Tracking objects across spatially separated, cameras with non-overlapping views

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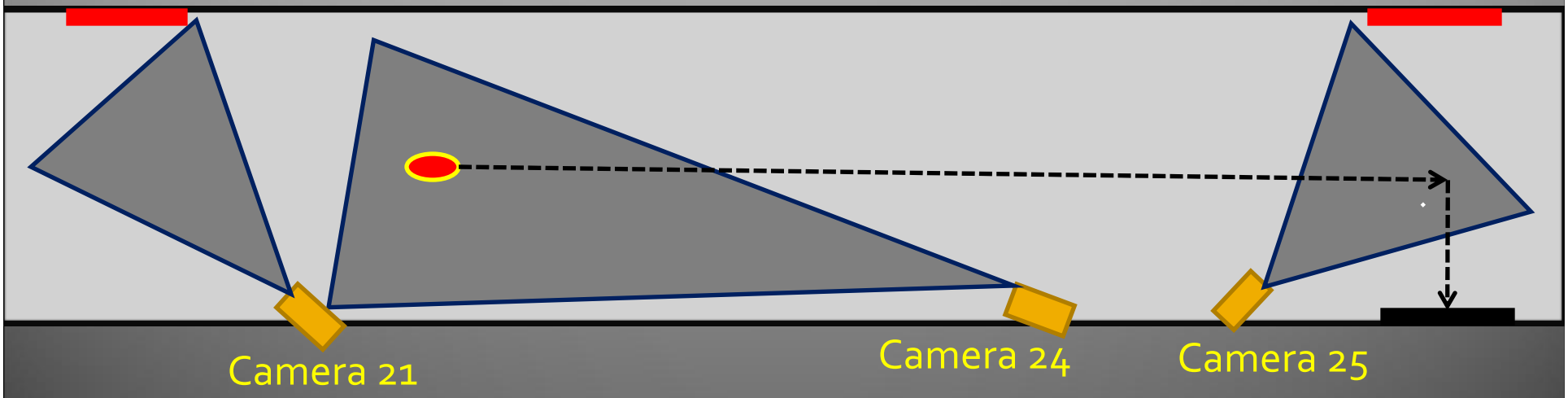


→ Exit

→ Restroom

→ Field Of View

→ Object (Human)

→ Camera

→ Projected Path

Applications

1. Surveillance
    I. Airports
        2. Casinos
        3. Banks

Alex Jones,
Infowars.net

2. Smart Buildings
    I. Energy conservation
        a. How many people in a room
            i. Heat
            ii. Lighting
            iii. Air Flow

Experimental Method

3Cues for tracking objects:

