

Total Word counts 546 (excluding reference part):

● **The table of Task 2 (Table 1)**

	Total number of cars	Cars per minute
Traffic_Laramie_1.mp4	6	2.023381
Traffic_Laramie_2.mp	4	2.271007

● **A brief description of the frame differencing and background subtraction techniques.**

■ Frame differencing (FD) is a technique in which computers can check the difference between two frames of videos. If there is an obvious change in the image (e.g., a moving event), the changed difference of pixels can be detected and reported. Most FD techniques have blur or threshold to detect real movement from noise (Kamperman, 2010).

■ Background subtraction (BS) refers to techniques that extract an image's foreground for further processing. The aim of BS is to detect any changes between foreground and background in image sequences. In detail, BS performs a

subtraction between the current frame and a background model, which may contain a static scene or any part that can be considered as background (OpenCV, n.d.).

- **A brief analysis of the application.**

- Install required modules: numpy, opencv-python, moviepy

- Solution 1 to Exercise 1.1:

- ◆ First, create a VideoCapture object and read the frames from an input file. The first captured frame is regarded as the baseline image.

- ◆ Second, calculate the difference between the baseline and the gray frame.

- ◆ Third, the difference frame named `delta_frame` is converted into a binary image which will be compared with a certain threshold (50), if it is greater than the threshold, it will be assigned the value of white (255), else it will be assigned the value of black (0).

- ◆ Fourth, identify all the contours in the image and filter out small contours that do not belong to a car shape. Then draw green rectangles to highlight car shapes and draw red lines to indicate the main street area.

■ Solution 2 to Exercise 1.2 (improvements):

- ◆ In the previous part, the first captured frame (initial frame) is regarded as the baseline image (i.e., background frame). In the method `cv2.absdiff()`, the difference between the baseline and the gray frame is calculated. Thus, I recommend using median frame as the background frame instead of initial frame in this part.
- ◆ function `backgroundDetection` can detect car movement. In addition, the function can also return the value for number of cars go into city center. The value of `num_car_into_city_center` will be used for exercise 1.2 to calculate the value of cars per minute.

■ The explanation of code in Exercise 2:

◆ **Calculate the required data by using two functions:**

`backgroundDetection()` and `VideoFileClip()`: First, get the value for numbers of cars go into city center on video 1 by

code `num_car_into_city_center_1 =`

`backgroundDetection('Traffic_Laramie_1.mp4', 4, 435).`

Second, get the video duration of each video in minutes

by code `video1 = VideoFileClip('Traffic_Laramie_1.mp4')`

and `video1_duration_in_seconds = video1.duration,`

and $result_{video1_duration_in_minutes} = video1_duration_in_seconds / 60$. In detail, we load the first video by VideoFileClip method and then calculate the first video duration in seconds, after which we divide the result by 60 to calculate the first video duration in minutes. Third, it is easy to calculate the value of cars per minute by $num_car_into_city_center_1 / video1_duration_in_minutes$. The operation is the same to when calculating required data on video 2.

- ◆ **Display the table on Jupyter Notebook:** we can either use pandas dataframe to print the required table 1 or just use Markdown format to display table 1.

References

Kamperman, K. (2010). Computer Vision: Frame differencing. Retrieved February 7, 2023, from <https://www.kasperkamperman.com/blog/computer-vision/computer-vision-framedifferencing/#:~:text=Frame%20differencing%20is%20a%20technique,district%20real%20movement%20from%20noise>.

OpenCV. (n.d.). How to Use Background Subtraction Methods.

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