Speed Detection: LADAR
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EE 494 - Consumer Optoelectronics
Outline - Speed Detection Systems

- Early Methods - Radar
  - Applications and Problems
- Modern Methods - Radar, Ladar
  - Applications and Problems
- Technology : Ladar
- Comparison - Radar vs. Ladar
  - Advantages and Disadvantages
**Basic Radar Devices**

- **RADAR - RAdio Detection And Ranging**
- Radar measures reflected radio signals
- Uses Doppler Theory to detect frequency shift in reflected waves
- The greater the Doppler shift, the greater the speed
Early Radar Devices

- **S - Band Radar**: operates at 2 - 4 GHz
  - Microwave ovens operate at 2.45 GHz
- **X - Band Radar**: operates at 10.50-10.55 GHz
  - Not accurate below 20 mph, has interference problems
- **K - Band Radar**: operates at 24.05-24.25 GHz
  - Water Vapor absorption band centered at 22.24 GHz
Modern Speed Detection

- **Ka - Band**: operates at 33.4 - 36.0 GHz
  - has 13 200-MHz channels, can operate in “hop” mode
- **Ladar**: uses light emitted at 904 nm (typical)
  - can use different wavelength, dependent upon material
The Technology of Ladar

- Ladar uses 3 semiconductor diodes to generate laser light
- Uses light pulses to make 2 consecutive distance measurements, then divides by time
- Lenses are used to collimate light to narrow beam
- Typically use ANSI Class I laser devices
**Ladar Technology**

- **Wavelength:** \( \approx 900 \text{ nm} \)
- **PRF:** 100 to 500 Hz
- **Pulse Width:** 5 to 35 ns

**Components:**
- **Laser**
- **Light Detector**
- **Signal Processor**
- **Data Processor**
- **Central Processing Unit (CPU)**
- **Display**
  - Speed: 299
  - Range: 1000

**Aperture:**
- 3 to 4 mrad
- 0.17° to 0.23°
Advantages of Radar

- Very flexible - can be used in a number of ways
  - Stationary mode
  - Moving mode
  - Two Directional mode
- Beam spread can incorporate many targets
- Can often select fastest target, or best reflection
- Still very reliable
Radar Disadvantages

- Time - Radar can take up to 2 seconds to lock on
- Radar has wide beam spread (50 ft diameter over 200 ft range)
- Cannot track if deceleration is greater than one mph/second
- Large targets close to radar can saturate receiver
- Hand-held modulation can falsify readings
- More interference sources
Ladar Advantages

- Faster lock-on time (less than 1/3 second)
- Very narrow beam spread (less than 6 ft over 2000 ft range)
- Better ability to track decelerating targets
- Typically mounted, and aimed with optical targeting device
- Fewer sources of interference
- Much more difficult to detect
Problems with Ladar

- Particles (dust, water) in air can limit range
- Rounded surfaces, the colors black, blue, and violet are poor reflectors
- Can be difficult to track target
- Alignment can cause severe error
- Extreme sunlight can be damaging
Conclusions

- Ladar is, in the correct environment, better suited for speed detection
- Ladar is not perfect, however
- There is still room for Radar patrolling
- Both could be used in concert to achieve maximum detection capabilities
Sources of Information

- http://members.aol.com/copradar/index.html
- www.motorists.org
- www.dot.gov
- www.fhwa.gov
- www.nhtsa.dot.gov