embedded VISION SUMMIT 2018

Understanding Real-World Imaging Challenges for ADAS and Autonomous Vision Systems – IEEE P2020

Felix Heide, CTO

5/22/2018

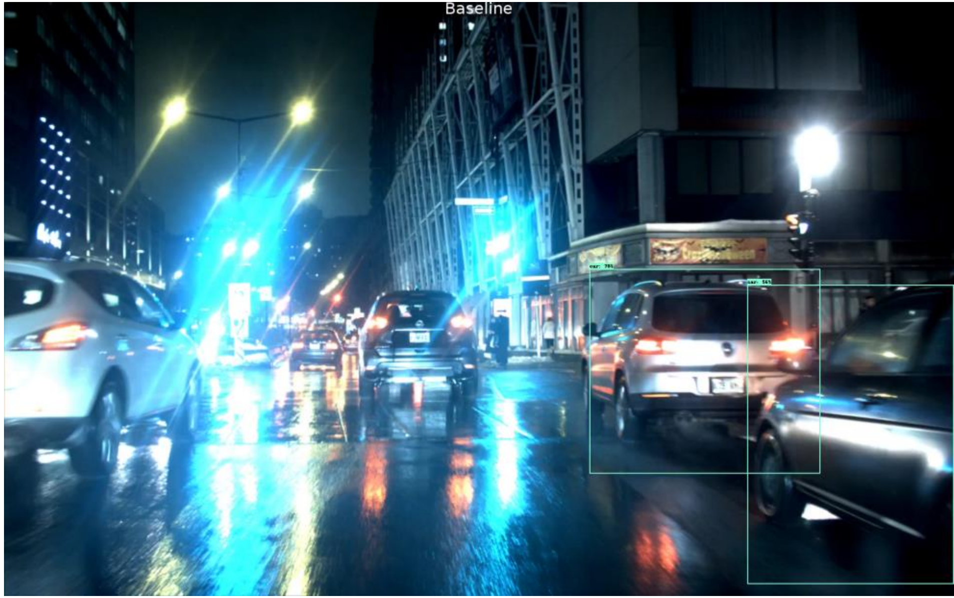
algolux

IEEE

The Real World For Perception Is Hard

…Extremely Hard

Faster RCNN ResNet Atrous
(0.38 on COCO, 0.8 mAP on Pascal)



ISP + Google SSD MobileNet

A Common Automotive Test Scene

And this is only a static scene… And the camera didn't get hot yet….

