Removing Fence and Recovering Image Details: Various Techniques with Performance Analysis

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***Abstract*— In recent world, detection and removal of fences from digital images become necessary when an important part of the view changes to be occluded by unnecessary structures. When a picture is taken, it may have certain structures or objects that are unwanted. Many scenes such as parks, gardens, and zoos are secured by fences and people can only take pictures through the fences. Images or videos taken at open places using low-resolution cameras, like smart phones are also frequently corrupted by the presence of occlusions like fences. For the background occluded by fences, the goal of image de-fencing is to restore them and return fence-free images. Multi-focus images are obtained and "defocusing" information is utilized to generate a clear image. The main aim is when a colored image is input having fence in the image and then deleting; removing the fence gives the resultant image with the removal of fence from the image. Also it involves filling the gaps of removed, damaged region to recover lost image details. This paper includes various methods for detection of fence(s), various methods for filling the gaps, literature survey and performance analysis of methods for background reconstruction.**

***Keywords*— Image De-fencing, Edge Detection, Fence Detection, Fence Removal.**

I. INTRODUCTION

The increase of inexpensive smart phones, tablets with poor quality cameras has led to a need for a post-processing i.e. image editing in photography tool that can automatically improve the image quality [2]. There are many components that may cause image defects and affect image quality. Images or videos taken at open places using low-resolution cameras, like smart phones are also frequently corrupted by the presence of occlusions like fences [4]. When the target location that the users sketch to capture are occluded by a fence, and the users are not permitted to cross the fence, a natural resolution is to be recorded the scenes with fences and resort to specific image editing photography tools for fence removal [5]. Object removal is the recovery of lost parts of an image in a given area so that the repaired image looks ordinary [8]. Straight approaches to image de-fencing suffer from imprecise and non-robust fence detection apart from being limited to processing images of only static occluded scenes [11]. Many times, a photographer captures scenes that are following fences such as wild animals in cages and natural locations behind pointed fences [12]. Removing or repairing the defect of a digital images or videos is a very active and attractive field of research concern to the image inpainting technique. When a picture is taken it may have certain structures or objects that are unwanted [18].

(Fig.1 Examples of images having Fence)

It is very easy for proper layout, while capturing a scene through a fence. Beyond reducing an image's visual quality, its value for many purposes may also be reduced [13]. The rest of this paper is organized as follows: Section II contains various methods for detection of fence. Section III deals with related work of various techniques for filling the gaps. Section IV presents Literature survey, section V describes of performance analysis of methods for background reconstruction and section VI includes conclusion.

II. VARIOUS METHODS FOR DETECTION OF FENCE

A. Sobels Method

The Sobel method also known as Sobel–Feldman operator or Sobel filter is used in image processing and computer vision, mostly within edge detection algorithms where it produce an image indicate edges. It is titled after Irwin Sobel and Gary Feldman. The Sobel–Feldman operator is based on rotate the image with a small, separable, and integer-valued filter in the horizontal and vertical directions and therefore relatively cheap in terms of computations. On the other hand, the gradient estimate that it produces is

relatively simple, in particular for high-frequency variations in the image [7]. The operator uses two 3×3 kernels which are rotate with the original image to calculate approximations of the derivatives that are one for horizontal changes, and one for vertical changes [7].

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \quad G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix}$$

(Fig.2 Mask of Sobels Method [12])

B. Prewitt Operator

In image processing the Prewitt operator is used, mostly within edge detection algorithms. Exactly, it is a distinct differentiation operator, measure for an approximation of the incline of the image intensity function. Prewitt operator provides two masks one for detecting edges in a horizontal direction and another for detecting edges in a vertical direction [1]. The Prewitt operator is related on rotate the image with a small, separable, and integer valued sort through the horizontal and vertical directions. Judith M. S. Prewitt is the developer of the Prewitt Operator. The gradient of a two-variable either vertical or horizontal function is at each image point a 2D vector with the workings given by the product in the horizontal and vertical directions [7]. Also the operator uses two 3×3 kernels which are rotate with the original image to calculate similarly of the derivatives: one for horizontal changes, and one for vertical changes. The maximum returns which are directly from the kernel are produced by the use of Prewitt Edge Detector [17]. The Prewitt edge detector is a proper way to measure the magnitude and orientation of edges. Prewitt operator gradient based edge detector is expected in the 3x3 neighborhoods for eight directions [7]. This operator does not place any importance on pixels that are closer to the center of the masks on horizontal and vertical functions.