1. SiZe
2. Movement
3. color

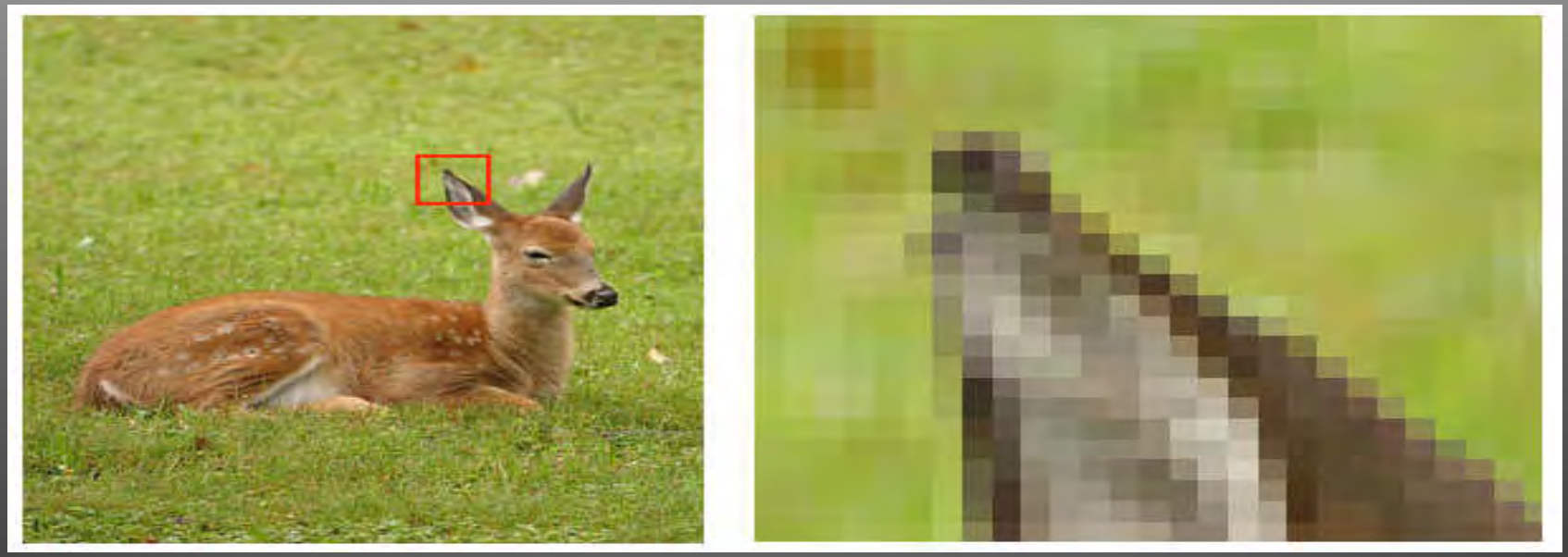
Research Objectives

Use color to track objects

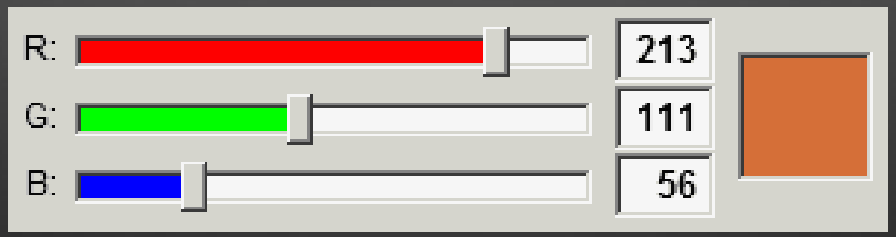
Evaluate color histograms

Evaluate color histogram with color calibration

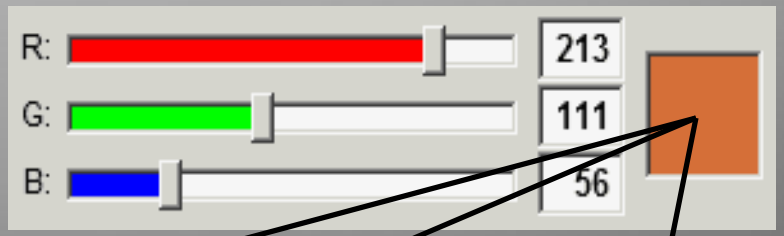
What is an Image?



Each pixel has a RGB Value which produce a color



WHAT IS A COLOR HISTOGRAM?

