Change Detection in Video using Pixel based Parametric Analysis

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Abstract

Background/Objectives: This paper contains the change detection between frames of a video. The main objective is to show how the sequence of frames differ from one another in a video. Methods/Statistical Analysis: The amount of change between two frames is measured using the pixel based change detection parameter’s Absolute Average Difference (AAD), Peak Signal to Noise Ratio (PSNR), Normalized Correlation (NC), Signal to Noise Ratio (SNR) and Mean Squared Error (MSE). These parameters detect the changes in each and every pixel of the frame with respect to other frame and values are calculated for each frame of a video and compared in the tables followed by analysis of the values. Findings: The results indicated the changes that are not perceived by the human eyes. They depict that if the change between two frames are visible to the human eyes then they differ more based on the parameter we have considered and if the change is not visible to the eyes then minute differences is observed between the two respective frames. Application/Improvements: The change detection plays a significant role in visual media. Based on the change detection of frames, analysis of a video can be done.

Keywords: Change Detection, Frame, Mean Squared Error, Normalized Correlation, Peak Signal to Noise Ratio, Pixel

1. Introduction

In a sequence of frames the detection of intensity changes in the two consecutive frames is an important. Converting a single scene into a multiple set of images is called framing of scene. Every video or scene consists of certain amount of frames. The more the clarity of the video is, the more is the number of pixels present in the frames of that respective video. Pixels in the frames of a video behave as a medium for depicting the video quality. So as the movement of frames at a particular constant rate constitute a video, it is important to detect the changes in the frames along the movement of the frames for obtaining the better quality. Detection of change based on the changes in pixels of the frames can be done effectively.

Human eye can sense the changes in video up to some extent and some changes are not in the vicinity of human eye. Change detection helps to identify some changes that cannot be perceived by the human eye. So detection of change based on the changes in pixels of the frames can be done effectively. Change detection is classified into two types, the supervised method and the unsupervised method. Detection of change based on the pixels values of images taken at different times comes under unsupervised method. In supervised method the change is calculated from the data produced from multi spectral images. Most widely used change-detection techniques in unsupervised method is “difference image” based on pixels. Many unsupervised methods were proposed which are based on parametric estimation of change detection. In various applications image processing measures plays a crucial role. MSE, PSNR and SNR are most widely used parametric measures. The parametric estimation of

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change detection based on pixels helps to study about the changes in frames of a video.

Based on object-based change detection of images presented the pixel based change detection in a traditional view which is more potential. Author in their paper shading model method and the derivative model method for change detection by simple differencing. An unsupervised technique in change detection is proposed by extracting feature vectors for each pixel values and clustering them. Thomas Schroder et al., in their paper proposed a deflagration detection algorithm that is based on image processing. This deflagration algorithm consist of two stages fire-like pixels are identified in the first stage and frequency based analysis is done in the second stage. A Linear Mixture Model (LMM) is proposed by which produces fractional images from each end members of scene and estimates the changes in pixels that occurred in fractions. Author in proposed a robust change detection technique based on difference of texture between two frames. Author in proposed modern change detection algorithms for core decision rules and common processing steps in a systematic survey in which each pixel is assigned to an object class and very powerful change detection algorithm is produced by change models. Author in proposed an universal image quality index that is applicable for various applications in image processing.

2. Change Detection Methodology

Generally the value of pixels in frames is responsible for the quality of the image. Since the video contains different sets of frames, the change detection is done based on how pixel values in each frame differs from other frames. The changes are detected based on some standard parameters like Absolute Average Difference (AAD), Peak Signal to Noise Ratio (PSNR), Normalized Correlation (NC), Signal to Noise Ratio (SNR) and Mean Squared Error (MSE). These standard parameters are calculated by comparing any two frames and can be calculated as follows.

2.1 Mean Squared Error

MSE is the simplest measurement for change detection between two frames. Suppose if two frames A and B are compared for change detection then MSE can be calculated by subtracting pixels of row column of frame A with row column pixels of frame B and the resulting set of pixels are squared. This Squared value set is summed and divided with the dimensions of the frames. MSE is calculated as follows.

\[
MSE = \frac{1}{RC} \sum_{i=1}^{R} \sum_{j=1}^{C} (A_{ij} - B_{ij})^2
\]

Here \(A_{ij}\) is the frame A.

\(B_{ij}\) is the frame B.

R and C are the row and column dimensions of the frame respectively.

MSE is one of the quality metric for frames. If the MSE value is low then the change between the two compared frames is less.

2.2 Peak Signal to Noise Ratio

Peak Signal to Noise Ratio depends on the MSE value. It is calculated based on the MSE value obtained. It is expressed in terms of decibels (dB). Suppose if two frames A and B are compared then PSNR value is calculated as follows.

\[
PSNR = 10 \log_{10} \left( \frac{\text{Max}(A)^2}{\frac{1}{RC} \sum_{i=1}^{R} \sum_{j=1}^{C} (A_{ij} - B_{ij})^2} \right)
\]

Where \(A_{ij}\) is the frame A.

\(B_{ij}\) is the frame B.

R and C are the row and column dimensions of the frame respectively.

