ELEN0016 - Computer Vision - Student project 2021

HELD Jan, NAA Marco, PEETERS Martin

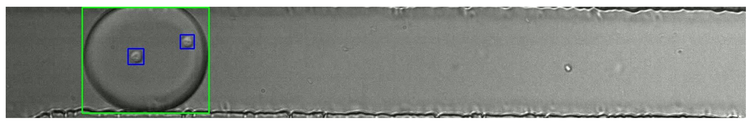
Abstract

- **Goal** : Detecting and counting droplets and cells in high frame rate videos
- First idea : **Background substraction**

⇒ too many limitations and poor results

- Second idea : **Deep learning**

⇒ You Only Look Once (YOLOv5)



- **Main results** :
  - Droplets : Nearly perfect detection (mAp@.5 of 0.987)
  - Cells : Satisfying results (mAp@.5 of 0.832)

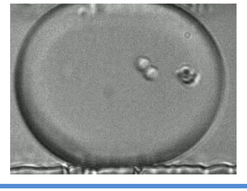
Problem statement

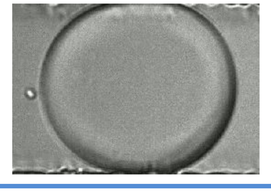
Objectives

- **Detecting** and **counting** droplets and cells in high frame rate videos
- **Tracking** of droplets in order to avoid counting them multiple times
- **Evalutate** the performance of our method

Challenges

- Cells close to each other are often detected as a single cell
- Avoid counting “noise” as a cell
- Find optimal trade-off between performance and inference time





Methodology

YOLOv5

- Divides the image into boxes
- Apply a single neural network
- Predicts bounding boxes and class probabilities
- State of the art in object detection

Model Training

- **Creation of dataset** :
  - We mainly used frames where we have at least one cell
  - Created three datasets :
    - Train set (70%)
    - Validation set (20%)
    - Test set (10%)
- **Train & Test** our YOLOv5 model on Colab

Counting algorithm

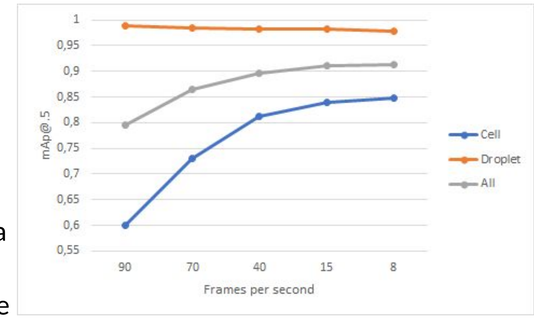
- We have a droplet class which contains:
  - x_coordinate of the droplet at time t
  - list containing the number of detected cells

- For each frame :
  - YOLOv5 detects all objects
  - For each detected droplet, we determine if :
    - it is a **new** droplet (create a new droplet object)
    - the droplets **was already in the previous frame** (we add the number of detected cells to the list of the droplet object)
  - We check if a droplet from the previous frame **left** the screen, if yes :
    - We take the average of the list of the droplet object
    - Increment the number of detected droplets and the number of x detected cells

Results

Comparison between models

- Mean average precision comparison between different models with increasing image size
- Extremely good results for detecting droplets
- Model with 40 fps seems to be a good trade-off between performance and inference time



Parameter tuning

- Find optimal **confidence threshold**
  - Balance between **precision** and **recall**
  - Choose threshold of 0.55
- **Droplets** : nearly perfect no matter the confidence threshold
- **Cells** : quite good results too, until some point where the precision drops

Final result

Class	Precision	Recall	mAp@.5	mAp@.95
All	0.92	0.908	0.909	0.645
Droplet	0.967	0.987	0.987	0.95
Cell	0.874	0.831	0.832	0.341

Conclusion

- YOLOv5s has exceeded our expectations
- Impressive results on challenge trial 1 & 2
- Possible **improvements** : only detect every second frame ⇛ **double speed**