Programmable Automotive Headlights

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Motivation

distracting illumination patterns of rain and snow in bad weather

blinding other drivers

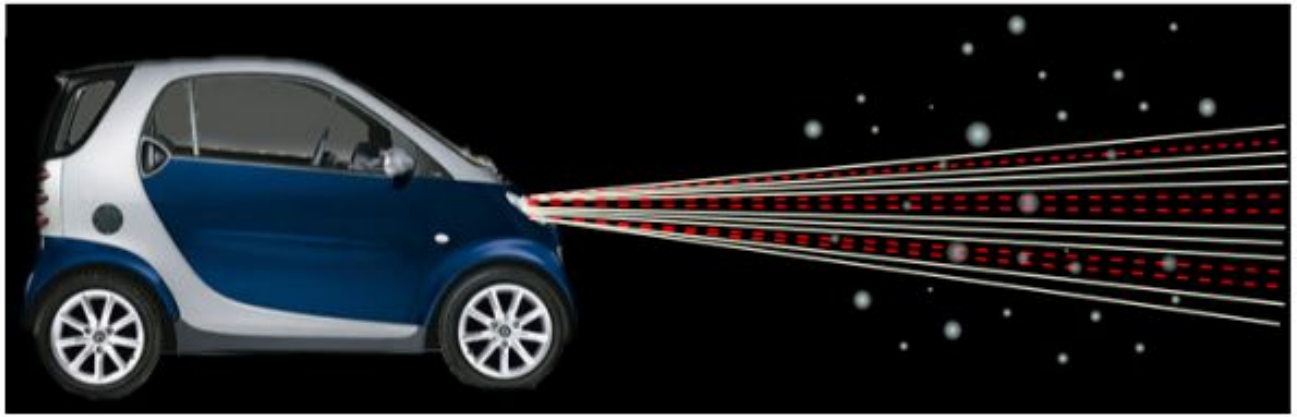
Advanced Headlights

- Lighting systems adapting brightness based on weather conditions
- Mechanically swivelling headlights based on vehicle’s turning radius
- LED-based headlights where individual LEDs can be turned on/off
- Swivelling LEDs to spotlight pedestrians

Programmable Automotive Headlights

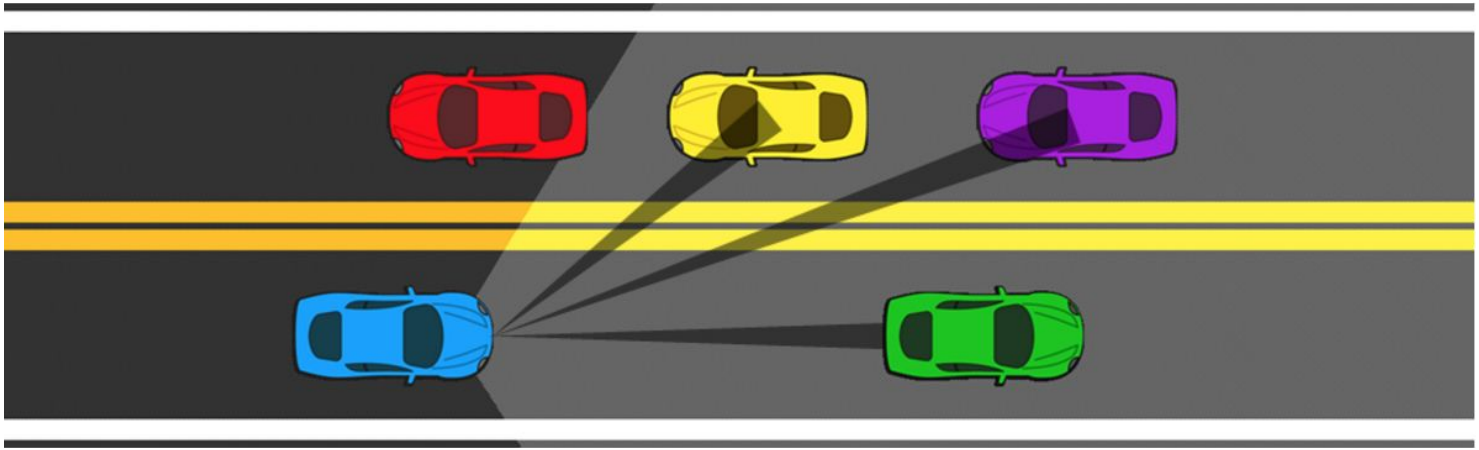
- Fast and highly reactive
- High resolution

