Capturing Front License Plate Images at Night.

How? Why? And is it Safe?

Taking Flash Pictures Was Dangerous

Let's do it safely now

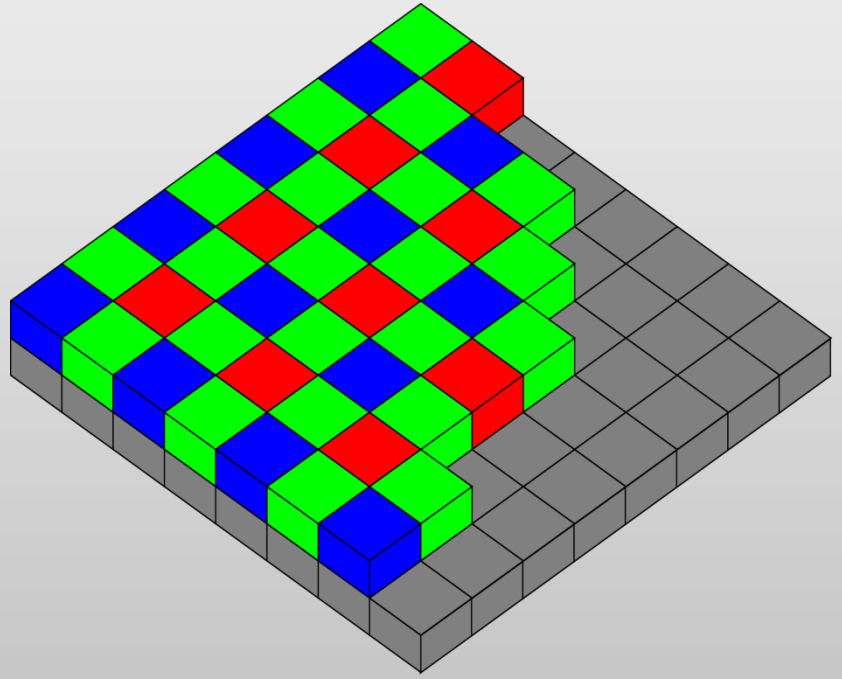
Homework assignment to follow

Why Front Imaging?

- Reduce uncollectable transactions
  - One toll road operator states that the single largest category of uncollectable transactions is unreadable rear plates
  - Many unreadable rear plates are on multi-axle vehicles, thus premium tolls are lost
- Improve Automatic License Plate Reading (ALPR)
  - Two (somewhat) independent opportunities to automatically read the plate
  - ALPR results from front and rear can be combined to improve yield and accuracy
- Dispute Resolution and Troubleshooting
  - Front Image usually shows the transponder (or lack thereof)
  - Although faces are avoided, a one-person or two-person determination can often be made

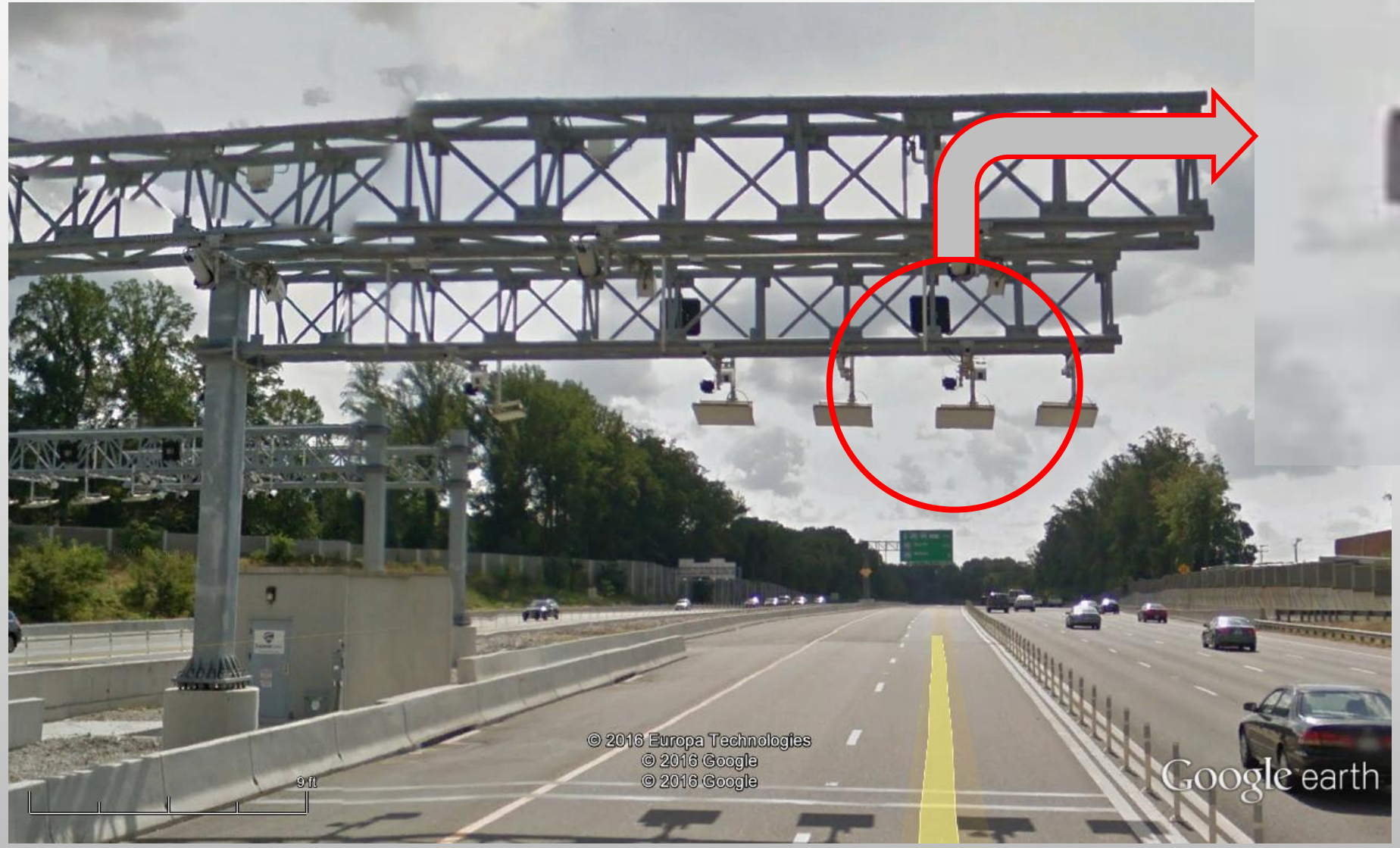
Color or Monochrome (B&W)?

