Performance Evaluation of Different Techniques of Differential Time Lapse Video Generation

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***Abstract* - There are numerous applications in which we use Video Communication, but the video size always remains one of the major difficulty associated with it as it increases the cost & bandwidth required to transmit the video . Based on the requirement most of the video recording does not need to be record everything, it requires only less information compared to a normal video therefore in order to save the storage requirement and time to visualization of the video, to do so it is need to remove non informative. Time lapse technique is a video generation technique in which each and every frame is capture and stored after some time interval. This time interval or frame selection can be based on a time period the framing device or difference between successive frames, based on that time lapsing is different for periodic or non periodic event. . If event is periodic or certain than we can use periodic time lapsing in which record each and every frame after a fixed duration of time. Differential Time Lapse video is a non periodic time lapse technique in which video generation of by capturing each frame and comparing with the previous stored frame. This can be achieved by different methods like pixel to pixel bit mapping, edge detection or motion detection. These are the methods for the frame section. Differential time lapse video does not give the information about at which time the event is occurred so in order to find the same in the video output loss less visual watermarking can be used. In this paper MATLAB based algorithm is used for generating the differential time lapse video where frame selection criterion are based on bit mapping algorithm and different edge detection techniques along with the date and time stamping using the loss less visual watermarking.**

***Keywords* - Time-lapse, Differential Time-lapse, Pixel to pixel mapping, Edge detection, Pixel difference threshold, watermarking**

I. INTRODUCTION

There are three famous techniques to generate time-lapse video. The time lapse video can be generated in real time or using post presses on the video. The different techniques which are used for the generation of time lapse are discussed below.

A. Time-lapse video using noncontiguous acquisition: In this method, frames are captured from the live video streams. We can set the frame capture interval property specifies how often frames are stored from video stream. For instant, if we set frame capture interval to 10, then only 1 in 10 frames are kept, the other 9 frames will be discarded. These selected frames are stored back to back to generate time-lapse video. Disadvantages are in order to have 20 frames in time-lapse video, we need to capture 20*n (where n is frame capture interval) frames. The system will be counting for each frame and waiting for the required number frame, means busy like polling algorithm based system.

B. Time-lapse video using time events: In this method, we make out timer running back side in the system and when timer runs out of time, we capture a frame and reload the timer to run it, and wait for time till timer runs out of time. Here, we capture frames at equally separated time period as in previous case. Compare to time-lapse video using noncontiguous acquisition, time gap is available between two successive frame capture while we just have to wait for timer running out. Advantage: Time gap can be utilized for image processing and storing or sending the information through net, allows us to generate real time application.

C. Time-lapse video using post processed data: This method is ideal for situation where we are not sure which frames are relevant during capture or where our processing would take too long time to occur during the acquisition. The possible application would be to delete frames that have no motion relative to the previous frames. Here, we may have the time gap between to consecutive frames and those needs to be stored for generating time lapse video. It makes sure that there is no redundant information present in video.

From above discussion it is clear that for the generation of time lapse video it is need to arrange frames in a specific order based on selection criterion. First step is to capture the initial frame and store it in a video file to compare it with the next frame [5].

Pixel to pixel bitmapping algorithm looks for the change in the intensity values of the pixels for the identification of difference between two consecutive frames. If the difference in the intensity value of the pixel of current frame and pixel of previously stored frame is greater than the predefine pixel difference threshold than the pixel of the current frame is considered as the modified one. If the total number of modified pixel exceeds 10% of total number of pixel in the previously stored frame then current frame is considered as modified frame and stored in to the video file else get discarded. Ones frame got selected it will go

for date and time stamping as the differential time lapse video is aperiodic technique it doesn't provide any information at which time the frame was captured for this loss less visible water marking issued.

In the edge detection criterion the current frame is compared with the edges of last frame stored by edge detection algorithm. If the edges are differed by some predefine value, then the frame is selected for storing in video file else discarded.