Programmable Automotive Headlights



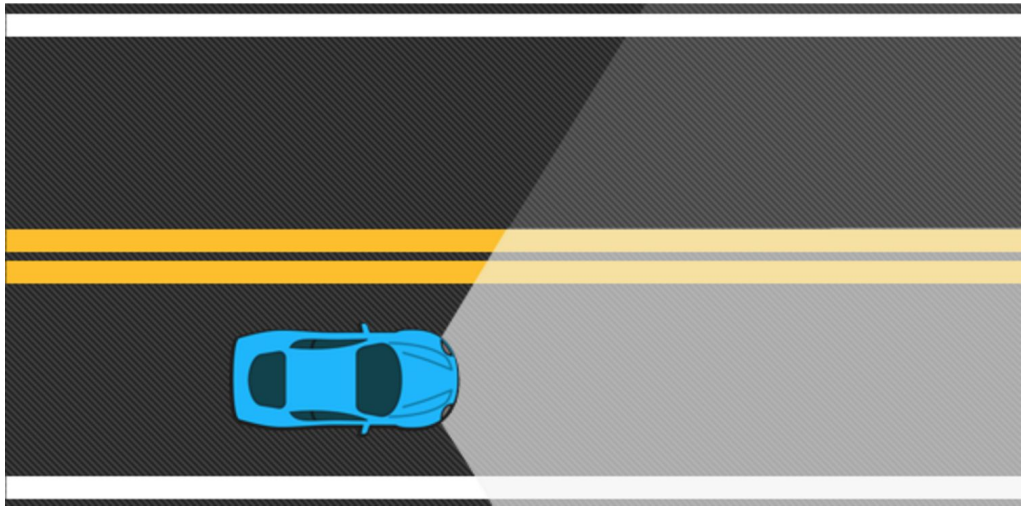
distributing light between raindrops and snow particles

Programmable Automotive Headlights



anti-glare headlights / high-beams

Programmable Automotive Headlights



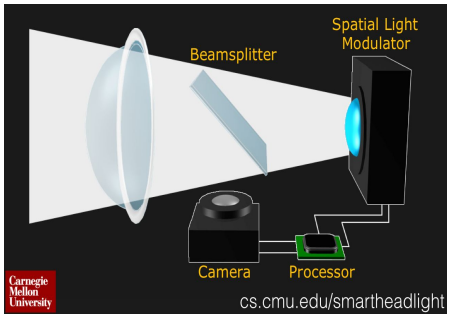
clearer illumination of driving lane

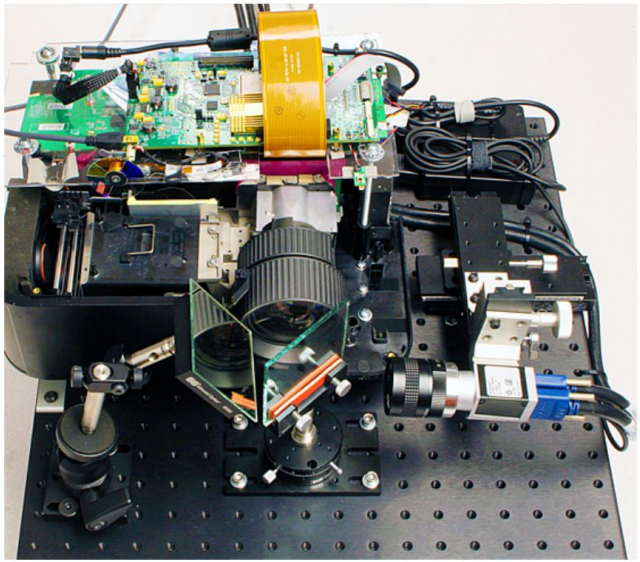
Programmable Automotive Headlights

early visual warning for obstacles

System Design - 4 main components

- Image sensor (CMOS) - Observes Road
- Processing unit - analyses images and controls headlight beam
- Spatial Light Modulator (SLM) - beam modification- varies intensity over space and time.
- Beam splitter