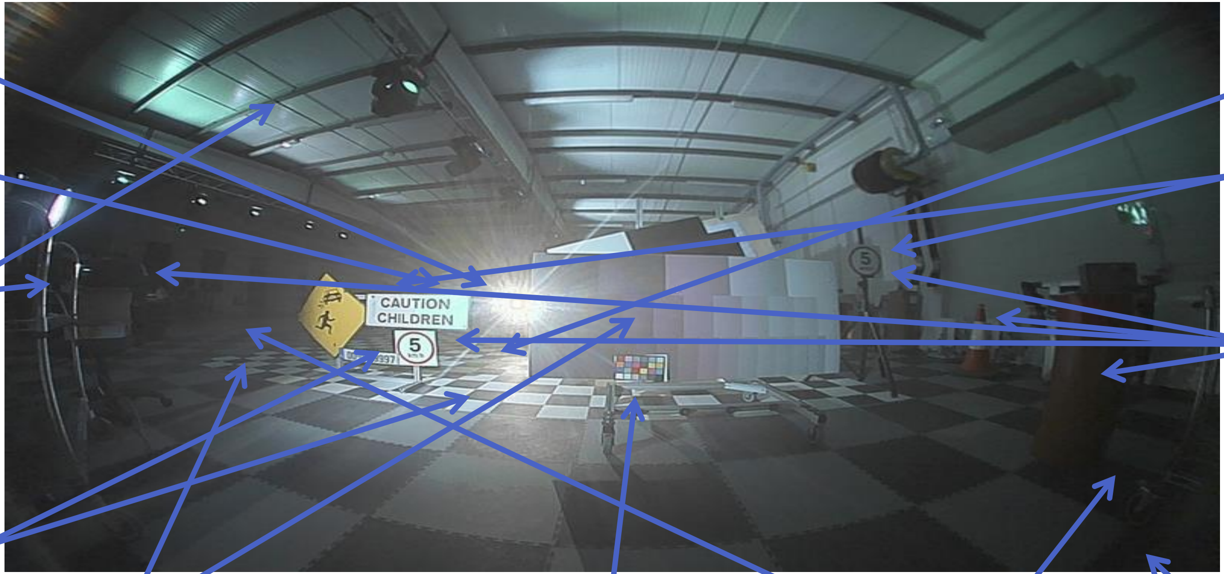
Optical Aberrations

Headlamp Resolution

Geometric Distortion

Naturalness

Sharpness



Moire

Traffic Signs

Utility

Contrast over brightness gradients

Colour Fidelity / White Balance

Structure in shadow

Noise handling

Simple Questions With Poor Answers!

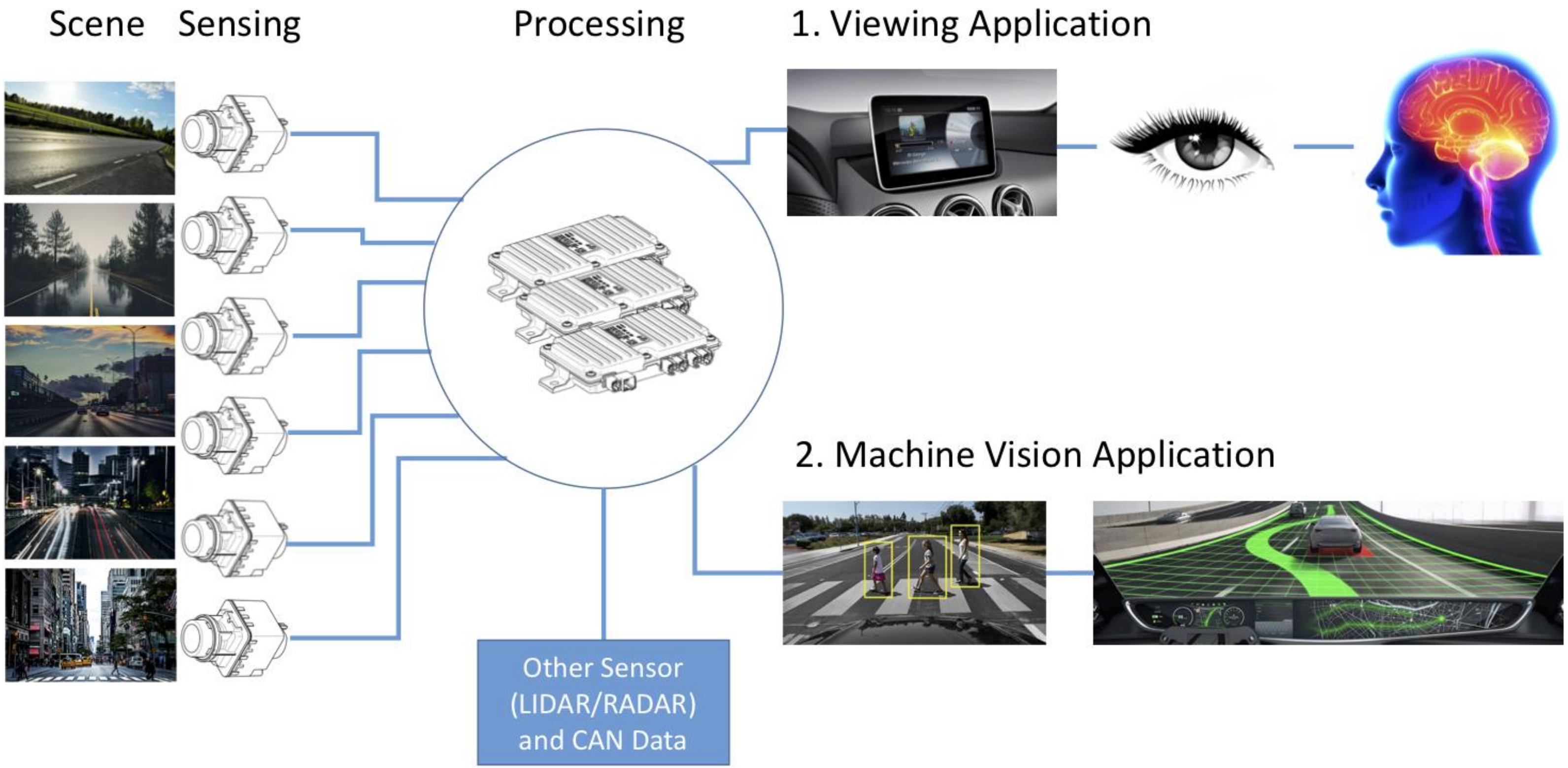
- When is an image “good enough” for viewing and computer vision?
- How do we describe “good enough”?
- What does a measure “mean”?
- “We need to detect a pedestrian behind a vehicle in all conditions”
    - What does that really mean in terms of physical quantities?
- How confident can we be in describing and defending the performance of our components as a subsystem of a safety critical system?
- Are we “overdesigning” our system / components and wasting money?

