User Guided Image Abstraction for Vectorization

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1. Introduction

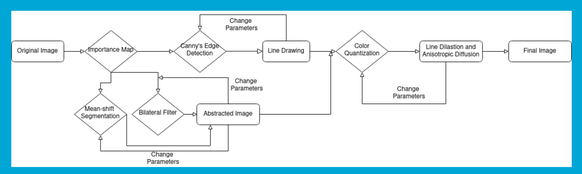
- Pixelated images do not scale well
- Low-resolution images → easily scaling vector images
- Essential step: Image Abstraction
- Reducing the complexity of an image while keeping the important information intact
- Important information:
  - Saliency, foreground & background, colors, light, edges, depth

The Goal of the Framework

2. Research Question

How can a photograph be abstracted to simplify its components with the goal of producing suitable content for vectorization with user interaction?

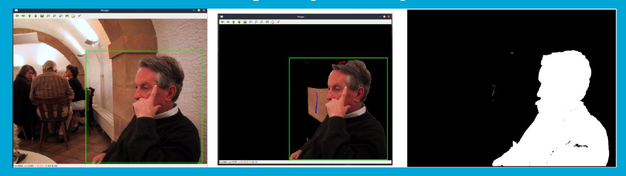
Framework Overview



3. Method

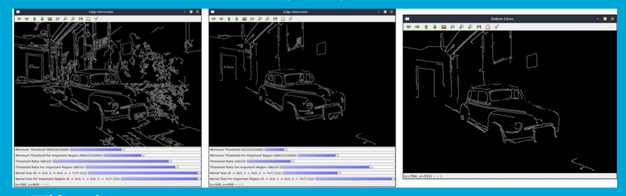
1. Importance map creation using GrabCut
   - Guided by user annotations
   - Later stages: important components are abstracted differently/less

Building the Importance Map



2. Line drawing using Canny's edge detection
   - Various parameters, delete incorrect edges, independent control over important region

Line Drawing by Edge Detection

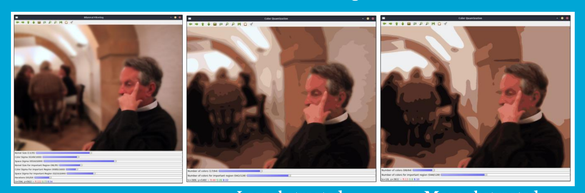


Without importance map | With importance map | Incorrect edges deleted

3. Abstraction with independent control over important region
   - Mean shift segmentation
     - Hill-climb clustering
   - Bilateral filtering
     - Smoothing, edge preserving

4. Color quantization
   - K-means clustering to reduce color palette, important region and background altered independently

Different Bilateral Filtering Results



Only bilateral filter | Less abstracted bilateral filter & less color quantized | More abstracted bilateral filter & more color quantized

5. Line thickness and anisotropic diffusion

4. Results and Conclusions

- Images are abstracted
  - Reduced color space,
  - Clear boundaries and edges
  - Regions with same color
  - Important information retained
- Both methods work well with automatic vectorization software (AutoTrace)
- Provide user input at every stage → user stays in the loop
  - Results depend on the user's choices and needs
- Abstraction while retaining important features
  - Without the need of special hardware like eye-trackers
  - Bilateral filtering and mean-shift work well in different types of images
  - Color quantization adds flexibility
- Bilateral filtering with quantization:
  - Color space reduced less, smaller uniform-colored regions
  - Better for landscape photos → complicated vectorization that requires more detail
- Mean-shift with quantization:
  - Larger regions with uniform color
  - Abstracted more→ less detail, suits the need for simpler vectorization

Portrait Photograph Vectorized
(White lines symbolize vectors)

Original | Bilateral & Color Quantization | Mean-shift & Color Quantization

Portrait Photograph

Original | Bilateral & Color Quantization | Mean-shift & Color Quantization

Landscape Photograph

Original | Bilateral & Color Quantization | Mean-shift & Color Quantization

Complex Photograph

Original | Bilateral & Color Quantization | Mean-shift & Color Quantization

5. Limitations and Future Work

- Bilateral: false edges or loose edges
- Mean-shift: number of clusters, high-dimensionality causes artifacts, textures are lost
- Canny: disconnected lines → Add scale space theory
- Importance map: one level of importance → Add many levels
- Quantization: sensitive to outliers, different clusters and compactness each time → Explore different clustering algorithms

6. References

- D. Decarlo and A. Santella, "Stylization and abstraction of photographs," Proceedings of the 29th annual conference on Computer graphics and interactive techniques - SIGGRAPH 02, 2002.
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