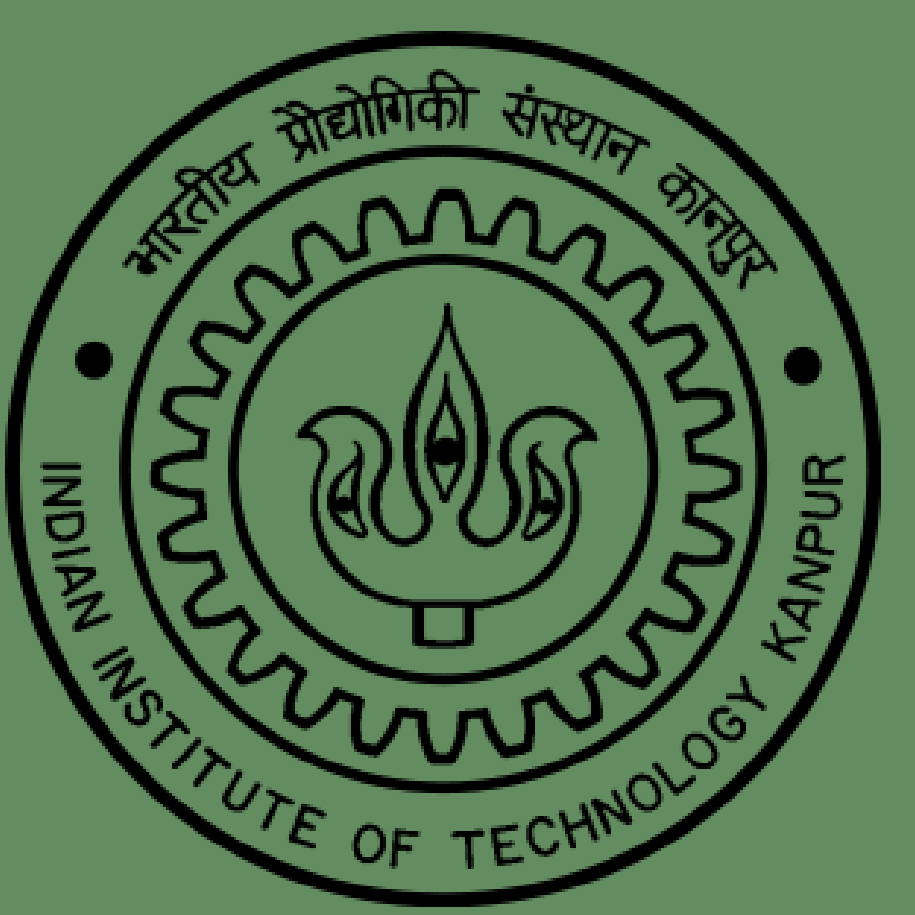# AUTOMATIC COLORIZATION OF GRAY SCALE IMAGES

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Introduction

In this project we have tried to colorize a gray scale image without much of a user intervention. This is a challenging problem because we have to create 3 dimensional information from 1 dimension for each pixel in the image. Thus the process cannot be fully automatic. We need to have some information based on content of the image.

Colorization methods are useful in coloring old cinemas and photographs, IR camera images, Astronomical photographs, Electron microscopic images, X –ray images and so on.

Works and Approaches

- For video coloring, people used to manually color entire frame for few shots of the videos and motion tracking and optical flow methods were used to colorize rest of the frames of video.

- There are generally two types of colorization methods followed in the community.
- One that is most popular requires a similar image to be provided by user, then various color transfer methods are applied based on some learned features of reference image.
- Other method people build a database of image and use image matching techniques to find the best match for the target image. Then some color transfer algorithm is applied.

Problems with these approaches

- Ultimately everything boils down to how effectively we can recognize patterns and objects in target image. Since these algorithms are fully accurate, thus it often happens that some region of image gets completely random colors, many times color leaks to other regions.

- Colorization mood entirely depends on mood of reference image. Ex: color of leaves of tree will be determined by whether reference image is of autumn or spring season.

