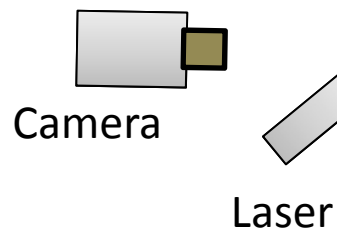


How does a truck condition monitor work?

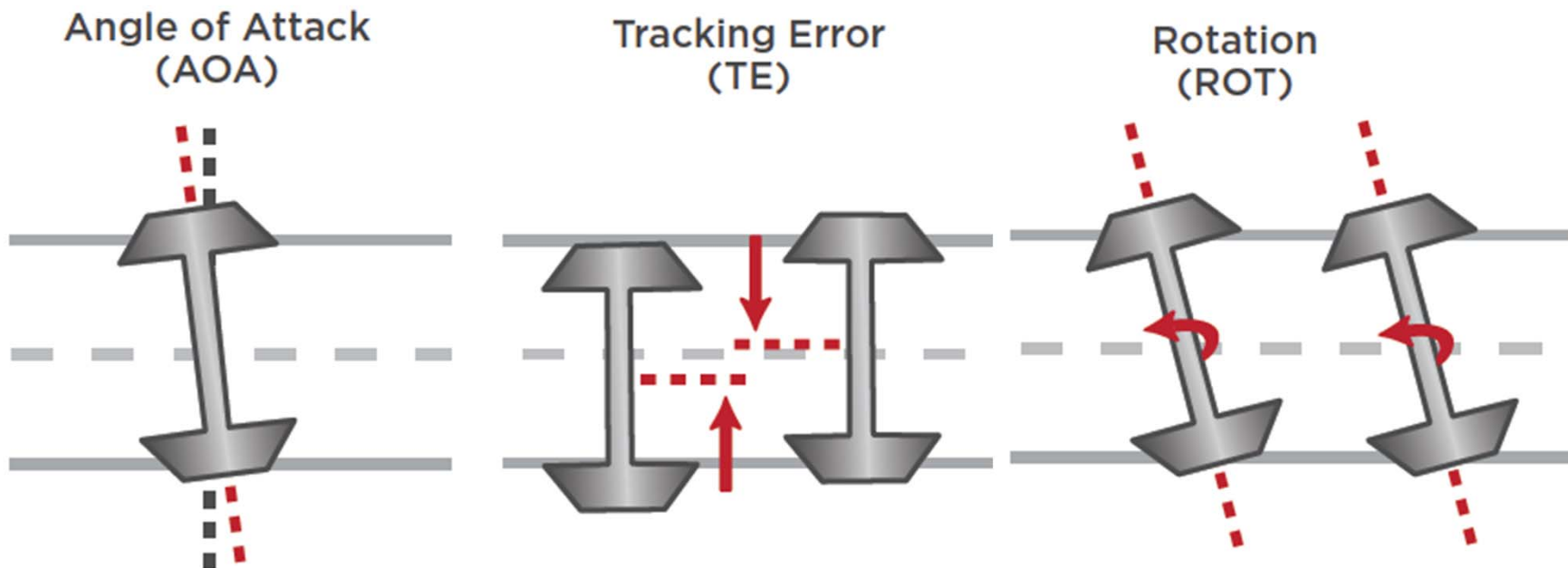
Image from Standard Car and Truck Maintenance Manual
<http://www.sctco.com/pdf/Section1.pdf>



Wayside
Laser/Camera
system measures
profile of wheel
plate.



How does a truck condition monitor work?



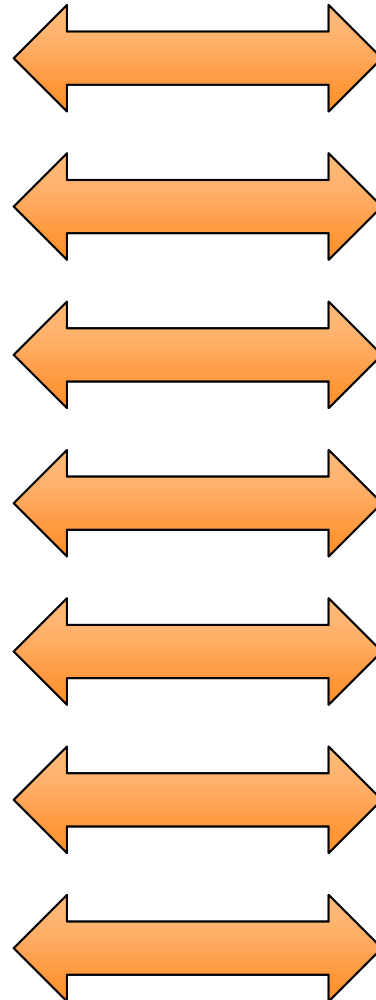
Images from Wayside Inspection Systems

http://wid.ca/sites/default/files/brochures/TBOGI/WID_TBOGI_Brochure_US.pdf



Track Measurement

Track Geometry Measurement
Ultrasonic Rail Flaw Detector
Instrumented Wheelset
Vehicle Mounted Rail Temperature Measurement
Rail Profile Measurement System
V/TI Monitor Axle Impact
Machine Vision