Edge detection is the process of identifying and locating sharp discontinuities in an image. The discontinuities are sudden changes in pixel intensity which characterize borders of objects in a image. Traditional methods of edge detection involve convolving the image with an operator (a 2-D filter), which is designed to be sensitive to large gradients in the image while returning values of zero in consistent regions. There are an very large number of edge detection operators available, each designed to be sensitive to definite types of edges. Variables concerned in the selection of an edge detection operator consist of edge structure, Noise environment and edge orientation [4].

The geometry of the operator finds a characteristic direction in which it is mainly sensitive to edges. Operators can be optimized to look for vertical, horizontal or diagonal edges. Edge detection is not easy task in noisy images, because both contain high frequency content. Attempts to reduce the noise result in distorted and blurred edges. Operators used on noisy images are normally larger in scope, so they can average enough data for reduction localized noisy pixels. Then outcome will be less accurate localization of the detected edges. All edges don't involve a step change in intensity. Effects such as refraction or reduced focus can result in objects with boundaries defined by a slow change in intensity [1]. The operator needs to be chosen to be reactive to such a gradual change in those cases. So, there are troubles of missing true edges, false edge detection, high computational time, edge localization and troubles due to noise etc. so, the purpose is to do the comparison of various edge detection techniques and examine the performance of the different techniques in various conditions. There are a lot of ways to perform edge detection. However, these techniques of edge detection can be grouped into two categories:

1. **Gradient based Edge:**
   The gradient method detects the edges through looking the maximum and minimum in the first derivative of the image.
2. **Laplacian based Edge Detection:**
   The Laplacian method finds zero crossings in the second derivative of the image for edge detection. An edge has the one-dimensional shape of a ramp and manipulating the derivative of the picture can emphasize its location.

II. PIXEL TO PIXEL BITMAPPING ALGORITHM

The simplified bit mapping algorithm is as depicted in the figure 1. Because of simplicity and its run faster and smoother in real time bit mapping algorithm is selected.

