EE-621-COMPUTER VISION PROJECT

OBJECT/TEXT REMOVAL USING IMAGE INPAINTING

DHEERAJ KUMAR BHARTI - 204102303

AJAY KUMAR GAUTAM-204102323

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1 Introduction

Digital image inpainting is a technique used for reconstruction of an image from a damaged image. The image should be damaged by the small portion . So digital image inpainting receives a large amount of the attention in the recent years .Image inpainting is technique which is use to reconstruct the original image from distorted image. Distortion of image can be line ,can be sketch on image. It has wide range of application such as removing the text from an image ,removing logos from an still images or videos.

The working principle of inpainting method is given as:

1.First we manually select the region to be inpainted .

2.Then using the prior information of image we used to fill the missing area of the image i e. color information is breach corrective from the region boundaries.

In this two algorithms are used for image inpainting:

1. FMM Algorithm (Fast Marching Method algorithm)

2 . NS Algorithm (Navier-Stokes algorithm) .

Figure 1: Image Inpainting

2 Inpainting Principle

Let us consider a point p which is situated on the boundary $d\Omega$ region Ω to be inpainted.

So first we take a small neighbourhood $B_\epsilon(P)$ of size ϵ of the known image around the point p.Inpainting is done by the value of image point close to the point p in $B_\epsilon(P)$. Then we consider the first order approximation of image $I_q(p)$ of the image in point p . $I_q(p)$ is defined as :

$$I_q(p) = I(q) + \nabla I_q(p - q)$$

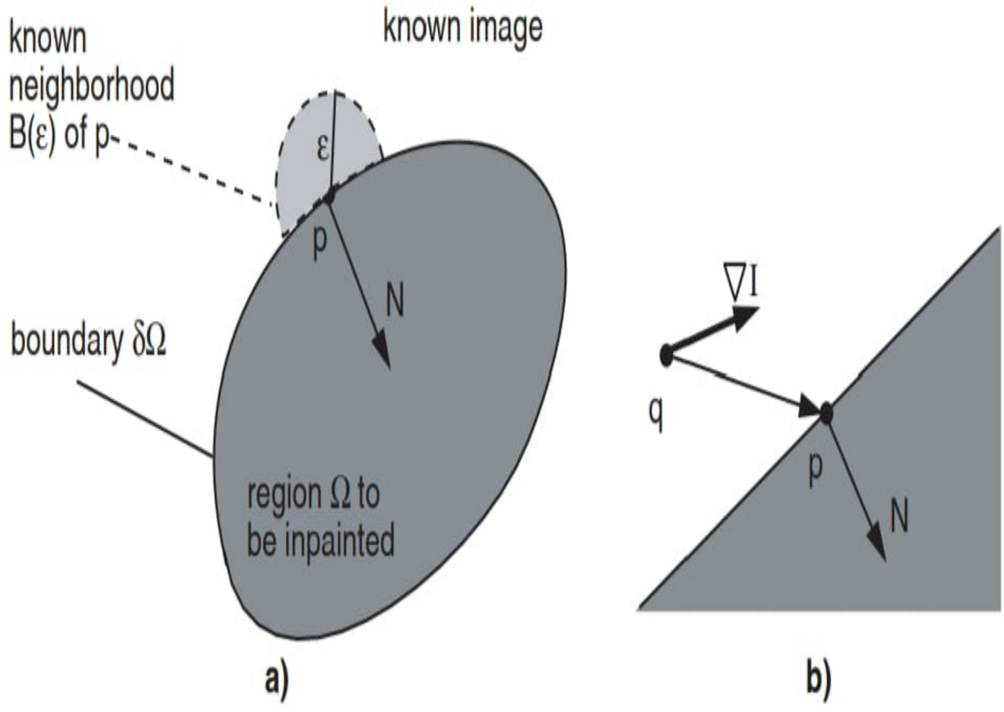


Figure 2: principle of image inpainting

We inpaint point p as a function of all point q in $B_{\epsilon}(P)$. Now by summing the estimates of all point q we inpaint point p as a function of all point q in $B_{\epsilon}(P)$ weighted by x(p,q) where x(p,q) is normalized weighted function .

$$I(p) = \frac{\sum_{q \in B_{\epsilon}(p)} x(p,q)[I(q) + \nabla I_q(p-q)]}{\sum_{q \in B_{\epsilon}(p)} x(p,q)}$$

The weighting function x(p, q) is designed such that the inpainting of point p propagates the gray value as well as the sharp details of the image in $B_{\epsilon}(P)$.

