Remove Logos from Video Using Linear and Fast Fourier Interpolation Methods

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ABSTRACT

The object removal from video is sometimes necessary in some application. The process of removing object includes remove text, logo, watermark or a particular object. These objects may be static or dynamic in the video. The removed object are detected by binary mask and try to fill the background of removed object that in a non-noticeable visually. A completion is the process of rebuilding lost or degraded parts from frames of the video. In this paper an efficient technique are proposed to fill the missing parts of the frames within the video. This work include two algorithms: The first algorithm is Vertical, Horizontal and 4Neighbors algorithm (VH4NA) that contain three stages for filling process (vertical, horizontal and 4neighbors interpolation). The second algorithm is Fast Fourier interpolation algorithm (FFIA) depends on the Fast Fourier Transform for filling lost areas. The results showed that the proposed algorithms to fill the missing or damage parts of the video frames are in a visually pleasing way. The First algorithm is used to fill the missing parts with simple background, while the second algorithm used to fill the missing parts with complex background. The time consumed for the implementation of the first algorithm is less than time for implementation of the second
Keywords: Image Completion, Image Inpainting, Fast Fourier Transform, Image Morphology and Image Texture Synthesis.

INTRODUCTION

T He development in the field of computer and communications technologies, and the significant progress made in the field of the Internet has facilitated the spread of information or infrastructure to get it solves a lot of problems. The video completion is an important research subject in the domain of image reparation. Completion is an important and new research in image processing. The elimination of part of an image is an important instrument in photo edit, film production, this instrument need meticulous work guided by talent artist to in painting the image easily and smoothly [1]. Completion is a process of removing defects from the images manually and automatically. Restoration of damage or lost area of images is an old practice; it is also called completion, restoration or retouching image. Operation of rebuilding the lost or damage area in video called video completion. Process of complete image is same as process of complete video, but in video there are more than one image at same time and need more time for processing. Image completion contains of filling the lost areas or modifies the damaged area in a visually pleasing way by an observer [2]. This method began to rebuild degraded area missing from photo or video by filling out the information that contains incomplete information. This method are padding the unknown regions of a frame caused by removal of a portion of that frame without any user intervention is a challenging problem in image editing and processing, for this problem there

are two methods for image completion; image inpainting and texture synthesis. Inpainting method is interested with image reconstruct, where spot, scratched and text are elimination. This method is fast and only work on small missing area. Texture synthesis method is work on large missing area and it is very slow but give good result to fill the missing or damage area in image or video [3]. There are many application for completion[4, 5 and 6]: used in cinema and modify old films, reconstruction old image, elimination of text , logo, scratches , stains , speckles, unwanted objected from frame, remove fixed and moving object in video or add Some effects. The aim of completion is to fill and repair the missing part in texture and structure in a visually pleasing way.

Related Works

Image completion in video is a process of removing the missing or damage area, or remove object and re-degraded areas in the video is called to complete the video. The process of completing image is closely related to a process of completing video, but in the video there is more than one image at the same time and this requires a long time. In recent years image completion in video has become an active research topic and began to take the attention of many researchers. For solve this problem many algorithms are improved. In the field of image completion several researches were developed. In 2000 Bertalmio introduced an algorithm for completion using patch similarities in digital image [7]. In [8] proposed method based on morphological process: (erosion and dilation). In process of erosion are used to reducing missing or damage region (target region).And in dilation process are used to gather information from region that surrounding region. In [9] proposed method based on two standard local similarity and two side gap filling technique for inpainting. In local similarity used when neighbor pixels are same in color and texture, In a two side used to see the information in the left and right (horizontal), also the top and bottom (vertical) of object have feature same the lost area. In [10] proposed inpainting method, the process of filling depend on patch instead of pixel, the patch was determined manually and then matching with other patch in images and the best patch was chosen to process of filling. Recently In [11] proposed completion method depend on exemplar search by in an algorithm to detected logo, by using map (a high-pass filter), and sift (scale invariant feature transform that), then Tracking and Extraction by us mean shift and backward tracking for removing logo and then completion.

Image Completion Methods in Video

The video are contains of sequence of frames, each frames are complete images with all characteristics. The aim of image complete in video is to filling lost or damage area in frame that removed optional or mandatory. And there are two major Techniques in image completion are: using Image Inpainting, using image Texture Synthesis.

