Manga Colorization

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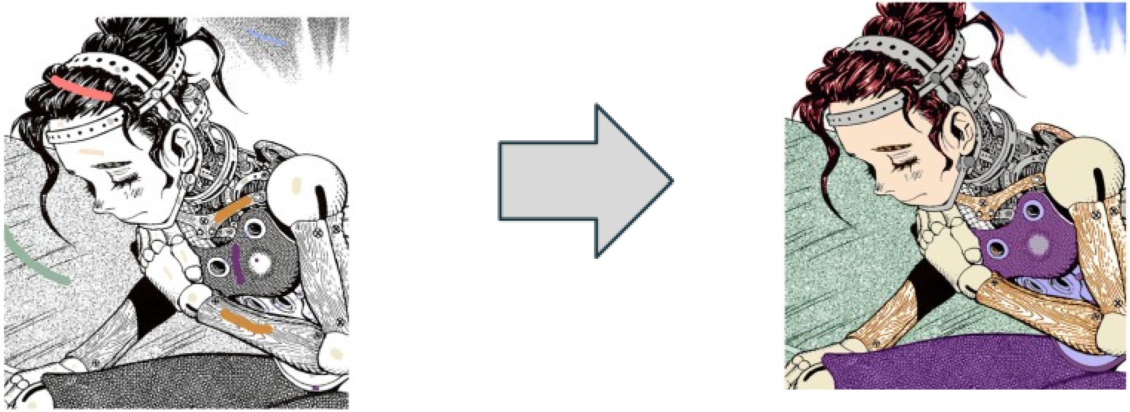
Manga Colorization

- Manga (Japanese comic book) is mostly available in black and white images. Coloring these images is referred to as ‘Manga Colorization’.



Basic Steps

- The whole process begins with taking input from user (scribble) on the region of interest.
- Region marked by the user is then segmented from the rest of the image.
- The segmented region is then colored using one of the various methods provided in the given paper (color replacement, stroke preserving, pattern to shading)

Step 1: Taking Input

Our application provides user with color choices and image to scribble on the region of interest.

Step 2: Segmentation

In manga comic there can be two types of regions -

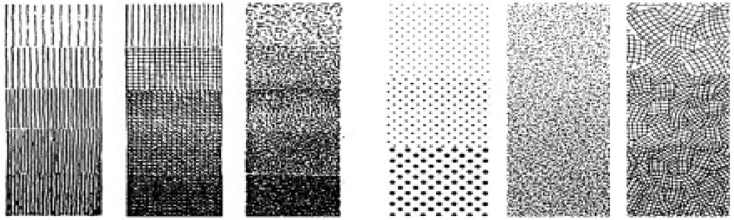
- Intensity continuos and
- Pattern continuos

Segmentation of these regions are independent of each other and uses region specific properties.

Manga properties

Most manga artists uses two types of patterns to express through the images -

- Hatching and
- Screening



(a) Hatching (b) Screening

These regions have pattern continuity which we have exploited in order to segment these regions.

Segmentation requirements

For segmenting regions Level set method was suggested in the given paper. But, due to the disadvantages of the traditional method we used Distance Regularized Level Set Method (DRLSE).

The DRLSE method avoids the dificulties of level set method by introducing a regularization term.

DRLSE for Image Segmentation

1. Let I be an image on a domain Ω, we define an edge indicator function g by

$$g = \frac{1}{1+|\nabla G_\sigma * I|^2}$$

2. For an LSF $\phi : \Omega \rightarrow \mathrm{R}$, we define an energy functional $\mathrm{E}(\phi)$ by

$$\mathcal{E}(\phi) = \mu \mathcal{R}_p(\phi) + \lambda \mathcal{L}_g(\phi) + \alpha \mathcal{A}_g(\phi)$$

Pattern Continuos Regions

For segmenting pattern continuos regions we needed to measure change in the pattern of pixel at boundary than pixels at scribble region (provided by user).

To calculate change in the pattern features are calculated of the pattern at the scribbled as well as boundary pixels.

‘Gabor Wavelet Transform’ is used to obtain these features.

