

Document Text Enhancement

Image Processing Term Project

By

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Aim



Enhancement of Text in images, mainly shopping bills, using Morphological Transformation Technique.

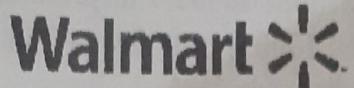


Compare text recognition classifier's confidence on various filters.



Compare Binary Image Thresholding technique like – Niblack, Adaptive Thresholding(Mean), and Sauvola.

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Test Images:

Filters and Techniques Used

Inverse Image Filter

Log and inverse Log Transformation

Power Transform

Contrast Stretching

Bit Plane Slicing

Median Filter

Average Filter

Gaussian Filter

Output of Text
Recognition Model:

Filter	Block		Line		Word	
	Confidence	Number	Confidence	Number	Confidence	Number
Original	97	4	97.2	31	96.7	166
Invert Filter	94	3	96.6	33	95.7	169
Inverse Log	96.2	4	96.81	31	96.45	168
Log	94	4	95.9	31	95.22	165
Power Transform(2, 4)	96.5	4	96.7	30	96	168
PT(0.8)	96.25	4	97.08	31	96.69	166
Contrast Stretching	90.5	5	95.84	31	95.71	173
Bit plane slicing	92.4	4	94.32	30	93.3	169
Median Filter	95	4	95.4	30	94.7	168
Average Filter	91.80	5	96.59	33	96.91	170
Gaussian Filter	97.0	4	97.11	31	96.78	167
Unsharp Masking	96.2	4	96.52	31	95.8	167

Binary Image Thresholding Technique

Thresholding is used to segment an image by setting all pixels whose intensity values are above a threshold to a foreground value and all the remaining pixels to a background value.



Niblack



Sauvola

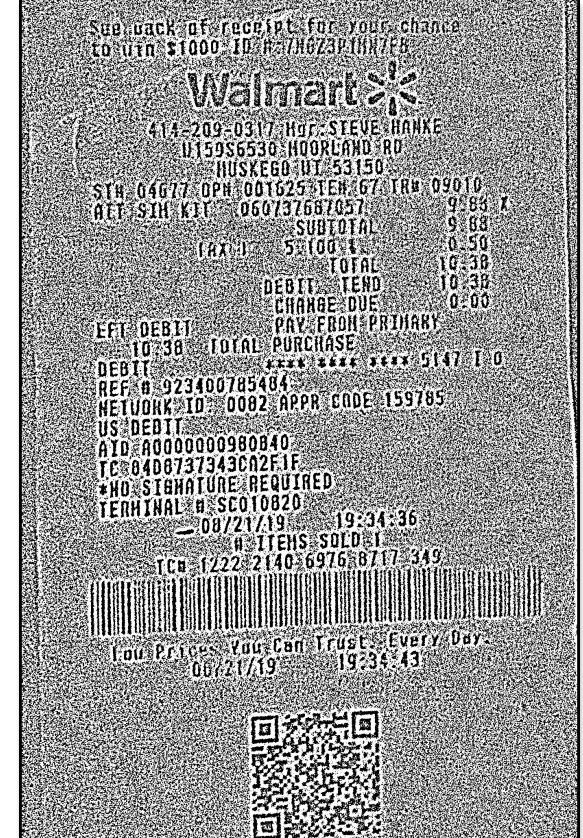


Adaptive Thresholding

Niblack

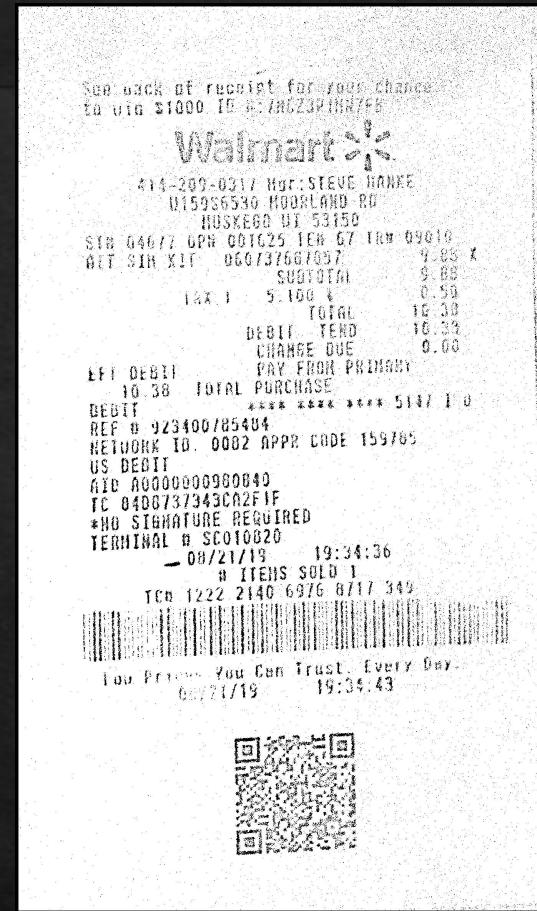
- The main objective of Niblack image segmentation is to extract and characterize structures with respect to some input features or expert knowledge.
- It is a local thresholding algorithm that adapts the threshold according to the local mean and the local standard deviation over a specific window size around each pixel location.
- Threshold is given by:

