Assignment 1

Topic: Background Segmentation and Eigenspaces

Due on or before: 15 February (Saturday), 2025

Maximum Marks: 9

Here is a video [please click on the above image to play/save/download the video] of two people loitering about aimlessly in a parking lot in front of the A. V. Williams Building, University of Maryland, College Park. (You may perhaps recognise the 6-footer in a greyish-blue shirt and dark trousers: he was quite lean and thin at that time...and healthy!)

Are you sick of him? Shoot him (with a camera)... Eliminate him from the picture...

In the marks distribution for this assignment, the total works out to 320, which we will normalise to get a score out of 9.

Part 1: Video Summarisation (120 marks)

Given a video, your task is to summarise the video in a few key frames. Report the following:

- On what grounds do you think will a key frame be segregated from a non-informative frame? (10 marks)
- The model used for purpose. (50 marks)
- The summarized final video. (15 marks)
- Experimentation with different number of frames. (15 marks)
- How do you select optimal number of frames? (10 marks)
- Can you think of some evaluation measure to compare the goodness of summarisation? (10 marks)
- You interpretation of the output (10 marks)

Hint: Please go with the flow. How do you define motion? Further, this involves eigen-analysis.

Library usage:

- You are free to use any library for eigen analysis.

However, usage of external sources such as multimodal LLMs (ChatGPT), or any other deep learning network to generate outputs in strictly prohibited. The result will be a straight **0** in the assignment.
- **Bonus:** except the SVD routine, if you code PCA from scratch, we will award you 20 bonus marks.

Part 2: Background Subtraction (120 marks)

Can you perform background subtraction on this video?
Use the idea of motion segmentation, from the papers below. To segment out the foreground, you may use the Sequential Labelling algorithm. Or K-Means, for that matter. Please generate *two* videos (in terms of the frames, and the video file as well) -

- the background, and
- one with the foreground objects

Please also submit an ASCII .txt file, which contains a description of the specific parameters used. The recommended programming language is C/C++/Java/Python, and the recommended software environment is OpenCV. No MATLAB for this assignment, please. This assignment aims at getting experience with Machine Learning algorithms which can easily be coded up. (There are many which cannot, and may be used as black boxes). Even in OpenCV (and other places), one may find numerous versions of the source code: for Gaussian Mixtures, K-Means, and Stauffer and Grimson's Background subtraction itself. Please do not copy/cut-and-paste code from the Internet: this will be penalised, as mentioned on the course webpage (the front page). You may read up different implementations, but please code from scratch.

- C. Stauffer, W. E. L. Grimson. Adaptive Background Mixture Models for Real-Time Tracking. *Proc. IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, vol. 2, pp. 246 - 252, 1999.
- C. Stauffer, W. E. L. Grimson. Learning Patterns of Activity Using Real-Time Tracking. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no. 8, pp. 747 - 757, 2000.

How does one handle MPEG videos?
Please feel free to use any video player to play MPEG video, and any decoder/encoder of your choice, on an operating system of your choice. You can download free MPEG software from the MPEG website at http://www.mpeg.org/
This contains links to many resources - free, and otherwise. Of particular importance to you may be the UC Berkeley MPEG player mpeg_play, and the MPEG Software Simulation Group's MPEG encoder and decoder mpeg2encode, and mpeg2decode, all of which are downloadable through the links - including the source code!
Internal Links [IIT Delhi]

Our evaluation criteria:

- Interpretability of the problem (20 marks)
- Originality in the code (40 marks)
- Output (30 marks)
- Experimentation (30 marks) Here, you will have to implement a GMM from scratch.
- Further, code similarity with GitHub repos is strictly prohibited (will again attract penalties) Some examples:
  - https://github.com/AjeyPaiK/Stauffer-Grimson-bgs"
  - https://ijssaggu.github.io/mog/
  - https://github.com/Mainak1792/Backround_Subtraction

Part 3: Background Subtraction in a Summarised Video(80 marks)

- Tune the parameters of the background subtractor for the summarised video. (40 marks)
- Compare the foreground/background of: (i) without summarisation and (ii) with summarisation. (40 marks)

Demo Schedule:

Venue: (to be announced)
Demos:

(To be announced) Those who stay outside the campus and may have some difficulty in manitaining the above timings, are to contact the TAs over email, well in advance. Ditto for others, who may have a valid reason for not adhering to the above schedule. Their demos will be rescheduled appropriately.

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