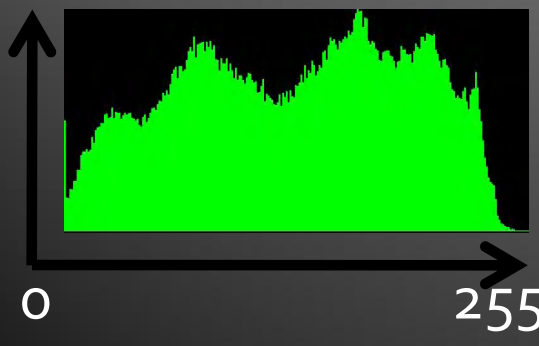


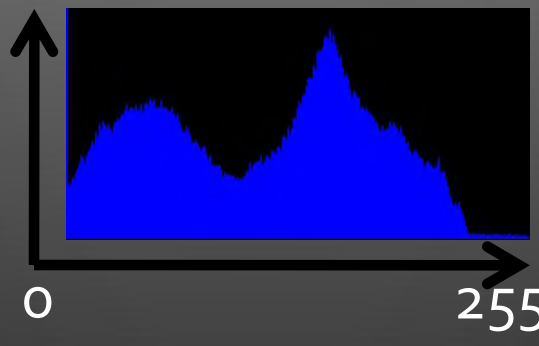
111

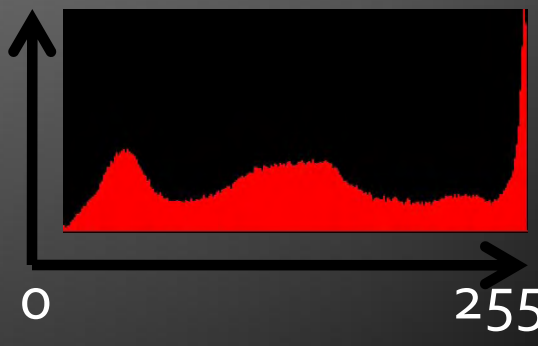
56

21

3



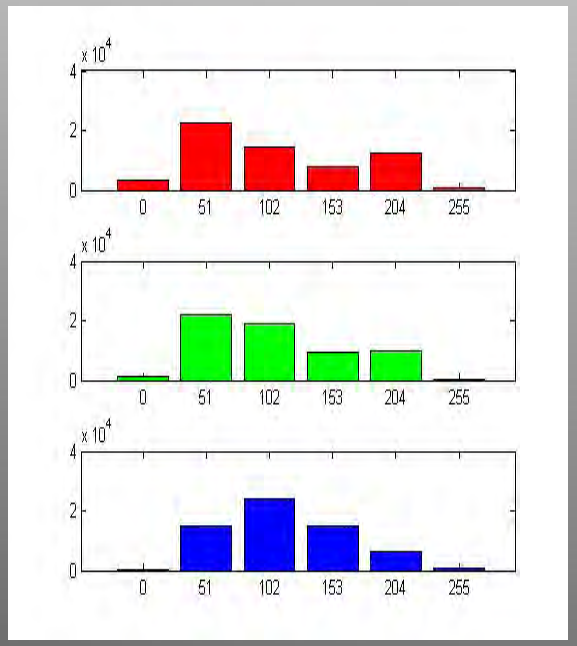


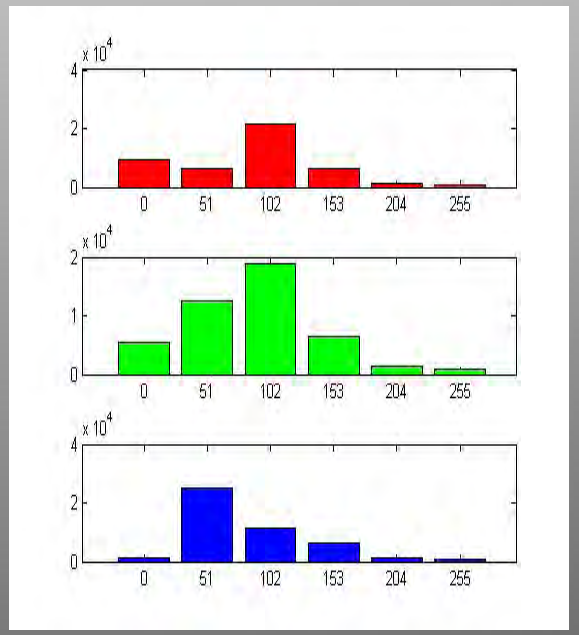


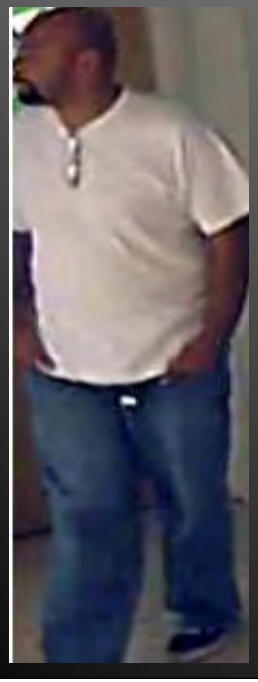
Each pixel RGB value is put into its correct bin