Image Inpainting

The methods significant to fill small lost pixels or damage area in image (frame). The thin holes and elimination are scratches from frames in old video. This technique used diffusion process that caused blurring when filling large crake in frames, e.g. elimination move or static object in frame; it is only work on small missing area [12]. The problem of this Technique is that interpolation approach depend on process of diffusion that solve a Partial differential Equation (PDE), that adjective the spread of color in lost or damage area in frames.

Image Texture Synthesis

Another method for completion process is called "texture synthesis". This method deals with a large missing damage and complex area in frame. And this method generates sample from source that are needed to complete. This method create new texture by take sampling or copy value from

source area to target (missed) area in order to fill lost area in frame. This method works on two steps. First step is per-pixel: In this step use only one pixel to fill the damage area, this lead to slow speed of reparation. Second step is use window (patch) of pixels are select from source that match the missing area in frame. This lead to speed process of reconstructs the lost area and accuracy. Finally this method gives good result but it slow and an algorithms that design for it is complex [13].

Image Completion

There are several techniques for image completion, below some commonly techniques used in image processing:

Image Interpolation

The interpolations are the process to find the missing values in the set of known values. These process is useful in several situations for example to enlarge (zooming) the image, to fill some gaps in image or to fill the gaps that results from object removal from images. This process depends on some theories and algorithms which are used in one dimensional (e.g. nearest neighbor interpolation) to find the relationship between the missing values with the known value, or using two-dimensional (e.g. bilinear interpolation) to find relationship between the missing values with the known value.

Fast Fourier Transform (FFT)

Fast Fourier Transform is the active and a quick way of Discrete Fourier Transform (DFT). Discrete Fourier Transform is the conversion that takes the Separated signal in spatial domain and converts this signal in its separated frequency domain performance. DFT is useful in the field of spectrum analysis. The speed of FFT is high and separated, and amount of separated nature of DFT is opportunity for analysis of signals spectrum in real time [14]. The characteristics of spectrum analysis may be useful for interpolation and find some missing values in other domain (frequency domain), then return to spatial domain using the inverse transform.

Morphological Image Processing

Morphology is an instrument for elicitation information of image that is helpful to performance and depicts the region of the shape and shapes' boundaries [15]. Morphology is usually deal with a binary image that contain only foreground (1) and background (0). Morphology used to remove noise from image and use to separate the object from the background of the image [16]. Morphological processes have two concept (Dilation and Erosion) Erosion is the operation used to reduce size of object depend on the structuring element (kernel) this kernel is two dimensional array with different shape of ones and zeros, where (X) represent the image and (Y) represent   the structuring element

$$E(X,Y) = X \ominus Y \qquad \qquad \text{... (1)}$$

Dilation is inverse operation of erosion. Dilation is used to expand object also depend on structure element. The morphological operation is used as a map for representing an object in the image

$$D(X,Y) = X \oplus Y \qquad \qquad \text{... (2)}$$

Proposed Method

This proposed work contains method with two main completion algorithms. The missing area is specified using binary mask. The mask was extracted from dataset that store some specific logos.