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -1 & 0 & +1 \\ -1 & 0 & +1 \end{bmatrix} \quad G_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ +1 & +1 & +1 \end{bmatrix}$$

(Fig.3 Mask of Prewitt Operator [12])

C. Roberts Detection

The Roberts Cross operator execute a simple, quick to compute, 2-D spatial incline dimension on an image. Lawrence Roberts in 1963 proposed the Roberts operator and was one of the first edge detectors. According to Roberts [7], an edge detector should have the following properties such as the produced edges should be well-defined, the background should supply as little noise as possible, and the strength of edges should match as close as possible to the edges. In general usage, the input to the operator is a grayscale image. Pixel values at each point in the output represent the projected complete magnitude of the spatial gradient of the input image at that particular point [3]. The Roberts operator contains of a pair of 2×2 convolution masks. One mask is simply and the other is rotated by 90° [7].

$$G_x = \begin{bmatrix} +1 & 0 \\ 0 & -1 \end{bmatrix} \quad G_y = \begin{bmatrix} 0 & +1 \\ -1 & 0 \end{bmatrix}$$

(Fig.4 Mask of Roberts Method [12])

D. Canny Method

John F. Canny in 1986 has developed the Canny Edge Detector. Also known as the "Optimal Detector". It is an operator that uses a multi-stage method to detect a wide range of edges in images. It has been widely used in different computer vision systems. It takes as input a gray scale image, and outcomes as output an image showing the positions of tracked strength ending [7]. The general principal for canny edge detection contains: Detection of edge with low error rate, which means that the detection should exactly catch as many edges. The edge point detected from the operator should accurately localize on the center of the edge [7]. At a given edge in the image should only be marked once, and any possible, image noise should not produce false edges. The Canny algorithm is flexible to different climates. Its parameters allow it to be customized to recognition of edges of different quality depending on the particular requirements of a given implementation [15]. Canny edge detection procedure is one of the ordinary edge detection techniques. The smoothing method is constantly needed before edge detection. Gaussian smoothing performance has been usually used in edge extraction [17]. Thus canny edge detection method is better detection of edges in noisy state by applying thresholding method.

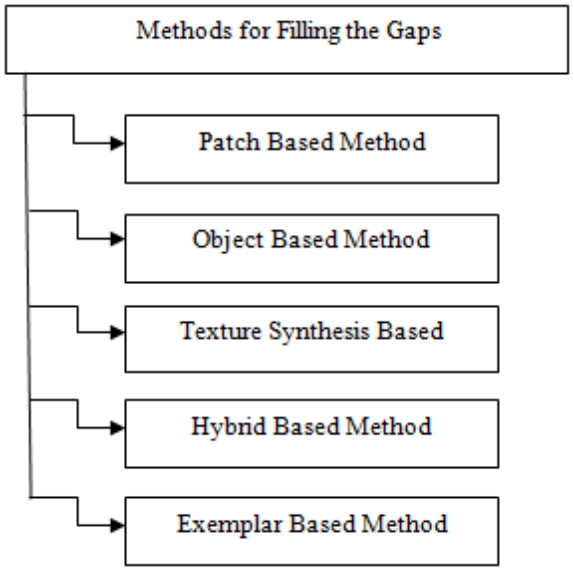
E. Performance Analysis of Methods for Detection of Fence

TABLE-I Performance Analysis of Methods for Detection of Fence

Operator	Advantages	Disadvantages
Sobels Method [12]	It is less susceptible to noise. The operator consists of a pair of 3×3 convolution kernels.	It produces thicker edges. So edge localization is poor in case of images having well details.
Prewitt Operator [12]	Simplicity and easy to implement for detection of edges and their directions.	These are sensitive to noise, Inaccurate.
Roberts Detection [12]	Roberts Edge Detector is a 2-D spatial gradient measurement on an image.	High sensitivity to noise.
Canny Method [12]	Using probability for finding error rate. It uses Localization and response. Better detection especially in noise conditions.	High Signal to noise ratio.

III. VARIOUS METHOD FOR FILLING THE GAPS

This section describes various methods on the filling of the gaps after removing the fence from image. Among all the methods Exemplar Based method is best for filling the gaps.



(Fig. 5 Different Methods for Filling the Gaps)

A. Patch Based Method

Patch priority and patch representation is two major steps in the method of patch based method. In the first step, video is converted into individual image frames. Edges to be removed by identified using edge detection method. This method understands structure and texture discrimination using patch sparse representation and structure default effectively [6]. B. A. Ahire [6] et al proposed system consists of four subjects: Object detection and tracking, virtual contour construction, Key position selection and mapping and synthetic posture generation. To obtain continuous object trajectories, the patch based image inpainting method is used to complete missing regions in the spatio-temporal slices. This method does not deal with the illumination change problems.