3 Algorithm for Image Inpainting

Here we proposed two algorithm for the image inpainting

1. FMM Algorithm (Fast Marching Method algorithm)

2 . NS Algorithm (Navier-Stokes algorithm)

4 FMM (Fast Marching Method)

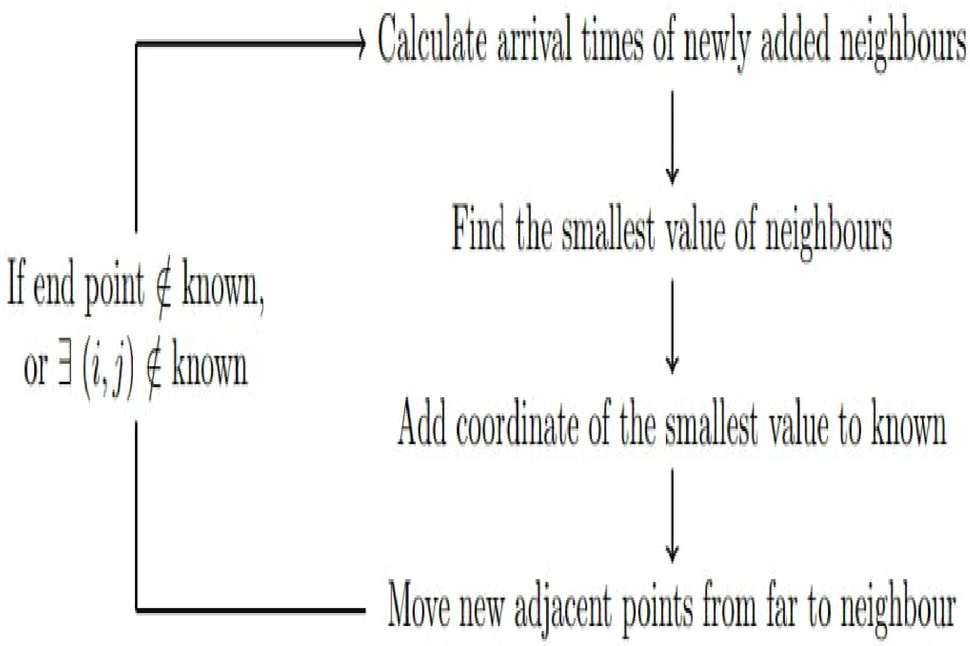
In general fast marching method is an algorithm which is used to solve the Eikonal equation :

$$|\nabla T|F = 1 \tag{1}$$

on Ω with T = 0 on $d\Omega$.

Distance map of the Ω pixel on the boundary $d\Omega$ is obtain by the solution of T from the equation (1) . For F(x) <0 for any point x the FMM method cannot be used to solve for T(x). In this we consider only F(x)> 0 so that only boundaries value formulation is used . Actually fast marching method can not be implemented straightforward . Fast marching method maintains the narrow band of the pixel .

The flow chart of Fast Marching Algorithm is given below:



For every pixel we store their value T and their gray value I and flag f might have three values
BAND : pixel belong to narrow band , T value updated
KNOWN : pixels belong to exterior to $d\Omega$,T and I are known
INSIDE : pixels belong to inside $d\Omega$,T and I are not known
The most important advantage of Fast Marching Method is that it takes very less computing time and gives approximate global result . But let in case we inpaint one pixel it uses all the neighbour information so there may chance of add any error information into the inpaint pixel and it violates the property of narrow band.
The algorithm is defined as

```
δΩ_i = boundary of region to inpaint
δΩ = δΩ_i
while (δΩ not empty)
{
  p = pixel of δΩ closest to δΩ_i
  inpaint p using Eqn.2
  advance δΩ into Ω
}
```

5 Navier- Stokes (NR) Algorithm

Let us consider a region Ω in a plane in which we want to inpaint from surrounding image pixels. Assume that outside of Ω the intensity of image is I_0 is a smooth function and we already know that I_0 and ΔI_0 on the boundary $d\Omega$. Now we want to design a Navier-Stokes based method for image inpainting .The analogy between fluid dynamic quantities and quantities in the image inpainting method is given as

Fluid dynamics	Image processing
stream function Ψ	Image intensity I
fluid velocity $\vec{v} = \nabla^{\perp}\Psi$	isophote direction $\nabla^{\perp}I$
vorticity $\omega = \Delta\Psi$	smoothness $w = \Delta I$
viscosity ν	anisotropic diffusion ν

The main goal is find the solution of Navier-Stokes equation in the region which to be inpainted .
There are many advantages of Navier -Stokes method:

1. This is a well established theoretical and numerical literature for the problem in which we can make inpainting algorithm .

2. This is very efficient method which is used to understand the transportation of information from the outer region into the inpainting region .

