Graph Modelling of 3D Geometric Information for Color Consistency of Multiview Images

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Objectives

- Input: Set of images of different appearance and unknown capture conditions.
- Color Synchronization across views using 3D information of the scene.
- No Reference Image.
- Possible application as a preprocessing step in 3D reconstruction pipeline.

Introduction

- Several Works on 3D reconstruction from image sets.
- For images with different tones, spatial blending cannot alleviate the problem of color inconsistency.

Literature

Tai *et al.* [1] EM for probabilistic segmentation. Reinhard Color transfer on Gaussian components.

Moulon *et al.* [2] Global color consistency. Finds common regions in images. Optimization framework to obtain gain and shift parameters (histogram) for each region for intensity transforms. Uses reference frame.

Volumetric Photo-consistency

- Φ defines cost of setting color label for $\mathbf{P}_i$ as l.
- $\mathbf{r}_i^s$ is the projection of $\mathbf{P}_i$ on frame s.
- V_{P_i} is a set of views in which $\mathbf{P}_i$ is visible.
- $c : \mathbb{R}^2 \mapsto \mathbb{R}^3$ is color lookup at image point.
- Ψ is the smoothness penalty. Solver [3].

$$\Phi(P_i, l_i) = \sum_{s \in V_{P_i}} \left| c(r_i^s) - l_i \right| \quad (1)$$

$$\Psi(l_i, l_j) = \begin{cases} \lambda_{i,j} & l_i = l_j \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