B. Object Based Method

Object based method is used to fill the area of the removal object. This method fills the area of the removal object and this mechanism can also be used to extract the background of videos [7]. N. Bhatewara, P. Kumar, and A. Agrawal et al [16] proposed method in which the object is removed and the texture is reconstructed in the entire video. This technique is for the videos captured by the still camera. The proposed method consists of a three step process. In the first step image frames are extracted from video. Then background objects are detected and tracked and in the next step motion in-painting fills the holes created by the object by copying information from object templates. The method does not perform well when illumination is change.

C. Texture Synthesis Based

Texture removal by D.R.Patil, [3] says that the recovery of missing parts in image with given region. It can be accomplish by image inpainting methods. The basic stages for texture synthesis based method involves in three parts such as text location, extraction and removal of text. Li et al [10]. has applied feature extraction using wavelet based approach along with texture analysis with use of neural network in order to detect scene text, localization, enhancement and tracking along the video or image. Efros and Leung [5] have given a useful and simple algorithm for highly related problem of texture synthesis. It is based on Markov Random Field and texture synthesis is done by pixel by pixel. The pixel is differentiating with the neighboring pixel randomly. This algorithm is very slow because the filling-in is done pixel by pixel matching. This is one of the earliest methods of image inpainting for removing or extracting texture based images. Heeger and Bergen [16] developed a texture synthesis algorithm which can construct matching texture given target texture. Their idea is based on texture discrimination means of human visual system. Thus Texture Synthesis based method is used for extracting the text and location of image gives perfect results.

D. Hybrid Based Method

Hybrid based inpainting technique is also knows as Image Completion. It is used for filling large target regions [1]. The proposed de-fencing algorithm for the hybrid based inpainting method works in four steps, starting with the view of the fence color model, which is used in the second step to division through the fence. Then third step, the fence mask is developed by eliminating the false positives and false negatives, and in conclusion the fence region is recovered by a hybrid inpainting algorithm [7]. The hybrid based method combines both texture synthesis and PDE based inpainting for carrying out the holes. The main idea following the approaches is that it decomposed the image into two separate parts such ad Structure region and Texture regions [16].

E. Exemplar Based Method

Exemplar Based approach originate the image information from known region to into missing region at square level. These have verified to be very useful inpainting algorithm. Sankaraganesh Jonna el al [4] has carried out that Exemplar based approach which includes the four main steps. In the first step the target region is marked by the user, in the second step filling preference are computed for the marked region and in the third step the searching and composting most suitable example for the target region in other frame and in fourth step updating image information is carried out for the resolution of image. According to Criminisi's model [8] an image is divided into two parts: Λ (Lambda) represents the undestroyed image region which is known as source region, and Ω (Omega) represents the damaged image region called the target regions. According to Jing Wang et al [8] says that the exemplar based

method consists of three main parts: Compute the filling priority, searching for the best matching patch and update image information. Ye-fei Liu and Fu-long Wang et al [9] proposed that exemplar based method is used a fixed patch size and search whole region from the targeted region. T. K. Shih, [16] suggested exemplar-based image in-painting algorithm by merging an improved patch matching strategy for image in-painting. Motion map is irregular in order to exactly locate the movement of objects. Thus Exemplar based method is very useful for detecting or removing unnecessary objects from the inserted images.