6 Results

The input degraded image is given as

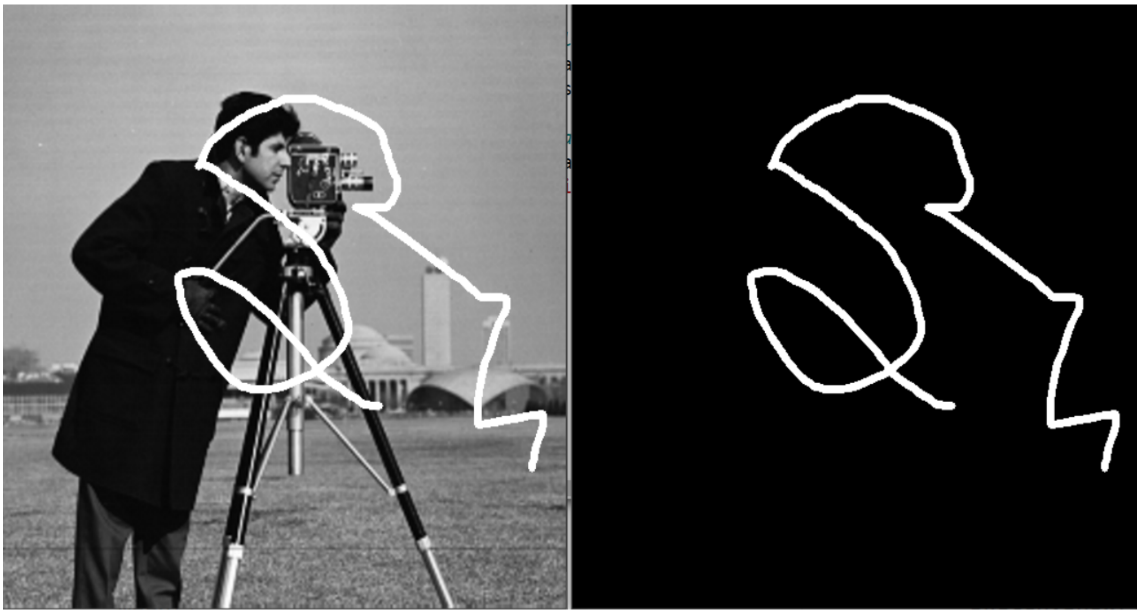


Figure 3: Input degraded] image

The output image using Fast Marching Method is obtain as

Figure 4: output image using FMM algorithm

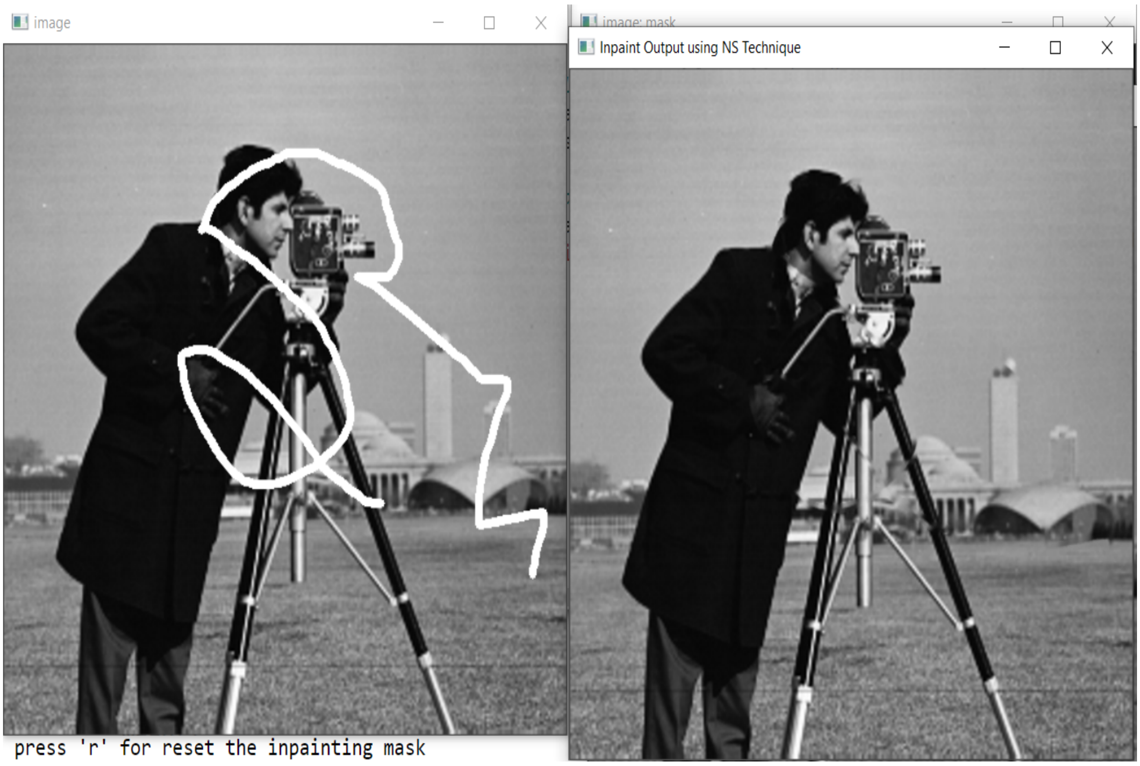


Figure 5: output image using Navier-Stokes Method

7 Conclusion

In this we proposed two type of algorithms are used in image inpainting ,first is Fast Marching Method second is Navier -Stokes Method. Fast Marching Method can not directly implemented in the literature while Navier-Stokes Method can be directly implemented in theoretically and numerically to solve problem in image inpainting . Both algorithms have their own advantages and limitations . Fast Marching Algorithm has very less computing time and also gives approximate global results.While Navier-Stokes method is very efficient method which is used to understand the transportation of information from the outer region into the inpainting region.

References

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