Accentuated pencil drawing with saliency map and LIC

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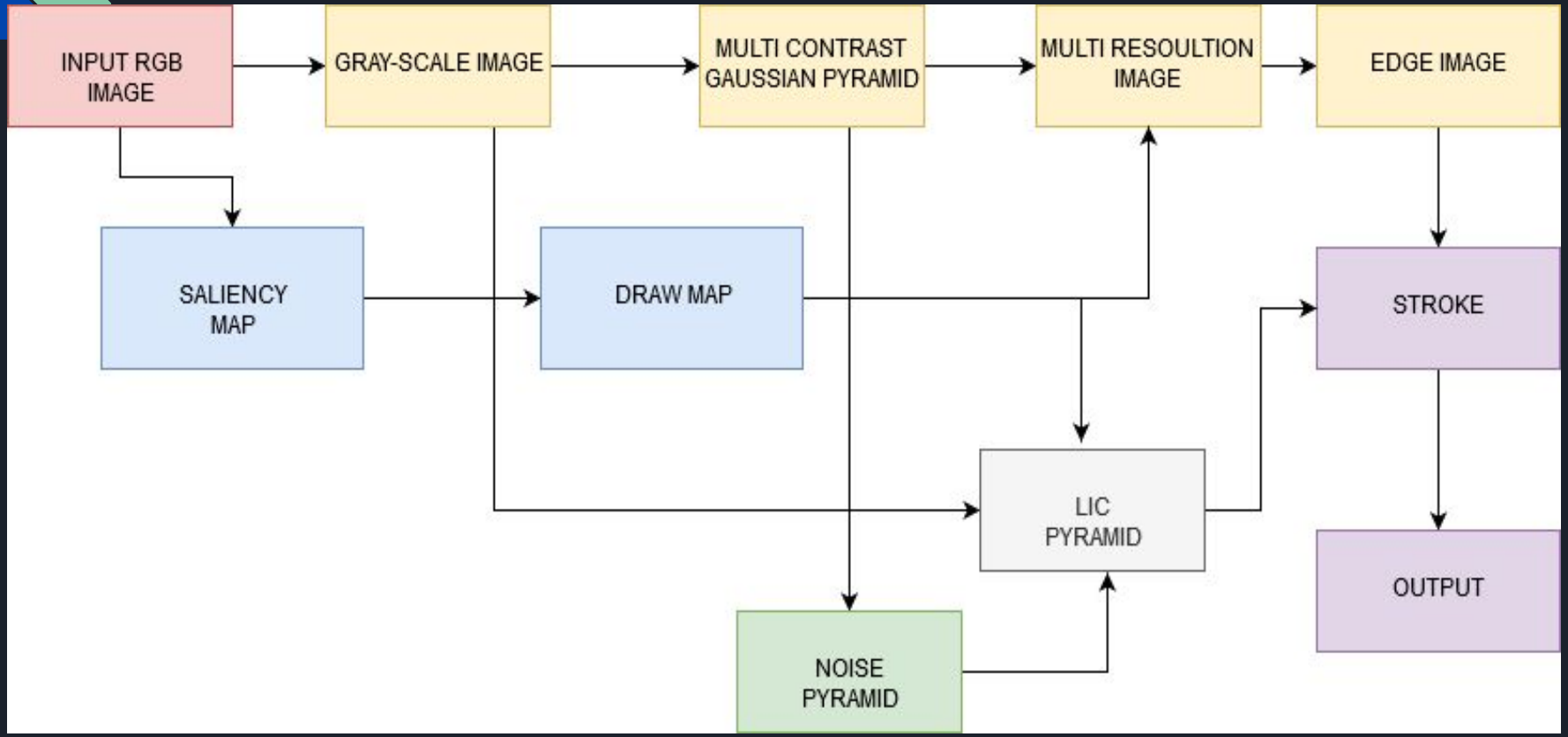
Idea of the project

To generate pencil drawing of the given image, with automatic accentuation effect using **saliency map** and **Line Integral Convolution**.

Eg:-

Pipeline of the algorithm



Multi- Contrast Gaussian pyramid

We create a gaussian pyramid of 4 levels.

- **level-0**: Contrast enhanced gray-scale image in original size
- **Level-1**: output from Gaussian blurring level-0 image and resizing to half of its size.
- **level-2**: output from Gaussian blurring level-0 image and resizing to half of its size.
- **level-3**: output from Gaussian blurring level-0 image and resizing to half of its size.

WHY THIS??

This Gaussian pyramid is useful to get the features at different resolutions (multi-scale image processing).