The First algorithm is Vertical, Horizontal and four Neighbors algorithm **(VH4NA)**, and The Second algorithm is Fast Fourier interpolation algorithm **(FFIA)**, the two algorithms are try to substituted the cracked (missed) pixel in frame of video and then fill the lost or degrade pixels with value in a visually plausible way. These missed pixels may be (object, text, spots, Scratches or logo) of these video. The proposed method is explained in figure (1). Video is a sequence of still images called frames, the frame is an array of 2D that contain pixels and each pixel have value (color pixel RGB). The reading of video is the step before preprocess. The preprocessing are extracted the frames from video (29 or 30 frames per second) and these frames be input to next stage for processing. The Selection of Algorithms: The proposed method contains two algorithms with different characteristic in qualities and complexities. The proposed method depends on factor to select the algorithms for completion. The selection of algorithms depend on analysis the texture that surround the missing area. The selections of algorithms are depending on some of statistical test. The tests are (mean, energy, entropy, standard deviation), of the surrounding pixels. These tests are useful to check up the texture of background of the missing or damage region in frames. The applying of two algorithms are depend on some specific threshold that can be responsible of selection one of these two algorithms.
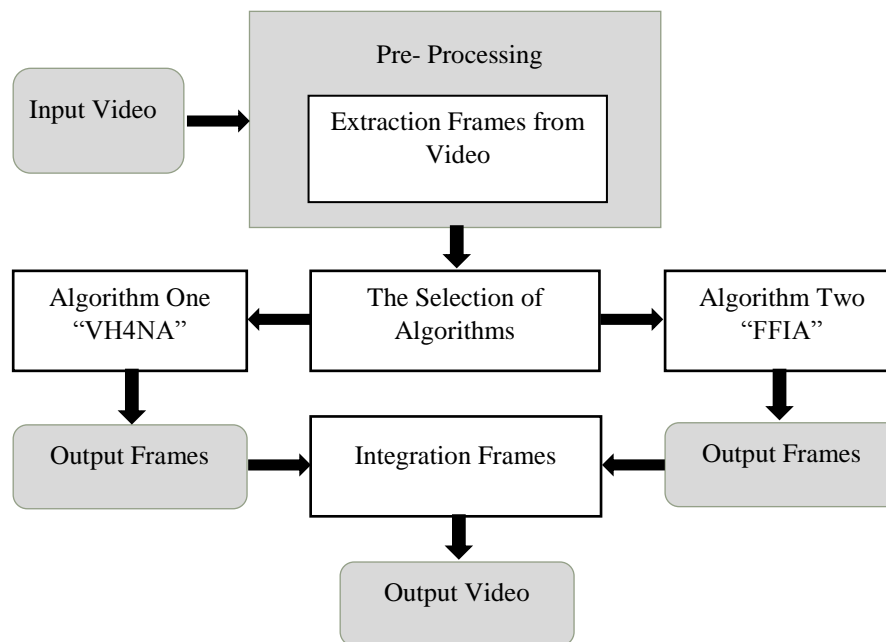
Figure (1): The block diagram explain the main process of the proposed methods

The First Algorithm (VH4NA)

The (**VH4NA**) is the first algorithm used in this work as shown in a figure (2). Each stage in the algorithm represents completion method:

> **The First Stage:** Is the vertical completion method, it interpolated the column pixel of the missed area in frame. The completion depended on binary mask to specify the missing region (logo) in frame of video. For each processed pixel (complete pixel) there are corresponding pixel in the mask (binary mask) have value (one) converted to (zero) after processed. Missing area are interpolated by take average of two pixels and put new value in

the center and then use this new value with another values to interpolated the reminder missing value.

