Segmentation of object from background in a gray-scale image

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1. INTRODUCTION:

Image processing area of study provides algorithms for analyzing images and videos. Due to its applicability in science and engineering, it has been taking more and more importance over the last decades. However, today these algorithms still cannot do many tasks the human brain can easily do. Due to this, it is important to keep improving image processing algorithms.

Some very important algorithms in image processing are called “image segmentation algorithms”, these algorithms divide an image in regions such that each region represents an object present in the image. For image segmentation applications where there is a gray-scale image consisting of an object and a background, these algorithms may segment the image by finding a gray intensity threshold, such that the pixels that have values equal or less than this threshold are classified as background pixels and the rest are classified as object pixels (or vice-versa). In this work, an image segmentation algorithm that finds a gray intensity threshold to segment the image which is more precise than the most popular same-class algorithms published is proposed.

2. ALGORITHM IMPLEMENTATION AND EVALUATION

The algorithm was implemented in C programming language. The algorithm finds the best gray intensity threshold to segment a gray-scale image (consisting of an object and a background) by just using the histogram of the image. If the algorithm is only applied to images where the object and background are distinguishable by their gray intensity values, then it is known that the histogram of the image has a shape that looks like two mountains separated by a valley. So this means that the gray intensity threshold must be ideally located in the valley. Knowing this, the algorithm makes a mathematical model of the histogram which consists of two three-parameter weighted gamma distributions separated by a gray intensity threshold. The estimated value of the gray intensity threshold of the model is the threshold used to segment the image.

The algorithm was tested on the 132 images of the IPCV-Lab image database. The quality of the segmentations were evaluated objectively by two different metrics, and subjectively by 8 humans. The results proved the proposed algorithm to be 5% more precise in general terms than the most popular same-class algorithms published, and 20% more precise for low contrast images.

3. SEGMENTATION EXAMPLE

In the following example, the forest (object) is to be segmented from the sky (background). Since the image to be segmented is a color image:

Figure 1: Color image (input)

it is converted to a gray-scale image:

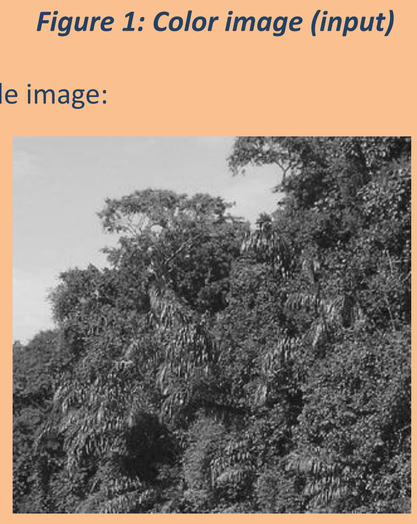

Figure 2: Gray-scale image to be segmented

where the pixels have gray intensity values that go from 0 (black) to 255 (white). The first step for segmentation is to obtain the histogram of the gray-scale image:

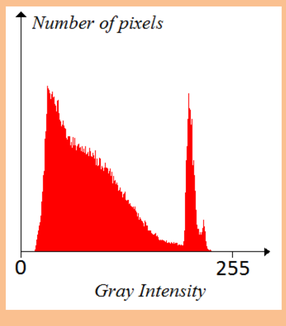

Figure 3: Histogram of the gray-scale image

The second step is to model the histogram of the gray-scale image using a mathematical model that consists of a pair of three-parameter weighted gamma distributions separated by a gray intensity threshold (called th_{op}). Figure 4 shows the model made by the proposed algorithm and Figure 5 shows the model made by the algorithm used by Matlab (which makes use of equally weighted Gaussian distributions).

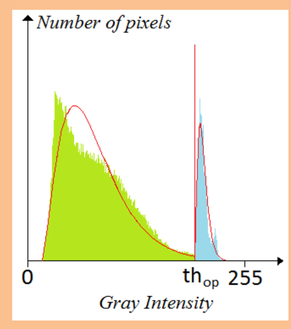

Figure 4: Mathematical model of the histogram of the gray-scale image (in red color) made by the proposed algorithm. Note: the histogram of the image is behind the model for comparison purposes

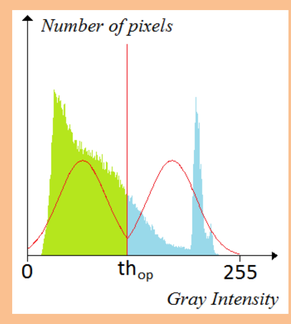

Figure 5: Mathematical model of the histogram of the gray-scale image (in red color) made by the algorithm used by Matlab. Note: the histogram of the image is behind the model for comparison purposes

The third step is to run through all the pixels of the gray-scale image and classify them in the following way: pixels having gray intensity values equal or lower than th_{op} are classified as background pixels, and pixels having higher values are classified as object pixels. Figure 6 shows the segmented image made by the proposed algorithm and Figure 7 shows the segmented image made by the algorithm used by Matlab.

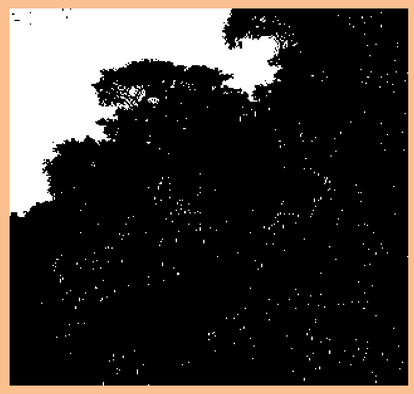

Figure 6: Segmented image made by the algorithm proposed

Figure 7: Segmented image made by the algorithm used by Matlab

where the background pixels are painted black, and the object pixels are painted white.

4. CONCLUSION

The algorithm proposed in this work proved to be 5% more precise in general terms than the most popular same-class algorithms published, and 20% more precise in low contrast images. The reason is that the histogram model proposed here has more parameters than the models proposed by others, which culminates in better approximations of the histogram that lead to better image segmentations. Since the algorithm just makes use of the histogram of the image and not the image itself, it is a low computational cost algorithm suitable for real-time applications.

5. MOST IMPORTANT REFERENCES

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B. M. Sezgin and B. Sankur. Survey over Image Thresholding Techniques and Quantitative Performance Evaluation. Journal of Electronic Imaging 13(1), 146-165, January 2004.