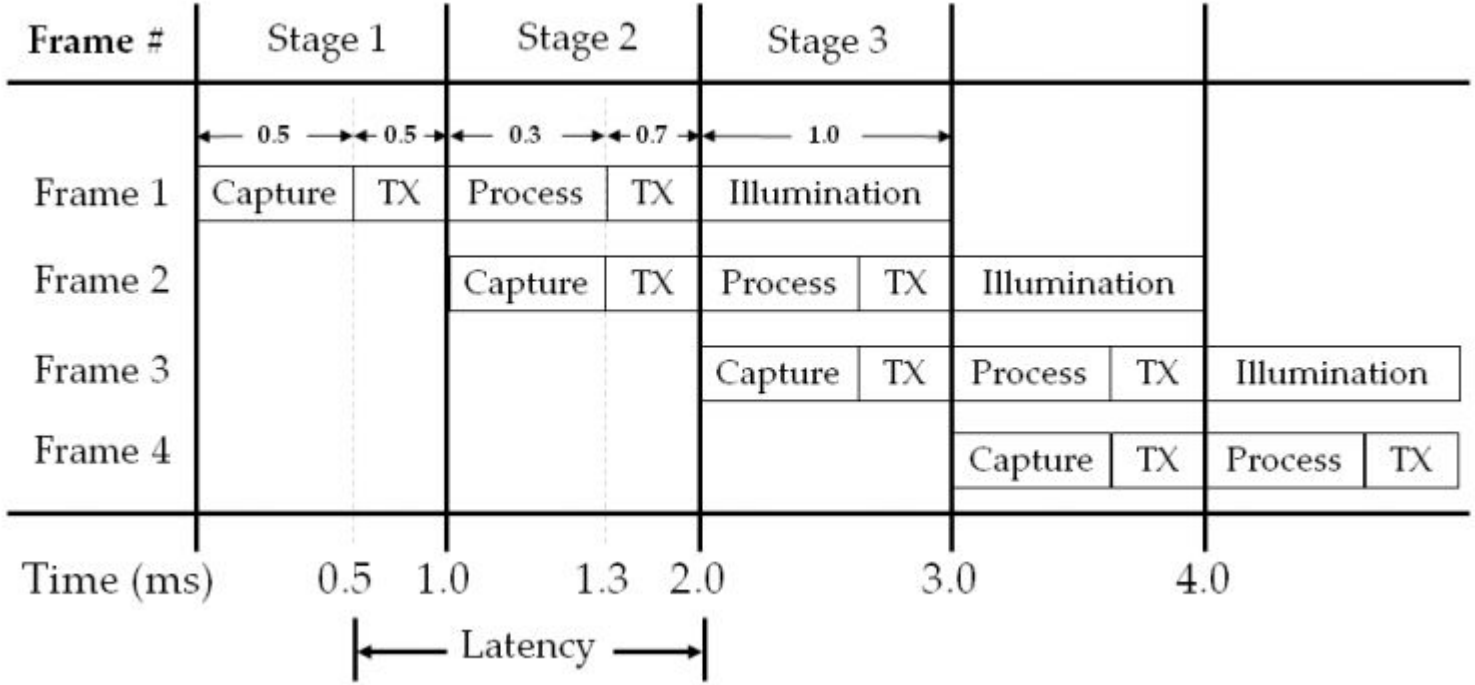
Sensing the road

CMOS sensor- Monochrome- Global shutter

Pipeline pixel architecture: Exposure during readout

Image processing and System control

Intel core 3.4 GHz (i7-2600) CPU - 8 cores - hyper threading technology



High speed illumination of the road environment

DMD chip - XGA (1024*768)- 7,86,432 beams

1024 bits / row --- 768 rows--too slow?

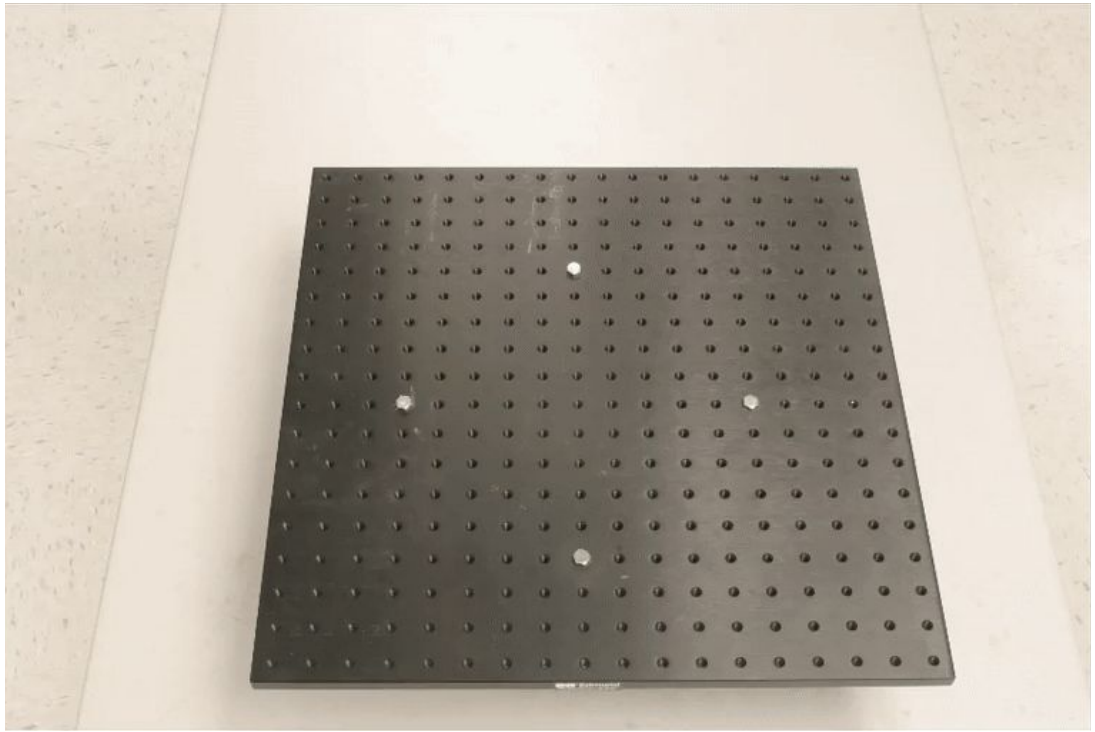
- Subsampled by factor 4 (256 bit vector)
- Missing rows -- illuminated by duplicating previous rows.

Further ,

- Image downsampled by factor 4(horizontally) & 2(vertically)