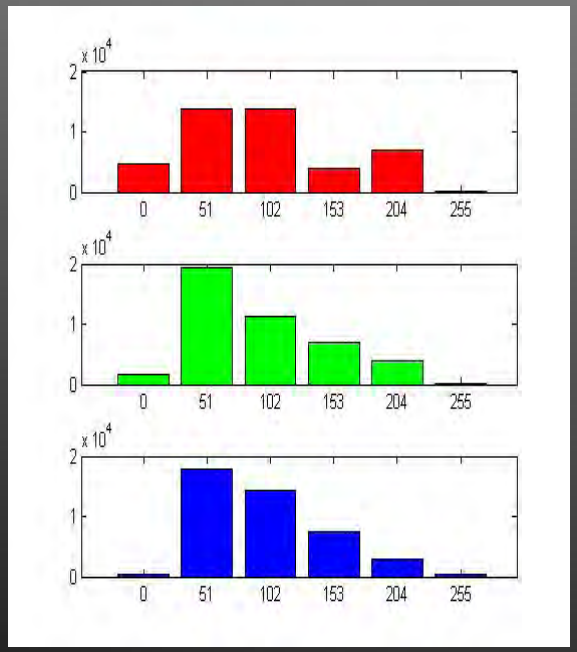
Camera 21

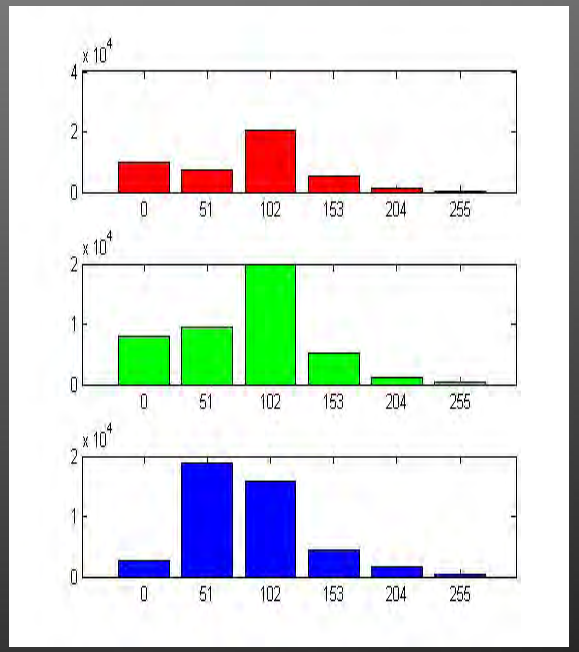
Camera 25

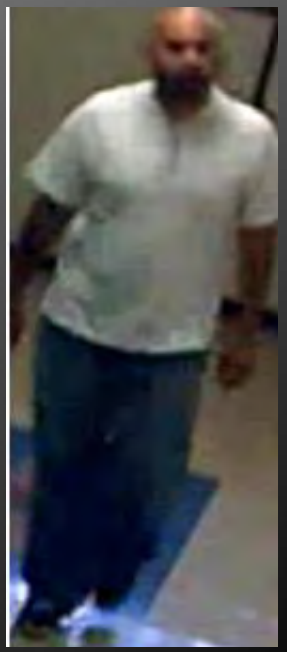












Histogram Intersection

$$H(\text{Target, Query}) = \frac{\sum_{j=1}^{n} \min(H_T[j], H_Q[j])}{\sum_{j=1}^{n} H_Q[j]}$$

