Perceptually based
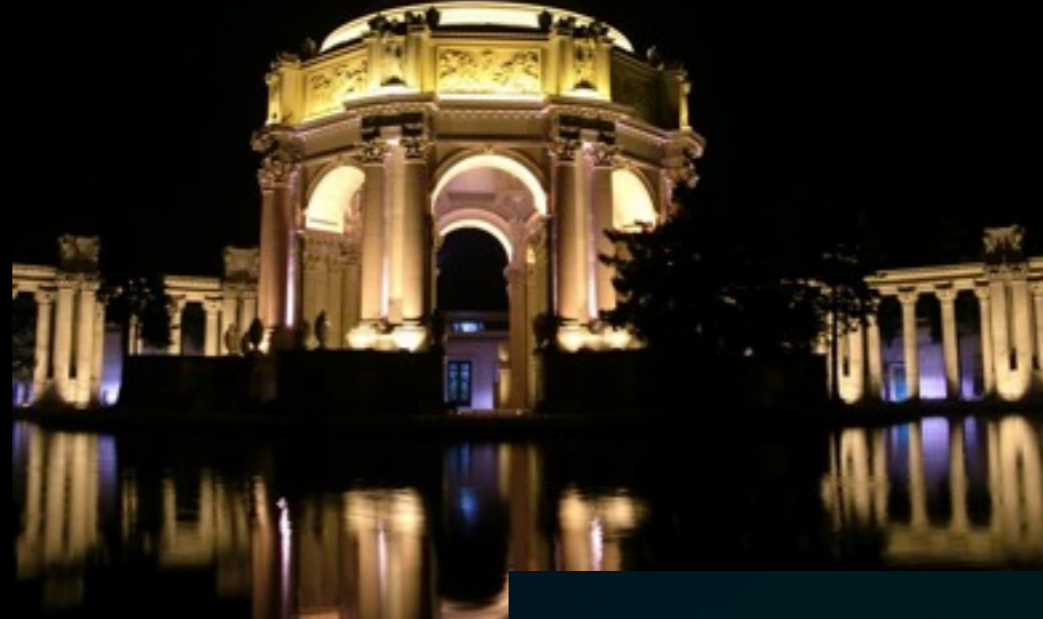# Tone Mapping for Low Light Video

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It often seems to me that the night
is much more alive and richly colored than the day.

-Vincent Van Gogh

- Problem
- Motivation
- Approach
- Results
- Future Work

Problem

- Image/Video taken in low-light does not match human perception well.

