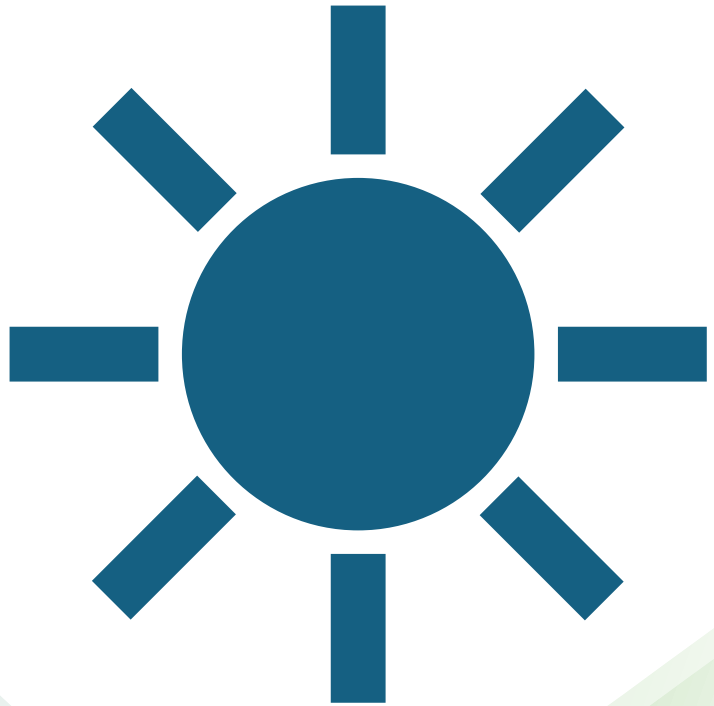
Projection Correction

Kincannon Wilson, James Wedum,
Nithin Weerasinghe

Problem Statement

- Images from projectors are susceptible to environmental perturbations
  - Light color
  - Light intensity
  - Surface color
  - Surface shape
  - Projector angle
- We seek to create a control system to correct for these issues
- Reactive-Adaptive Projection Correction System (RAPcSys)



Existing Solutions

- Keystone Correction
- Color Management Systems
- Ambient Light Sensing
- Digital Signal Processing
- 3D Look-Up Tables

A previous approach to projection correction

- "Real Time Adaptive Radiometric Compensation" (Grundhoefer & Bimber 2007)
- Requires specialized GPU algorithm

Methodology

Reactive-Adaptive Control System

- Feed-forward controller for image shape
- Feed-back controller for color correction