A Need For Automotive IQ Standards

- Auto vision has moved from comfort to safety functions… critical to saving lives!
  - World Health Org. notes >1.25M people die each year due to accidents and between 20 and 50 million more people suffer non-fatal injuries
- Little agreement on the *characterization* of image quality in automotive systems
- Several standards in place for strongly restricted aspects of the signal chain, but these do not transfer meaningfully to the applications

IEEE SA - 2020 - Standard for Automotive System Image Quality

Proposed Goal



Participation Across The Automotive Ecosystem

SENSE MEDIA
GM
Labsphere
Image Engineering
FotoNation
Panasonic Automotive
Valeo
IEEE
RENESAS
Fastree 3D imagers
VOLKSWAGEN
DAIMLER
DXO
Ford
Fujikura
GEO Semiconductor Inc.
imatest
JAGUAR
LAND ROVER
OpenAI
NXP
MAGNA ELECTRONICS
NUI Galway OÉ Gaillimh
Sunex
BOSCH Invented for life
parc A Xerox Company
NVIDIA
videantis passion for video
PennState
smartsurv
Texas Instruments
ARM
TESLA
VOLVO
OmniVision
life.augmented
automotive engineering iav
codeplay
intel
LeddarTech MASTERING LIDAR SENSOR TECHNOLOGY
XENOMATIX AUTOMOTIVE VISION SOLUTIONS
TATA
algolux
BMW
ON Semiconductor
SONY
cadence
NomiCam
TATA ELXSI
Continental
HITACHI Inspire the Next
IBM
VECTOR
SAMSUNG
LG Electronics
GENTEX CORPORATION A Smarter Vision
SMR Samvardhana Motherson Reflectec
NISSAN
MITSUBISHI ELECTRIC RESEARCH LABORATORIES
PSA PEUGEOT CITROËN