Problem

- ~~Problem~~

- Motivation
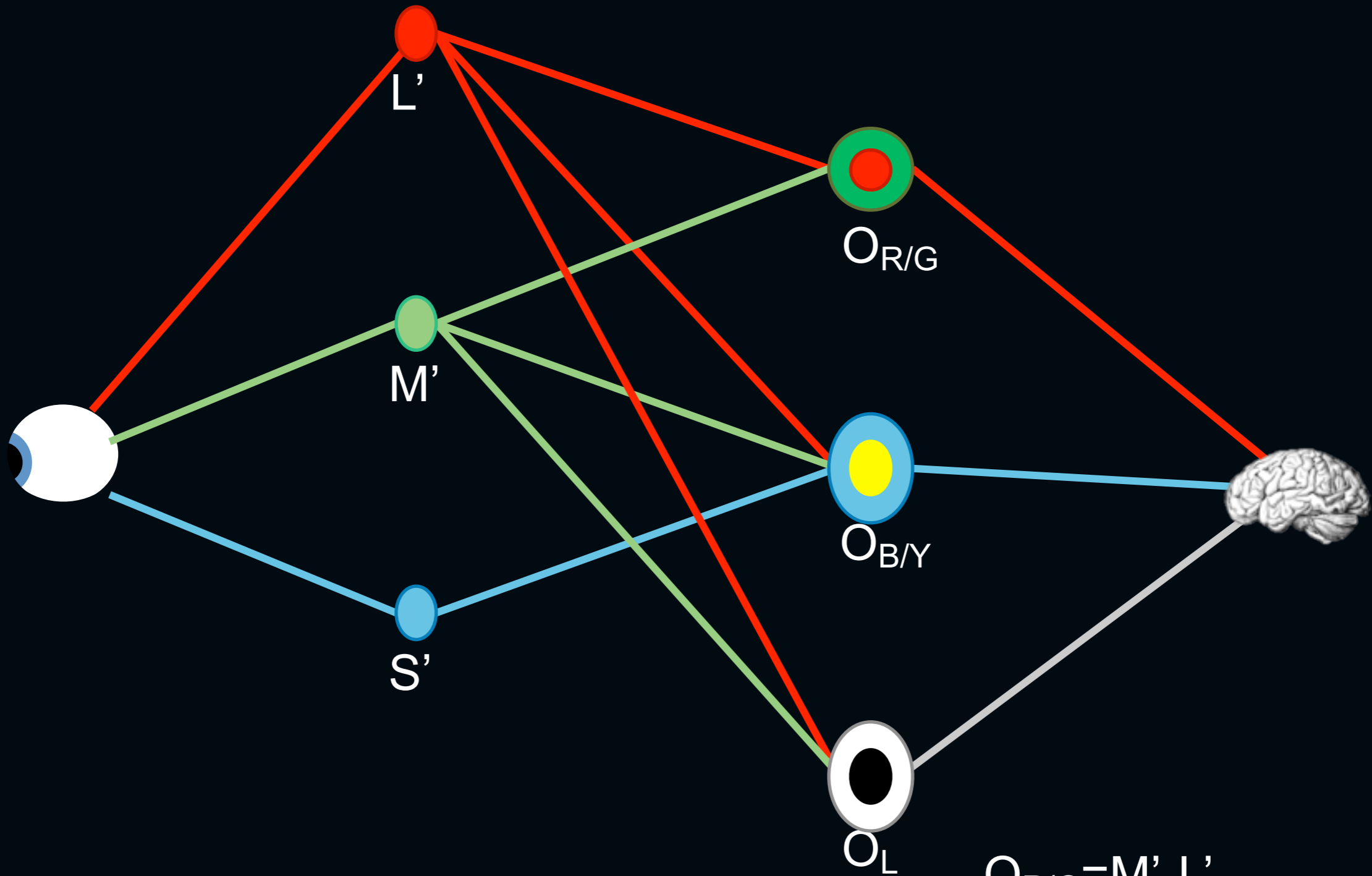
- Approach

- Results

- Future Work

Motivation

- Cinematographers often color correct the film they shot at night time.

- "With semi-automated process, we can discover new looks and lessen the time we spend on color correction." --Daryn Okada, Cinematographer