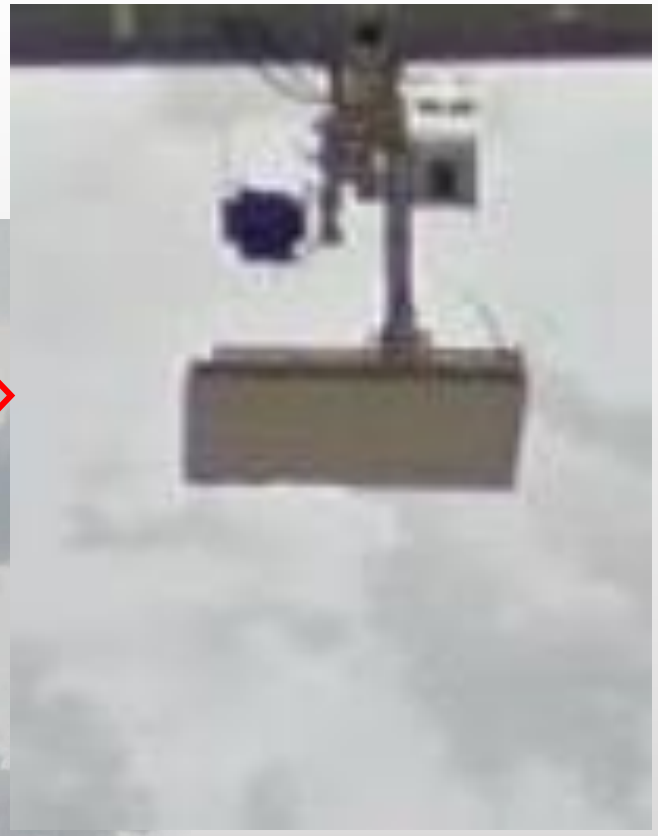
- Color is good
  - Some ALPR uses color to assist with jurisdiction (state) and plate type determination
  - Reviewers like color images
- Monochrome is good
  - Higher resolution imaging (Bayer Color Filter requires interpolation)
  - Higher sensitivity (Bayer Color Filter discards 2/3 of the light)
  - Night imaging can use near infrared (versus need for white light for color)
- Given the choice, people want color