IEEE-SA P2020 Subgroups

Subgroup 1
LED Flicker Standards

Subgroup 2
Image Quality for Viewing

Subgroup 3
Image Quality for Computer Vision

Subgroup 0
IQ Requirements and Specs on Standards

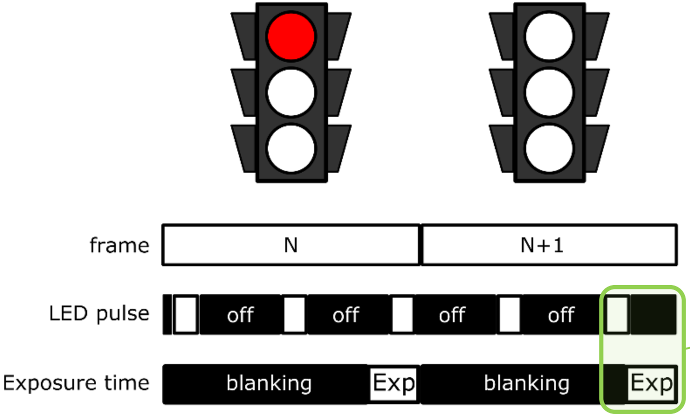
IEEE-SA P2020
Management & Operations

Subgroup 4
Camera Subsystem Interface

Subgroup 5
Image Quality Safety

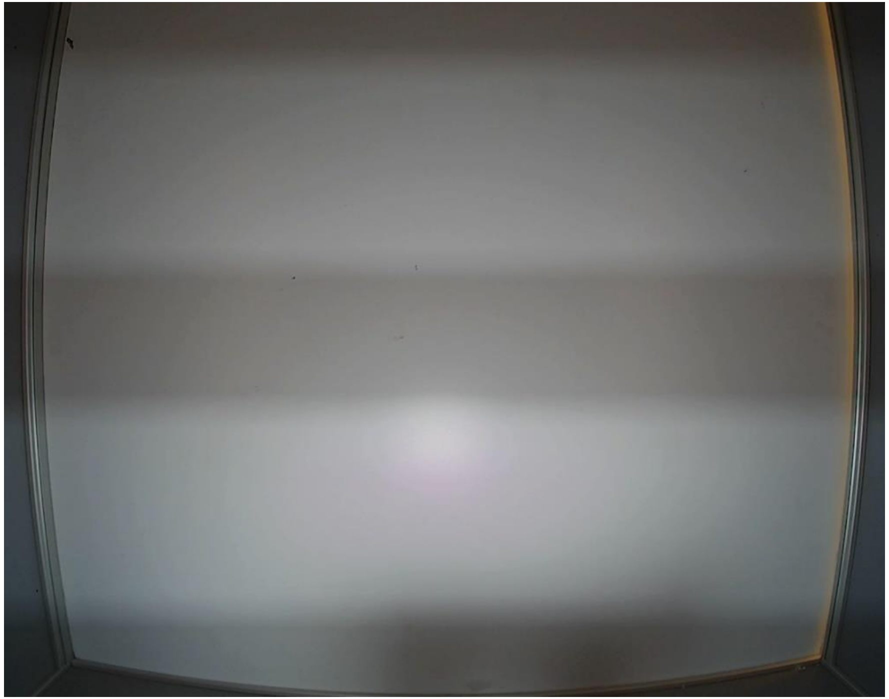
Subgroup 6
Customer Perception of Image Quality