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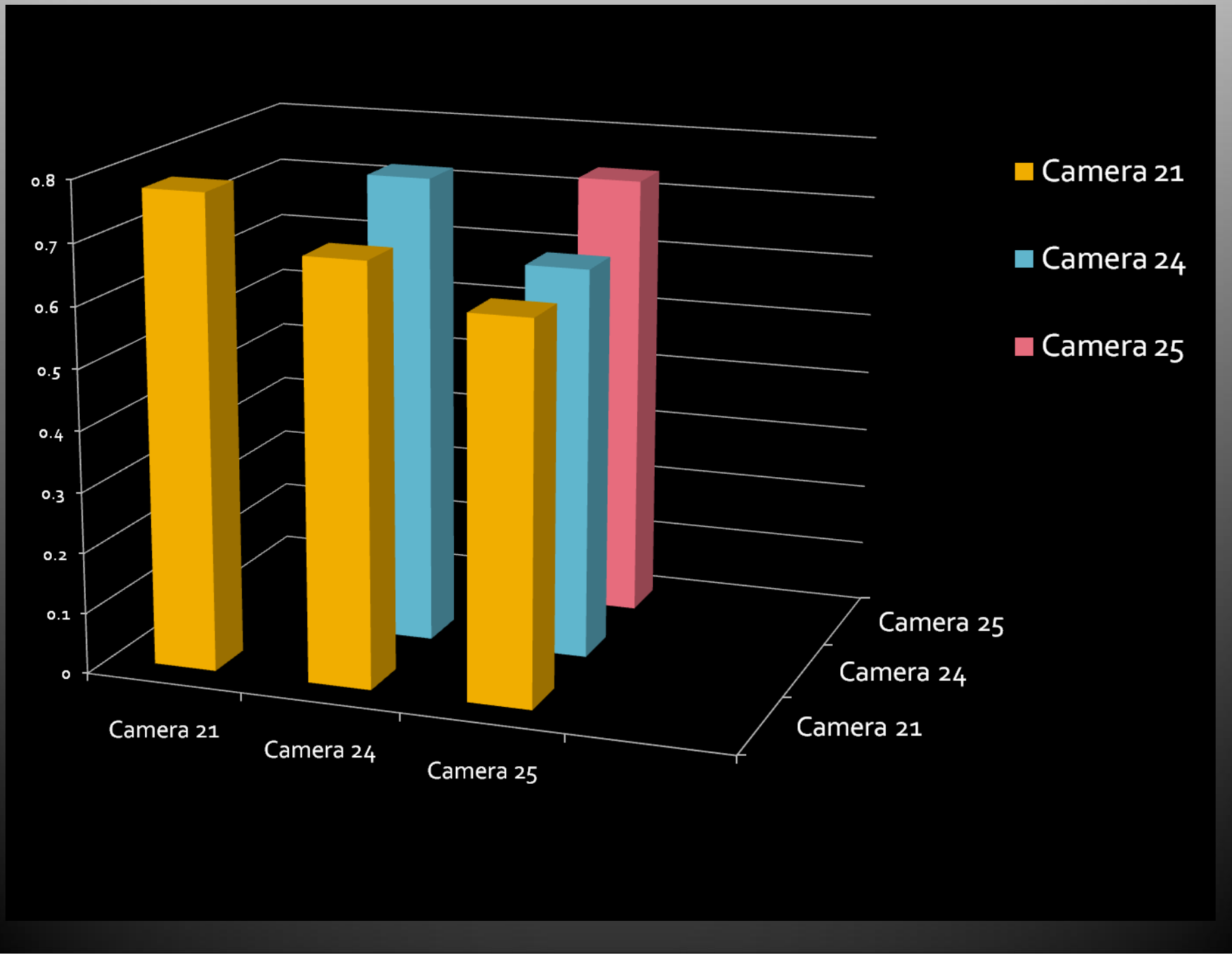
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Camera 21
Camera 24
Camera 25
Camera 25
Camera 24
Camera 21
Camera 21
Camera 24
Camera 25