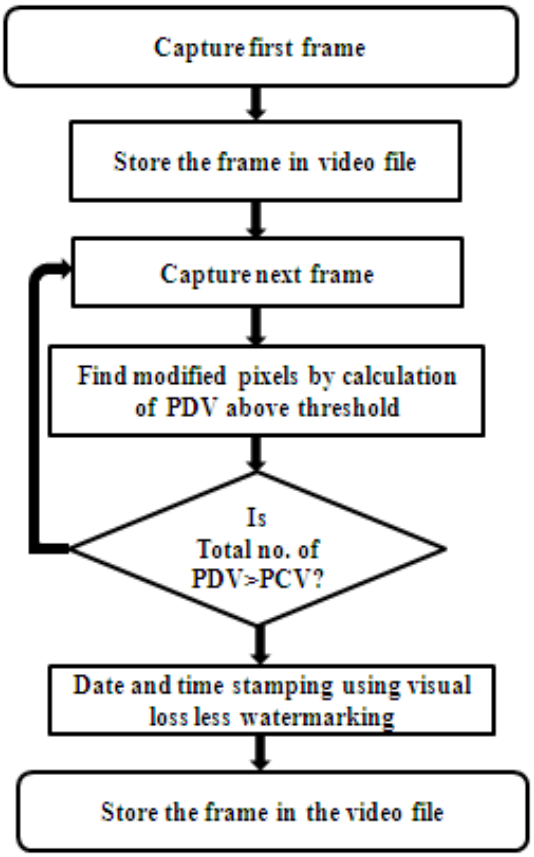


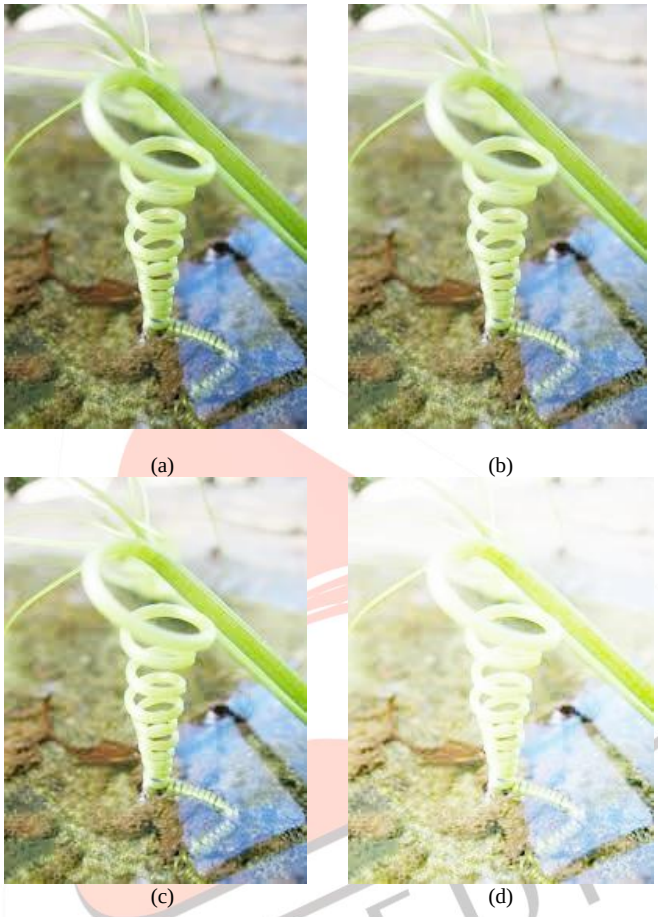
Figure 1: Algorithm of pixel to pixel bit mapping

The initial frame is capture and stored in to the video file to be generate then the next frame is captured. This frame is compared with the previously already stored frame on the pixel to pixel basis. If the difference in the pixel value of current and previously stored frame is greater than by some predefine threshold (PDT) then the pixel of current frame is considered as

modified one. The value of the pixel difference threshold is kept around 20 to ensure that the intensity of the pixel doesn't change due to some environmental change but due to some change in object only. If the total no of modified pixel i.e. pixel difference value (PDV) exceeds some predefine pixel cutoff value (PDC) then the current frame is consider as modified one and it will be stored in to the video file else get discarded[1][2]. So it is clear that the quality of the video is totally depends upon the parameters PDV and PDC

III. LIMITATION OF BITMAPPING

The figure2 shows the sequence of images whose brightness increases frame by frame. The changing effect cannot be visualized in nearer figure easily, but as comparing

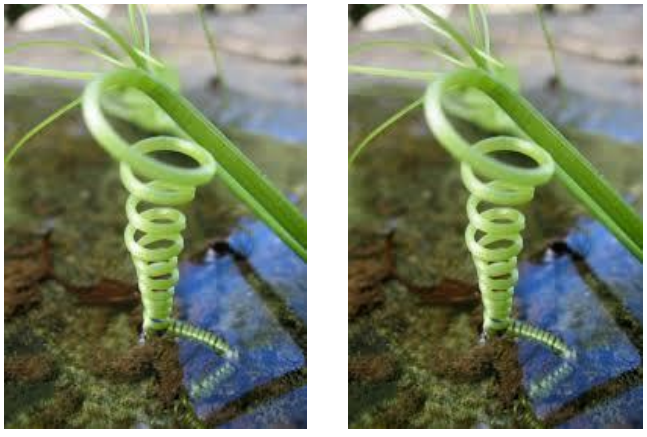


(a) (b)

(c) (d)

Figure 2 : Effect of change in brightness

The first with third or fourth it can be visualized easily. The figure 3 shows the sequence of images whose contrast changes frame by frame; the change is so that between two consecutive frames cannot be identified.



(a) (b)

(c) (d)

Figure 3 : Effect of change in contrast

The brightness and contrast modifies the intensity of the pixel and if such modified pixels are considered as PDV the frame selected doesn't convey any information because it is got selected only because of change in brightness or contrast not due to change in movement. This will affect our goal which is to reduce the size of video. One of the ways to solve this problem is to increase the value of pixel difference threshold above 20 but due to this the important fine details may be lost.

