Preselection of separation units and ML-supported operation of an extraction column

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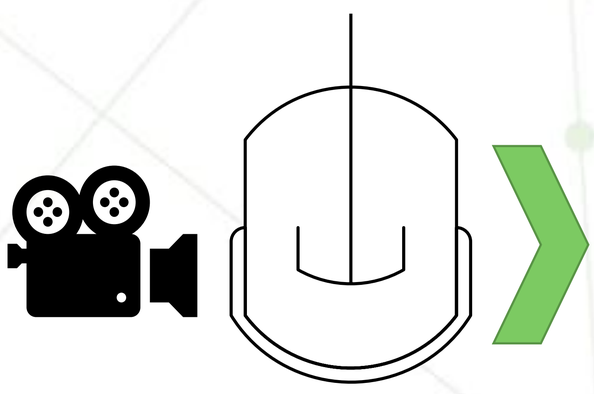
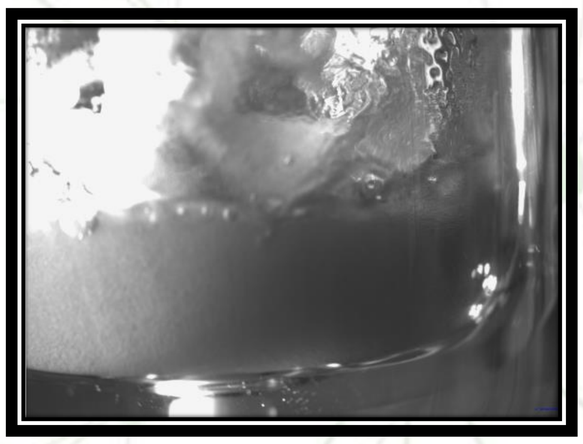
Preselection of separation units

- Goal: specify the best separation unit based on minimum of pretrial



With stirring

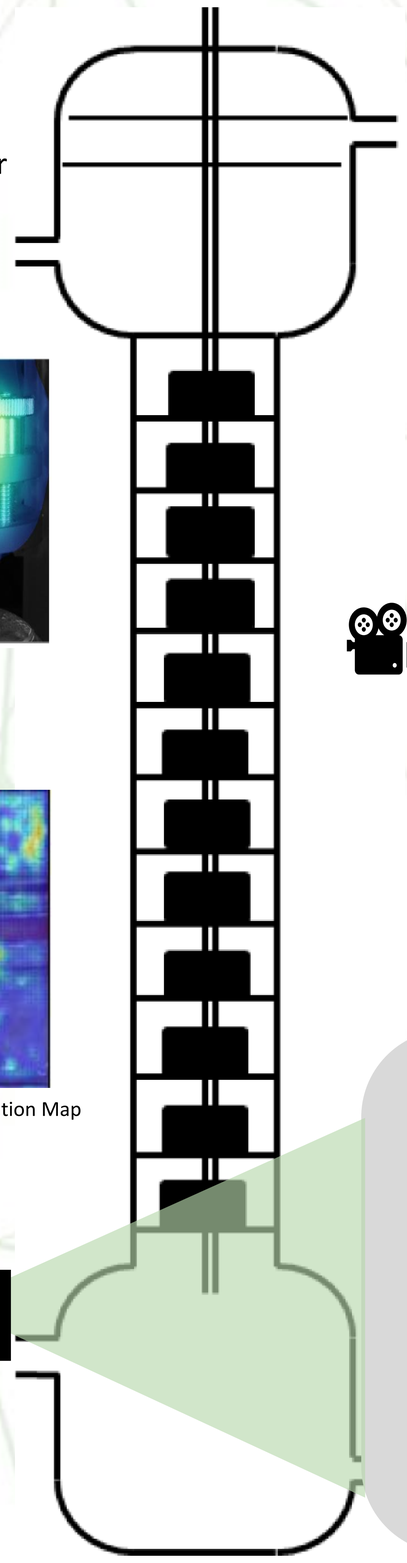


Without stirring, after ~ 30 sec

Without stirring, after ~ 1 minute

Goal: online AI-based image analysis

- Binary Classification to observe regular operating state or unwanted flooding state