Spatial Light Modulator

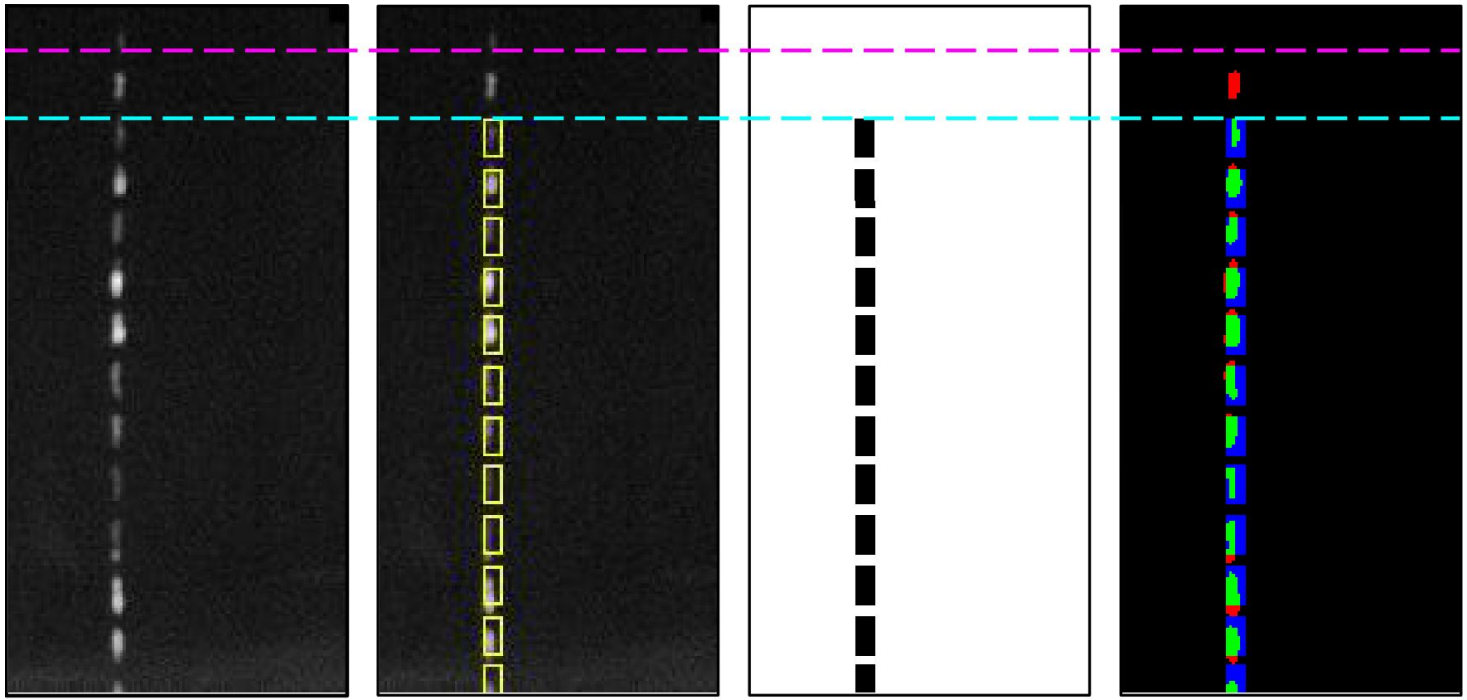
Co-located Projector-Camera System



Improving Visibility During Rain / Snow

- Tradeoff between accuracy and light throughput
- Exploits high resolution and fast processing speed
- Detection by background subtraction and binary thresholding
- Algorithm optimized for fast speed instead of accuracy

Improving Visibility During **Rain** / Snow



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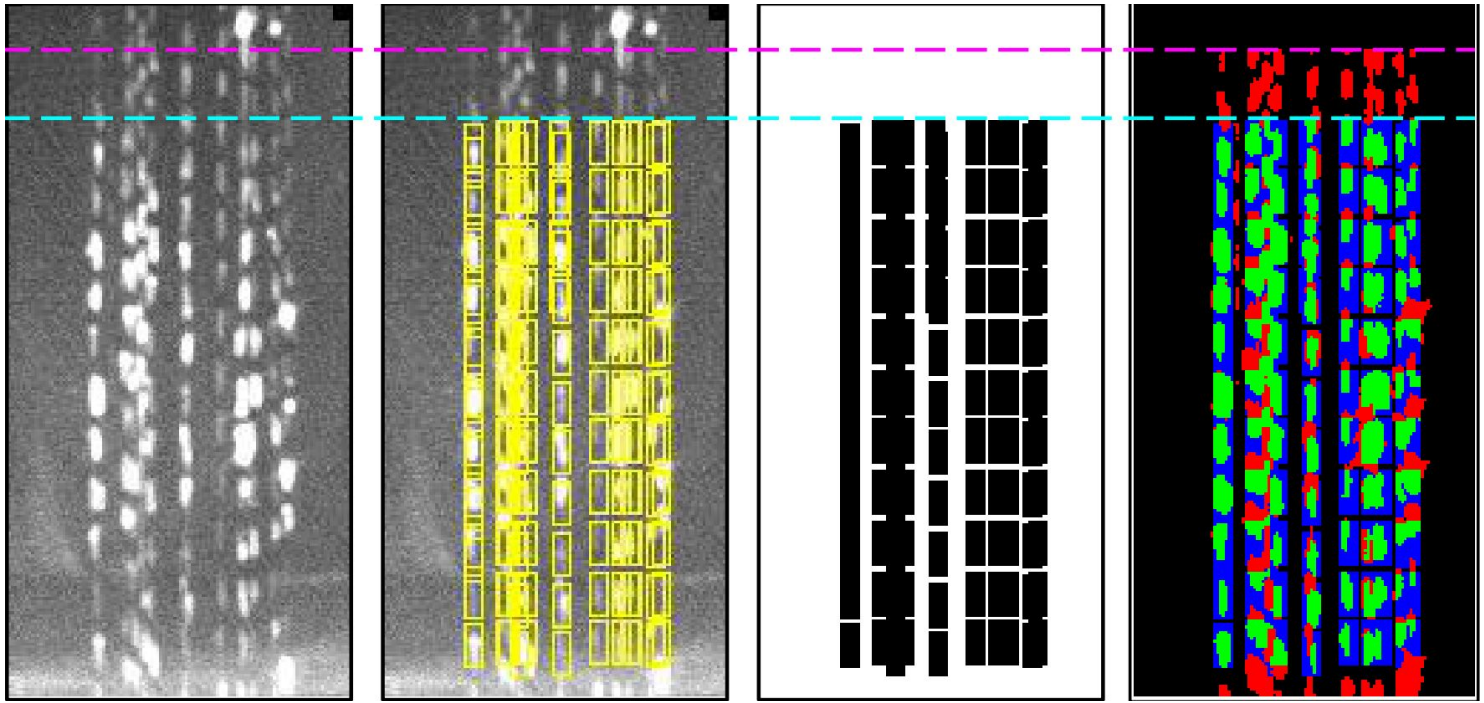