IV. EDGE DETECTION BASED ALGORITHM

Limitation of the previous techniques i.e. bit mapping can be overcome with the help of various edge detection techniques. In edge detection based differential time lapse video generation difference between two frames i.e. frame selection criteria is based on the edge detected output of the frame. In this type of frame selection criterion the comparison of frames has been carried out on the basis of amount of the difference in the edges of the successive frames.

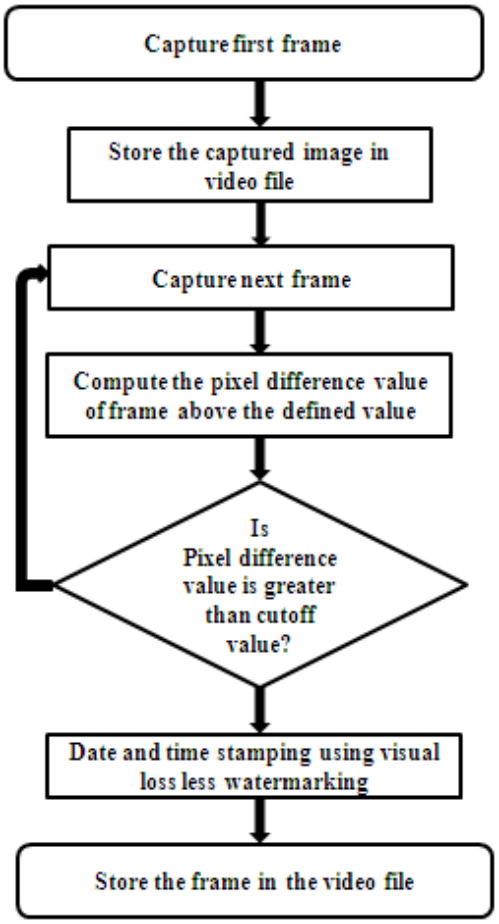


Figure 4 : Algorithm of edge detection based time-lapse video generation

As the edges of the frames could not be affected by change in the brightness and contrast of the major drawback of the bit mapping algorithm is overcome, means in this type the frame selection is independent from the effect of change in brightness and contrast. The main advantage of using this method is that the edges are not so much affected due the contrast and/or brightness changes. Hence we do not have to proceed for these changes. The simplified algorithm is used to generate the differential time

lapse video instead of with complex algorithm of motion detection is because it is real time application and for that the simplest algorithm performs well. The simple edge comparison based algorithm is used to sense the motion.

The simplified algorithm is shown in the figure 4. After capturing the first frame and processed to detecting its edges it will be stored to video file as initial frame[1].The next step will be to get the next frame and then detect its edge and compare it with the saved reference edge of last saved frame in video file. The comparison will be made based on pixel to pixel comparison of presence as well as absence of an edge pixel. The number of changes in the presence of edge pixel in two frames will be counted and treated as the error or motion pixels. If the motion pixel count or say error is greater than threshold value than this frame will be time and date stamped for the record of event occurrence timing and then it will be saved in the video file and its edge will be taken as the reference edge for the next frame, else this will discarded and go for the next frame. Here the main thing should be taken in account is that the thresholding for frame to be saved or not is depend on the edge detection technique used. Here we can set the number for the number of frame which we want to store in the video file and it is totally depends on the application the limitation can also be made in terms of time period over which we want to capture the live video frames.