Color Transformation

Example linear transformation matrix for a 2 Bin RGB quantisation.

$$\begin{bmatrix} I_{r_1} & I_{r_2} & I_{g_1} & I_{g_2} & I_{b_1} & I_{b_2} \end{bmatrix} * \begin{bmatrix} t_{r_1r_1} & t_{r_1r_2} & t_{r_1g_1} & t_{r_1g_2} & t_{r_1b_1} & t_{r_1b_2} \\ t_{r_2r_1} & t_{r_2r_2} & t_{r_2g_1} & t_{r_2g_2} & t_{r_2b_1} & t_{r_2b_2} \\ t_{g_1r_1} & t_{g_1r_2} & t_{g_1g_1} & t_{g_1g_2} & t_{g_1b_1} & t_{g_1b_2} \\ t_{g_2r_1} & t_{g_2r_2} & t_{g_2g_1} & t_{g_2g_2} & t_{g_2b_1} & t_{g_2b_2} \\ t_{b_1r_1} & t_{b_1r_2} & t_{b_1g_1} & t_{b_1g_2} & t_{b_1b_1} & t_{b_1b_2} \\ t_{b_2r_1} & t_{b_2r_2} & t_{b_2g_1} & t_{b_2g_2} & t_{b_2b_1} & t_{b_2b_2} \end{bmatrix} \simeq \begin{bmatrix} T_{r_1} & T_{r_2} & T_{g_1} & T_{g_2} & T_{b_1} & T_{b_2} \end{bmatrix}$$