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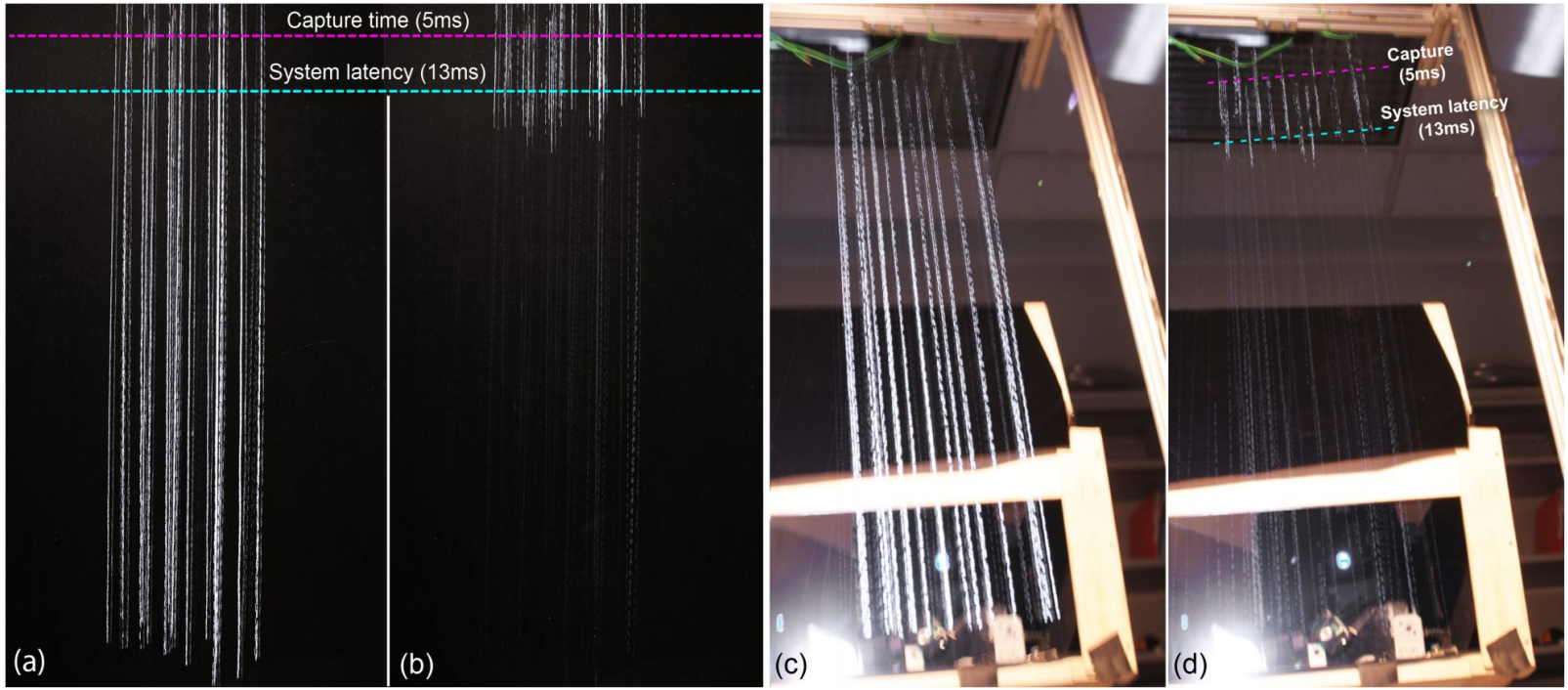