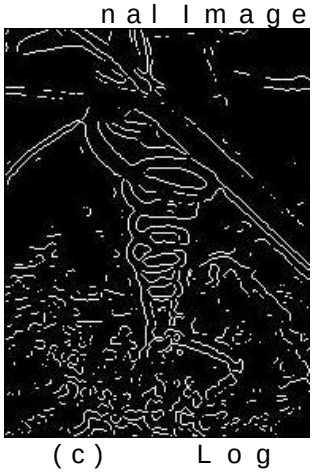
V. SELECTION OF EDG EDETECTION OPERATORS

There are main edge detection operator grouped into two categories, gradient and Laplacian. The gradient method detects the edges through looking the maximum and minimum in the first derivative of the image. Robert, Sobel etc are example of the first derivative. The Laplacian method finds zero crossings in the second derivative of the image for edge detection. Prewitt, Canny, Laplacian etc are examples of the second order derivative. Figure5 shows the original image and the results obtained by applying the different edge detectors to it. Most edge detection methods work on the assumption that the edge occurs where there is a discontinuity in the intensity function or a very steep intensity gradient in the image Using this assumption, if one take the derivative of the intensity value across the image and find points where the derivative is maximum, then edge could be located. The gradient is a vector, whose components measure how rapid pixel value are changing with distance in the x and y direction The Sobel and Roberts's operator are an example of the gradient method. The Sobel is a discrete differentiation operator, manipulating an approximation of the gradient of the image intensity function (Sobel & Feldman, 1968) [4].

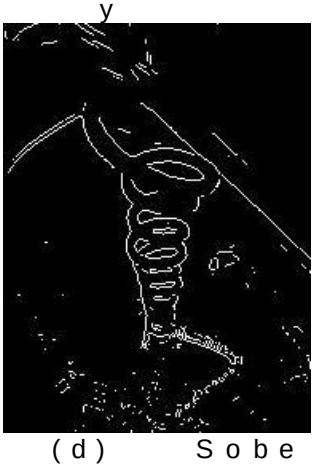
The Canny edge operator was designed by John F. Canny in 1986 and uses a multistage algorithm to detect a wide range of edges in images[4]. In addition, canny edge detector is a complex optimal edge detector which takes significantly longer time in result computations. The image is firstly run through a Gaussian blur to get rid of the noise. When the algorithm is applied, the angle and magnitude is obtained which is used to determine portions of the edges to retain. There are two threshold cut-off points where any value in the image below the first threshold is dropped to zero and values above the second threshold is raised to one [4].The Laplacian is a 2-D isotropic measure of the 2ndspatial derivative of an image. The Laplacian of an image highlights area of quick intensity variation and is therefore often used for edge detection. The Laplacian is often applied to an picture that has first been smoothed with somewhat similar to a Gaussian smoothing filter in order to

(a) Original Image

(b) Canny



(c) Log



(d) Sobe

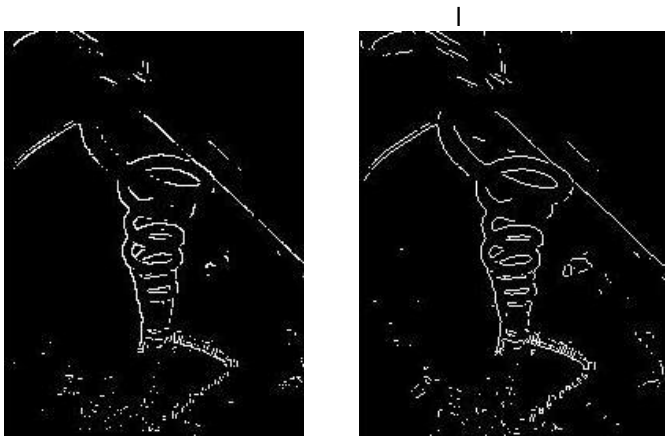


Figure 5 : (a) to (f) Original image and its edge results with different edge detection techniques

its sensitivity to noise. The operator usually takes a single gray level image as input and generates another gray level image as output[4].

