Image Inpainting

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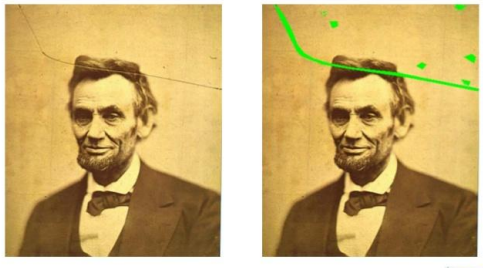
What is image inpainting

- In the digital world, inpainting is a sophisticated algorithm to replace lost or corrupt parts of an image.
- This technique reconstructs images by filling in holes with the neighborhood pixel values.



Applications of image inpainting

- Removing scratches on barcodes
- Removing text and logos from still images
- Image Reconstruction
- Touch up of old photos

Examples

Inpainting Algorithms

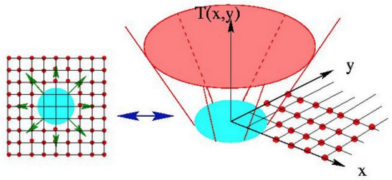
- Fast Marching Method
- Texture synthesis
- Exemplar based image inpainting

Inpainting using Fast Marching method

- Starts from the boundary of the inpaint region and gradually moves inwards
- In the order of pixel's distance until all the pixels in the missing region are filled
- information to fill the missing region is determined by the values of the known image region
- higher weight is assigned to the pixels lying near the normal of the boundary and boundary contours

Fast Marching method

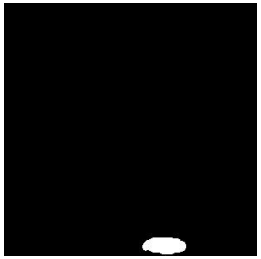
$$|\nabla u(x)| = 1/f(x) \text{ for } x \in \Omega$$
$$u(x) = 0 \text{ for } x \in \partial\Omega$$



Where f(x) is a speed function in normal direction at the point (x) on the boundary curve. 'u' is the time at which the contour crosses the point (x)

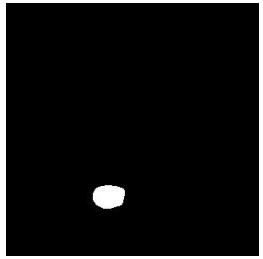
Results

Object Removal


Results

Image reconstruction


Texture Synthesis

- Textural inpainting use to captures the texture and possible noise.and also complete the missing regions using similar neighbourhoods of the damaged pixels.
- But this method cannot inpaint larger portions of image.

Results

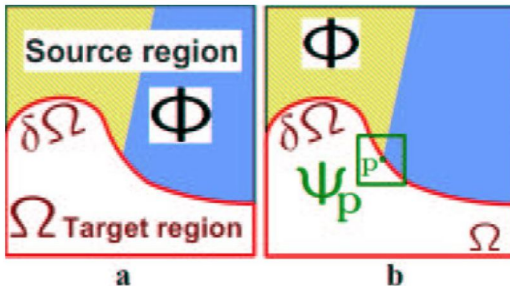

In typical inpainting techniques, some blur is produced.

Exemplar based image inpainting method

- An efficient approach to reconstructing large target regions.
- Exemplar-based Inpainting approach iteratively synthesizes the target region by most similar patch in the source region.
- The exemplar based approach samples the best matching patches from the known region.
- This algorithm also overcome the drawbacks of PDE based inpainting.
- Also it removes smooth effect of the diffusion based Inpainting algorithm.

(a) Original image, with the target region Ω, its contour δΩ and the source region Φ clearly marked.

(b) We want to synthesize the area delimited by the patch ψp centred on the point p €δΩ.



Basically, the exemplar based inpainting has three steps:

- *Computing the patch priorities*: Priority is defined as the product of the confidence C(p) term and the data D(p) term.

$$P(\mathbf{p}) = C(\mathbf{p})D(\mathbf{p}).$$

$$C(\mathbf{p}) = \frac{\sum_{\mathbf{q}\in\Psi_\mathbf{p}\cap(\mathcal{I}-\Omega)} C(\mathbf{q})}{|\Psi_\mathbf{p}|}, \qquad D(\mathbf{p}) = \frac{|\nabla I_\mathbf{p}^{\perp} \cdot \mathbf{n}_\mathbf{p}|}{\alpha}$$

Where Ψp is the target patch, α is a normalization factor, np is a unit vector.

- *Propagating texture and structure information*: Once the patch with highest priority is found by computing the patch priority, we then fill the target region with the data extracted from the source region. We search the source region for a patch that is similar to the target patch and then propagate the pixels.
- *Updating confidence values*: We iteratively update the confidence values after filling each patch with the best matching patch. The confidence value is frozen once a pixel is filled

Results

Results

Figure: (a) Input image (b) Mask image (c) Output image

Results

Comparison with inbuilt OpenCV function

(a) FMM method (b) Navier Stokes method (c) Our method