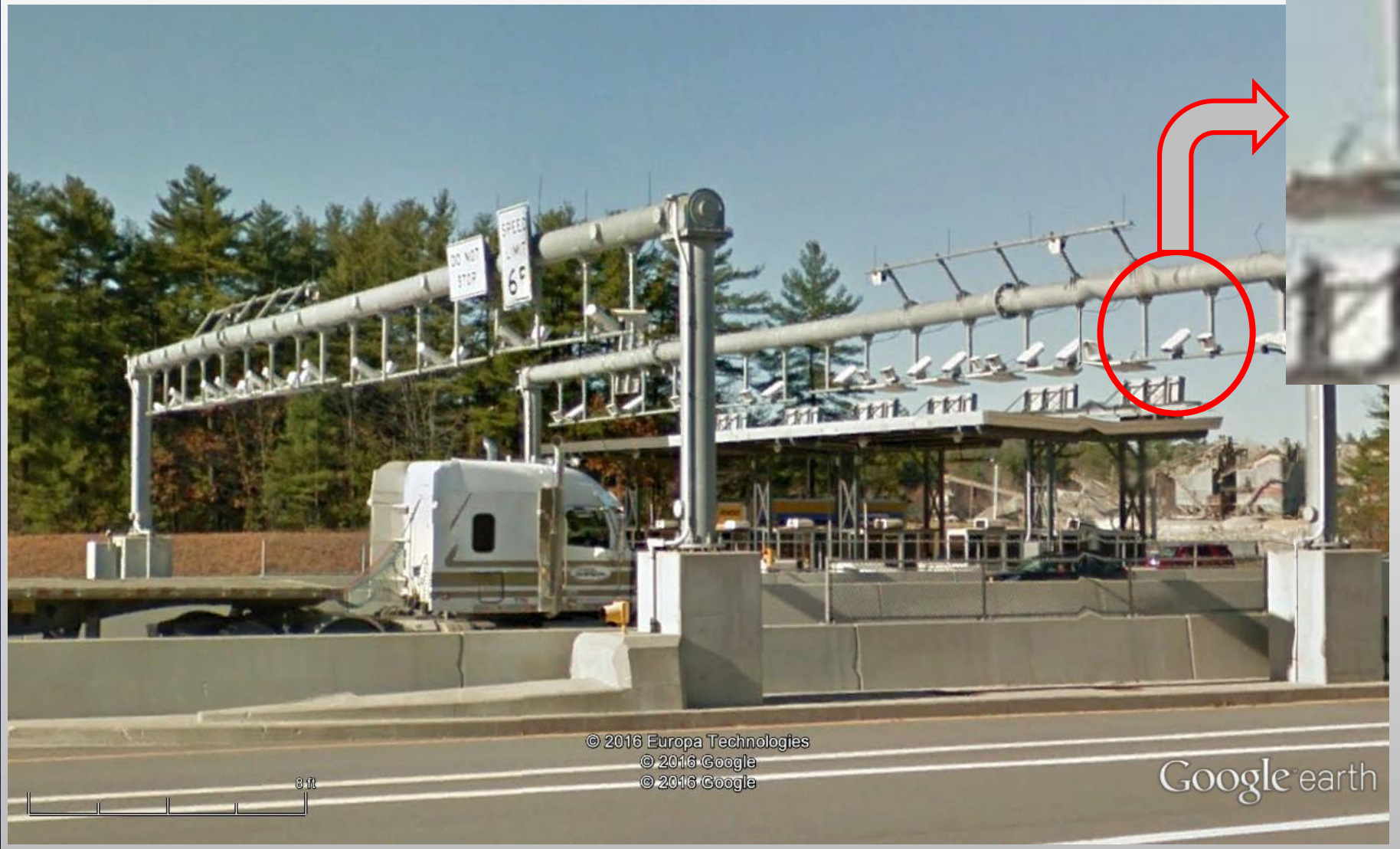
Front Lighting Method White Stroboscopic

Front Lighting Method
Near Infrared





Front Lighting Method
White LED Ring + Blue (near UV)



Safe Front Image Illumination Criteria
Avoid the three D's

- Do Not **Disable** (The illumination event deleteriously affects the driver's vision system, preventing observation of the roadway or other vehicles)
- Do Not **Distract** (The illumination event unnecessarily and unproductively consumes the driver's vision system resources)
- Do Not **Disturb** (The illumination event unnecessarily and unproductively engages the driver's cognitive resources)

No Disable

- Illumination Engineering Society of North American (IESNA) sets disability glare as Veiling Luminance > 30% of Adaptation Luminance
  - For roadway lighting - limit illuminator brightness to the driver's eye (veiling luminance) to 30% of the driving scene brightness
  - This criteria was not developed for continuous illuminators, thus it alone is not sufficient for flash-type illuminators
- Do not disable the rods, thus preserving Mesopic Vision, where both rods and cones are engaged in the nighttime driving task
  - Limiting scene luminance to 2.5 nits (candela per square meter) preserves Mesopic Vision
  - Although nighttime construction light towers may violate this criterion, fortunately front imaging illumination for AET systems can easily adhere to this criterion

