

A Survey: Different Techniques of Video Inpainting

Jignasha H. Patel¹ Prof. Jignasa N. Patel²

¹M. Tech. Student ²Assistant Professor

¹Department of Information Technology ²Department of Computer & Information Technology

^{1,2}Shri S'ad Vidya Mandal Institute of Technology Bharuch, India

Abstract— Inpainting is the process of reconstructing lost or declined parts of images and videos. A computer vision technique is proposed to remove an unwanted object in a video sequence for digital processing. Video Inpainting is one of the most challenging problems in computer vision which is used for removing an undesired object from an input video. Recently various special effects have been employed in video production. We will survey on novel techniques of Video Inpainting which applies to both static and free moving camera videos. The method can be used for object removal, error concealment and background reconstruction which can be used to improve the quality of videos. Many methods have been developed for video inpainting.

Key words: Video Inpainting, Exemplar based Method, Partial Differential Equation (PDE) Based Method, Object Based Method, and Texture Synthesis Based Method, Patch-Based Method

I. INTRODUCTION

Process of restructuring damaged parts of an image in a visually reasonable way is known as an Inpainting. There are two types of inpainting: Image Inpainting and Video Inpainting. In recent times, digital inpainting have been a very popular field of research in the area of image processing [1]. Images are contains damaged and also unwanted parts in its foreground. So these parts are removing from the images, some hole appear which is known as a missing regions and image inpainting is the process of rebuilding missing regions using its own data [1].

Author Bertalmio offered inpainting techniques in 2000 and three also offer three types of inpainting techniques. First is Partial Differential Equations (PDE Based methods), second method category includes statistical methods and third is exemplar-based methods. These methods are used to fill the missing regions by copying content from the known parts of the image in a structural and textural synthesis framework [1].

The wide applications of digital camera and the digitization of old photos inpainting has become an automatic process which is operated on digital images. More than scratches removing the Inpainting techniques are also applied to object removal, text region and other automatic modification of images and video.

II. OUTLINE OF THE PAPER

The rest of this paper is organized as the following: Section II presents about Video Inpainting. Section III focus on different techniques of Video Inpainting. Section IV comparisons of different techniques of Video Inpainting. Section V literature survey and the last section summarizes the key points and conclusion of this paper.

A. Video Inpainting

Currently video has become a significant media of communication in the world. Video Inpainting plays an important role in the area of image processing and computer vision similar to the image inpainting. In video, process of filling-in of the misplaced Regions is known as a Video Inpainting. Image inpainting is done only in the spatial domain but video inpainting is done in the spatio-temporal domain. There are many areas and applications of the video inpainting technique from the renewal of damaged videos and paintings to the removal or replacement of the selected objects in the video [2].

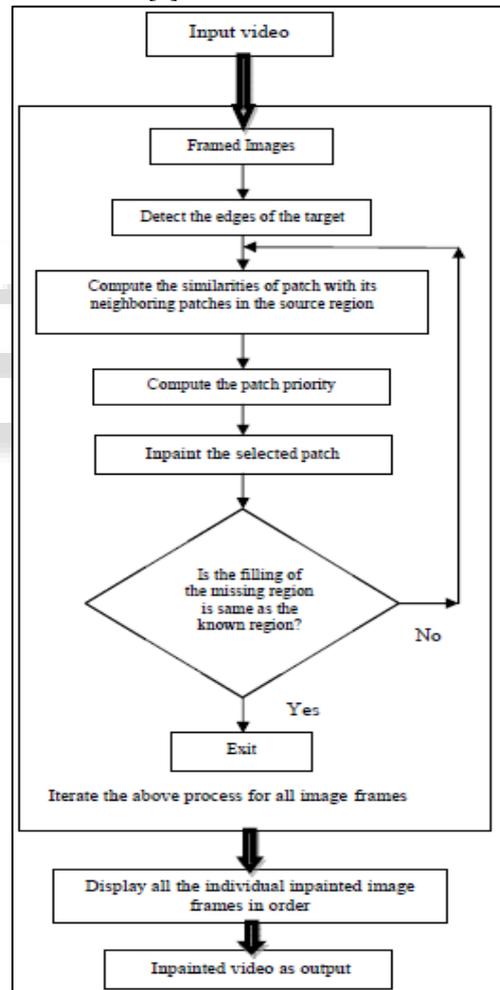


Fig. 1: Flow diagram of the video inpainting [2]

Eliminate objects or re-establish missing or tainted regions present in a video sequence by applying spatial and temporal information from neighboring divisions by using Video inpainting techniques. The superseding objective is to generate an inpainted area that is merged effortlessly into the video so that visual consistency is maintained throughout and no alteration in the affected area is visible to the human eye when the video is played as a sequence.