Pattern Continuos Regions

Mathematics behind it,

$$W_{m,n}(u,v) = \int_{\Omega} I(x,y) g^*_{m,n}(u-x, v-y) dxdy,$$

$$\mu_{m,n} = \int\int |W_{m,n}(x,y)| dxdy,$$

$$\sigma_{m,n} = \sqrt{\int\int (|W_{m,n}(x,y)| - \mu_{m,n})^2 dxdy}.$$

Pattern Continuos Regions

When to stop the evolution curve is decided by a coefficient which reduces as we go towards boundary of the region. This coeeficient is called ‘Halting’ coefficient.

Halting term defined for such region,

$$h_P(x,y) = \frac{1}{1 + |D(T_{\text{user}}, T_{\text{front}}(x,y))|}.$$

Intensity Continuos Regions

Segmenting such regions is fairly easy as compared to pattern continuos regions. Halting coefficient defined for such regions depend on the convolution of image with gaussian filter.

$$h_I(x,y) = \frac{1}{1 + |\nabla(G_\sigma \otimes I(x,y))|}$$

Step 3: Colorization

We have implemented following three methods of colorization after the region is segmented,

- Color replacement,
- Stroke preserving and
- Pattern to shading

Color replacement

This method is for intensity continuos regions. For such region, filling color can be trivially done by replacing the black or white color by the user color on the scribble.

Stroke preserving

Pattern continuos regions are colorized by bleeding colors out of the strokes/patterns. Mathematics behind it,

$$Y_{\text{new}}(x,y) = Y_{\text{user}} \otimes |1 - h_I(x,y)|^2,$$

$$(U,V)_{\text{new}} = (U,V)_{\text{user}}$$

where Y,U and V are image channels in YUV space.

Pattern to Shading

This method allow us to fill color as if we are shading ,i.e, it fills color according to density of pattern in pattern continuos regions. Mathematics behind it,

