Deliverable #1

weeks 3-5

Work Summary

week 1	Study Python
week 2	Explore OpenCV tutorials
week 3	Shape oriented approach
week 4	Create new dataset / Retry previous algorithms / Explore new approach
week 5	Color oriented approach

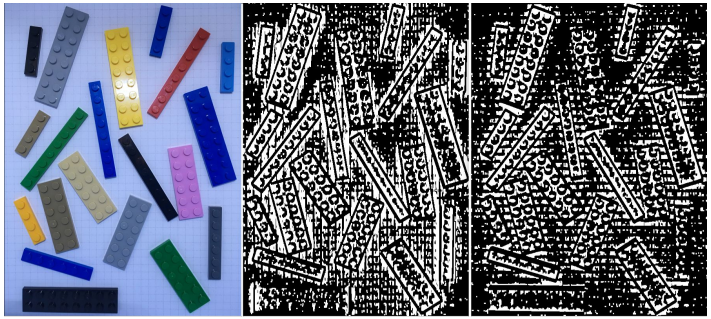
First Approach - Shape Oriented

Idea:

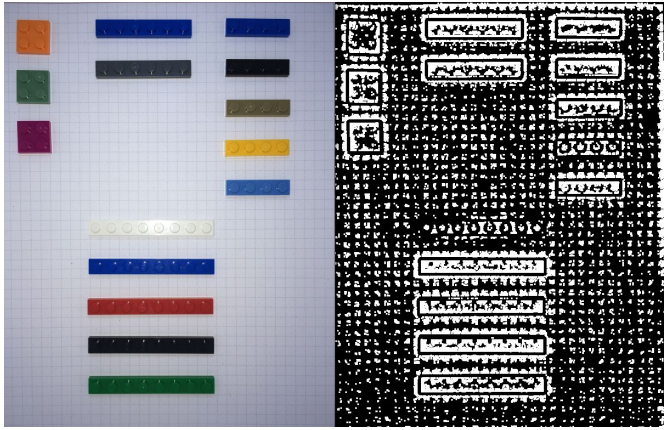
1. Try various edge/corner detection algorithms to extract the pieces (feature detection)
2. Segment each piece (segmentation)
3. Figure out the shape: rect or non-rect (classification)
4. Extract the color (classification)

Method 1 - High-Pass Filters

Sobel X Sobel Y



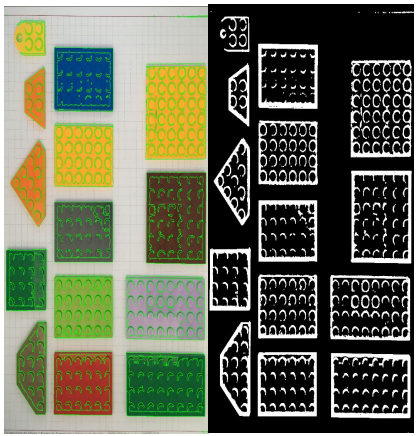
Laplacian

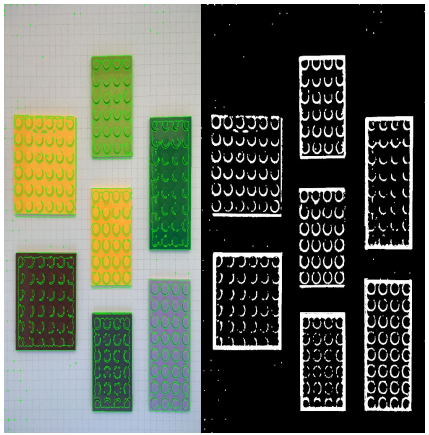


Limitations:

- Pieces touching each other (even with different colors).
- Case dependant configuration parameters (needs frequent adjustments).
- Identification problems with low contrast objects (e.g. white pieces on white background).