Motivation

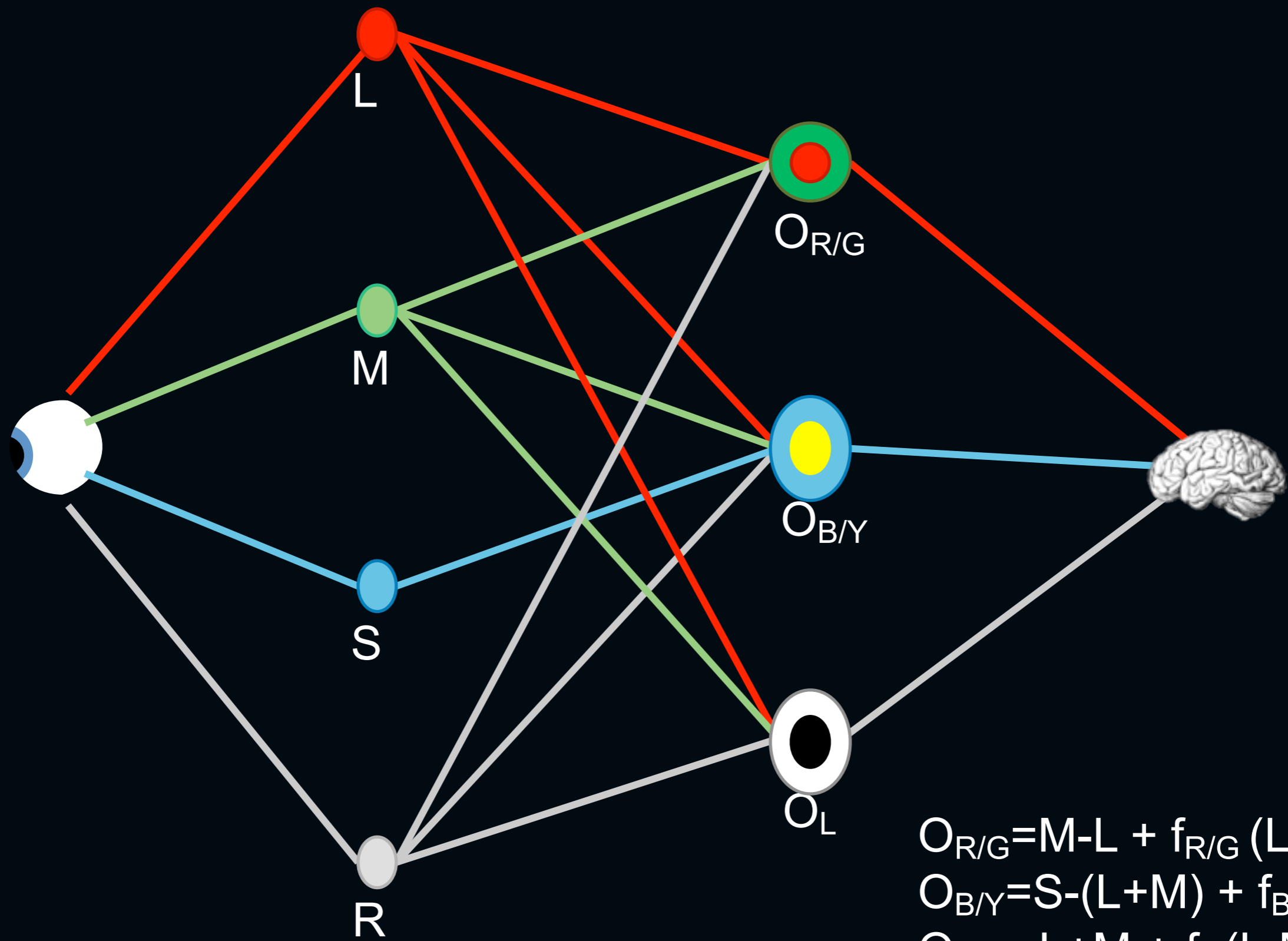- There is non-linear color shift that happens when eye transitions from light