Computer Vision Course — A.A. 2021/2022

Lab 2: Motion Detection

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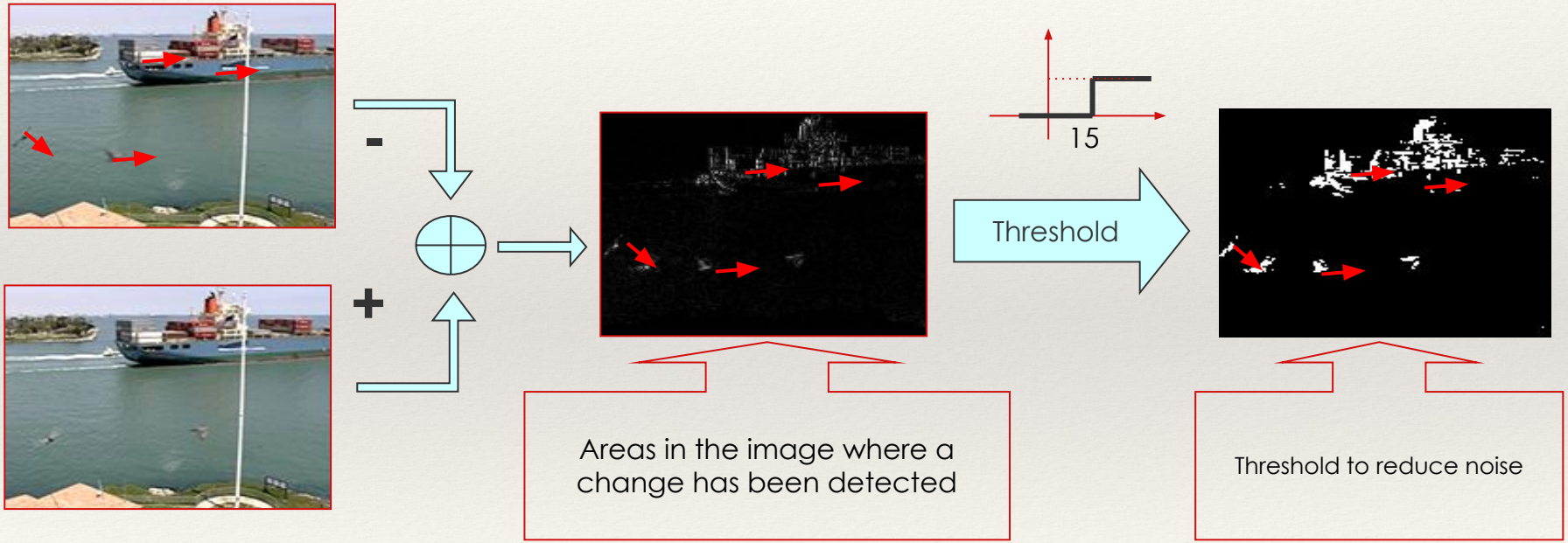
What's up today?

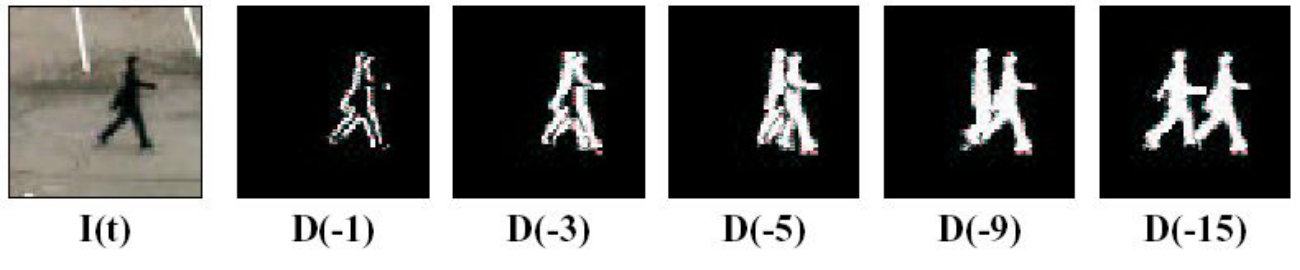
- Frame differencing
- Background Subtraction
- Adaptive Background Subtraction
- Adaptive Background Subtraction: Mixture of Gaussians