Our Method

The approach we follow is based on *Colorization by example by R. Irony*. It is a semi-supervised method. Process is mainly classified in four major sections:

- **Segmentation of Reference image**

  The algorithm requires at least 2 to 3 segments.
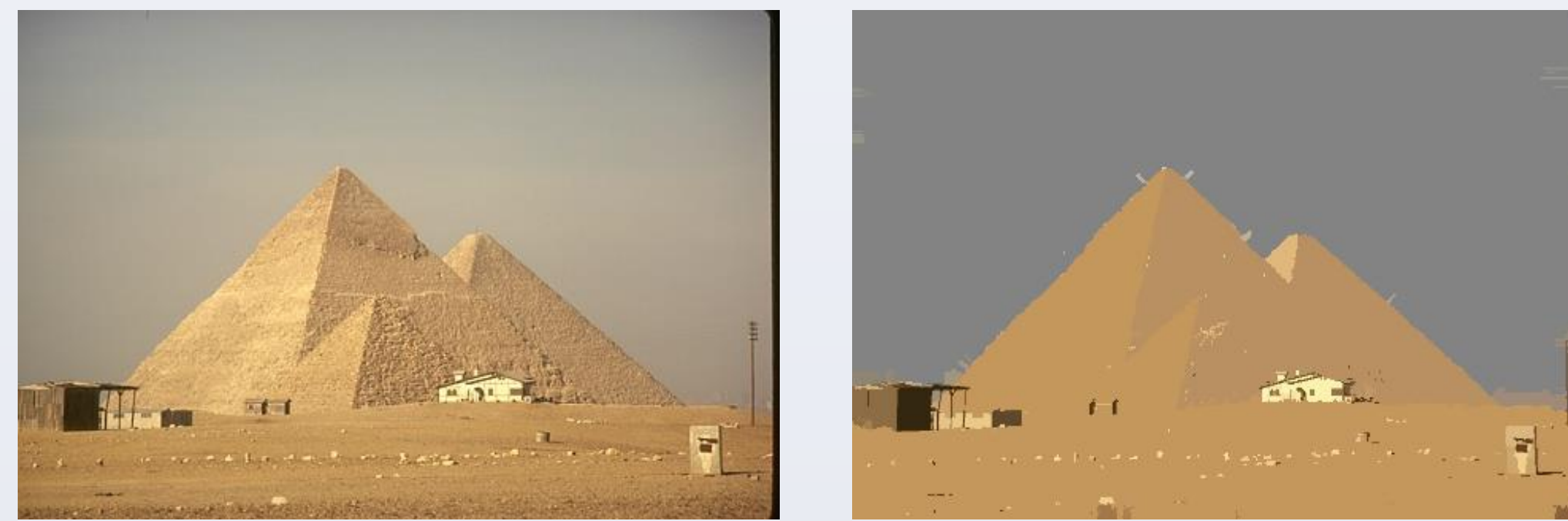
Reference: Taken from BSD300   Segmentation using [3]

- **Training and Classification**

  Corner point feature descriptors are **not** useful when we have determine which part of image should get what color. **Texture information** of the images are more accurate when we have to match **regions** of the images.

In our method we have used DCT coefficients as texture descriptors as they are known to be invariant to translation and rotation.