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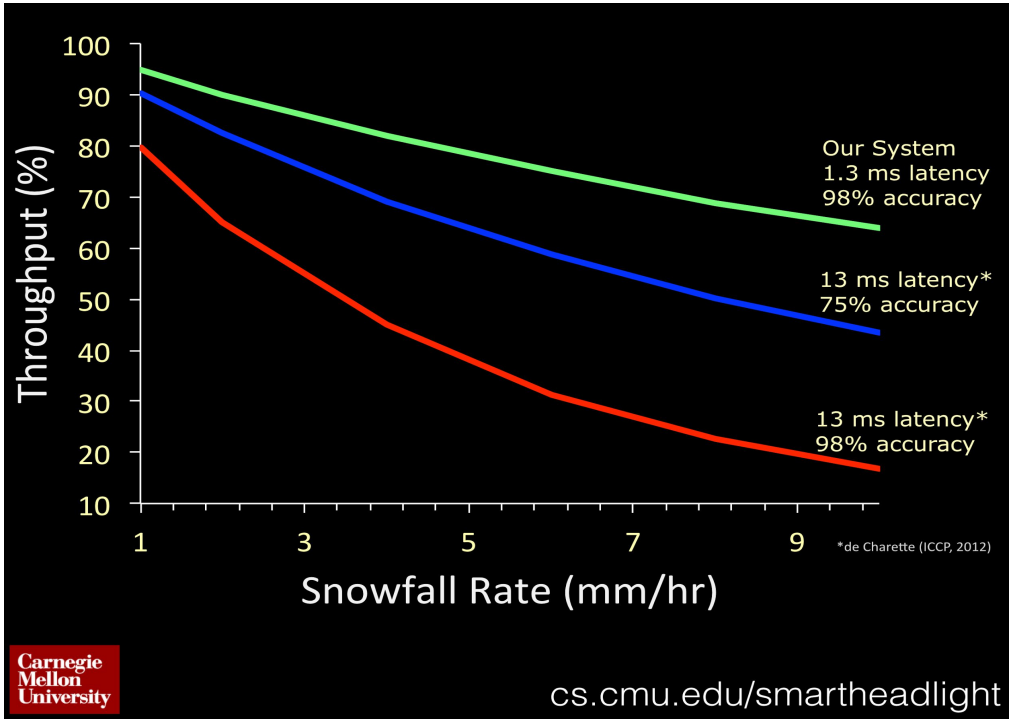
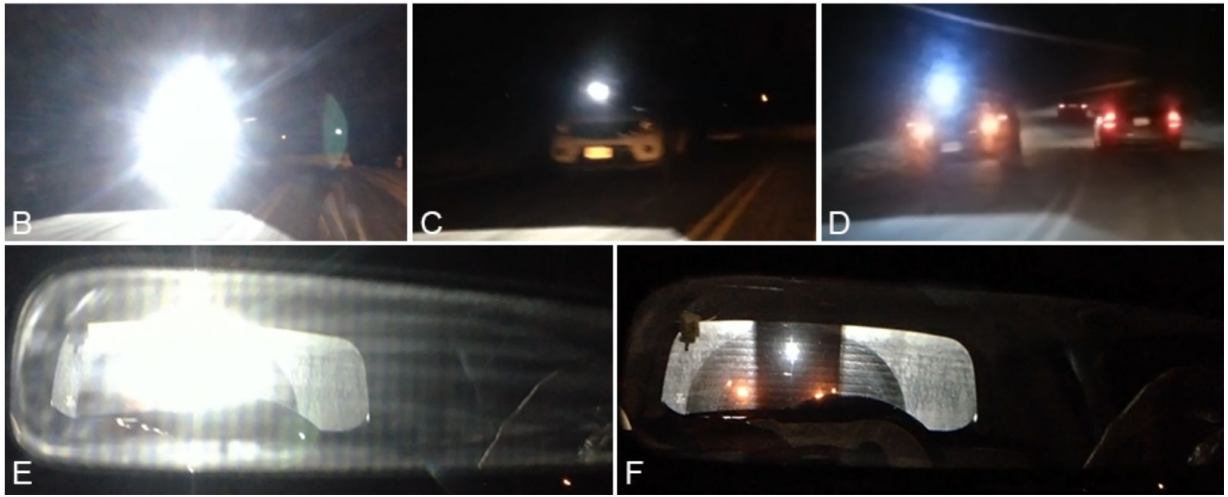


Anti-Glare High Beams

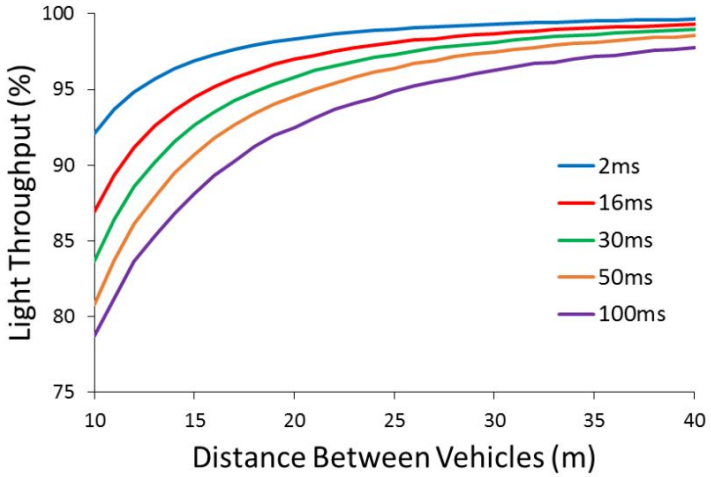
- Headlights are detected by assuming they are the brightest object in the FOV
- Short exposure time and thresholding