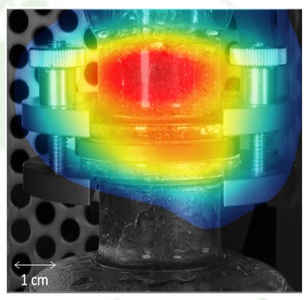


First Dataset: promising results

- Small Dataset consisting of some states, regarding volume flows and stirrer speed settings
- Resnet18[1], 98 % Accuracy

State/ Metric	Precision	Recall
Flooding	0.985	0.957
Regular Operating State	0.958	0.985

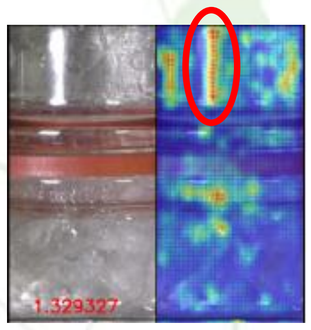
- Class activation map in correct region



Class activation map

Second Dataset: “Clever Hans” effect

- Expanded Dataset with all conditions necessary for the operation of the column
- Anomaly detection, LeNet[2] ROCAUC-Score 0.85
- Observation of clever Hans effect: classification decision based on illumination reflection instead of droplet occurrence



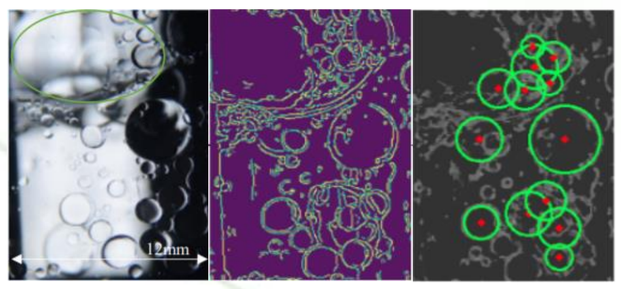
Raw Image and its Class Activation Map

Third Dataset: Hackathon

- Image acquisition using transmitted light solves illumination problems
- Ongoing Hackathon, no final results yet
- Very good prefinal results (high accuracy)

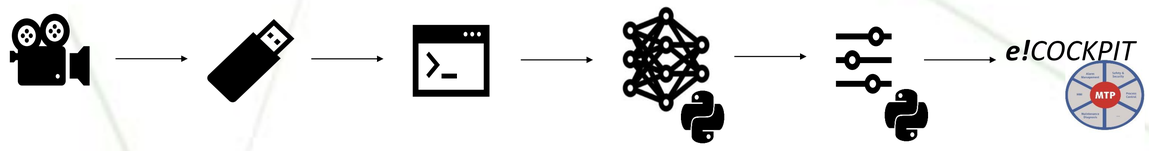
Further research & Automation

- Droplet size Distribution to obtain more accurate description of the extraction state



Raw image | CNN result | Hough Transformation

- Investigation of AI Transferability between columns: Investigation of extraction column at Merck



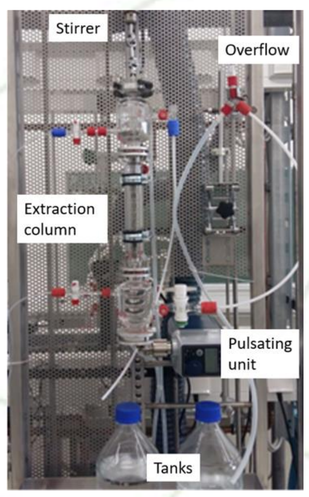
- Hardware optimisation for automated image generation: Elgato cam link
- Automation of the column based on the online evaluated AI results

Binary Image Classification

Flooding

Regular Operating State

Extraction column



[1] He, Kaiming; Zhang, Xiangyu; Ren, Shaoqing; Sun, Jian (2015-12-10). "Deep Residual Learning for Image Recognition"

[2] Y. LeCun et al, Backpropagation Applied to Handwritten Zip Code Recognition, Neural Computation. 1 (4): 541–551, 1989

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