Noise Pyramid

Noise pyramid is way of

We generate a noise pyramid from the multi-contrast gaussian pyramid by using random dithering, so that low resolution layers have low density of black pixels.

$$NP(n,x,y) = \begin{cases} 0, & 1 + \frac{n}{N}(PI(n,x,y) - 1) < T \\ 1, & \text{otherwise} \end{cases}$$

where NP is the noise pyramid, PI is the Multi-contrast gaussian pyramid

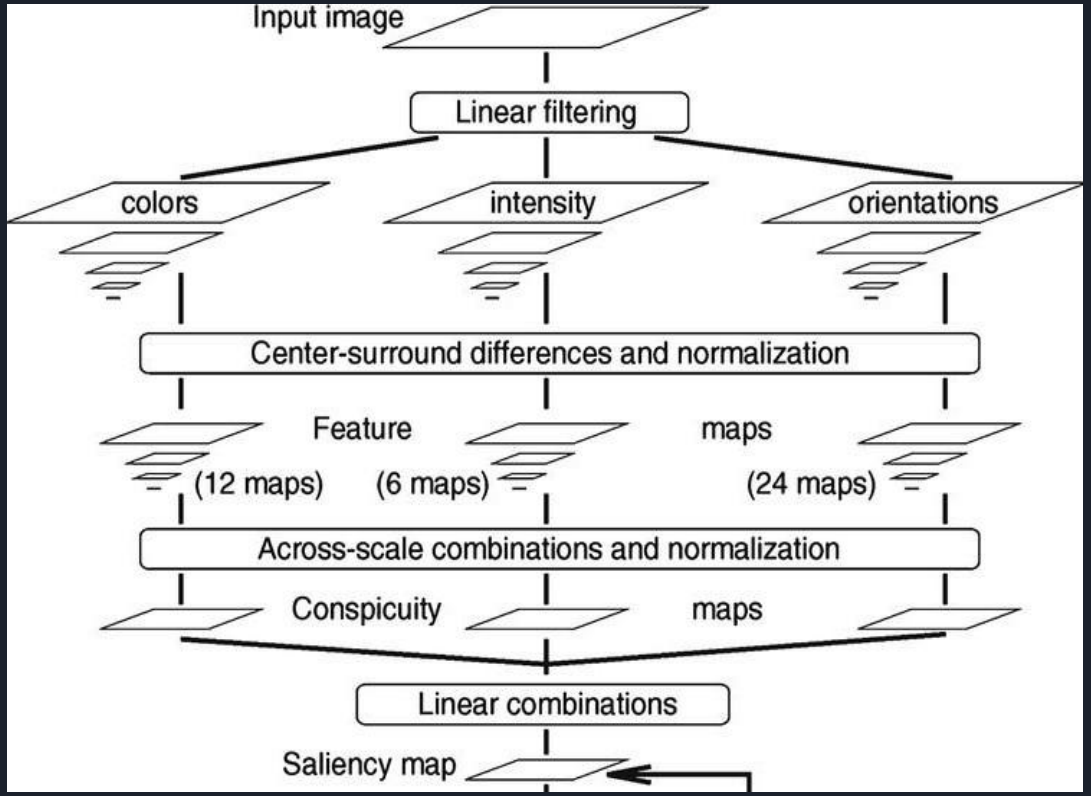
n,x,y is the coordinates of the pixel in the pyramids. N is the no of layers in the pyramid.

T is the threshold of random dithering.

saliency map

- ➔ Saliency map is a spatial map showing the strength (degree of saliency) of the visual attention.

Generating a saliency map



Draw Map

➔ In saliency map, the saliency value is nonlinearly emphasized or suppressed to simulate the lateral inhibition mechanism.

If we simply use the original saliency map for controlling the local rendering parameters, almost no strokes would be drawn for most areas of the image.

Solution:

Suppress the nonlinear effect of saliency map by taking a square root of the saliency value and then further smooth it with a Gaussian filter.


Input Image
Saliency Map
Draw Map

Multi Resolution image

Why this? - For keeping a smooth transition between the areas of different level of detail

Instead of computing edges from Multi-Contrast Gaussian Pyramid directly, we first generate a single Multi-Resolution Image by choosing pixels from the suitable layer of the pyramid according to the saliency value in the Draw Map.

r = DM(x,y).N

a = r - floor(r)

MI(x,y) = (1-a). PI(floor(r), x, y) + a. PI(floor(r), x, y)