Method 2 - Canny Edge





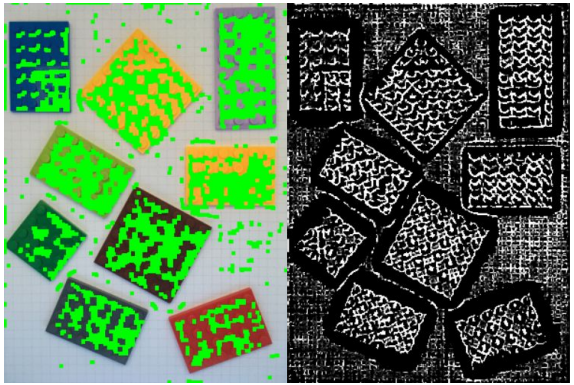
Best performance method:

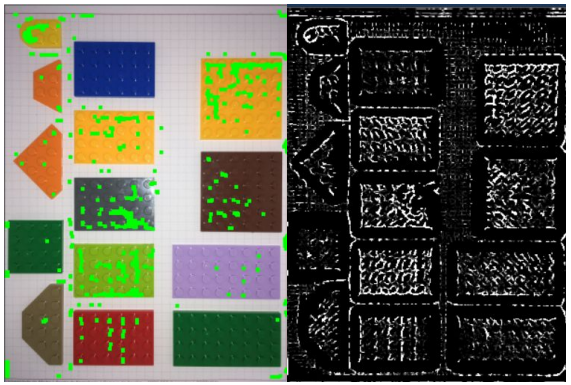
- More robust (needs less parameter adjustments).
- Good results with straight shaped-objects

Limitations:

- Pieces touching each other (even with different colors).
- Difficulties with round-shaped objects
- Identification problems with low contrast objects (e.g. white pieces on white background).

Method 3 - Harris Corner





Worst performing method.

The graph paper background poses a major challenge.

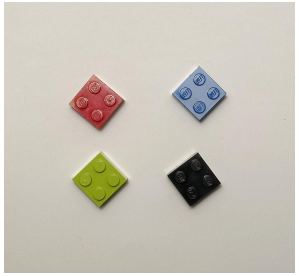
Initial Difficulties/Challenges

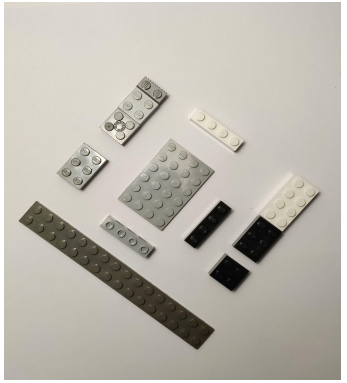
1. The dataset provided didn't feature the most simple scenario:
   plain background + 1 simple rect piece with a highly contrasting color to perform initial tests.
2. The dataset provided featured a graph paper background full of unwanted high frequency content.
3. Trying to eliminate the background lines with some processing decreased the performance of the edge detection algorithms especially on images with lots of pieces close to each other.

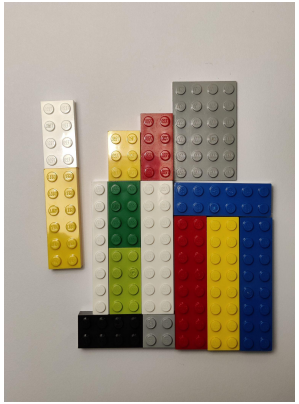
Solution - Generate New Dataset

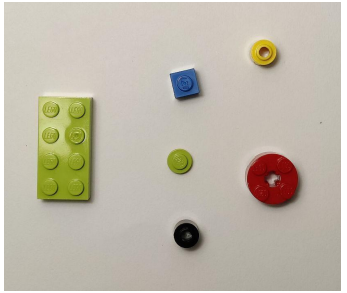
- New dataset with a plain white background.
- Capture each image with 2 different lighting conditions.
- Create different scenarios with increasing difficulty.

Some images of the new dataset feature pieces with non-uniform lighting which created other problems.









Results with New Dataset

The overall performance/robustness of the previous algorithms improved with the new dataset

Scenarios with multiple pieces touching each other (even with different colors) still remains the biggest challenge.

This led us to...

Second Approach - Color Oriented

Idea:

1. Try to extract/segment pieces using it’s color properties (thresholding).
2. Intermediate image processing.
3. Classify the shape and color (classification).

Method - Color Thresholding

Future Improvements

- Integrate watershed method to extract the color gamut of each piece.
- Explore the LAB color space
- Refine shape classification (square, rectangular, trapezoidal, circular, etc).

Thank you for your attention.