K-means Image Segmentation Application

User Manual

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1. Introduction

The K-means Image Segmentation Application is a powerful tool that allows users to segment images into distinct regions based on color similarity using the K-means clustering algorithm. This application is useful for image analysis, object detection, and creating color-based masks of images.

2. Getting Started

To start using the application:

1. Launch the application
2. The main window will appear with an empty image area and control buttons
3. Begin by loading an image using the "Load Image" button

3. Main Interface

The application interface consists of:

- A large central image display area
- Control buttons at the bottom
- Clustering settings panel

- Image preview area

4. Features

Loading Images

1. Click the "Load Image" button
2. Select an image file (supported formats: PNG, JPG, JPEG, BMP, TIFF)
3. The image will be displayed in the main window

- Note: Large images will be automatically resized to maintain performance while preserving quality

Applying Filters

1. Click the "Apply Filters" button to open the filter dialog
2. Available filters:
    - No Filter
    - Gaussian Blur
    - Median Blur
    - Bilateral Filter
    - Sharpen

Each filter has adjustable parameters:

- Gaussian Blur: Kernel Size and Sigma
- Median Blur: Kernel Size
- Bilateral Filter: Diameter, Sigma Color, and Sigma Space
- Sharpen: Amount

The filter dialog provides:

- Real-time preview
- Side-by-side comparison with original
- Reset option to revert changes
- Apply button to confirm changes

Image Segmentation

1. Set the number of clusters (2-10) using either:
    - The slider

- Direct numerical input

2. Click "Segment Image" to process
3. The segmented image will appear in the main display

Managing Cluster Masks

1. After segmentation, click "Show Cluster Masks" to open the mask dialog
2. The dialog shows:
   - Individual cluster masks
   - Color information for each cluster
   - Visibility toggles for each cluster
3. Features:
   - Toggle visibility of individual clusters
   - Preview combined result
   - Reset all clusters to visible
   - Apply changes to main view

Saving Results

1. Click "Save Segments" to save the segmented image
2. Choose save location and format
3. Option to save individual cluster masks:
   - Creates a separate directory for masks
   - Each visible cluster saved as individual file
   - Maintains color information

4. Features & Controls

Button Controls

1. **Load Image Button**
   - Opens a file dialog window
   - Supports formats: PNG, JPG, JPEG, BMP, TIFF
   - Maximum recommended image size: 4000 x 3000 pixels
   - Larger images will be automatically resized
2. **Apply Filters Button**
   - Opens the Filter Window
   - Enabled only after an image is loaded
   - Changes are previewed in real-time

- All changes can be reset or cancelled

3. **Segment Image Button**
   - Begins the segmentation process
   - Enabled only after an image is loaded
   - Uses the number of clusters specified in the settings
   - Shows processing status during segmentation
4. **Save Segments Button**
   - Opens the Save Dialog
   - Enabled only after segmentation is complete
   - Allows saving both the segmented image and individual masks
   - Default format is PNG
5. **Show Cluster Masks Button**
   - Opens the Cluster Masks Window
   - Enabled only after segmentation is complete
   - Shows all cluster masks with visibility controls
6. **Open Help PDF Button**
   - Opens system file dialog to select and view help documentation
   - Supports PDF format only

Filter Window Controls

1. **Filter Type Dropdown**
   - Options:
     - No Filter
     - Gaussian Blur
     - Median Blur
     - Bilateral Filter
     - Sharpen
2. **Gaussian Blur Parameters**
   - Kernel Size:
     - Minimum: 1
     - Maximum: 31
     - Must be odd number (automatically adjusted)
     - Default: 5
   - Sigma:
     - Minimum: 0.1
     - Maximum: 5.0

- Default: 1.0
- Step size: 0.1

3. **Median Blur Parameters**
   - Kernel Size:
     - Minimum: 1
     - Maximum: 31
     - Must be odd number (automatically adjusted)
     - Default: 5
4. **Bilateral Filter Parameters**
   - Diameter:
     - Minimum: 1
     - Maximum: 31
     - Default: 9
   - Sigma Color:
     - Minimum: 1
     - Maximum: 150
     - Default: 75
   - Sigma Space:
     - Minimum: 1
     - Maximum: 150
     - Default: 75
5. **Sharpen Parameters**
   - Amount:
     - Minimum: 0.1
     - Maximum: 5.0
     - Default: 1.5
     - Step size: 0.1

Clustering Settings Controls

1. **Number of Clusters Input**
   - Direct numerical input field:
     - Minimum: 2
     - Maximum: 10
     - Must be whole numbers
     - Default: 3
2. **Clusters Slider**

- Horizontal slider control:
  - Minimum: 2
  - Maximum: 10
  - Step size: 1
  - Default: 3
- Synchronized with numerical input

Cluster Masks Window Controls

1. **Cluster Visibility Checkboxes**
   - One per cluster
   - Can be toggled individually
   - All checked by default
2. **Preview Section**
   - Shows real-time preview of visible clusters
   - Updates automatically when toggles change
3. **Control Buttons**
   - Reset All: Returns all clusters to visible state
   - Apply Changes: Applies current visibility settings
   - Close: Exits without applying changes

Save Dialog Options

1. **File Format Selection**
   - PNG (*.png) - Default
   - JPEG (*.jpg,* .jpeg)
   - All Files (.)
2. **Mask Saving Options**
   - Option to save individual cluster masks
   - Creates separate directory named "{original_filename}_masks"
   - Each mask saved as "cluster_{number}.png"

Usage Tips for Controls

1. **Filter Window**
   - Preview updates in real-time
   - Use Reset button to revert all changes
   - Apply preserves changes, Cancel reverts them
   - Original and filtered views shown side by side

2. **Cluster Controls**
    - Slider and input field are synchronized
    - Changes take effect when segmentation is run
    - Higher numbers create more detailed segmentation
    - Lower numbers create broader segments
3. **Mask Window**
    - Use checkboxes to hide unwanted segments
    - Preview shows combined result
    - Changes don't affect original until applied
    - Reset All quickly restores all clusters

5. Technical Notes

- Supported image formats: PNG, JPG, JPEG, BMP, TIFF
- Maximum recommended image size: 4000 x 3000 pixels
- Larger images will be automatically resized
- K-means clustering parameters:
    - Minimum clusters: 2
    - Maximum clusters: 10
    - Maximum iterations: 100
    - Convergence criteria: 0.2

6. Troubleshooting

Common issues and solutions:

Image Won't Load

- Verify file format is supported
- Check file isn't corrupted
- Ensure sufficient system memory

Segmentation Is Slow

- Reduce image size
- Decrease number of clusters
- Apply smoothing filter first

Poor Segmentation Results

- Try different numbers of clusters

- Apply appropriate filters first
- Ensure image has good contrast
- Consider pre-processing with filters

Application Not Responding

- Wait for current operation to complete
- Close and restart application
- Check system resources
- Reduce image size if necessary