VI. LITERATURE SURVEY

TABLE II: A Survey on Fence Removal and Recovery of Lost Image Details

Publication/ Year	Title	Overview	Positive Aspects	Limitations
Springer/ 2016	Image de-fencing framework with hybrid inpainting algorithm [1].	Users are requested to mark fence pixels, and then color segment is required. Hybrid inpainting algorithm is proposed with exemplar-based technique.	The proposed technique is able to remove both regular and irregular fences.	The proposed de-fencing algorithm is not capable to detect Asymmetrical fences and restore the fence region.
IEEE/ 2014	Super-Resolution De-Fencing: Simultaneous Fence Removal and High - Resolution Image Recovery Using Videos [2].	Proposed a single framework where the maximum estimate of the High resolution image is obtained using multiple Low resolution fenced frames of the video.	When the fence is removed from the image, the filling space (holes) required gives low resolution of the image.	Illumination change problem.
IEEE/2015	Text Detection and Removal from Image using Inpainting with Smoothing [3].	Location, Extraction, and removal of text from image is the main part of paper. Unwanted Text from the images is detected. Removing text from the images gives low resolution. Holes generated are filled with the neighbor inpainting.	The PSNR (Peak Signal to noise ratio) value of images without smoothing is less than PSNR values for images with smoothing.	Gives poor resolution of image when the detection of text is done and smoothing of text gets with low resolution.
IEEE/2015	A Multimodal Approach for Image De-fencing and Depth Inpainting [4].	Using Kinect camera, removal of fence or occlusion is detected. Markov Random Field technique is used to detect the fencing from the image. Affine scale-invariant feature transform descriptor (ASIFT) is used to fill the gap or hole from the detected image.	Addressed the problem of identification of the fence pixels by using the captured depth data.	A real-time automatic image de-fencing and depth completion algorithm which will be useful with the advent of cameras equipped with the depth sensors.
IEEE/2014	Video De-Fencing [5].	The main target is to restore video clip with images corrupted by Fence/occlusions during capture. The fence detected gives more pixels.	The proposed algorithm is validated on real-world video clips with fences.	The proposed method had difficulty when the background scene and fence like objects had similar depths.
IEEE/2015	My camera can see through fences: A deep learning approach for image de-fencing [11].	In this paper, semi-automated de-fencing algorithm using a video of the dynamic scene. Also use convolution neural networks for detecting fence pixels. The split Bregman optimization approach was used to obtain the de-fenced image.	Results shows for both synthetic and real-world data to the superiority of the proposed algorithm over the state-of-the-art techniques.	If an object moves nonlinearly during an occlusion period, the tracking and detection of image may not compose sufficiently accurate postures. The proposed method does not deal with the illumination change problem that occurs if lighting is not uniform across the scene.
IEEE/2010	Fence Removal from Multi-Focus Images [14].	In this paper proposed a method for a fence removal from the image using multiple focusing. Multi-focus images are acquired and "defocusing" information is utilized to generate a clear image.	Results show that there is an effectiveness of the proposed method.	As a future work, the quality of the final result will be improved by more accurate ray tracing.
SPRINGER/ 2010	Image De-fencing Revisited [15].	Real-life problem in photo editing where one would like to remove or change fence-like objects are unavoidable. Multi-view inpainting is performed to fill in occluded areas with information.	Lattice detection method produces improved results over the state-of-the-algorithm by 30%.	Future goal is to deal with large view angle changes between multiple views.
IEEE/2015	RIFO: Restoring Images with Fence Occlusions [18].	This paper proposes a novel approach to restore images from fence occlusions (RIFO). The	Disoccluded regions are restorated by a patch based approach using matrix	The proposed method does not deal with the illumination change problem that occurs if

		proposed method consists of two steps: fence detection, and disocclusion restoration. Complete fence is detected by expanding the fence structure.	completion. Results show that method reliably detects and removes fence from images.	lighting is not uniform across the scene.
SPRINGER/ 2014	Automatic inpainting by removing fence-like structures in RGBD images [19].	Introduce an automatic Inpainting technique to remove undesired fence-like structures from images. Specifically, the proposed technique works on the RGBD images which have recently become cheaper and easier to obtain using the Microsoft Kinect.	Basic idea is to segment and remove the undesired fence like structures by using both depth and color information and fill the regions from the removal of fence with exemplar based method.	Efficiency for restore and repairing images improves time consuming problem.

V. PERFORMANCE ANALYSIS

Table III summarizes performance analysis of methods for background reconstruction providing addition knowledge advantages and disadvantages of each method. Among all the methods, the analysis shows that Exemplar based method is best for background reconstruction.

TABLE III: Performance Analysis of Methods for Background Reconstruction

Name of Methods	Advantages	Disadvantages
Patch Based Method [13]	This method is used for reconstruction of the recovery of the images but does not give perfect results.	The method does not deal with the texture objects when the reconstruction of the object is recovery from the input image or video.
Object Based Method [8]	Object based method uses geometric approaches for filling in the missing information in the region which should be in painted. These algorithms focus on the consistency of the geometric structure also based on objects.	It does not deal with the illumination change problem that occurs if lighting is not uniform across the scene.
Texture Based Method [3]	It is cheap and useful. New texture is synthesized by querying existing texture and finding all similar neighborhoods.	This method does not handle for edges as well as boundaries. May lose linear structure and combined textures. Does not working with other language rather English. Not suitable for large objects also for curved structure.
Hybrid Based Inpainting Method [1]	Hybrid based method is very efficient and deals with the perfect resolution of the image when removing the background of the object like fence. It is used for filling large target (missing) regions. Hybrid method is a combination of both structure and texture in images.	Illumination change problem. Lighting is not uniform. Results in blur effect in the image.
Exemplar Based Method [9]	This method is an efficient approach for reconstructing large target regions. It is used to rebuild texture part as well as structural part of an image.	Exemplar-based method does not handle curved and nonlinear structure.

VI. CONCLUSION

The basic idea works with image de-fencing and filling the gaps to recover lost image details. Among the methods for detection of fence, the canny method is the best method because it gives accurate results. Among all the methods for background reconstruction, analysis shows that Exemplar based method is best. As the future work, the quality of the final result will be improved by more accurate resolution; also the work can be done on the image having the blur effect after removing the fence.

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