Video is a sequence of image frames and generally twenty five frames per second are runs in video when video is start. Less than twenty five frames per second will not be defined as a video since the display of those will appear as a flash of still image for the human eye [2].

The main variance between the video and image inpainting approaches using texture synthesis is in the size and characteristics of the region to be inpainted. Video is the display of the image frames in order and that's why Video inpainting may also know as the grouping of frame by frame image inpainting. Generally all the natural images are composed of structures and textures. The primal sketches of an image like the edges, corners, etc. are referred to as the structure of an image and the image regions with feature statistics or homogenous patterns including the flat patterns are referred to as the texture of an image [2].

Image inpainting is done in spatial domain, whereas the video inpainting is performed in both spatial and temporal domain. It is used to remove objects or restore missing regions in the video sequence. Normal flow of the Video Inpainting is shown into below figure 1:

III. VIDEO INPAINTING TECHNIQUES

Numerous techniques have been established for video inpainting. This paper presents analysis on following video inpainting techniques 1) Exemplar based method 2) Partial differential equation (PDE) based method 3) Object based method 4) Texture synthesis based method 5) Patch-based method.

A. Exemplar Based Method

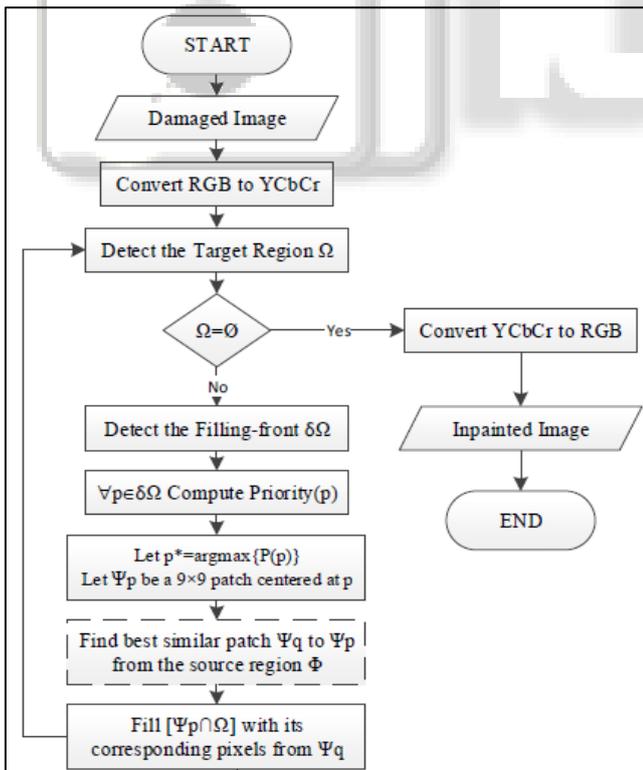


Fig. 2: Flowchart of fast and simple exemplar-based inpainting algorithm [4]

The exemplar based method is a very important class of inpainting procedures. Fundamentally it consists of two basic steps: in the first step priority is given to all the patches and in the second step best matching patch is

selected. The main advantage to use this process is that it handles large holes successfully. But only used for simple texture and structure region. Sufficient samples are required to synthesis the target region. Generally, an exemplar-based Inpainting algorithm includes the following four main steps: In first step preparing the Target Region, in which the initial missing areas are removed and represented with appropriate data structures. Second step is calculating Filling Priorities, in this step a predefined priority function is used to compute the filling order for all unfilled pixels $p \in \delta\Omega$ in the beginning of each filling iteration. Third step is a Searching Example and Compositing, in which the most similar example is searched from the source region Φ to compose the given patch, Ψ (of size $N \times N$ pixels) that centered on the given pixel p and last and fourth step is Updating Image Information, in which the boundary $\delta\Omega$ of the target region Ω and the required information for computing filling priorities are updated [3]. Process flow of fast and simple exemplar-based inpainting algorithm is shown below figure 2:

B. Partial Differential Equation (PDE) Based Method

In the last decade many video Inpainting techniques have been developed for large variety of applications. Partial Differential Equation (PDE) based technique works in iterative manner. According to this algorithm lines which are arriving at the border of the region should be smoothly inpainted, from the outside of the border to the inner region. It Produce good results if missed regions are small one and target region is non-textured, but take long time if target region is large. Some blurring effect is presented in the resultant video sequence [3].

Partial differential equation (PDE) based technique works iteratively. This method is smoothly in-paint the border region of image. The PDE based approach focus is to fill in the hole spatially by extending the edges and then by a diffusion process filling the hole with smoothed color information. This method is effective when only restoration scratches and spots are required. One of the drawback in this method is temporal correlation is not considered between two consecutive frames. This approach produces blurring artifacts because of extensive smoothing [5].