We can apply Knn classification at this position, but working in higher dimensions leads to many miss-classifications.
Now one can just apply PCA and get top n Eigen-vectors to get n dimensional sub-space.
But we can do better than this –
1) Keep low value Eigen-vectors
   of intra class differences.
2) Keep high value Eigen- vectors
   of inter class differences.
3) Apply Knn in above sub-space.
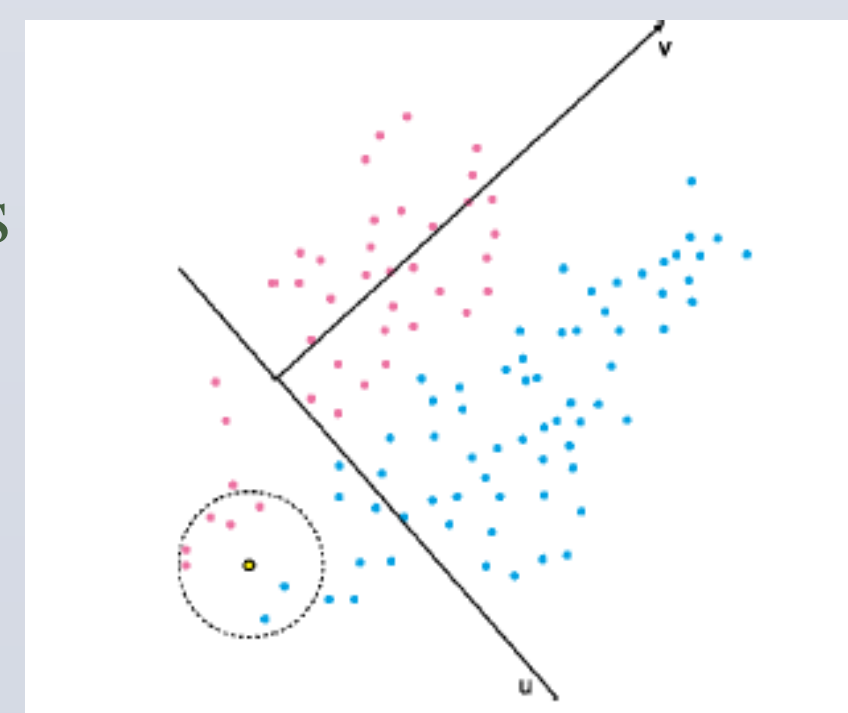
- **Colorization**

  Minimizing miss classifications –

  We replace the labels of each pixels with dominant label in its neighbourhood.

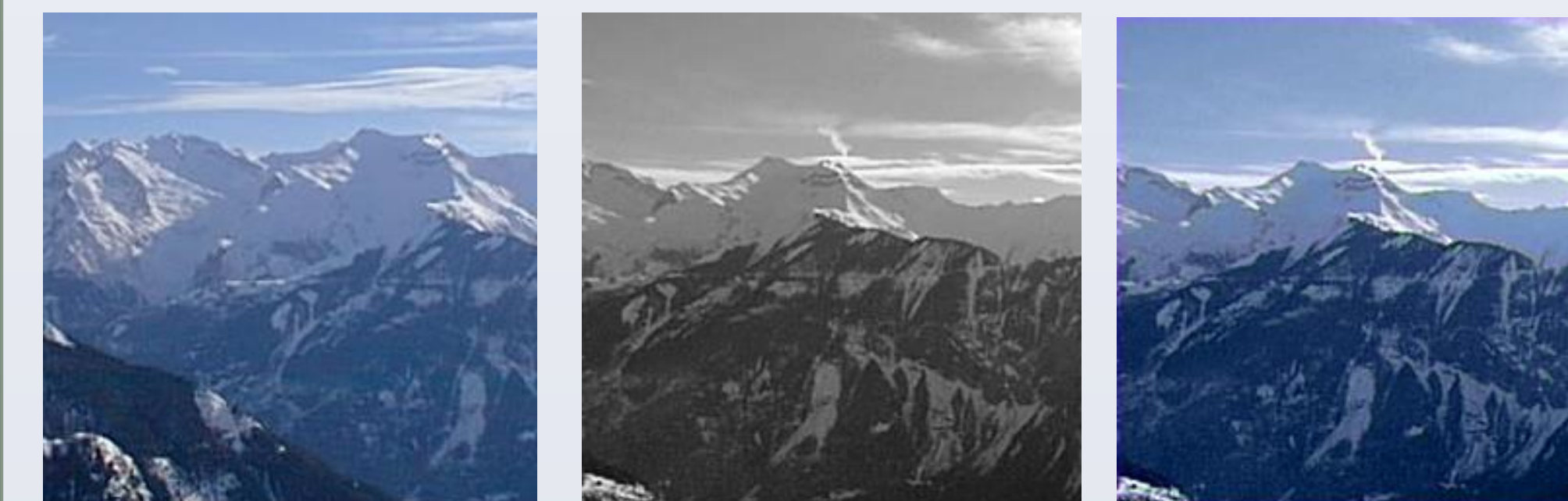 Color of a pixel p is given by :

