Project 1:

Crowd Counting

11761 - Image and Video Analysis
Master's Degree in Intelligent Systems

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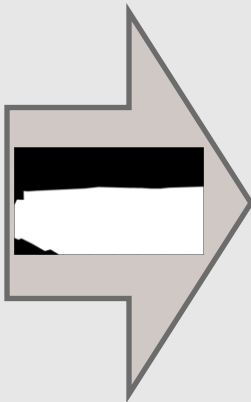
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Table of contents

01.

Preprocessing methods
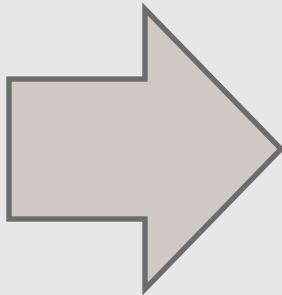
Defining preprocessing pipelines

Common preprocessing steps
Static background removal

Common preprocessing steps
Background substraction

Main proposed pipelines

Proposal 1	Proposal 2	Proposal 3

Static Background Removal

Background Substraction (unique image/image averaging)	CLAHE

Upper and lower thresholding	Water removal (HSV thresholding)	Background Substraction
Otsu thresholding	Sand removal (simple thresholding)	Upper and lower thresholding
	Otsu thresholding	Otsu thresholding

AND Pixel Operator

02.
Detection methods

Detection methods used

Simple Blob Detector
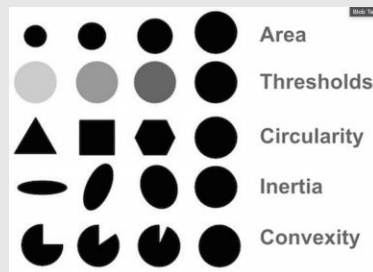
Contour Detector

DBScan

Simple Blob Detector

A Blob

A group of connected
pixels in an image that
share some common
property
Found through connected
component Labelling

Parameters Influence

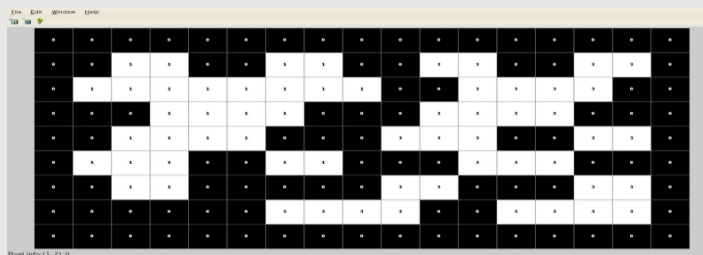
Parameters Us ed

Min area = 2
Max area = 100
Min Circularity = 0.75
Min Convexity = 0.75
Min Inertia Ratio = 0.15

Connected Component Labelling Example

Contour Detector

Contour

Curves joining all the
continuous points
along the boundary of
an object, having the
same color or intensity
Use Border Following
Algorithm. Top-
Bottom, Left-Right
scanning for pixel of
right intensity to trace
contour.

Parameters Used

Contour Area < 50
cv2.CHAIN_APPROX_SIMPLE = compress
vert/ horizontal/ diagonals segments into
points
cv2.RETR_EXTERNAL = external contours
only

Contour Detection Example

DBScan

Clusters

Near (Euclidean-based)
      points are identified as
      clusters.
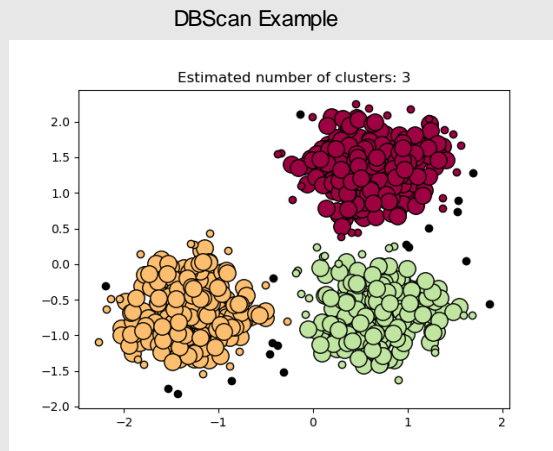(x,y) of high intesity pixels
      as points!
In this case, human pixels
      should be clustered.
Lower min_samples =
      more false detections!