$$\text{np.mean}(mx) + (C) * \text{np.std}(mx)$$



Sauvola

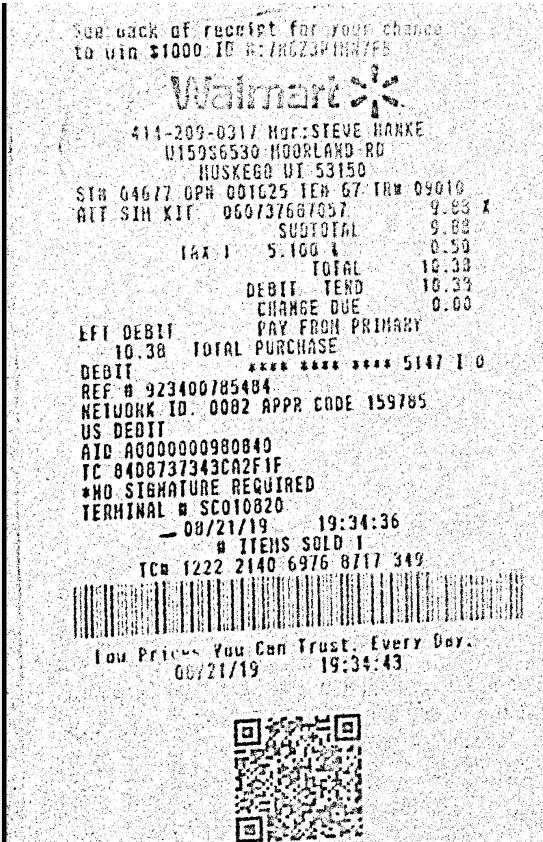
- Sauvola proposed to compute a threshold at each pixel using:
$$T = m \times \left[1 + k \times \left(\frac{s}{R} - 1 \right) \right]$$
- The reason of using Sauvola is that it performs relatively well on noisy and blurred documents and computationally efficient.
- left Image enhanced using guassian filter->contrast stretching->unsharp masking->sauvola => Right Image



Adaptive Thresholding

- Adaptive thresholding changes the threshold dynamically over the image.
- local threshold is to statistically calculated.
- Simple and fast statistic functions include the *mean* of the *local* intensity distribution,
- Threshold is given by

$$\text{np.mean}(mx) - C$$



Morphological Image Processing

Theory

- ❖ Morphological transformations are some simple operations based on the image shape. It is normally performed on binary images. It needs two inputs, one is our original image, second one is called **structuring element** or **kernel** which decides the nature of operation. Two basic morphological operators are Erosion and Dilation. Then its variant forms like Opening, Closing, Gradient etc also comes into play.

- ❖ Erosion: The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels (i.e. white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger.
- ❖ Dilation: The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels (i.e. white pixels, typically). Thus areas of foreground pixels grow in size while holes within those regions become smaller.

Morphology Output

Erosion:

Erosion performed using
unsharp masking =>
adaptive thresholding =>
erosion



Dilation:

Performed using
unsharp
masking =>
adaptive
thresholding
=>dilation



Morphological Output

Opening =>



Closing =>



Conclusion

- ❖ Applying filters to image, increase the confidence by 2-3 %, although small but proves that there exist a path for performance increase Firebase MLKit
- ❖ Performing Binary Thresholding, via niblack, saulov, and adaptive thresholding proved beneficial in some cases, at the same time increase random noise(salt pepper with high pixel size) this noise becomes an issue while applying morphological transformation
- ❖ Morphological Transformation operation, opening and closing on dark image gave a significant increase in confidence of the image.

References

- ❖ <https://homepages.inf.ed.ac.uk/rbf/HIPR2/filtops.htm>
- ❖ <https://benchpartner.com/explain-bit-plane-slicing-techniques-in-image-processing/>
- ❖ <https://homepages.inf.ed.ac.uk/rbf/HIPR2/stretch.htm>
- ❖ <https://theailearner.com/2019/01/26/power-law-gamma-transformations/>
- ❖ <http://homepages.inf.ed.ac.uk/rbf/HIPR2/adptrsh.htm>
- ❖ <http://www-sop.inria.fr/members/Naveed-Bin.Rais/thresholding-rais.pdf>
- ❖ https://www.researchgate.net/publication/307612238_Fast_implementation_of_the_Niblack_binarization_algorithm_for_microscope_image_segmentation
- ❖ https://www.researchgate.net/publication/304621554_ISauvol_a_Improved_Sauvola's_Algorithm_for_Document_Image_Binarization
- ❖ https://docs.opencv.org/trunk/d9/d61/tutorial_py_morphologic_ops.html