Low-pass filter

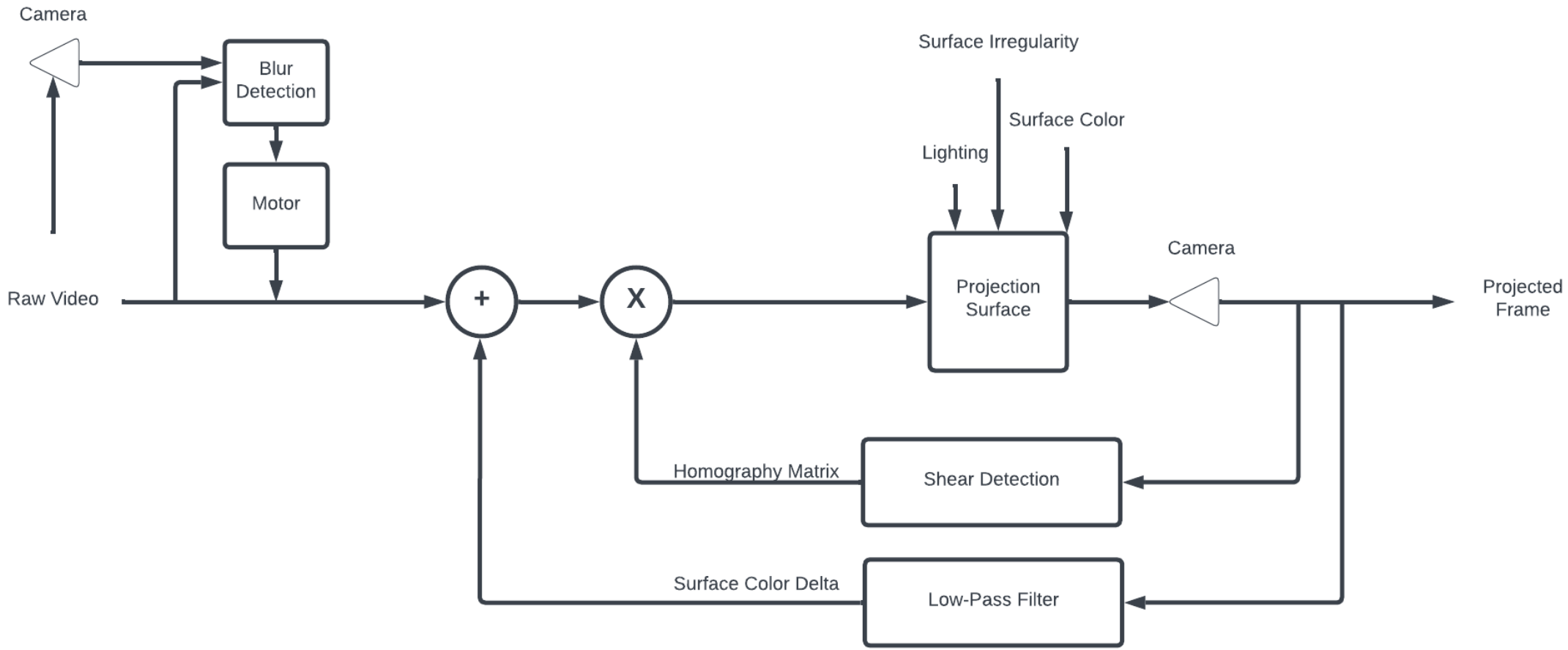
- Attenuate high-frequency information (such as motion)
- Focus on low-frequency delta (background/environment color)

PD controller for motor with rotary encoder for real-time focus adjustment

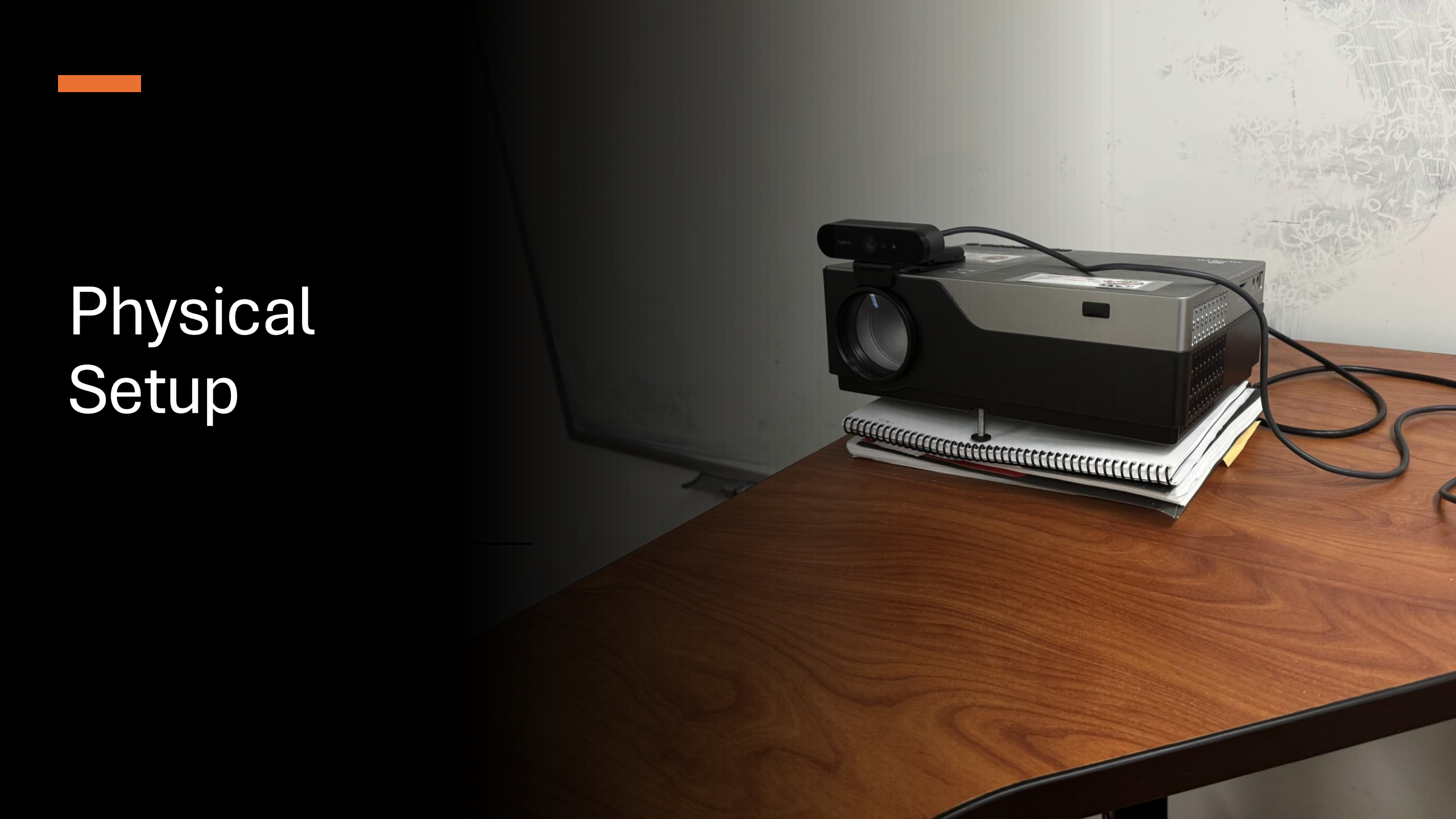
- Potential correction for rapid perturbations, such as the projector being struck