to low-light condition.
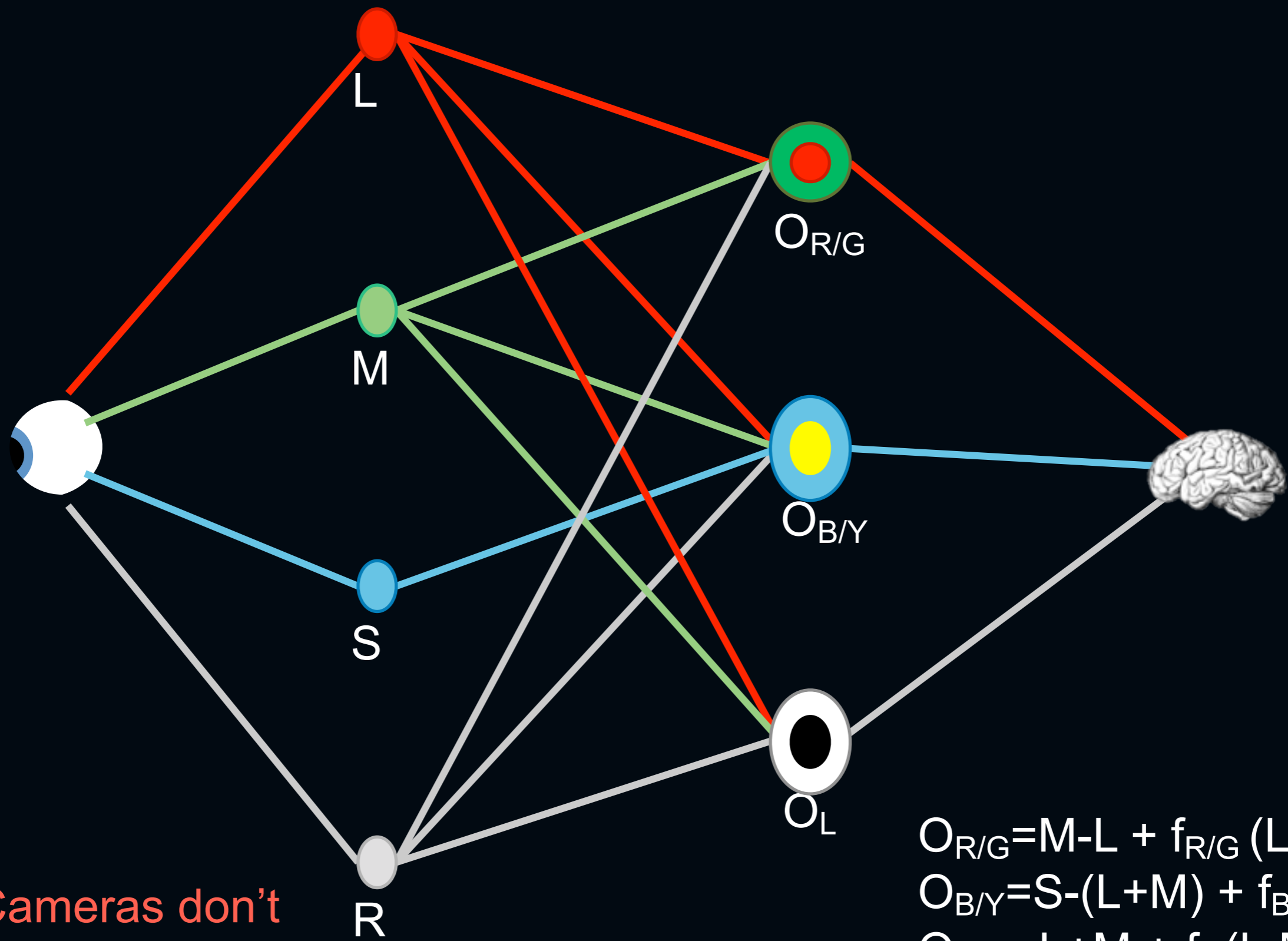
$O_{R/G} = M' - L'$
$O_{B/Y} = S' - (L' + M')$
$O_L = L' + M'$