C. 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 employed to extract the background of videos. Narendra Bhatewara et.al [6] proposed a new method in which the object and the unwanted item will be removed and the texture is reconstructed in the entire video while maintaining the reliable flow of video. Simple flow of object removal inpainting method is shown below:

This new approach involves the steps of preprocessing, motion inpainting, and background filling-in. In preprocessing step, segmenting each frame of a video into foreground and background, detecting the foreground objects and then tracking those detected objects. In motion inpainting step, fill the holes created by the occluding object by copying information from object templates generated in preprocessing step and in last step, background filling-in will fill the remaining holes by copying corresponding background from background model [6].

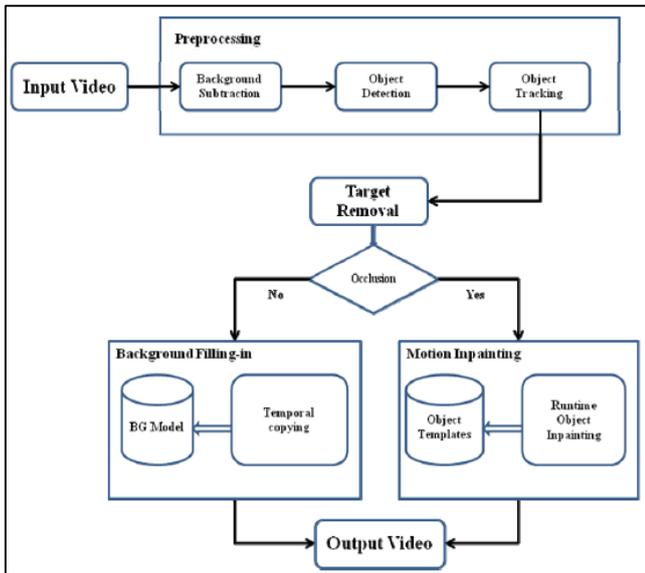


Fig. 3: Flow of object removal Inpainting method [6]

D. Texture Synthesis Based Method

Global optimization-based texture synthesis video restoration and inputs structure information is used to find texture, node and motion feature into video and image restoration. Assuming the inpainting region of image I is Ω , and its boundary is $\partial\Omega$. The square module \mathcal{M}_p of outline in object region, whose centre point p is on the outline $\partial\Omega$, its module contains part of synthesized pixels. Each pixel point in the module has a priority P and confidence C . The sequence of filling should be from outside to inside gradually. The procedures of Texture Synthesis Based algorithm are [7]:

- Step 1: compute the priority of all the modules on $\partial\Omega$ and choose the block \mathcal{M}_p waiting to be inpainted which has the maximum priority;
- Step 2: Search the optimal matching block \mathcal{M}_e ;
- Step 3: Copy image data information of source sample matching block to target sample block, and mark \mathcal{M}_p as inpainted;
- Step 4: Update Ω and C . Repeat step 1 to 4 till Ω is null.

E. Patch-Based Method

Block-based sampling and simultaneous propagation of texture and structure information is used in patch based methods. Similar concept is extended in video in-painting. B.Vidhya et.al [8] introduced the in-painting method based on patch propagation. Patch priority and patch representation is two major steps in this process. First, video is converted into individual image frames. Edges to be removed by identified using edge detection method. Confidence of a patch is computed from each frame by using nonzero similarities to the neighboring patches which computes patch structure sparsity. Higher priority is given to the large patch structure sparsity in in-painting. Patch propagation is performed to propagate the image inwardly. This method differentiates structure and texture discrimination using patch sparse representation and structure sparsity effectively [8].

Author B. A. Ahirel et.al [9] define a new method. There are three phase: In first phase, Background Subtraction Algorithm is used in which first consider a one color frame after that find the next frame and Calculate the color difference between these two frames. If the difference between two pixel values is greater than the threshold, the movement of that pixel is considered as significant and at last after thresholding the difference image, each pixel is classified as a foreground or background image pixel. Second phase is Patch based image in painting technique is used to complete missing regions in the spatio-temporal slices. The method first defines the filling direction of the missing regions based on the precedence of the missing region. Third phase Key posture based sequence matching is used retrieve the most similar postures among the number of posture and used to reduce the complexity of posture sequence retrieval. Last phase is Synthetic posture generation is help to segment the extracted skeletons into their constituent components. Patch based image Inpainting algorithm for getting the better results as compared to the previous methods.

IV. COMPARISON OF INPAINTING TECHNIQUES

Technique Name	Advantages	Disadvantages
Exemplar based method [3] [4]	Several video show more accurate. Better result for inpainting large missing area.	It will work only if the missing region contains simple structure and texture.
Partial differential equation (PDE) based method [3][5]	This method Provide simplicity.	This method Provide simplicity but cannot handle large area.
Object based method [6]	Addressed the complete occlusion and inpainted the completely occluded object successfully.	This technique cannot handle the case when a significant portion of the object is missing. It has difficulty in Inpainting curved structures.
Texture synthesis based method [7]	Focused on maintain the structure of the inpainting area. It Produce good results if missed region are small one and target region is non-textured.	Take long time if target region is large. Some blurring effect is presented in the resultant video sequence.
Patch-based method [8] [9]	Reduce Complexity. Removes objects with good subjective quality. Increasing the quality of output video.	If an object moves nonlinearly during an occlusion period, the virtual trajectories may not compose sufficiently accurate postures.