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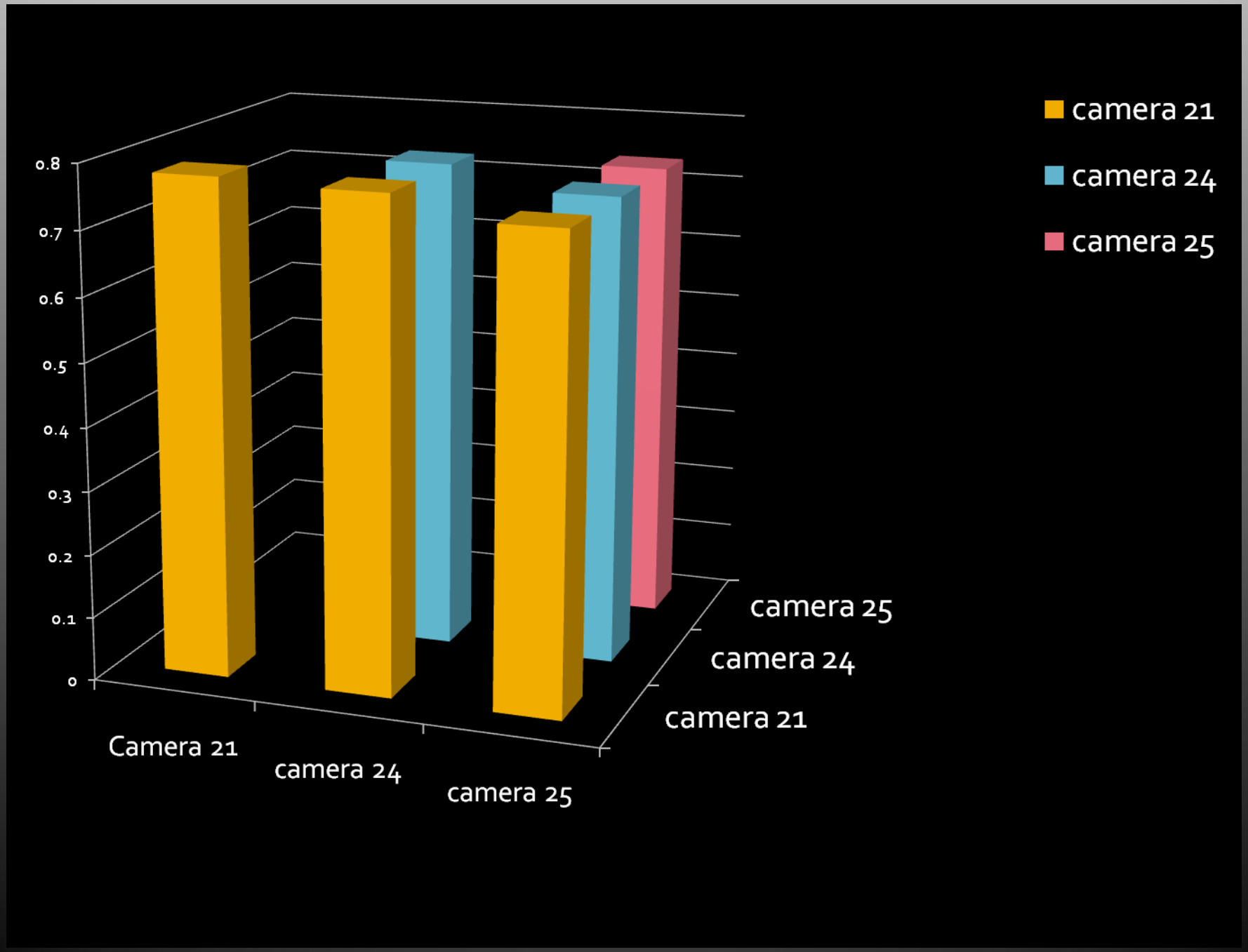
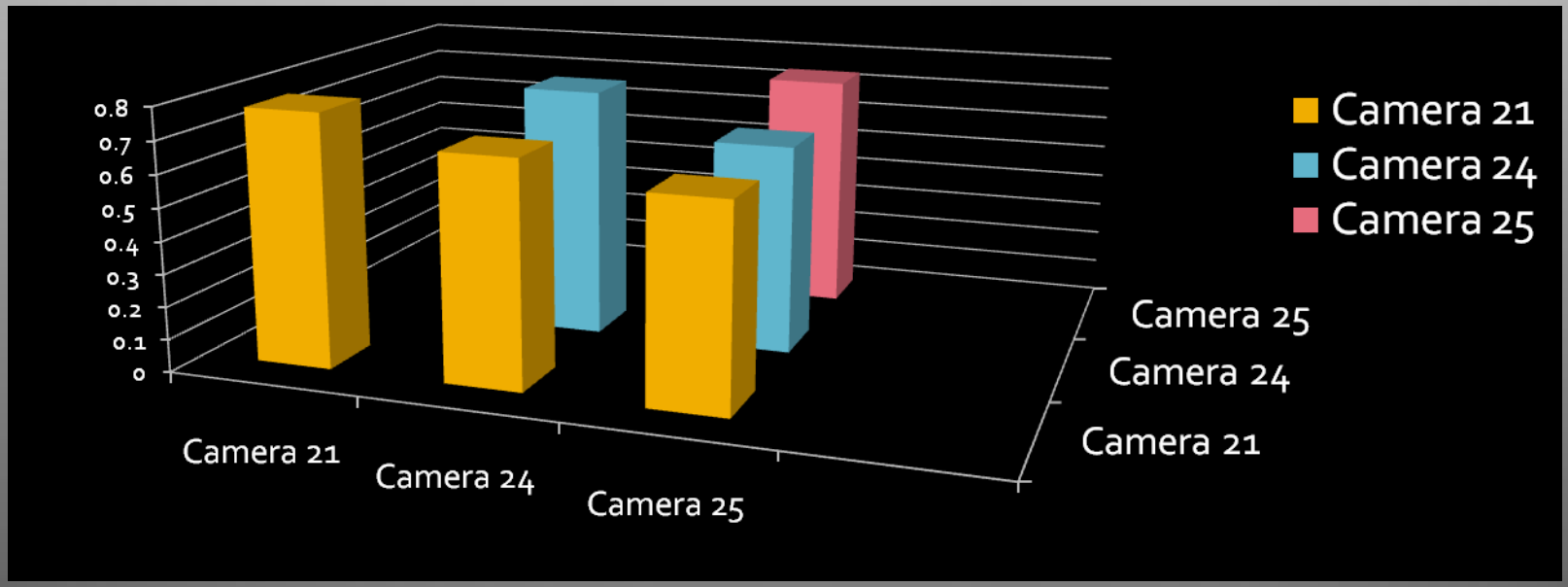
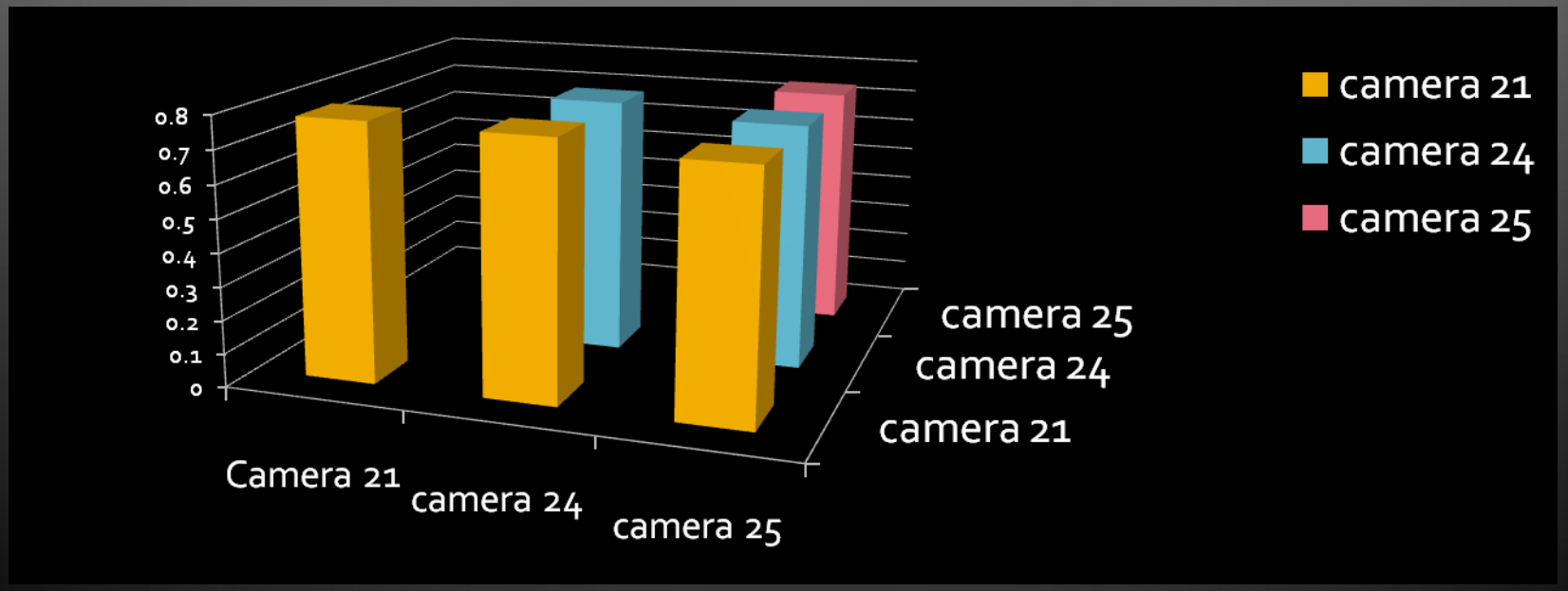
Color Transformation is a way to supplement for the changes between cameras due to lighting and settings.


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Camera 21
camera 24
camera 25
camera 25
camera 24
camera 21
camera 21
camera 24
camera 25

Before Calibration



After Calibration



Conclusion

- Because of lighting and camera settings, object tracking across cameras by color matching is difficult.
- Each camera views the same object differently.
- Calibration improves object recognition between cameras.

Acknowledgments

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Thank You.