Single-sensor, low-cost option

- Dual-sensor with rotary encoder


Camera
Blur Detection
Motor
Raw Video
+
X
Surface Irregularity
Lighting
Surface Color
Projection Surface
Camera
Projected Frame
Homography Matrix
Shear Detection
Surface Color Delta
Low-Pass Filter

Physical Setup



Software Setup

SHOWING IMAGES

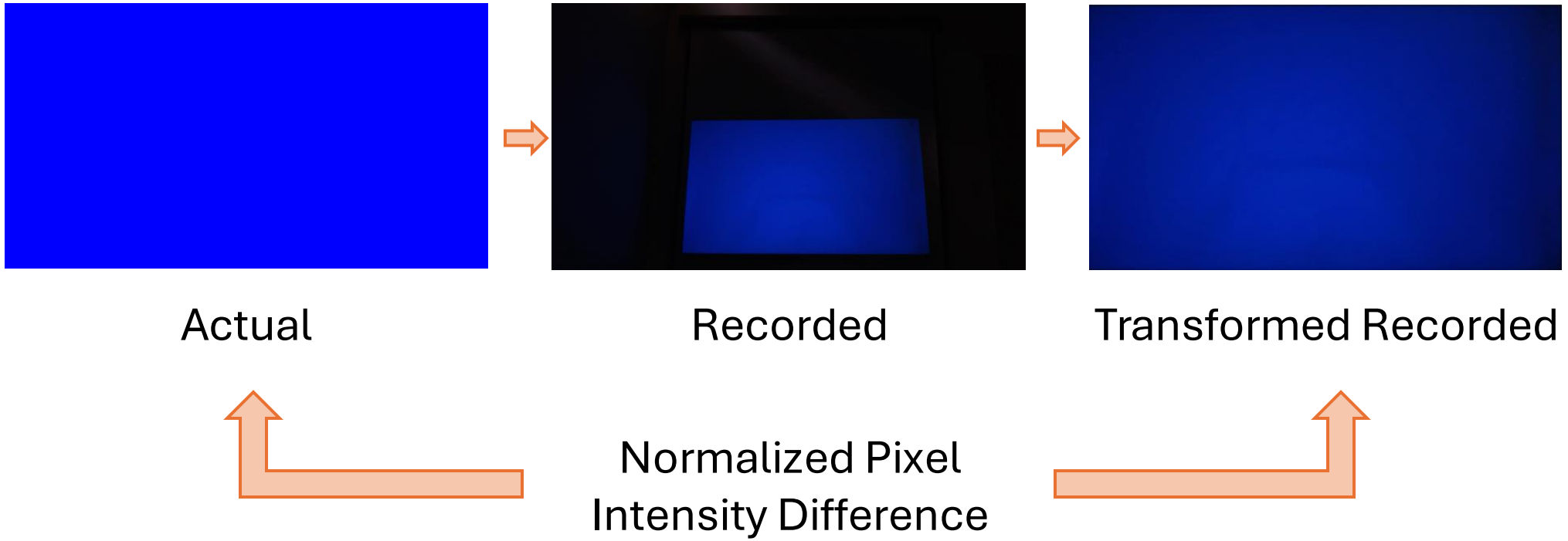
TRANSFORMING IMAGES (BEST SIFT MATCHES, CONTOUR-BASED, MANUAL)