oncoming driver glare

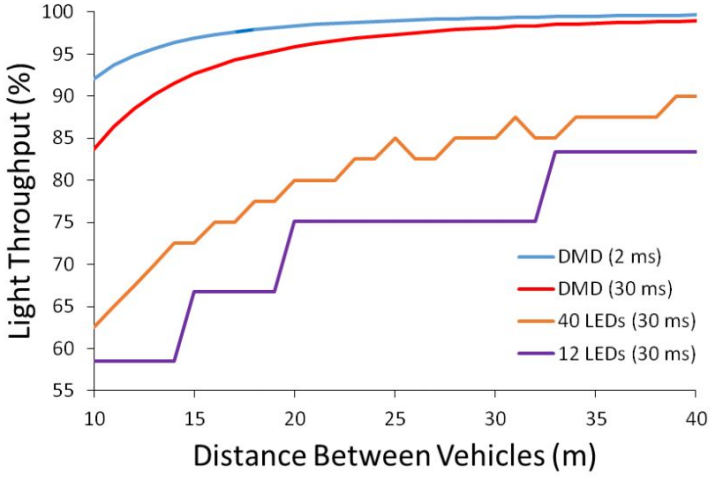
rear-view mirror glare



Anti-Glare High Beams



comparison between system latencies



comparison between systems

Improved lane illumination

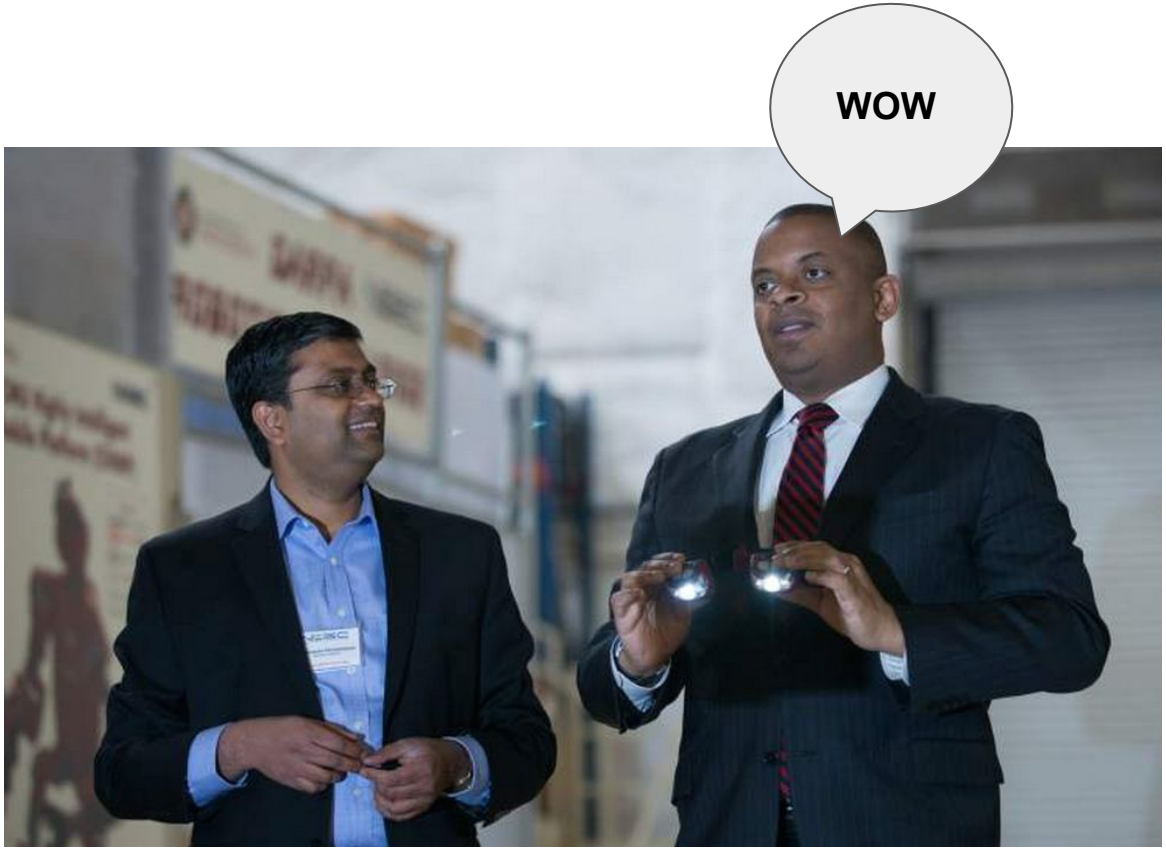
Conclusion and future work

- Presents method to control light beam over time and space.
- Better visibility in snow and rain
- Better illumination of road lanes,sidewalks and dividers
- 1-1.25 millisecond reaction time.(No flicker)
- Need to make prototype compact and test for heat and vibrations.