The Second Stage: Is the horizontal completion method that get frame and mask from previous stage. The horizontal are interpolate row pixel from the pixel near to the missing region from the left and the right, and these pixels are not filling from previous stage. The output of these stages is input to the last stage.

```
┌─────────────────┐          ┌─────────────────┐
│      Frame      │          │      Mask       │
└─────────────────┘          └─────────────────┘
         │                            │
         ▼                            ▼
┌──────────────────────────────────────────────┐
│         Vertical Completion Method           │
└──────────────────────────────────────────────┘
         │                            │
         ▼                            ▼
┌──────────────────────┐    ┌──────────────────────┐
│ Partial Completion   │    │  Mask1 after Vertical │
│      Method          │    │  Completion Method    │
└──────────────────────┘    └──────────────────────┘
         │                            │
         ▼                            ▼
┌──────────────────────────────────────────────┐
│        Horizontal Completion Method          │
└──────────────────────────────────────────────┘
         │                            │
         ▼                            ▼
┌──────────────────────┐    ┌──────────────────────┐
│ Partial Completion   │    │ Mask2 after Horizontal│
│      Method          │    │  Completion Method    │
└──────────────────────┘    └──────────────────────┘
         │                            │
         ▼                            ▼
┌──────────────────────────────────────────────┐
│      Four Neighborhood completion method     │
└──────────────────────────────────────────────┘
                     │
                     ▼
           ┌─────────────────┐
           │  Output Frames  │
           └─────────────────┘
```
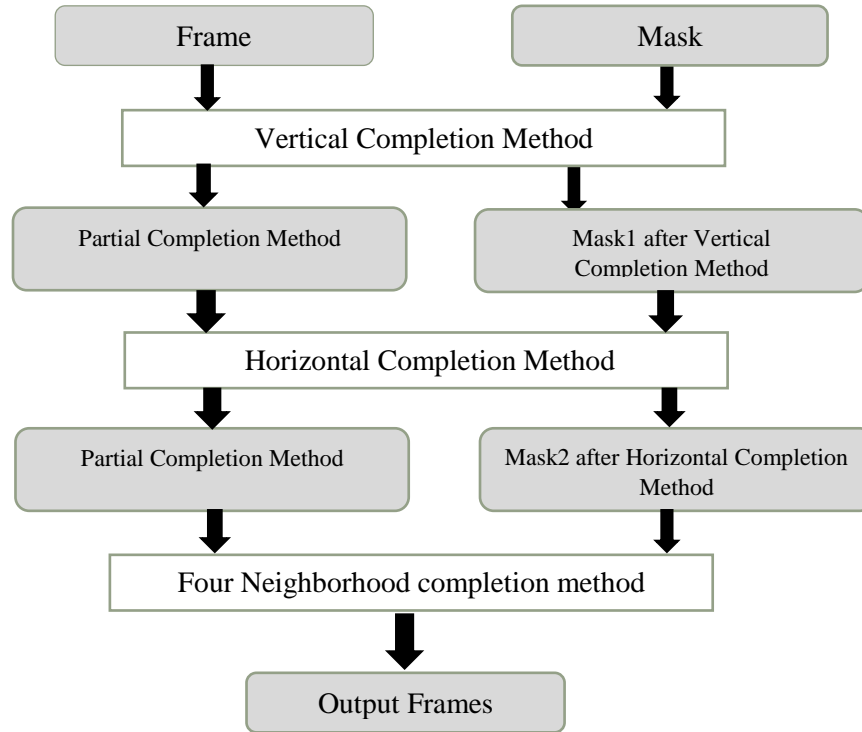
Figure (2): The block diagram explain the (VH4NA) algorithm for Completion

The Third Stage: Is a four neighborhood completion method. This method is process the reminder pixel that not fills from previous stages. By take average of missing pixel that not fills before. The technique is taking the average from the source pixel of the four neighborhood of missing pixel. Using window (3*3) slide on a frame when the center of window have value "1", the average of the four neighbor pixel value are calculated from the source frame (original frame) if there pixel value are greater than zero. That are represented in equation (3).

$$P(i,j) = \frac{p(i-1,j)+p(i,j+1)+p(i+1,j)+p(i,j-1)}{4} \qquad \text{... (3)}$$

Where mask (i, j) =1

The Second Algorithm (FFIA)

The **(FFIA)** is the second algorithm in proposed method; the algorithm used the fast Fourier transform as base to complete the missing region. The algorithm selects some pixels from

$P(i-1,j-1)$	$P(i-1,j)$	$P(i-1,j+1)$
$P(i,j-1)$	$P(i,j)$	$P(i,j+1)$
$P(i+1,j-1)$	$P(i+1,j)$	$P(i+1,j+1)$