LED Flicker Example



Exposure time and PWM pulse do not overlap.
Light is missed

LED Flicker Example
Banding & Brightness Modulation

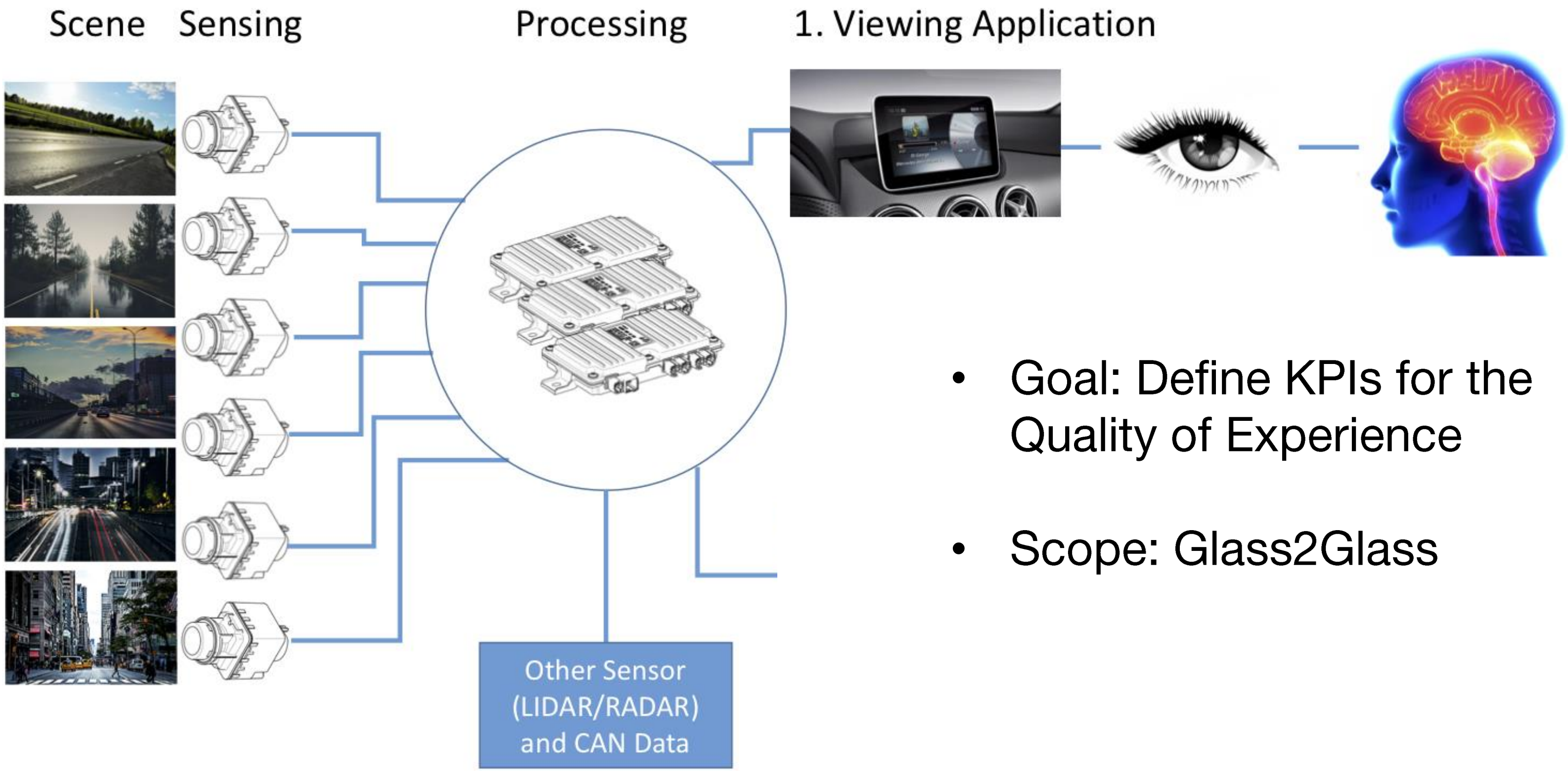


Example of a banding artifact. This image was captured with a rolling shutter image sensor.
In this example, the scene is illuminated by a diffuse light source driving by a 75Hz, 10% duty cycle signal.

LED Flicker Standards

- Goals
  - Clear LED flicker problem statement
  - Clarity regarding LED flicker terminology (e.g. mitigation vs elimination)
  - Standardized test procedure to assess flicker
  - KPIs for assessing LED flicker mitigation
- Impact: to mitigate
  - Driver distraction and perceptual quality issues
  - ADAS/AD gaps (sign detect or vehicle intent)
  - Epilepsy potential