Max(A) is the maximum pixel value in frame A.

\[
\frac{1}{RC} \sum_{i=1}^{R} \sum_{j=1}^{C} (A_{ij} - B_{ij})^2
\]

is the MSE value of two frames A and B.

PSNR value is inverse to the MSR value. If the PSNR value is low then the change between two compared frames is more. Higher the ratio, the less is the noise between frames.

2.3 Signal to Noise Ratio

The SNR is used to measure the sensitivity of the image or frame. It is expressed in terms of decibels (dB). If two frames A and B are compared then the SNR value is obtained as follows.

\[
SNR = 10 \log_{10} \left( \frac{\sum_{i=1}^{R} \sum_{j=1}^{C} (A_{ij})^2}{\sum_{i=1}^{R} \sum_{j=1}^{C} (A_{ij} - B_{ij})^2} \right)
\]
Where,

$A_{i,j}$ is the frame A.
$B_{i,j}$ is the frame B.
R and C are the row and column dimensions of the frame.

The limitations for SNR value is similar to PSNR value. The more the SNR value the less the change occurred between two frames.

2.4 Normalized Correlation

Normalized Correlation evaluate the closeness of two images or frames. It is complimentary to the difference based measure. For two frames A and B it is calculated as follows

$$NC = \frac{\sum_{i=1}^{R} \sum_{j=1}^{C} (A(i,j) \times B(i,j))}{\sum_{i=1}^{R} \sum_{j=1}^{C} (A_{i,j})^2} \tag{4}$$

Where,

$A_{i,j}$ is the frame A.
$B_{i,j}$ is the frame B.
R and C are the row and column dimensions of the frame.

Normalized correlation value ranges between -1 and 1. The two frames are said to be similar if the NC value is equal to one, if it deviates more from one then there is change in the two frames based on the amount of its deviation from one. The change between the frames is minimum if the value ranges near to 1.

2.5 Average Absolute Difference

The Average Absolute Difference is the mean of the absolute difference of the two frames or images. The AAD for two frames A and B is calculated as follows:

$$AAD = \frac{1}{N} \sum_{n=1}^{N} |A - B| \tag{5}$$

N is size of the frame.

If the Absolute Average Difference value is less, the change detected between the frames is less.

3. Results and Discussion

Based on these parameters, change detection is found between the frames and analysed. 8 consecutive frames of a video are taken and the change detection is found for them by comparing each frame with the rest of the 7 frames. From the 8 frames that we have considered 4 frames from frame-3 to frame-6 are shown in the Figures 1, 2, 3 and 4.

These frames look identical to human eye and the change is not perceived by the human eye. The parametric values are calculated for each frame and they are as follows. MSE values are tabulated in Table 1. PSNR values are tabulated in Table 2, SNR in Table 3, NC values in Table 4 and AAD values in Table 5.

Based on the values of parameters obtained for each parameters the relation of one frame with the others in terms of change detection is clearly depicted. As each parameter has some limitations in its value in the change...
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Detection metrics detection is done very effectively. A relation is depicted based on how these parametric values for each frame is changing with respect to other frames. The graphical representation of the parametric values are shown in Figures 5, 6 and 7.

### Table 1. MSE values

| FRAMES | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | 0.38690 | 0.3809 | 0.3821 | 0.3907 | 0.3652 | 0.3675 | 0.3677 | 0.3674 |

### Table 2. PSNR values

| FRAMES | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | 30.8569 | 30.7046 | 30.6736 | 30.5915 | 30.4201 | 29.4408 |        |       |

### Table 3. SNR values

| FRAMES | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | 19.9509 | 19.7988 | 19.7297 | 19.6851 | 19.6754 | 19.5193 | 20.5339 |       |

### Table 4. NC values

| FRAMES | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | 0.0998 | 0.0999 | 0.0999 | 0.0999 | 0.0999 | 0.0999 | 0.0999 | 0.0999 |

### Table 5. AAD values

| FRAMES | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | 0.3769 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

The Figure 5 gives the relation of how MSE values of frames are varying in a set of frames. The Figure 6 is related to PSNR value and Figure 7 for NC values.
4. Conclusion

In this paper different change detection parameters were analysed and experiments are conducted by considering a set of frames for a video. The frames that are shown in Figure 1 to Figure 4 seems to be similar to the human eye. The changes occurred between them cannot be perceived by the human eye. The experimental results depicts the minute changes between the consecutive frames. For the two frames in Figure 1 and Figure 2 which represents frame 3 and frame 4 in Tables the MSE analysis value changes from 55.26 to 56.16 similarly PSNR value changes from 30.7 to 30.64. For Figure 3 and Figure 4 which represents frame5 and frame6 the MSE and PSNR values changes from 56.75 to 56.88 and 30.59 to 30.58 respectively. These parametric results show changes that are not visible to the human eyes. From the results it is clearly depicted that if there are N frames in a video, if the change between the frames N-5 and N-4 is clearly visible to the human eye then the change detection parameters show greater change in the values. In the 8 frames that are chosen for experimental purpose the change between the frame-1 and the remaining frames can be perceived by the human eye so the parametric values shows greater change sensing values when it is compared with rest of the frames.

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