Experiment-3.1

Aim of the Experiment : A scene change detection based on Gaussian Mixture Model.

Problem Description :

Scene change detection based on Gaussian Mixture Models (GMM) is a technique used to identify significant transitions or changes between consecutive frames in a video sequence. The underlying idea is to model the pixel intensity differences between frames using a statistical model, typically a mixture of Gaussian distributions. By analyzing the characteristics of these differences, scene changes such as cuts, fades, or other types of transitions can be detected.

The process of Scene change detection using GMM includes:

1) Frame Difference: The first step in scene change detection is to compute the absolute difference between consecutive frames in the video sequence. This operation highlights regions in the image where significant changes in pixel intensity occur.

2) Modeling Differences with GMM: The absolute differences obtained in the previous step are treated as observations to be modeled statistically. A Gaussian Mixture Model (GMM) is used to represent the distribution of these differences. GMM assumes that the observed data is generated from a mixture of several Gaussian distributions, each representing a different source of variation in the data. In the context of scene change detection, GMM is used to capture the variability in pixel intensity differences caused by various factors such as motion, lighting changes, or scene transitions.

3) Parameter Estimation: The parameters of the GMM, including the means, covariances, and mixing coefficients of the Gaussian components, are estimated from the observed pixel intensity differences. This estimation is typically done using an iterative optimization algorithm such as the Expectation-Maximization (EM) algorithm.

4) Likelihood Calculation: Once the GMM is fitted to the observed data, the likelihood of each pixel intensity difference belonging to the background model is computed. This likelihood represents the probability that a given pixel difference is consistent with the background distribution learned by the GMM.

5) Thresholding: A threshold is applied to the likelihood values to generate a binary mask indicating regions of the image that are likely to be part of the background (unchanged) or foreground (changed). Pixels with likelihood values below the threshold are classified as part of the background, while those above the threshold are classified as part of the foreground.

6) Scene Change Detection: By analyzing the binary mask, significant changes in the scene can be detected. If a large portion of the image is classified as foreground (indicating significant changes), it suggests the presence of a scene change. The specific criterion for determining a scene change (e.g., the percentage of foreground pixels) and the threshold used for binary classification can be adjusted based on the characteristics of the video and the desired sensitivity of the detection algorithm.

Code :

```
% Load video
videoReader = VideoReader('snowfall.mp4');

% Parameters
numFrames = videoReader.NumFrames;
threshold = 30; % Adjust according to your video characteristics

% Background modeling with GMM
backgroundFrames = read(videoReader, [1, 50]); % Capture initial frames
background = mean(backgroundFrames, 4); % Compute background model
backgroundGray = rgb2gray(background);

% Fit GMM with regularization
gmm = fitgmdist(double(backgroundGray(:)), 3, 'Regularize', 0.01);

% Scene change detection
for i = 51:numFrames
    % Read frame
    frame = read(videoReader, i);
    subplot(1,2,1), imshow(frame);
    title("Original Frame");
    frameGray = rgb2gray(frame);

    % Calculate difference
    diffFrame = abs(double(frameGray) - backgroundGray);

    % Thresholding
    binaryDiff = diffFrame > threshold;

    % Post-processing (optional)
    binaryDiff = bwareaopen(binaryDiff, 50); % Remove small noise

    % Display result
    subplot(1,2,2), imshow(binaryDiff);
    title(['Frame: ', num2str(i)]);
    sgtitle("Ashish Kumar, 23MAI10008")
    drawnow;
end
```

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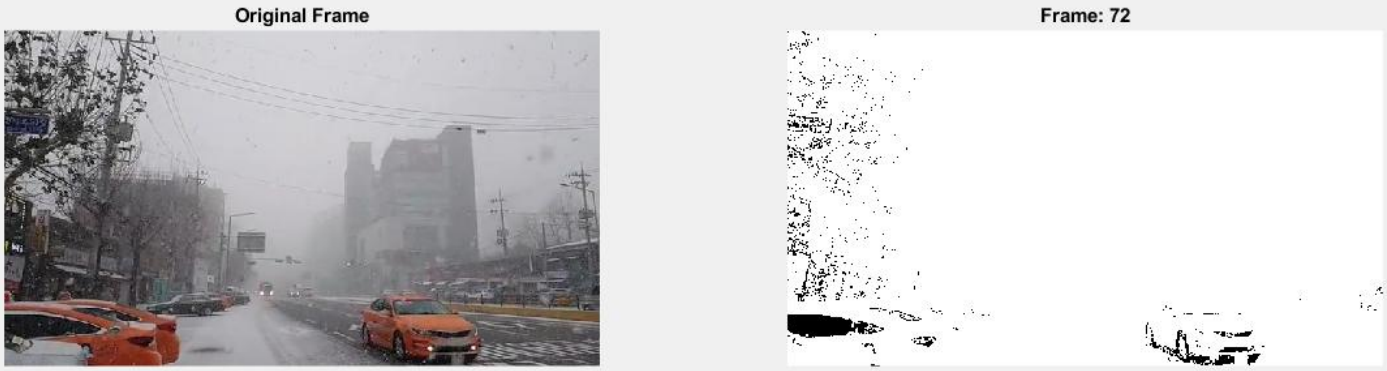
Output :

Ashish Kumar, 23MAI10008



Ashish Kumar, 23MAI10008

Learning outcomes :

1. Learnt about the concept of scene change detection.
2. Learnt about the concept of Gaussian Mixture Model.
3. Learnt about the foreground and background objects in a frame.
4. Learnt about mean, standard deviation and scale for gaussian model.
5. Learnt about the challenges related to scene change detection.