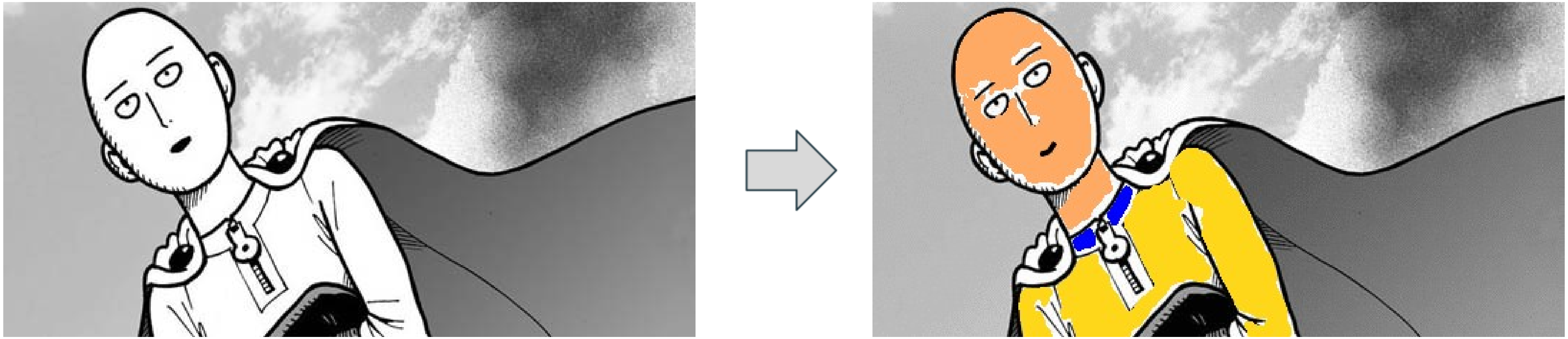
$$Y_{\text{new}} = sY_{\text{user}},$$

$$(U,V)_{\text{new}} = (U,V)_{\text{user}}$$

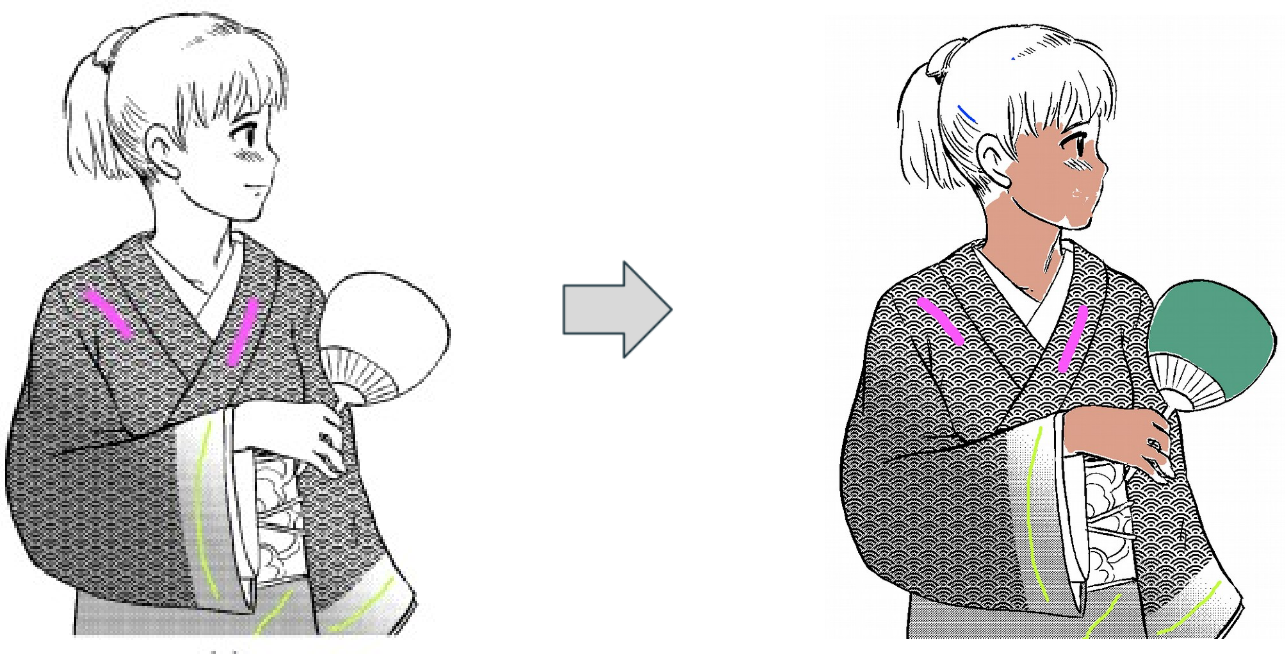
where,

$$s = f \otimes Y_{\text{image}}.$$