IQ For Viewing – System Level

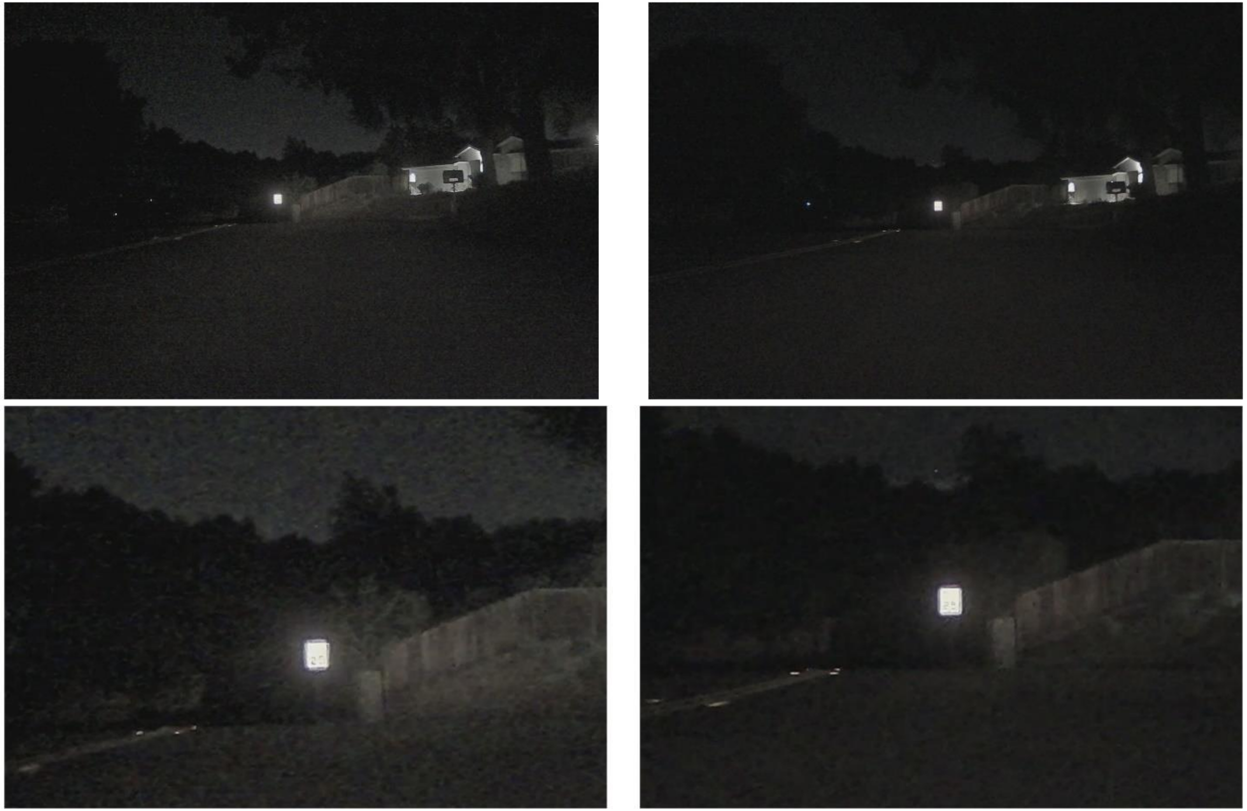


- Goal: Define KPIs for the Quality of Experience
- Scope: Glass2Glass

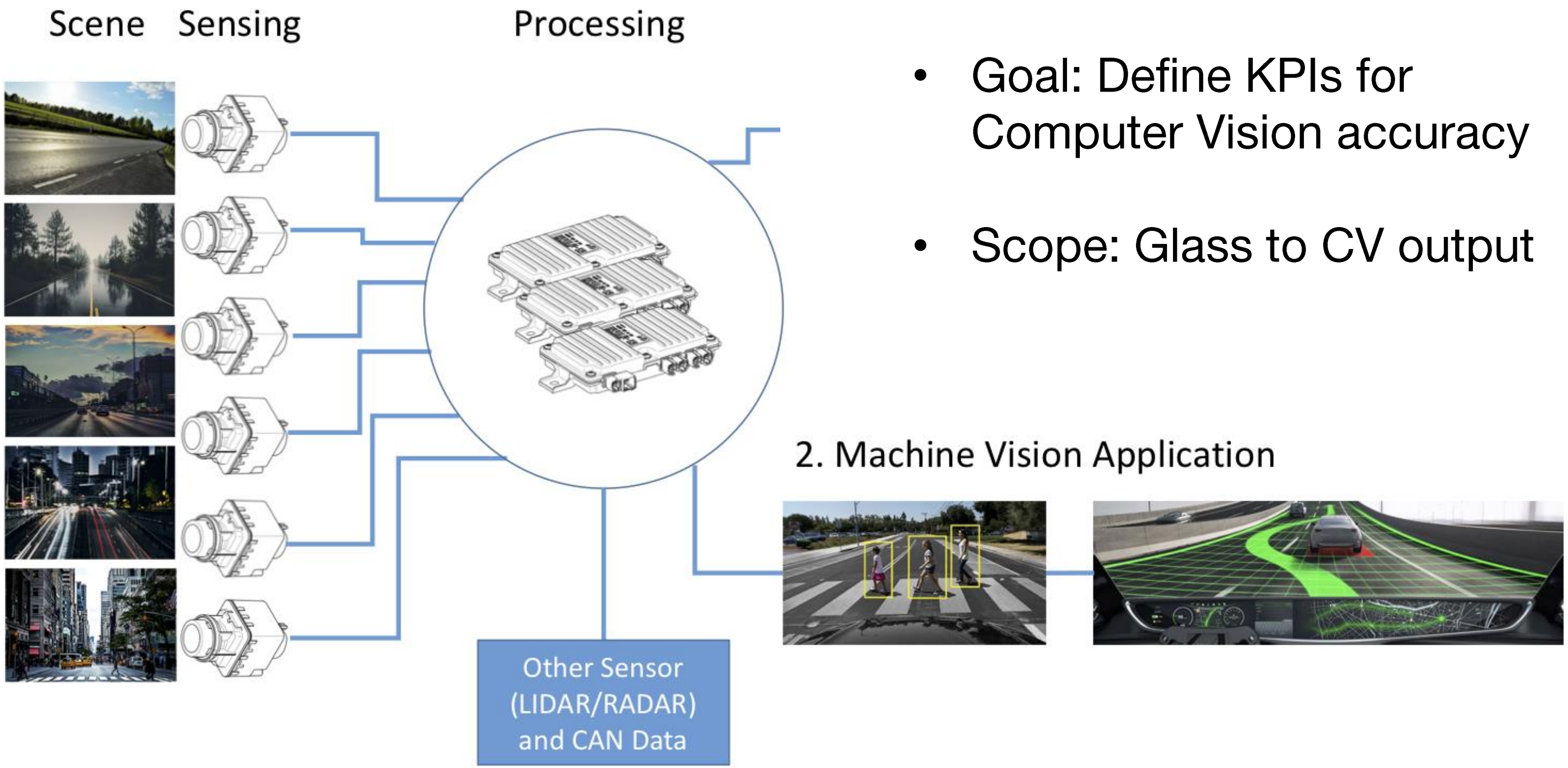
IQ For Viewing – Scope Details

- AR Integration / Harmonization
- Pixel Density
- Street Level
- Interaction with vehicle illumination
- Homogeneity Brightness / Color
- Artifacts
- Control Function Step Response
- HDR / Tone Mapping
- Mixed Light Environments
- Texture Preservation
- Sharpness Balancing
- Color Grading
- Glass 2 Glass
- (LED) Flicker Mitigation
- Vehicle Level
- Customer Domain
- View Harmonization
- “Classic” KPIs SNR / DR / MTF / ΔE