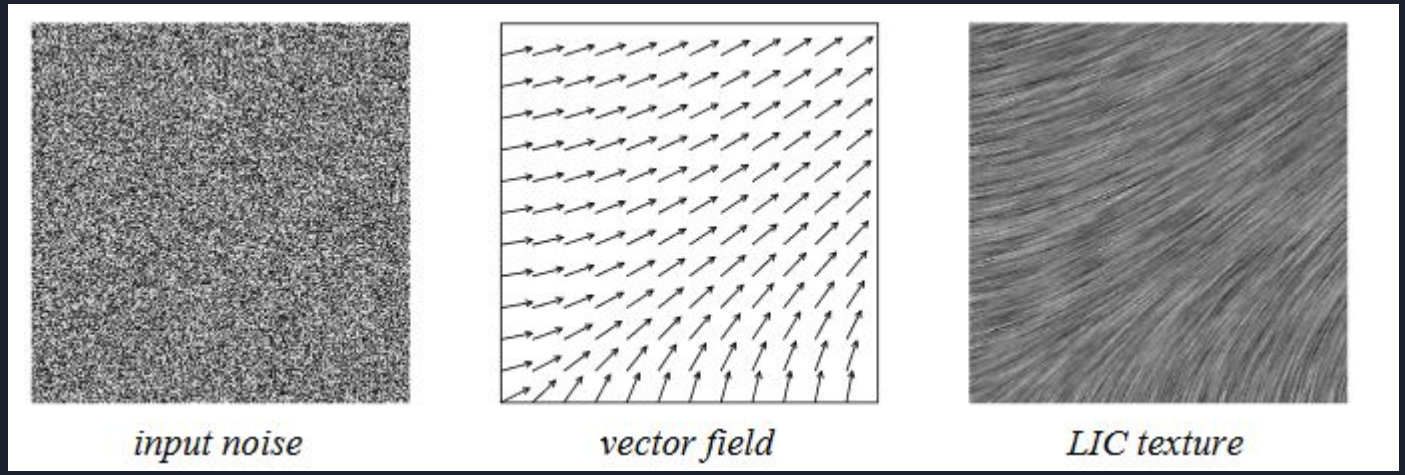
where $PI(n,x,y)$ is the value of the pixel (x,y) at the nth $\in[0,N]$ layer of pyramid. MI is the multi resolution image.

Line Integral Convolution(LIC)

Line integral convolution is a technique to visualize a vector field. The method is based upon locally filtering an input texture along a curved stream line segment in a vector field, it is able to depict directional information at high spatial resolutions.

- Given an image, first we generate vector fields in horizontal and vertical direction(using sobel filters).
- In LIC, a input random noise is blurred along the vector fields.
- So, from the layers of Noise pyramid generated in the previous step, we perform LIC using vector field of the input image.

Line Integral Convolution(LIC)



LIC Pyramid

We generate a multi-scale gaussian pyramid with layers of LIC outputs for Noise pyramid layers.

LIC Image

- Just like we generated a multi-resolution image from gaussian pyramid and draw map, we generate a multi-resolution LIC image from LIC pyramid and draw map.

  r = DM(x,y).N
  a = r - floor(r)

  LIC(x,y) = (1-a). PLIC(floor(r), x, y) + a. PLIC(floor(r), x, y)

Where LIC is the LIC image, PLIC is the LIC pyramid.

Edge Image

Edge Image is calculated as follows:

$$Edge(x,y) = \begin{cases} 1, & MI(x,y) > Ave(x,y) - E \\ 0, & \text{otherwise} \end{cases}$$

Where Edge is the Edge Image, MI is the Multi-resolution image, Ave(x,y) is the average of the 5∗5 neighborhood of pixel (*x*,*y*). *E* is an offset to control the density and width of the edges.

Stroke Image:

Stroke image is generated by taking weighted average of LIC image and Edge image.

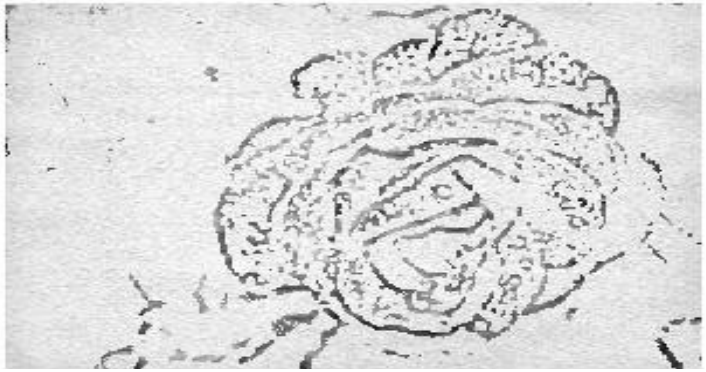
Output:

Output image is obtained by compositing the stroke image with the paper sample.

Some Outputs for Images

Input

Output



Input

Output

Failure Case

(When background has more no. of edges, the saliency map couldn’t focus totally on the foreground image(according to the viewers)

OTHER OUTPUTS FOR INPUT IMAGES ARE AVAILABLE IN THE GITHUB REPOSITORY

Work Distribution

Work Item	Main Contributor
Saliency Map	Phani Rithvij and Surendra
LIC	Sriteja
Multi Contrast gaussian pyramid, Noise pyramid	Surendra
Multi Resolution Image	Sriteja
Edge Image,Stroke Image,Output	Phani Rithvij

Thank you!