No Distract

- The vision system triggers frequent eye Saccades, which are rapid jerking eye movements to direct the fovea (high-res part of vision) to interesting portions of the overall visual field.
  - A front illuminator flash unavoidably triggers a Saccade (in itself not bad)
  - Saccade angles are limited and sometimes trigger a head movement also
  - Triggering a head movements are unnecessary and unproductive distractions
  - Therefore, front illuminators should not trigger the driver's head to move
- Pupillary Light Reflex (PLR) is an autonomic reaction of the vision system to sudden changes in scene brightness
  - The PLR constriction and dilation cycle takes 0.8 to 1.2 seconds, during which the vision sensitivity is reduced
  - Dark adapted pupils are up to 10 mm diameter, thus 1 mm is a small distraction
  - Studies have shown that limiting the PLR to less than 1 mm prevents "Discomfort Glare", which is pain associated with the PLR
  - Therefore, limiting the PLR to 1 mm prevents unnecessary and unproductive distractions

No Disturb

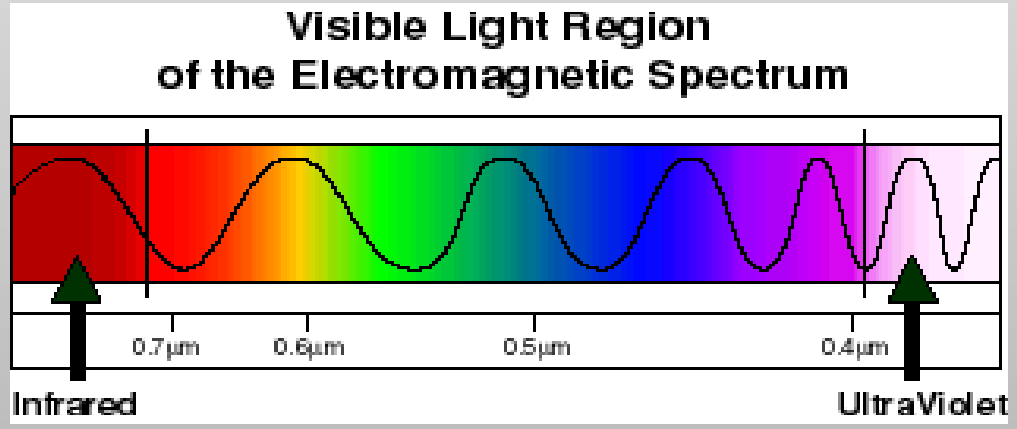
- Do not trigger a “What was that?” response
  - Many drivers will take note of an illumination event
  - But after 2-3 exposures to the event, the driver should stop noticing
  - Therefore, driver’s reaction to the illuminator should be observed during a test program (e.g. a focus group)
- Do not trigger driver complaints during operation
  - Illumination system evaluation should include a method to collect driver complaints about the illumination system, along with other elements of the toll system
  - Prior to implementing a front illumination system, prior operational experience and complaints (if any) for that illumination system should be examined

3D Avoidance Method
Put light where it is needed and not in driver's eyes

- Driver's eyes are nearly always higher than front vehicle license plates
- So, control the light emissions to the lower part of the front image and leave the upper part unilluminated
- But this method still illuminates the pavement and vehicle in front of a driver, so its utility has limits

3D Avoidance Method
Filter the Spectrum

- Monochrome imaging can tolerate near infrared and a small part of the visual spectrum
  - Near infrared and some visual spectrum (red) is common
  - Rendering some colors (blues) requires near ultraviolet and some visual spectrum (blue)
  - But care is taken to avoid “spectral aberration”, a lens focus shift between daylight (wide spectrum) and nighttime (narrow spectrum)
  - But blue lights and red lights have meaning to drivers (emergency vehicles) so care must be taken
- Color imaging requires the whole visual spectrum, so this method is not applicable



3D Avoidance Method – Short Flash

- Toll Imaging requires 750 microsecond or shorter exposure intervals
- We can “see” lightning strokes that are only 10 to 50 microseconds long
- Due to eye “saccades” the vision system “lengthens” short bursts to about quarter-second
- Short bursts of light (e.g. strobe flash) Can be counterproductive
- Human vision reacts actually increases perceptibility of short flashes

3D Avoidance Method
Hide the flash in plain sight

- Short flashes of light are perceived by the vision system as movement
- The vision system is tuned to detect movement
- Flashing from dark to bright to dark is a large (infinite) apparent movement
- Flashing from dim to bright to dim is a smaller apparent movement
- Therefore, a short flash of light can be partially hidden by a dimmer continuous light

Homework assignment Nighttime driving

- New Hampshire Everett Turnpike Hooksett Plaza ORT
  - Blue light flashes for front / rear
- Tobin Bridge SB AET
  - White flashtube strobes for front / rear
  - No background flash
- Massachusetts Turnpike AET
  - White LED strobes for front / rear
  - Background light mostly obscures the triggered flash