Sample Data

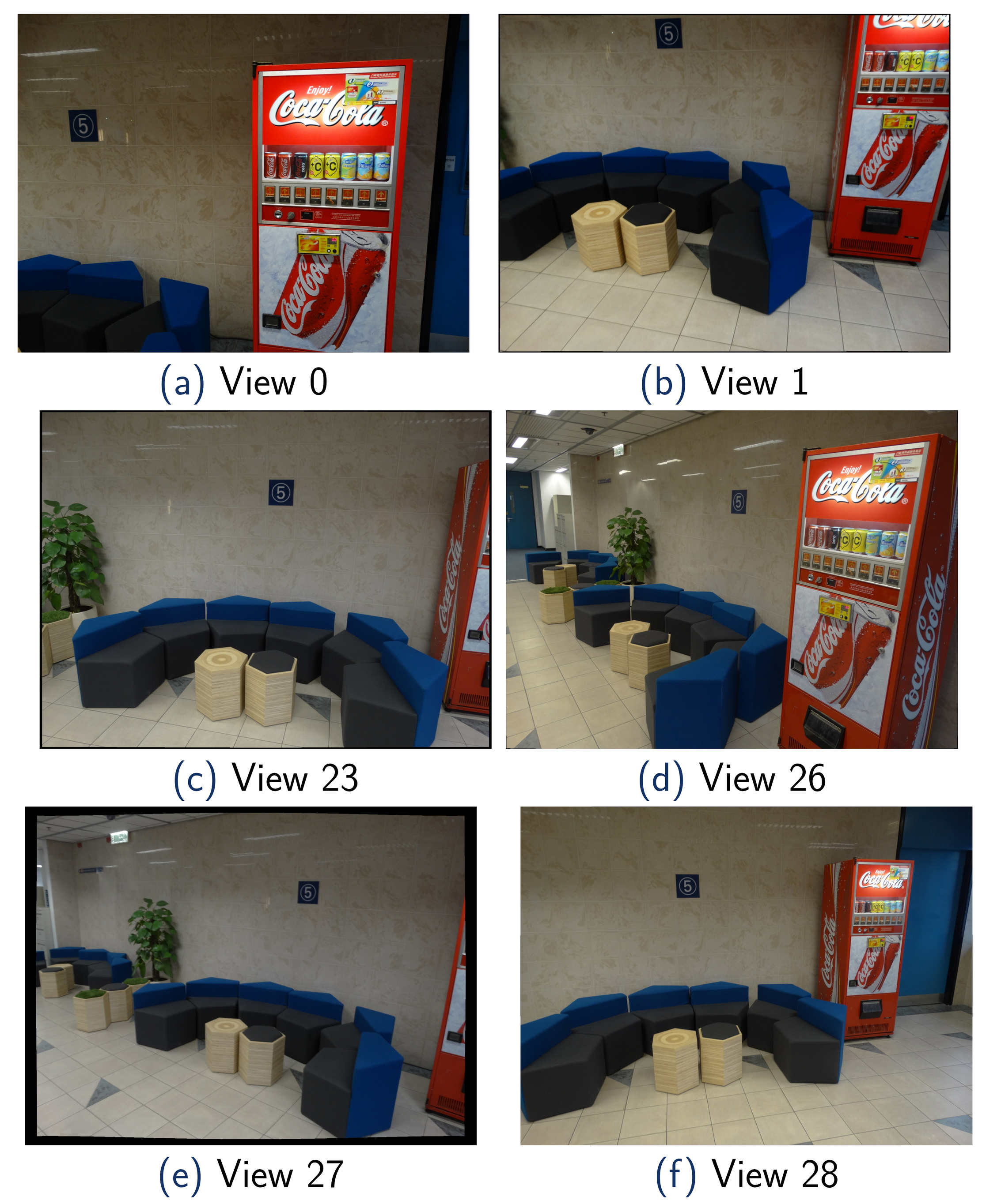

Figure: Showing selected views of the dataset. Inconsistency in color. For example, shades of blue of the chairs, shade of back wall are different across views.

Results

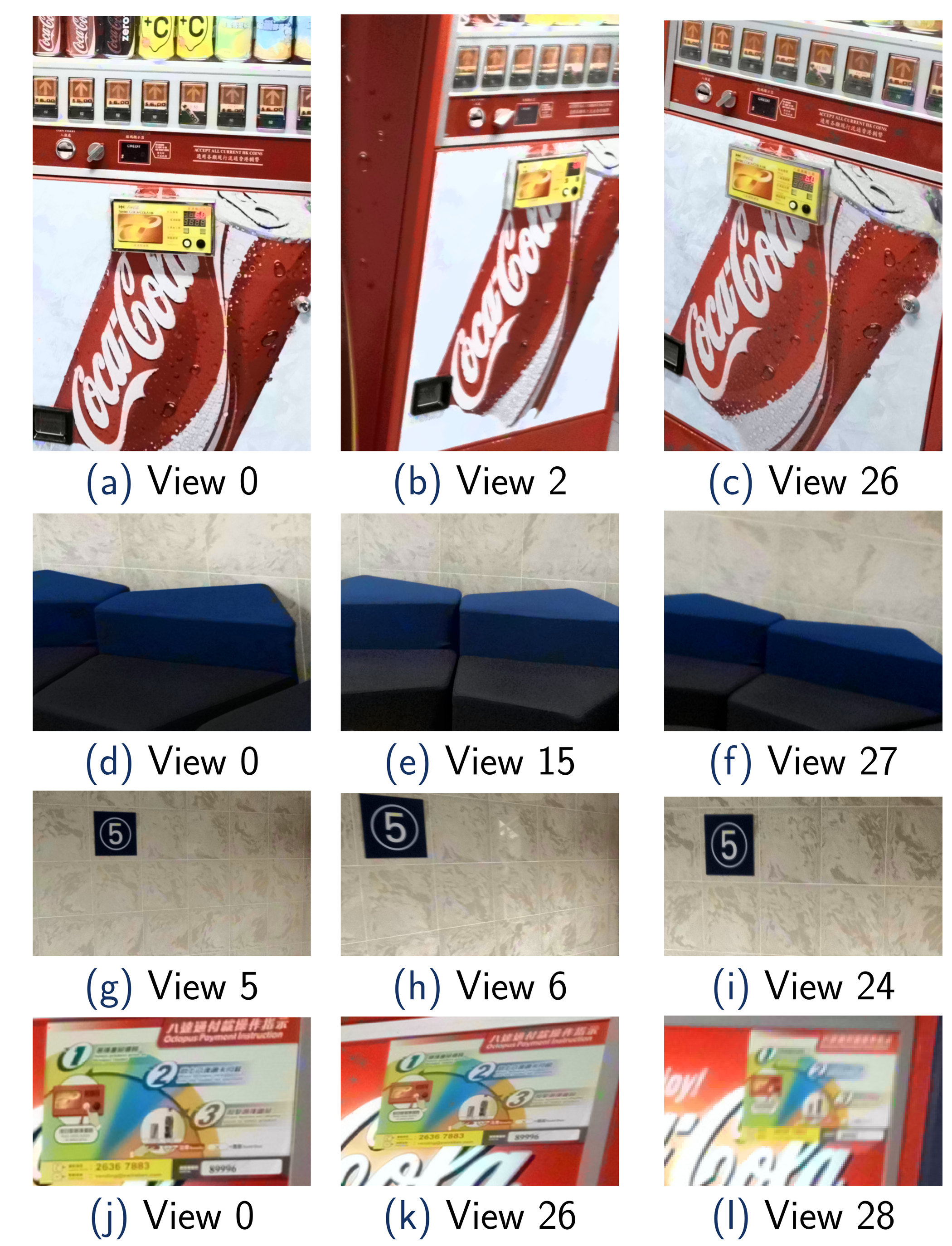

Figure: Re-colorization Results

Re-colorization

- Cost function inspired from Levin *et al.* [4].
- They suggested to use Graph-Cuts solver.
- We analyzed KKT conditions to reduce the solver to system of Sparse Linear Equation.