Slide courtesy of Kirk & O'Brien

$O_{R/G} = M-L + f_{R/G}(L,M,R)$

$O_{B/Y} = S-(L+M) + f_{B/Y}(L,M,S)$

$O_L = L+M + f_L(L,M,R)$

Cameras don't account for this forth channel.

$$O_{R/G}=M-L + f_{R/G} (L,M,R)$$
$$O_{B/Y}=S-(L+M) + f_{B/Y} (L,M,S)$$
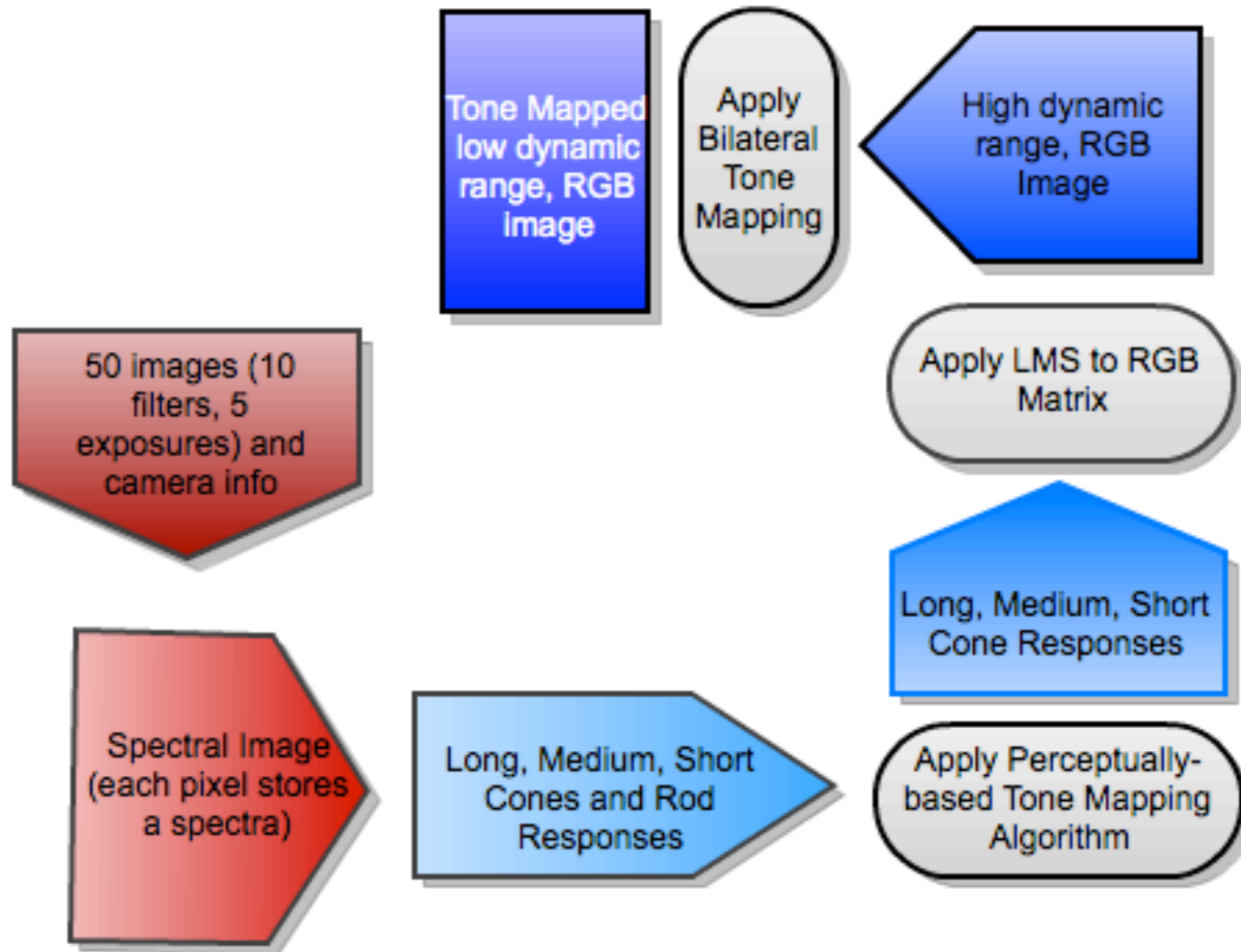$$O_L \ =L+M + f_L (L,M,R)$$

L

$O_{R/G}$

M

$O_{B/Y}$

S

R

O_L

- ~~Problem~~

- ~~Motivation~~

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Approach

Perceptually Based Tone Mapping (PBT)

Tone Mapped low dynamic range, RGB Image

Apply Bilateral Tone Mapping

High dynamic range, RGB Image

50 images (10 filters, 5 exposures) and camera info

Apply LMS to RGB Matrix

Long, Medium, Short Cone Responses

Spectral Image (each pixel stores a spectra)