$$C(p) = \sum_{q \in N(p,\ell)} W_q C(M_q(p)).$$

RESULTS

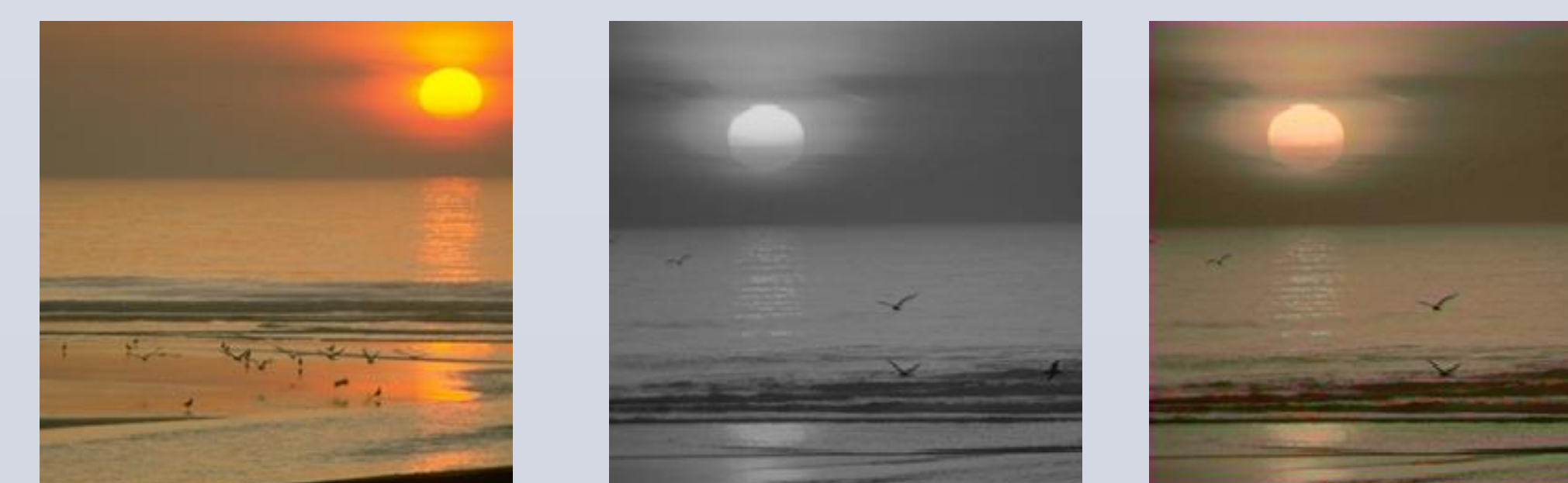Reference   +   Target   =   Colored

Reference   +   Target   =   Colored

Reference   +   Target   =   Colored

Reference   +   Target   =   Colored

Conclusions

- Process is highly dependent on correct segmentation of reference image.

- Texture and object contents of reference and target image must be same for precise coloring.

- The performance of the algorithm decreases for occlusive images.

Future Work

- In order to achieve fully automatic approach for one categories of images (say natural images) we can build a collection of object sensing filters which can be used to detect object usually found in our chosen category (ex: sky, coasts, sun, trees, mountains etc. in our case).

- Then we can use these detectors to classify different parts in our target image and transfer color with the best match from a dataset of images.

- This approach can also be easily extended to automatic colorization of videos.

References

1. Colorization by Example,R.Irony, D.CohenOr, and D. Lischinski,
   Eurographics symposium on Rendering (2005)

2. Colorization using Optimization, -
   Anat Levin, D.Lischinski, Yair Weiss,SIGGRA(2004)

3. RIUL: Edison. RIUL, Center for Advanced Information Processing, Rutgers University, (2009) http://coewww.rutgers.edu/riul/research/code/EDISON/

4. Dataset used (all result Images) : LabelMe , Computational Vision Cognition Laboratory (MIT)