Table 1: Comparison of Inpainting Techniques

V. LITERATURE SURVEY

No	Publication	Title	Description	Advantages	Disadvantages
1.	IEEE – 2013 [6]	Intelligent Video Inpainting System for Texture Reconstruction	In this Paper, the unwanted item will be removed and the texture is reconstructed in the entire video while maintaining the reliable flow of video.	- Addressed the complete occlusion and inpainted the completely occluded object successfully.	Works on stationary background videos not on dynamic background videos.
2.	IEEE – 2016 [7]	Video Inpainting Algorithm Based on Texture Synthesis	This paper focus on a digital video Inpainting algorithm which calculates the movement value of video in each frame and finds panoramic picture the research status of the newest domestic and foreign technological method.	Results are better than the single-frame texture and model restoration. - Low complexity. - High processing speed.	Time consuming. Blurring effect is presented in the resultant video sequence
3.	IEEE – 2014 [9]	Video Inpainting of Objects using Modified Patch based Image Inpainting Algorithm.	In this paper author define a new method of an object-based video Inpainting that can maintain the spatial consistency and temporal motion continuity of an object simultaneously.	Reduce Complexity Removes objects with good subjective quality. Increasing the quality of output video.	The virtual trajectories may not compose sufficiently accurate postures. Does not deal with the illumination change problem that occurs if lighting is not uniform across the scene.
4.	IEEE – 2016 [10]	Caption detection and removal from video images with complicated background using intelligent inpainting scheme	In this paper, author presents a technique of caption removal which is based on the color edge detector.	Improved algorithm could efficiently raise detecting accuracy and repairing efficiency, and reduce the probability of mismatching. High performance.	Time consuming and the damaged regions are big, the repaired image will appear obvious fault on the boundary. Removes only texts.
5.	IEEE – 2015 [11]	video inpainting with short term windows: application to object removal and error concealment	In this paper, they propose a new video inpainting method which applies to both static and free-moving camera videos.	Proposed approach has a reduced complexity. Efficient and provide high quality results.	- Not works on inpainting both background and moving objects in the videos.
6.	IEEE – 2013 [12]	An Automatic Inpainting Scheme for Video Text Detection and Removal	In this paper author works on automatic video text removal in order to detect and remove embedded video texts and fill-in their remaining regions by appropriate data using an unsupervised clustering and the stroke width transform (SWT).	Proposed approach does not require complicated background-foreground, motion layer segmentation, or optical flow mosaics computation. High performance. Effective and efficient.	- Only texts are removed.
7.	IEEE – 2013 [13]	Video Inpainting Model for Camera Motion Based on Improved Background Subtraction Method	In this paper, author defines a new detection moving object method combining the surf algorithm and the background subtraction.	- Better robustness - Higher accuracy - Lower error	- Background subtraction has disadvantage is that large amount of calculation, modelling difficulties and inaccurate fixed update rate.
8.	IEEE – 2013 [14]	Static Object Removal from	In this paper author works on new scheme which is based	Fast and efficient. Effectively maintains	The proposed method fails when the damaged

		Video Scene Using Local Similarity	on a fast and efficient video completion method to recover static damaged area without the widespread search process.	the spatial and temporal consistency after removing static damaged area. - Reduces the completion time.	region is occluded by moving objects. Method cannot apply on moving camera and repairs only the first frame instead of all frames.
9.	IEEE – 2011[15]	Contour-Based Video Inpainting	Author has developed a new video inpainting approach for filling the hole created by an object.	Reduce the running time. Improved quality of video.	The proposed method will no longer produce pleasant results. - Cannot work for dynamic Background.
10.	IEEE – 2013 [16]	Tracking Based Depth-guided Video Inpainting	In this paper author proposed a new technique for video inpainting using depth information which is based on tracking.	Increases efficiency and decreases the computational time.	Proposed method is for static camera and unable to handle the occlusion problem, which reduces robustness of the algorithm.

Table 2: A Survey on Message Filtering

VI. CONCLUSION

The aim of video Inpainting is to rebuild the missing part or holes which are created by damage or removal of any selected objects from video. The key problem in video completion is to keep the spatial temporal information. In this paper we are discussed about various inpainting techniques which are valuable for image processing examination and also find the advantages and disadvantages of these all Inpainting methods. Video Inpainting is a comparatively young and active research area for image processing field.

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