Long, Medium, Short Cones and Rod Responses
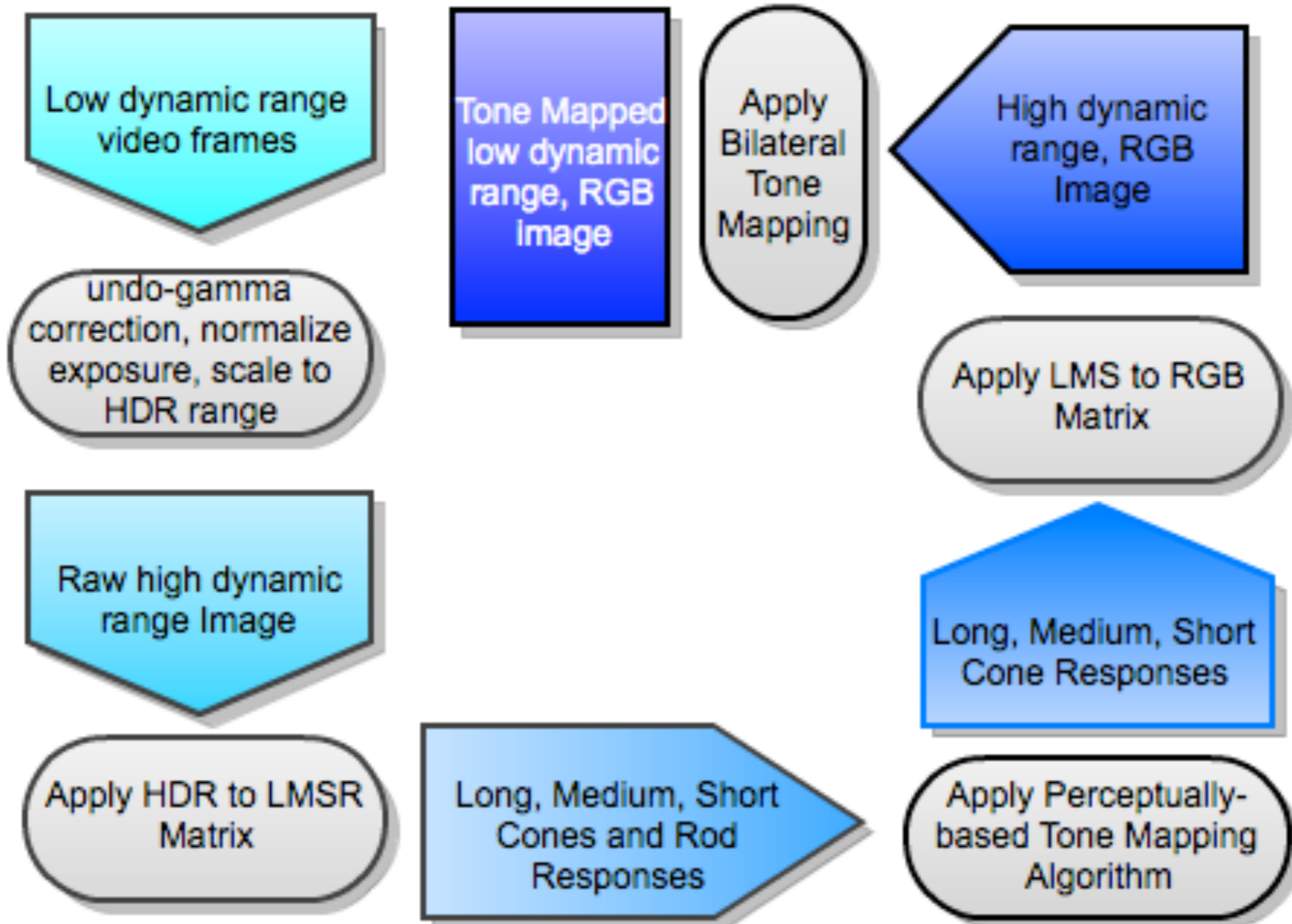
Apply Perceptually-based Tone Mapping Algorithm

Approach

Our Pipeline

LDR RGB to HDR RGB

LDR RGB -> Raw RGB -> HDR RGB -> PBT

- Low dynamic range RGB is converted to raw RGB.

  - Undo gamma, white balance gain.

- Raw RGB converted to HDR range by normalizing exposure.

HDR RGB to LMSR

- We train a four by three matrix to convert HDR RGB to LMSR using least squares.