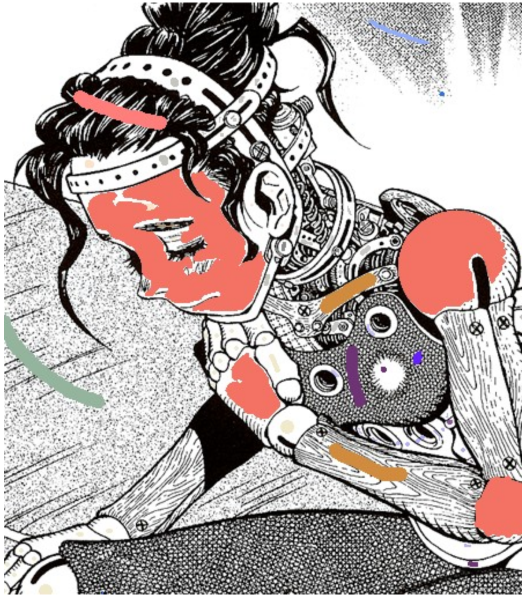
Results



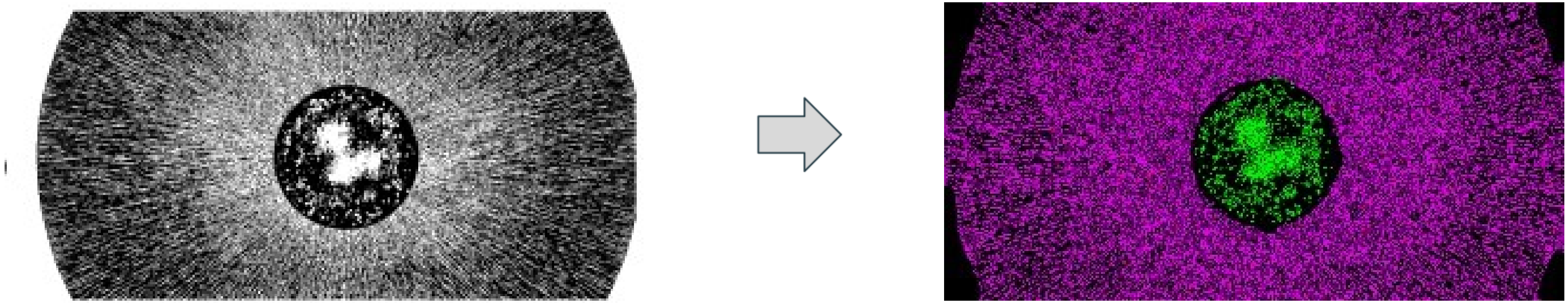
Results



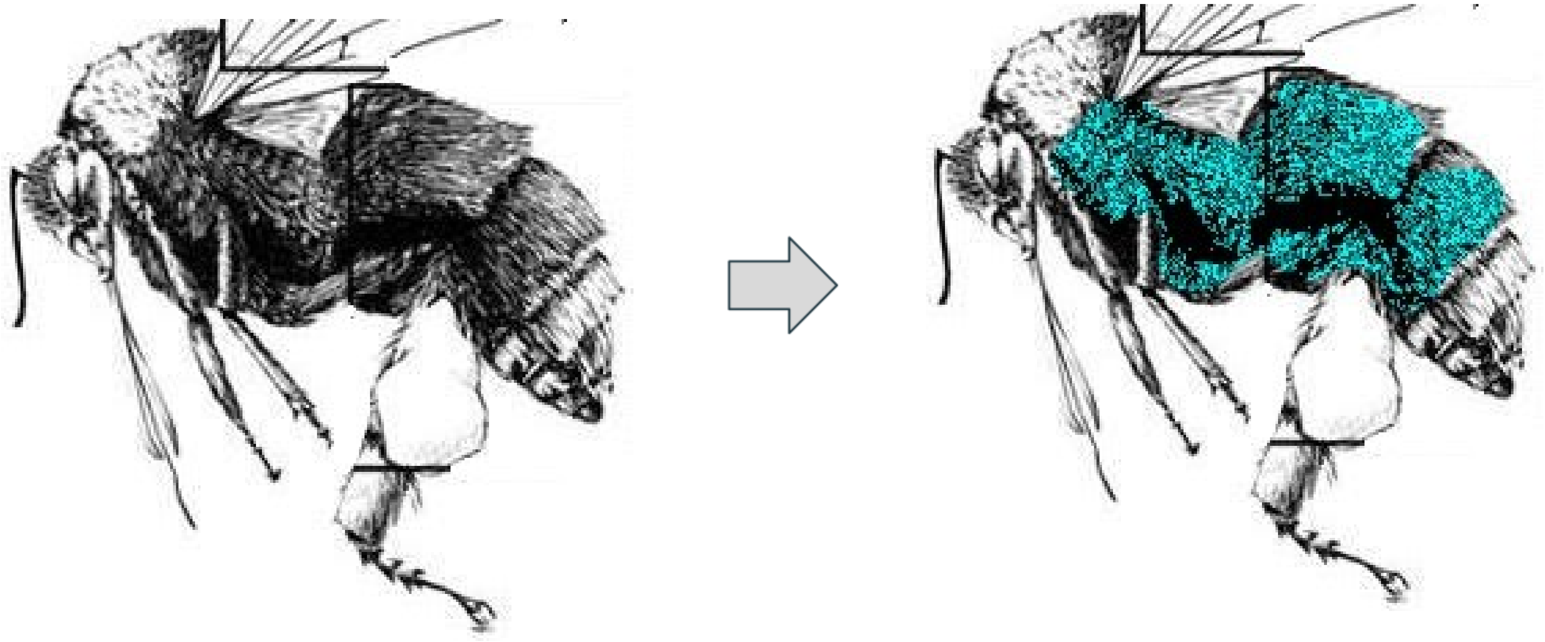
Results



Results



Results



Results