Trading-off Information vs. Visual Aesthetics



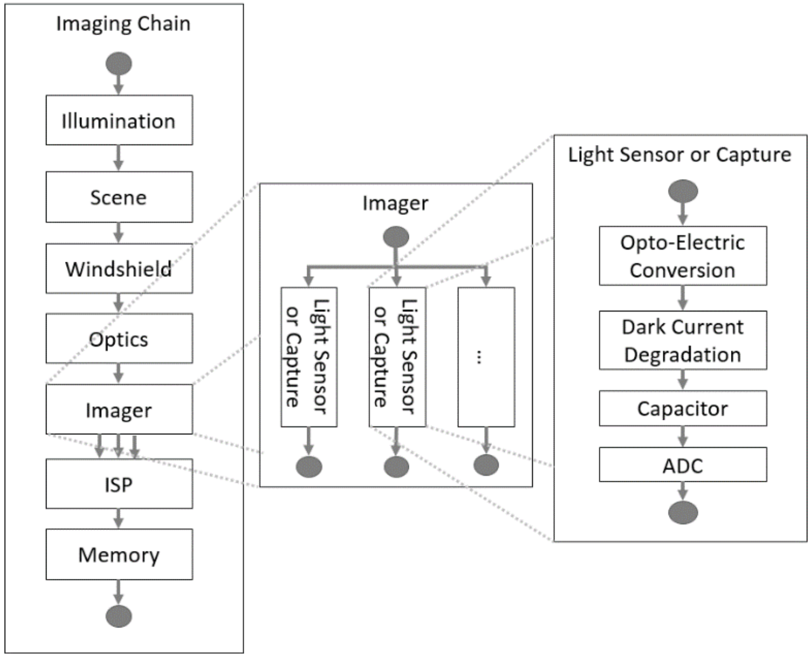
IQ For Computer Vision – System Level



- Goal: Define KPIs for Computer Vision accuracy
- Scope: Glass to CV output

KPIs For Detection Probabilities

- Contrast Detection Probabilities
- Color Separation Probabilities
- Flicker Mitigation Probabilities
- Geometric Separation Probabilities



IEEE P2020 Whitepaper And Call To Action

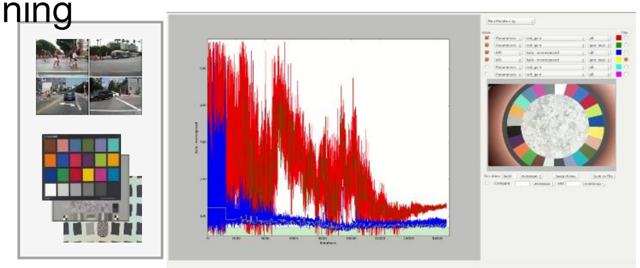
- The working group is about to publish
- P2020 goals, activities, and progress
  - Raise awareness that image quality for automotive is not well-defined and P2020 is trying to remedy
  - Connect with other people already working on similar challenges
  - Attract more people to participate… Please join!

https://standards.ieee.org/develop/project/2020.html

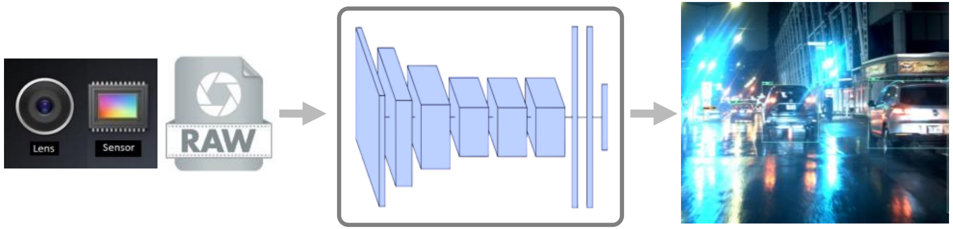
Acknowledgement and special thanks to Patrick Denny & Brian Deegan of Valeo for their P2020 materials in this presentation

Algolux – Driving Safety in Autonomous Vision

CRISP-ML: Automate and optimize IQ tuning



CANA: Full DNN stack for robust perception



- HQ in Montreal, offices in Palo Alto & Munich
- 25 employees; 21 in R&D (11 PhDs)
- Active in academic & industry communities

$10M Series A

May 1, 2018

GM

DRIVE CAPITAL

[intact]

real

embedded VISION ALLIANCE VISION PRODUCT OF THE YEAR 2018

AutoSens Awards

Most Exciting Startup

Vision Systems Design 2018 Innovators Awards GOLD

Vision Systems Design 2018 Innovators Awards SILVER