$$\begin{aligned} \underset{U}{\text{minimize}} \; & U_s^T (D_s - W_s)\, U_s \\ \text{subject to } & U(c_{s,j}) = u_{s,j}, \; j = 1 \dots n_s \end{aligned} \quad (3)$$

$$\begin{bmatrix} A & 0 \\ B^T & A^T \end{bmatrix} \times \begin{bmatrix} U^* \\ \nu^* \end{bmatrix} = \begin{bmatrix} u \\ 0 \end{bmatrix} \quad (4)$$

System Overview

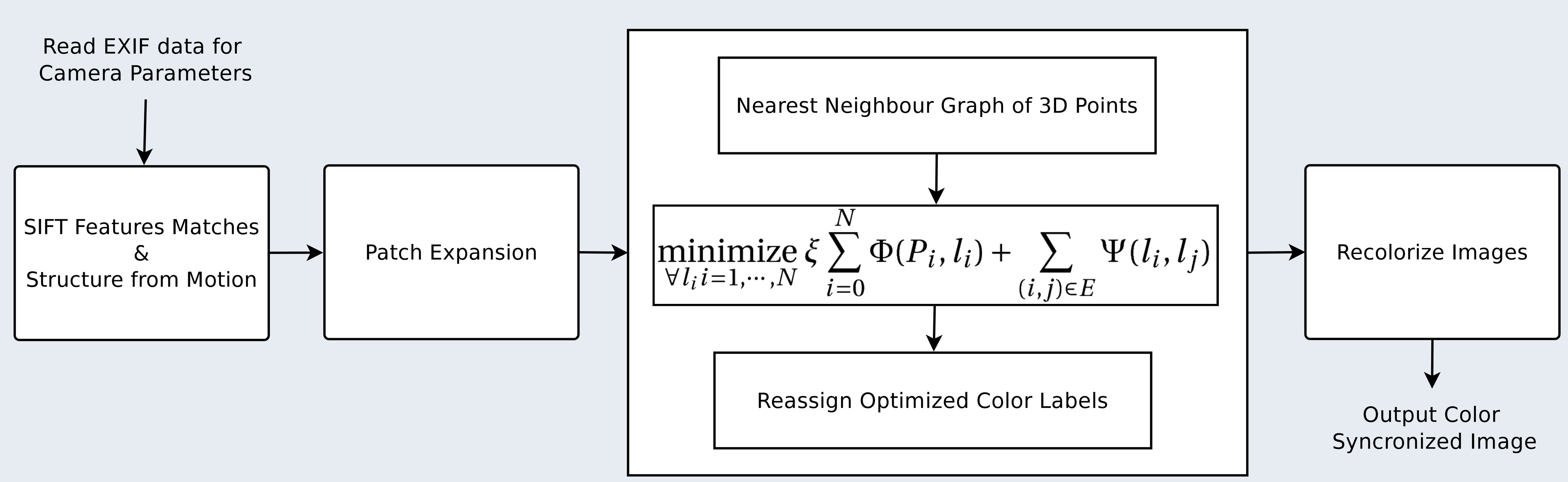

Figure: Figure caption

Key References

[1] Yu-Wing Tai, Jiaya Jia, and Chi-Keung Tang. Local Color Transfer via Probabilistic Segmentation by Expectation-Maximization. In *CVPR (1)*, pages 747–754. IEEE Computer Society, 2005.

[2] Pierre Moulon, Bruno Duisit, Pascal Monasse, et al. Global Multiple-View Color Consistency. In *Proceedings of Conference on Visual Media Production*, 2013.

[3] Igor Gridchyn and Vladimir Kolmogorov. Potts model, parametric maxflow and k-submodular functions. In *Computer Vision (ICCV), 2013 IEEE International Conference on*, pages 2320–2327. IEEE, 2013.

[4] Anat Levin, Dani Lischinski, and Yair Weiss. Colorization using optimization. *ACM Trans. Graph.*, 23(3):689–694, 2004.

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