Experiment-3.3

Aim of the Experiment : Optical flow estimation in video sequences.

Problem Description :

Optical flow estimation is a fundamental problem in computer vision that involves tracking the motion of objects in a sequence of images or a video. The term "optical flow" refers to the apparent motion of objects in an image caused by the relative motion between the observer (camera) and the scene being observed. Estimating optical flow involves determining the velocity vector of each pixel in an image, indicating the direction and magnitude of its motion between consecutive frames.

Concepts related to Optical Flow Estimation:

1) Motion Assumption: Optical flow estimation relies on a key assumption known as the brightness constancy assumption. This assumption states that the intensity of a pixel does not change between consecutive frames, under constant lighting conditions. Mathematically, it can be expressed as:

2) Optical Flow Equation: Based on the brightness constancy assumption, the optical flow equation is formulated. It relates the spatial gradients of the image intensity to the motion of pixels:

3) Methods for Estimation:

a) Differential Methods: These methods compute the optical flow by directly solving the optical flow equation using spatial and temporal derivatives of image intensity. Techniques like Lucas-Kanade and Horn-Schunck fall under this category.

b) Correlation-based Methods: These methods search for the best match between small image patches in consecutive frames. Techniques like block matching and template matching are commonly used.

c) Variational Methods: These methods formulate the optical flow estimation as an optimization problem, where a cost function is minimized subject to constraints. The energy-based methods like the variational optical flow and the level set methods are examples.

4) Challenges and Limitations:

a) Illumination Changes: Optical flow estimation can be sensitive to changes in illumination, violating the brightness constancy assumption.

b) Textureless Regions: In areas with little texture or uniform regions, optical flow estimation becomes challenging due to the lack of distinctive features.

c) Large Displacements: Estimating optical flow accurately for large displacements or complex motion patterns is difficult.

5) Applications:

a) Video Compression: Optical flow estimation can be used in video compression algorithms to predict motion between frames, enabling efficient compression by transmitting only the differences.

b) Motion Analysis: It is used in various motion analysis tasks such as object tracking, activity recognition, and gesture recognition.

c) Visual Effects: Optical flow estimation is essential in generating realistic visual effects in movies and video games, such as motion blur, object resizing, and scene stabilization.

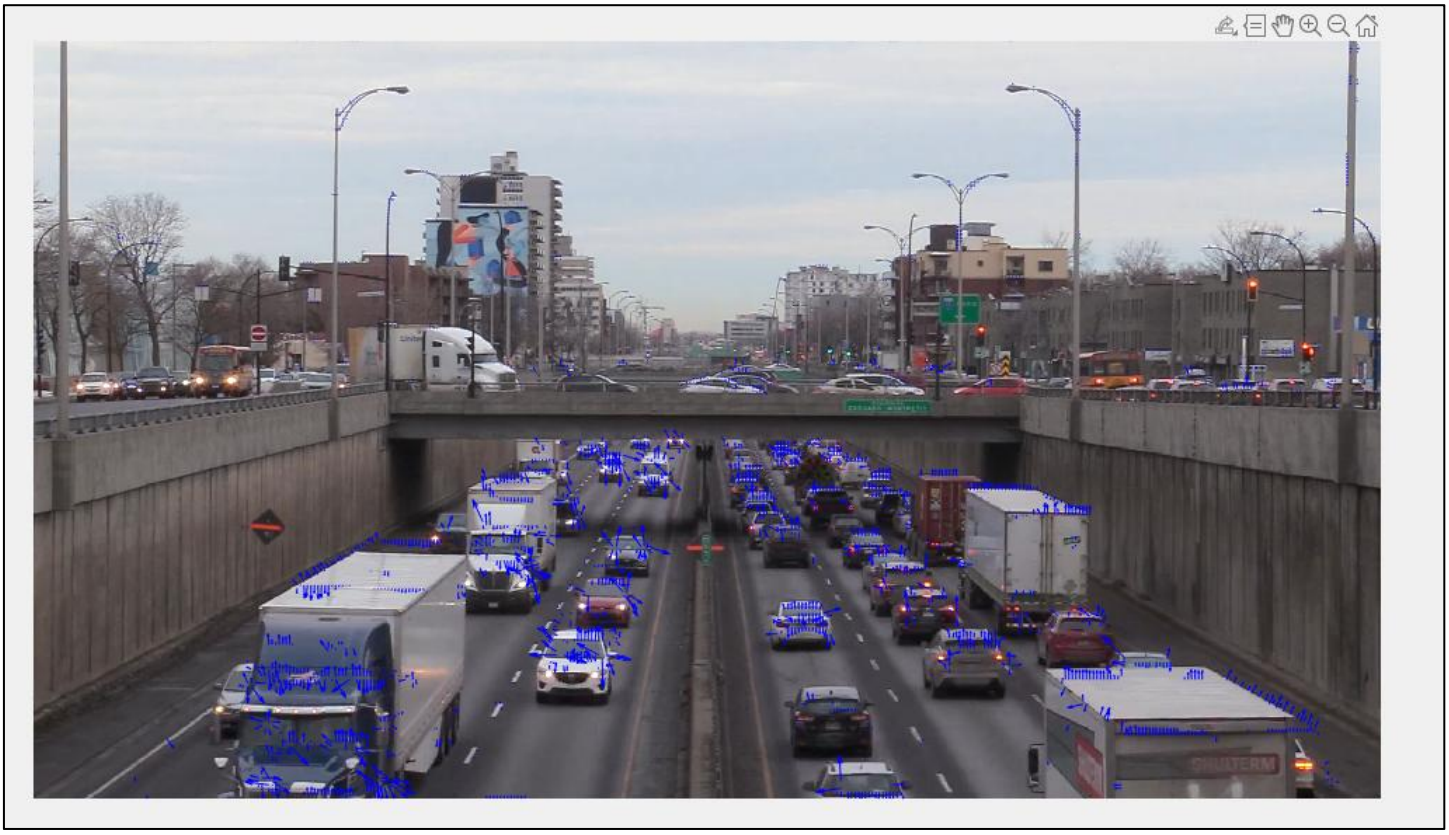
In summary, optical flow estimation plays a crucial role in various computer vision applications by providing information about the motion of objects in video sequences, enabling tasks like tracking, compression, and motion analysis.

Code :

```
% Read the video file
videoFile = 'optical.mp4';
videoObject = VideoReader(videoFile);

% Read the initial frame
prevFrame = readFrame(videoObject);
prevFrameGray = rgb2gray(prevFrame);

% Create optical flow objectclc
opticFlow = opticalFlowLK('NoiseThreshold',0.01);

while hasFrame(videoObject)

      % Read the current frame
      currFrame = readFrame(videoObject);
      currFrameGray = rgb2gray(currFrame);

      % Estimate optical flow
      flow = estimateFlow(opticFlow, prevFrameGray);

      % Display optical flow
      imshow(currFrame);
      hold on;
      plot(flow, 'DecimationFactor', [5 5], 'ScaleFactor', 10);
      hold off;
      drawnow;
```

```
        % Update previous frame
        prevFrameGray = currFrameGray;
end
```

Output :



Learning outcomes :

1. Learnt about the concept of Optical flow estimation.
2. Learnt about the assumption of Optical flow estimation.
3. Learnt about different method for estimation of optical flow.
4. Learnt about challenges related to optical flow estimation.
5. Learnt about applications of optical flow estimation.