CAMERA INPUT

COLOR CORRECTION

METRICS

Performance Metric



Buffer of pixel-wise corrections

Median

Average

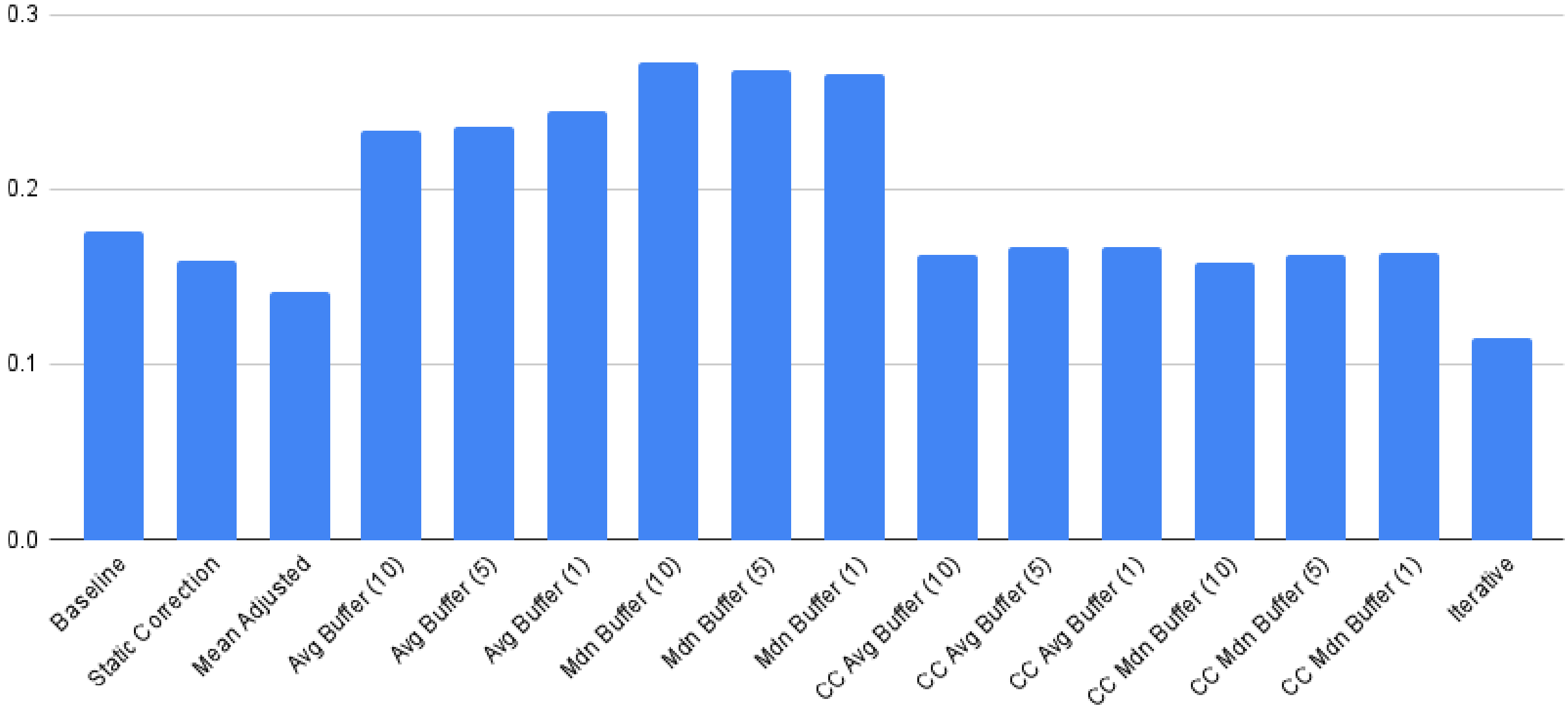
Buffer of mean color corrections

Median

Average

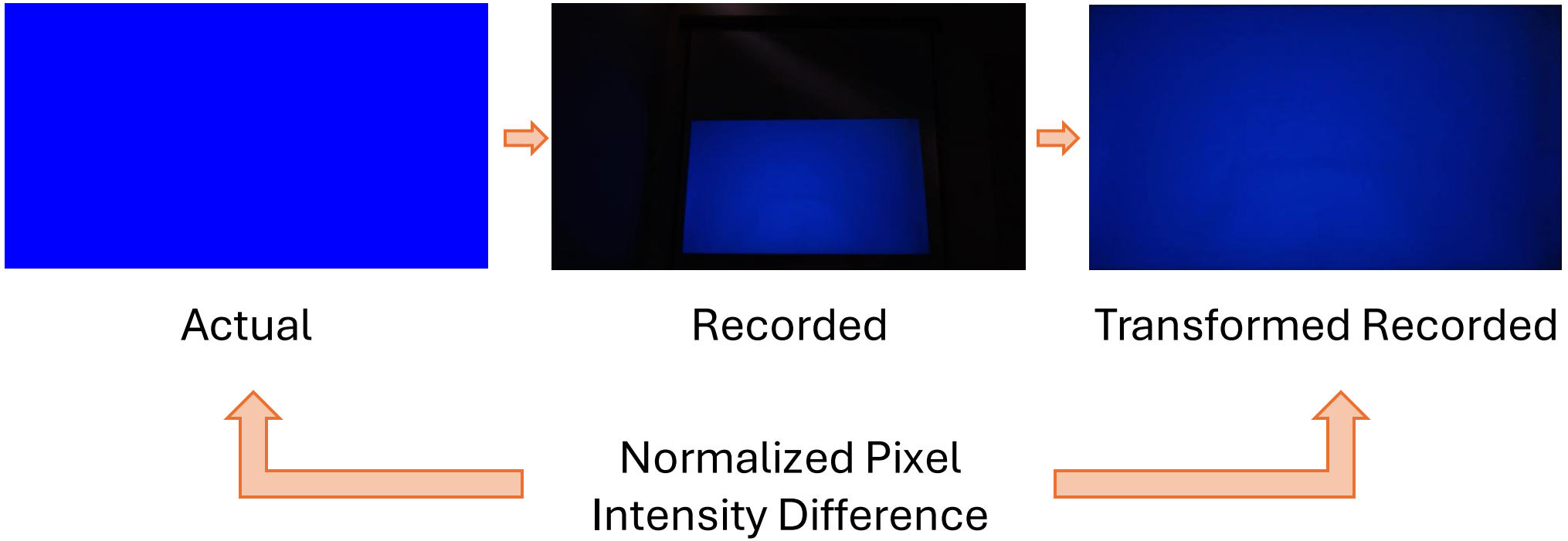
Iterative Corrections

Results


0.3
0.2
0.1
0.0
Baseline
Static Correction
Mean Adjusted
Avg Buffer (10)
Avg Buffer (5)
Avg Buffer (1)
Mdn Buffer (10)
Mdn Buffer (5)
Mdn Buffer (1)
CC Avg Buffer (10)
CC Avg Buffer (5)
CC Avg Buffer (1)
CC Mdn Buffer (10)
CC Mdn Buffer (5)
CC Mdn Buffer (1)
Iterative

A Closer Look at Iterative Corrections

Performance Metric



Conclusion

- Began with pixel-wise corrections and shifted to mean-based color corrections but a larger buffer was needed
- Employed an iterative adjustment method to optimize color correction for individual frames
- Future directions:
  - Utilize larger buffer and integrate low pass filter
  - Refine the machine-learning model to improve accuracy and reduce artifacts.


Questions