Table 1: Frame selection of different techniques of edge detection with various thresholds

TECHNIQUE	NUMBER OF SELECTED FRAMES	FRAME SELECTION RATIO(%)
THRESHOLD 1 = 10000		
Canny	289	100.00
Sobel	287	99.31
Prewitt	284	98.27
Log	289	100.00
Roberts	289	100.00
THRESHOLD 2 = 15000		
Canny	289	100.00
Sobel	222	76.82
Prewitt	210	72.66
Log	276	95.50
Roberts	235	81.31
THRESHOLD 3 = 20000		
Canny	280	96.89
Sobel	172	59.52
Prewitt	167	57.79
Log	265	91.70
Roberts	197	68.17

THRESHOLD 4 = 25000		
Canny	260	89.97
Sobel	113	39.10
Prewitt	109	37.72
Log	248	85.81
Roberts	161	55.71
THRESHOLD 5 = 300000		
Canny	243	84.08
Sobel	69	23.88
Prewitt	60	20.76
Log	227	78.55
Roberts	118	40.83

From figure 5 it is clear that the Canny and the LoG operators which uses the second order derivative to find out the edges are covering the fine details also as compare to the Sobel and Roberts which uses first order derivative to find out the edges.

VI. RESULTS

The performance of the pixel to pixel bit mapping and the edge detection for the differential time lapse video must be checked on same video stream, which is not possible in the case of real time video streaming data. In order to overcome this limitation, already stored video file is converted in to the frames and then applied to generate the differential time lapse video. Here in this paper for the performance evaluation we consider the video rhino.avi an uncompressed avi file with the resolution of 1920×1080 for each frame. This video contains 289 frames and it acquires the 9.08 MB of storage space.

Form table 1 it can be easily seen that for each of the technique number of selected frames for the video generation is different based on different threshold. By observing this table we can make a parameter named frame selection ratio as

F.S.R = Number of selected frames/Total no. frames. This single parameter gives the idea about the number of frames selected for the video.

VII. COMPARISON OF BOTH ALGORITHMS

The comparison of both algorithms can be possible in non real time only so again we consider the same rhino avi discussed earlier.

Table 2 :Comparison of both the techniques

TECHNIQUE	THRESHOLD	NO.OF FRAMES SELECTED	SIZE OF VIDEO (MB)	FSR (%)
BIT MAPPING	10000	281	8.83	97.23
	15000	278	8.73	96.19
	20000	268	8.42	92.73
	25000	253	7.95	87.54
	30000	245	7.70	84.78
EDGE DETECTION	10000	289	9.08	100
	15000	289	9.08	100
	20000	280	8.79	96.89
	25000	260	8.16	89.97
	30000	243	7.63	84.08

Here for the edge detection canny operator is used, reason can be easily understood by studying table no.2. Value of PDT will be kept constant at 20. The comparison of the algorithm should be done on parameters like processing time, size of output video

and the frame selection ratio on the by keeping the value of threshold same for both the algorithm. From table no.3 it can easily be understood that the processing time required by the edge detection algorithm is more as compared to the bit mapping algorithm this is because finding and comparing edges will consume more time. But in other way we can say that the accuracy of the edge detection is higher because it covers fine details also which may have been lost the in bitmapping algorithm. Covering the fine details increases the no of frame selected which ultimately affects our aim to reduce the size of video. So selection of the threshold should be depending upon the application in which whether we want to cover the fine details or not.

VIII. CONCLUSION

Unknown movement time-lapse method is presented for creating non-periodic time-lapse video which provide superior compression of time without lost any of the important information. Based on user-specific characteristics, we can generate time-lapse videos with periodic or non-periodic lapse in time. Our suggested non-periodic lapse chooses the frames of the time-lapse video using an image processing in MATLAB application which is user specified and hence performance of the system is better on special cases where user defines their parameters.

The performance of the edge detection criterion is good compared to pixel to pixel bit mapping or motion detection criterion in terms of accuracy. Comparative of the different edge detector criterion is quite difficult to analyze as the image and video are dynamic here, still by visualizing the effect of edge detection in table 2, it can be seen that Canny and LoG based edge detection contains fine details; while Prewitt and Sobel based edge detection contains major edges only. Hence, from this it can be concluded that for indoor differential time lapse video generation Canny and LoG are preferable while for outdoor generation Sobel and Prewitt are preferable. Though, any edge detector operator can be utilized depends on observation area.

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