Vehicle Measurement

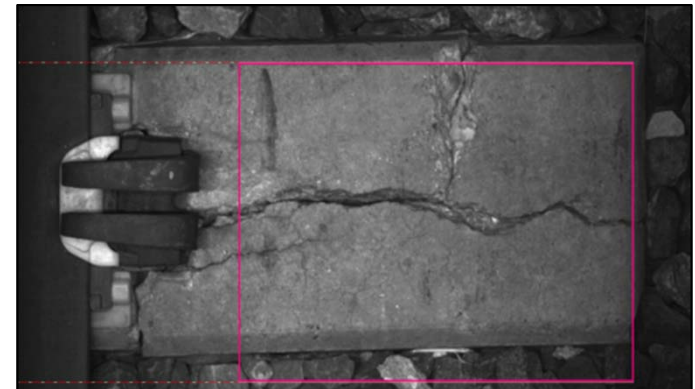
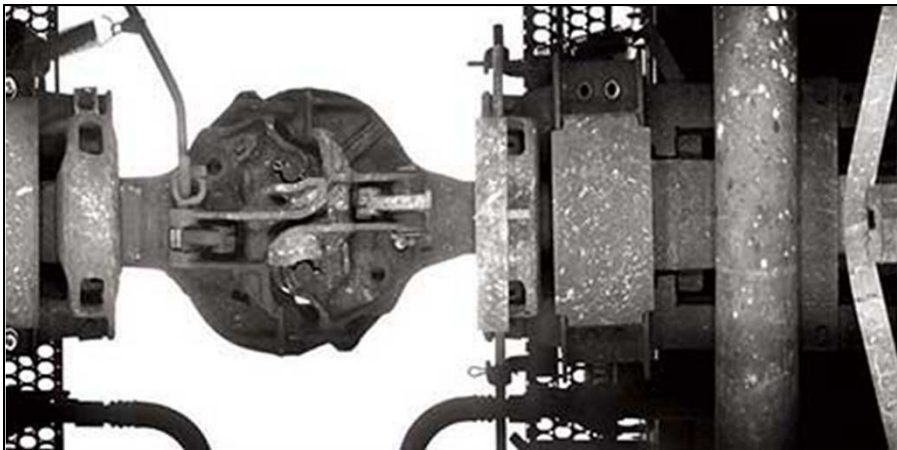
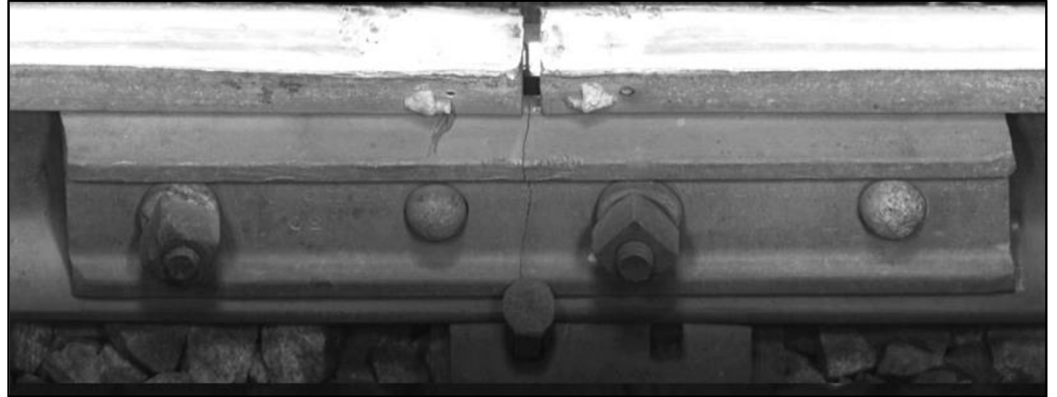
Truck Condition Monitor
Cracked Wheel Detector
Truck Performance Detector
Hot/Cold Wheel Detector
Wheel Profile Detector
Wheel Impact Load Detector
Machine Vision



What is the Future of Railway Measurement Technology?



1) Machine Vision



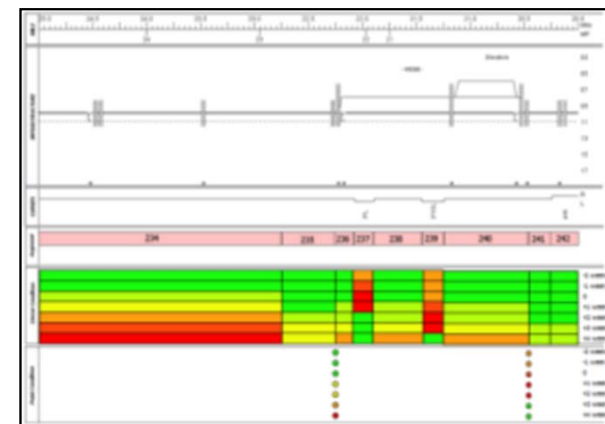
2) Autonomous Track Inspection

- Use revenue vehicles to measure
- Decreased inspection costs
- Increased survey coverage
- Supplement manned patrols



3) Data and Decision Management

- Becoming “predictive” rather than “reactive”
- Detecting trends and patterns
- Automated decision making



Questions?