Score

Score

Score



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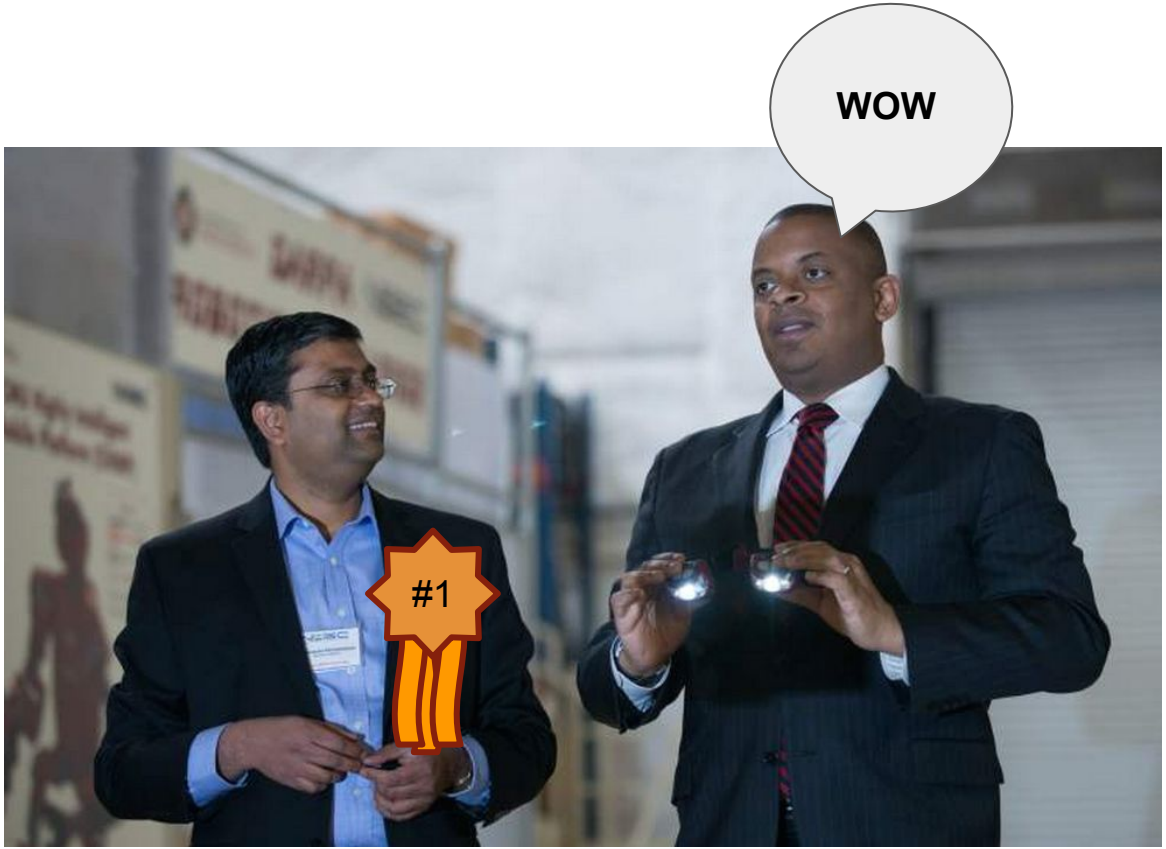
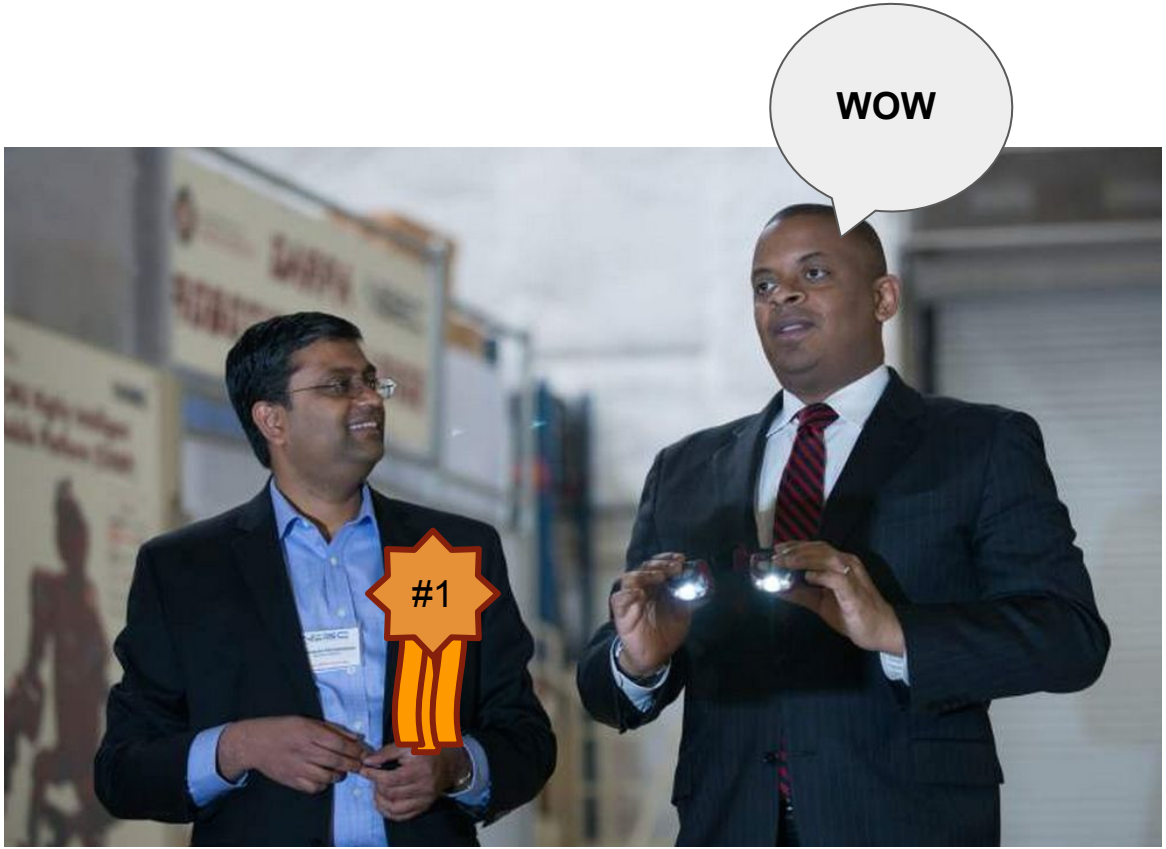


Score

Score: 1



Score

Pros:

- Demonstrates Feasibility
- Simple algorithms for improved latency

Cons:

- Most of the meat of the work is in previous papers
- Even the previous papers didn’t go into much detail about the algorithms
- This paper wasn’t supposed to be an option to present in this class

Questions?