surrounding area that are missed. The selection values (window) contain the missed object and some source pixel from surrounding area of missed region. From this window some periodic selective pixels are gotten, and these results "new window" smaller than selected window. The new window transform to frequency domain by fast Fourier transform, and get the same size window in frequency domain. The interpolation process contains insertion a new value between the values in the new window (in frequency domain), and then get a window similar to original window in size, and then transform it by inverse fast Fourier transform and return to the spatial domain. These processed are completed the missing pixels. Figure (3) illustrated this algorithm.
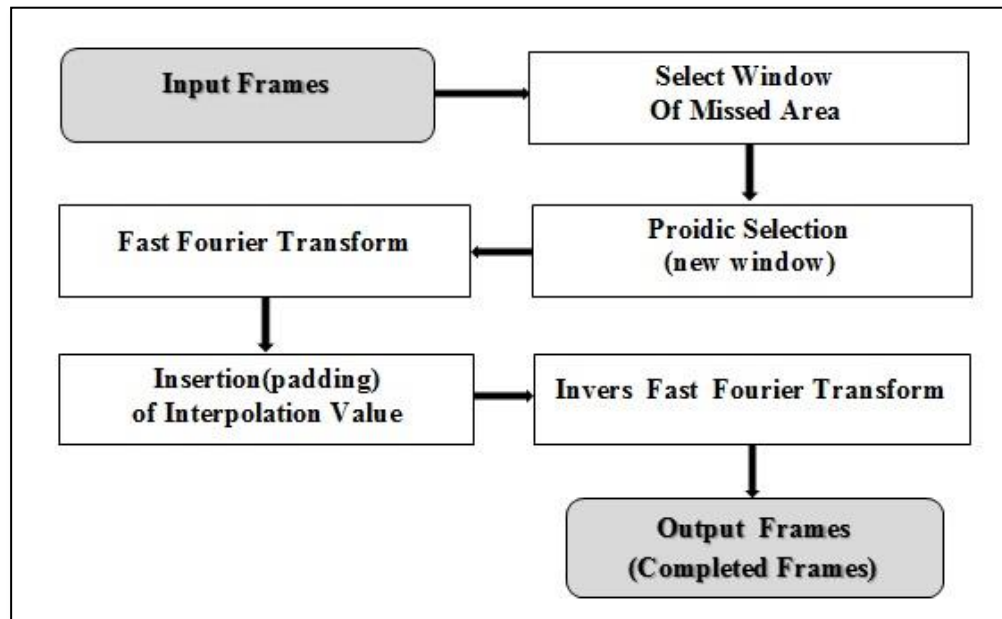
Figure (3): The block diagram explains the (FFIA) algorithm for completion Results

The qualities of frames results from proposed method are tested to evaluate the completion method with respect to original frames. The mean square errors and peak signal to noise ratio are used for testing frames. Table (1) explain the PSNR and MSE m of some sample of frames, while figure (4) explain some sample of the original and completion frames.

Table (1): The fidelity criteria results of frames

Algorithm1 (VH4N)			Algorithm2 (FFIA)		
Examples	**MSE**	**P-SNR**	**Examples**	**MSE**	**P-SNR**
Frame1	152.773	26.1734	Frame1	360.474	21.7415
Frame2	156.941	26.1734	Frame2	435.441	21.7030
Frame3	160,552	25.8741	Frame3	447.524	21.6226
Frame4	168.138	22.5621	Frame4	439.193	21.7042
Frame5	176.111	22.4520	Frame5	422.333	21.6630

The complexities of proposed method are different on each algorithm (algorithm1, algorithm2). The time consuming for each processing of each frame are explain in Table (2). The (VH4N) algorithm is less time consuming than (FFIT) algorithm. The proposed algorithms are depending on selection process.

Table (2): The time consuming for each algorithm

Algorithm1 (VH4N)				Algorithm2 (FFIA)			
Frame1	0.836 Sec	Frame6	0.734 Sec	Frame1	0.941 Sec	Frame6	0.933 Sec
Frame2	0.801 Sec	Frame7	0.736 Sec	Frame2	0.922 Sec	Frame7	0.923 Sec
Frame3	0.795 Sec	Frame8	0.739 Sec	Frame3	0.929 Sec	Frame8	0.914 Sec
Frame4	0.796 Sec	Frame9	0.729 Sec	Frame4	0.921 Sec	Frame9	0.952 Sec
Frame5	0.803 Sec	Frame10	0.737 Sec	Frame5	0.920 Sec	Frame10	0.913 Sec
Average: 0.771 sec				**Average: 0.9268** sec			

Figure (4): The implementation of the proposed methods

CONCLUSIONS

The proposed method presented efficient methods for filling the missing area in the frames of video. The operation of completion the missing area (logo) is estimated   depending on background information whether background are static or dynamic. The first algorithm (VH4NA) is deal with

simple background while the second algorithm is deal with complex background to fill the missing areas in sequential frames in video. The quality of frame completion of the first algorithm (VH4NA) has given less average of MSE (32241.1926) and high average of PSNR (24.647) while the second algorithm results MSE (420.993) and PSNR (21.68686). The average time complexity of first algorithm (0.771sec) was less than the second algorithm (0.9268 sec). The proposed method can be applied to remove text, watermark, scratches or moving object. The proposed methods are flexible for contribution with other method.

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