Frame differencing



Frame Differencing: Time Scaling

$$D(N) = \left\| I(t) - I(t+N) \right\|$$

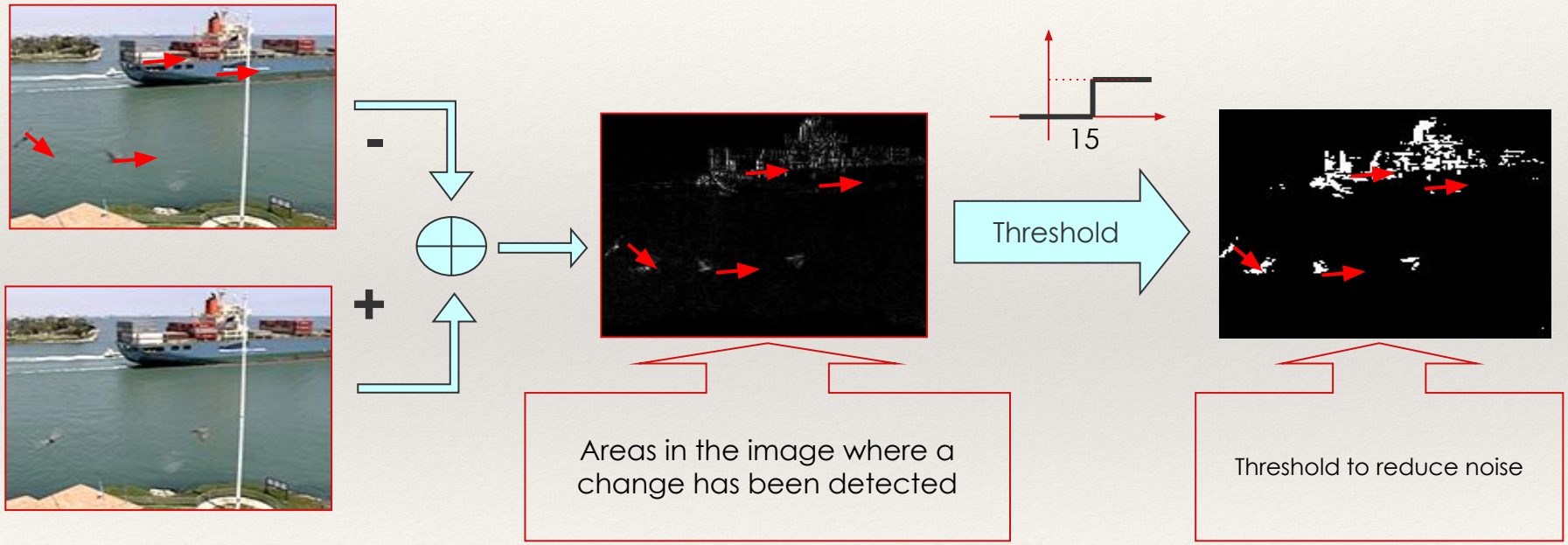


Exercise: frame differencing

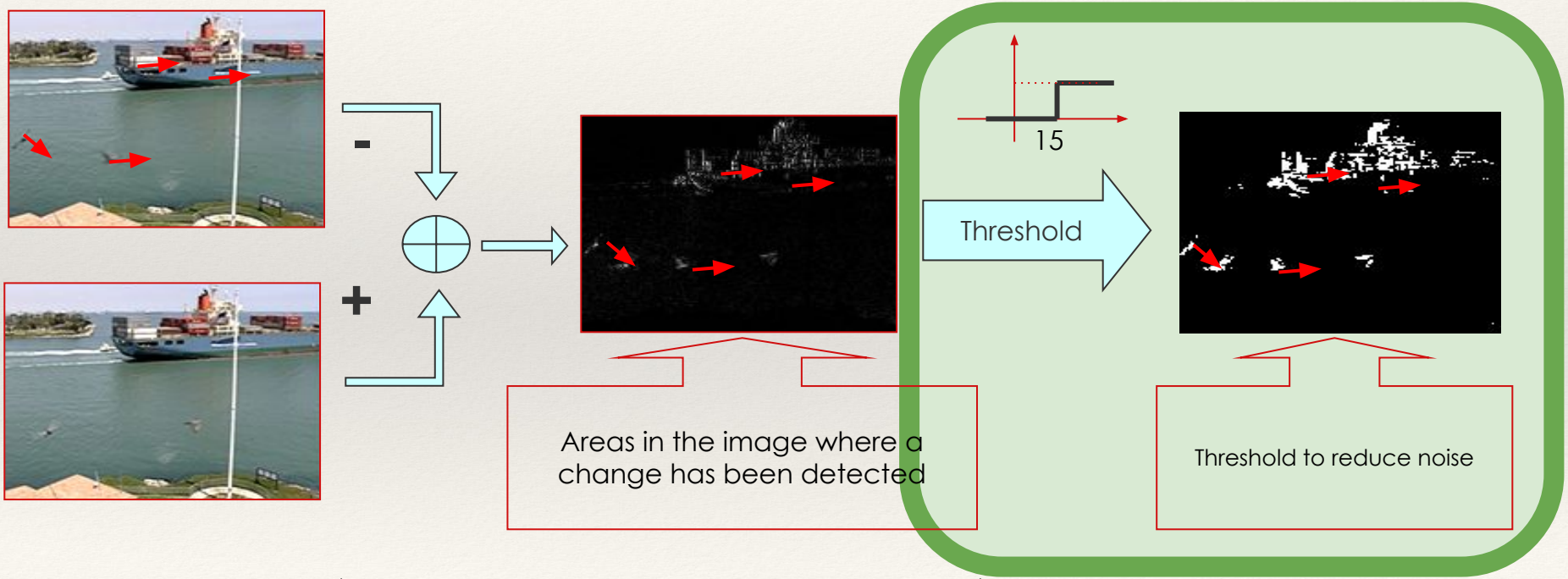
- Initialise a new project
- Open a video
- Convert frames to grayscale
  - `frame_gray = cv2.cvtColor(frame_color, cv2.COLOR_RGB2GRAY)`
- Use a list to store frames!
  - `frames = [ ]`
  - 💡How to append frames to array: `frames.append(frame_gray)`
- Implement the function
  - `result = cv2.absdiff(I(t),I(t+N))`
  - 💡Hint: `t+N` can be thought as `t-N`

$$D(N) = \left\| I(t) - I(t+N) \right\|$$

What's missing in the implementation?



Apply thresholding on the mask




```
cv2.threshold(diff, THRESH, MAXVAL, TYPE)
```

Background Subtraction

Pseudo-code

```
B = I(0);
…
    loop time t
    I(t) = next frame;
    diff = abs[B - I(t)];
    Map(t) = threshold(diff);
...
end
```

Adaptive Background Subtraction

- Use a parameter **α** *(learning rate)* to weight the contributions
  - $B_t = \alpha I_t + (1-\alpha) B_{t-1}$
    - $\alpha = 0 \rightarrow$ bg sub, no update
    - $\alpha = 1 \rightarrow$ frame differencing

Mixture of Gaussians

$$P(x_t) = \sum_{i=1}^{K} \omega_{i,t} \eta(x_t, \mu_{i,t}, \Sigma_{i,t})$$

- $\omega_{i,t}$ is the weight for the current Gaussian
- Select *K*
- Rank the Gaussians on the basis of
  - Peak amplitude
  - Weight
  - Standard deviation

$$\omega_{k,t} = \alpha M_{k,t} + (1 - \alpha)\omega_{k,t-1}$$

- α is the so-called learning rate
- M is **1** for the matching model and **0** otherwise

  → if it is not the matching model, the weight is decreased

Exercise

- Go to OpenCV 4 documentation
- https://docs.opencv.org/4.x/
- Check the parameters for the `BackgroundSubtractorMOG`
- Try to change the number of Gaussians and the history (how much time you want to spend to learn the background model) used and check the results

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- Change the MOG to `BackgroundSubtractorMOG2`
- Use the method `getBackgroundImage()` to get the background
- Display the background and observe how it changes over time with different values of the learning rate parameter