Parameters Used

Epsilon = 4
Min_Samples = 40

DBScan Example

03.

Evaluation methods

Evaluation methods used

Image-level

Mean Squared Error is used as an image-level indicator of performance.

Person-level

Based on the predictions obtained, we carry out a **one near neighbor algorithm without replacement**, with thresholded distance, to decide to which category the detection belongs (TP, FP, FN).
Distance between neighbor use Euclidean Distance of 100.

Precision, recall and F1-Score are computed.

04.
Obtained results

Pipeline 1

Green: real annotations
Blue: detections
Detector: Blob

MSE	16179.3
Mean Precision	0.431
Mean Recall	0.896
Mean F1-Score	0.582

Pipeline 1

Green: real annotations
Blue: detections
Detector: Blob

MSE	16179.3
Mean Precision	0.431
Mean Recall	0.896
Mean F1-Score	0.582

Pipeline 2

Green: real annotations
Blue: detections
Detector: Blob

MSE	113420.6
Mean Precision	0.205
Mean Recall	0.972
Mean F1-Score	0.339

Pipeline 2

Green: real annotations
Blue: detections
Detector: Blob

MSE	113420.6
Mean Precision	0.205
Mean Recall	0.972
Mean F1-Score	0.339

Pipeline 3

Green: real annotations
Blue: detections
Detector: Blob

MSE	88323.5
Mean Precision	0.26
Mean Recall	0.958
Mean F1-Score	0.41

Pipeline 3

Green: real annotations
Blue: detections
Detector: Blob

MSE	88323.5
Mean Precision	0.26
Mean Recall	0.958
Mean F1-Score	0.41

Combined Pipeline

Green: real annotations
Blue: detections
Detector: Blob

MSE	719.6
Mean Precision	0.696
Mean Recall	0.843
Mean F1-Score	0.762

Combined Pipeline

Green: real annotations
Blue: detections
Detector: Contour

MSE	427.8
Mean Precision	0.827
Mean Recall	0.675
Mean F1-Score	0.743

Combined Pipeline

Green: real annotations
Blue: detections
Detector: DBScan

MSE	279.9
Mean Precision	0.734
Mean Recall	0.672
Mean F1-Score	0.702

Conclusion

- Detections are only as good as mask!
- Combined Pipelines show good results in terms of curbing false positives.
- HOG-SVM Tried but not very good
- Potential
  - Better HSV thresholding!
  - Smart Pipeline Section!
  - Different Parameters for detection depending on areas in image.

Input image

Histogram of Oriented Gradients
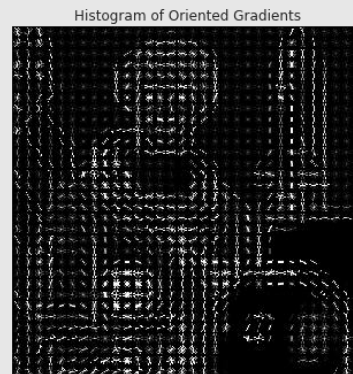
References

- Images
  - DBScan: 'https://scikit-learn.org/stable/auto_examples/cluster/plot_dbscan.html'
  - Contour: 'https://www.semanticscholar.org/paper/Fast-human-detection-in-crowded-scenes-by-contour-Beleznai-Bischof/bb3b6bb0c13d66be0a80f66172e943435efe68ab/figure/0'
  - Blob Parameters: 'https://learnopencv.com/blob-detection-using-opencv-python-c/'
  - Connected Labeling: 'https://en.wikipedia.org/wiki/Connected-component_labeling'
  - HOG-SVM: 'https://medium.com/analytics-vidhya/a-gentle-introduction-into-the-histogram-of-oriented-gradients-fdee9ed8f2aa"

Thank you for your attention