0.053	0.054	−0.061
0.039	0.043	−0.046
0.008	0.020	−0.011
0.029	0.042	−0.037

Clamping Negative LMSR Values to Zero

Adding Offset to LMSR

Comparison to Naive Blue Gain

Input

Comparison to Naive Blue Gain

- ~~Problem~~

- ~~Motivation~~

- ~~Approach~~

- Results

- Future Work

Results

- http://www.ocf.berkeley.edu/~yglee/proj/fp11/Home.html

Results

Input

Results

Output 1
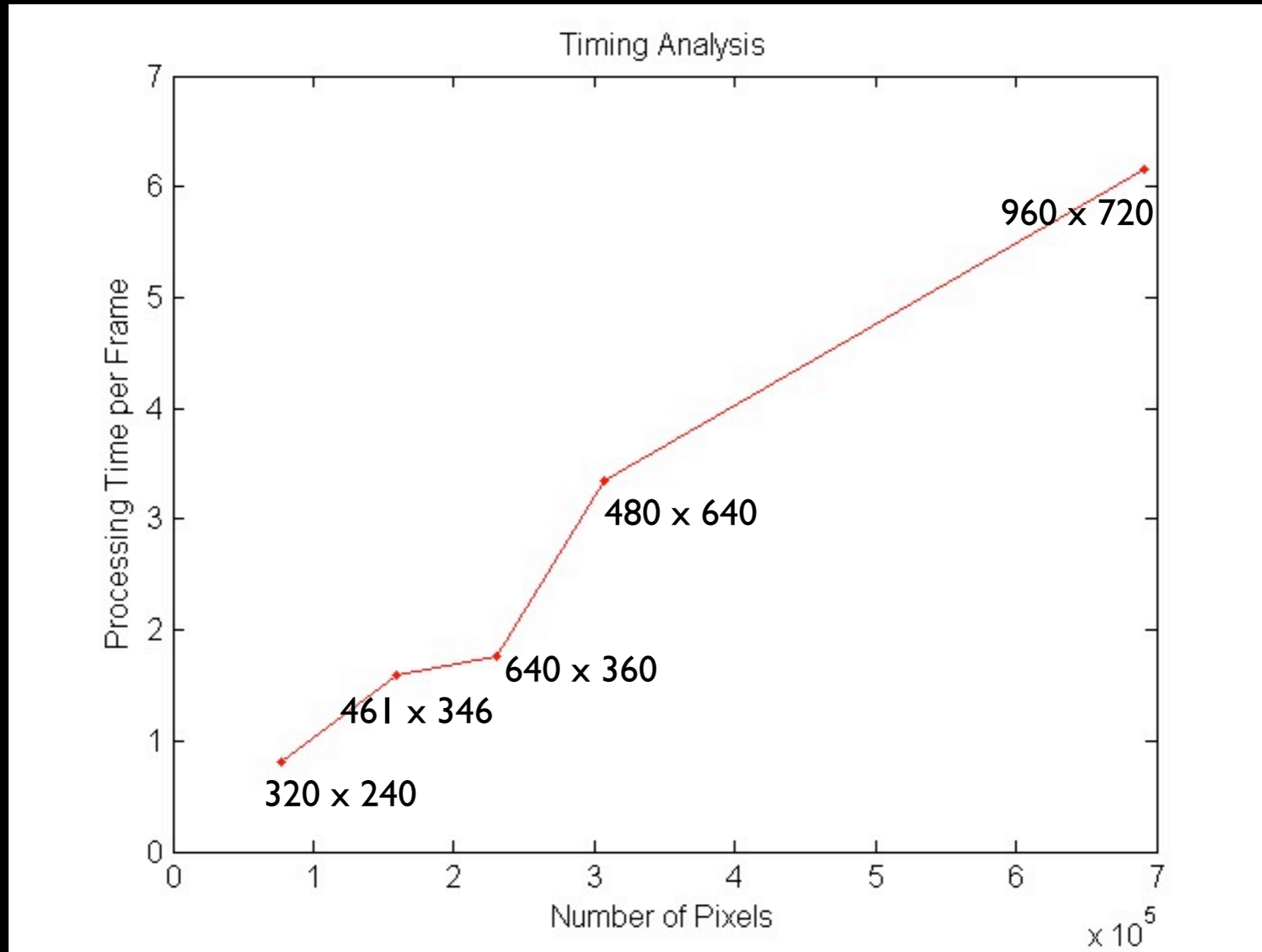
Results

Output 2

Results

Input

Results

Input

Timing

- ~~Problem~~

- ~~Motivation~~

- ~~Approach~~

- ~~Results~~

- Future Work

Future Work

- Negative lmsr values ->how to get rid of them.

  - constraint optimization on training matrix

  - build a lookup table

- Make tone mapping faster.

- ~~Problem~~

- ~~Motivation~~

- ~~Approach~~

- ~~Results~~

- ~~Future Work~~

Questions?