

Using of Fuzzy Technologies for Image Processing

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Abstract

The diploma thesis deals with application of fuzzy logic in image processing especially the edge detection of objects in the image. The thesis hereby suggests a new approach to the edge detection in image processing. The main task is design and implementation of the fuzzy edge detector in MATLAB and LabVIEW. The goal is testing of the fuzzy edge detector on the jewelry stone images and result comparison with “classical” edge detectors. The emphasis lays on time efficiency and visual results of detectors.

Introduction

The edge detection is one of the most important algorithms in image processing. The main task of the edge detection is to locate pixels in the image that correspond to the edges of the objects located in the image. The edge detection with using of fuzzy logic is relatively new. Fuzzy logic is not based on mathematical operations but follows human reasoning. The reasoning of fuzzy logic is based on commonsense rules of the uncertain world and does not need any threshold for edge determining. Well designed fuzzy logic edge detector can work when some other methods might fail or give wrong results.

The task of my diploma thesis was prepared in cooperation with Preciosa Company. The main reason of my topic is to suggest a new approach to the edge detection in image processing. Preciosa Company tries to find the most reliable and efficient algorithm for the edge detection of jewelry stones to apply it in manufacturing. My work tries to help Preciosa Company in choosing the most appropriate algorithm.

Experiments and methods

Every fuzzy edge detector must have implemented fuzzy inference system. Fuzzy Inference System (FIS) is a way of mapping from a given input to an output using fuzzy logic. In fact, a FIS consist of four modules (Figure 1). With using of fuzzy rules from expert knowledge are pixels classified as edge or non-edge.

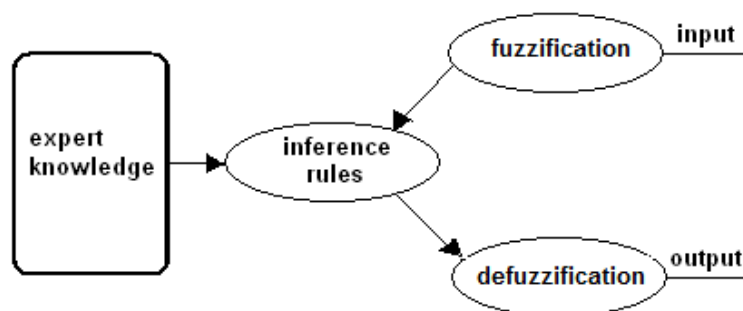


Figure 1: Structure of Fuzzy Inference System (FIS)

In fact I have made three fuzzy edge detectors. One of them was made with 2x2 sliding window mask. Because of a small window mask this algorithm is relatively fast and very simple. The rest two algorithms were made with 3x3 window mask. First of them was made according to literature suggested rules [2] and it has not had precise results. Algorithm has some problems with detecting of

diagonal edges. For this reason I have implemented another fuzzy detector with 3x3 window mask. I added four more rules and the results are superior to the previous algorithm.

All my algorithms were implemented in MATLAB with using of Fuzzy Logic Toolbox and in LabVIEW with using of Fuzzy Logic Toolkit for implementation of Fuzzy Inference Systems.

I have also implemented some classical edge detection algorithms (Laplace operator, Sobel filter and Canny detector) for comparison with my fuzzy edge detectors.

Results and Discussion

Function of fuzzy detectors was tried on the pictures with jewelry stones. My fuzzy detectors work without any preprocessing of the original image. With well prepared fuzzy inference system it is possible to precisely detect only border of the stone and eliminate all unwanted objects (Figure 2). Classical algorithms also precisely detect all edges but unwanted objects are also considered as an edge. This is possible to eliminate with some preprocessing. For example morphological closing can eliminate unwanted objects on the top of the detected stone.

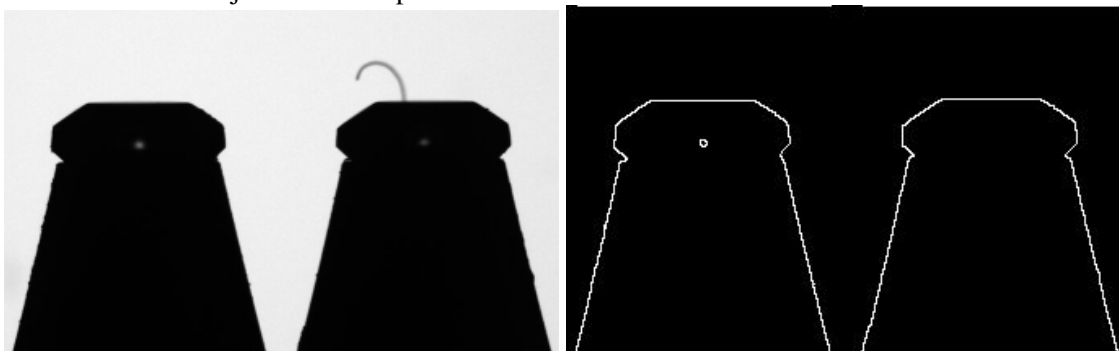


Figure 2: Original image on the left hand side. Fuzzy edge detector with small (2x2) sliding window mask result on the right hand side.

The main emphasis of this diploma thesis lays on time efficiency of algorithms. Unfortunately the fuzzy edge detectors are really slow. Fuzzy edge detectors with using of Fuzzy Logic Toolbox or Fuzzy Logic Toolkit are more than hundred times slower than classical edge detectors and for this reason I tried to make another algorithm which I called “simple” fuzzy algorithm. I skipped fuzzification and defuzzification part from fuzzy inference system (Figure 1). I used only the middle part of fuzzy inference system which uses IF-THEN rules. The visual results from this algorithm are comparable to the results from fuzzy edge detectors. This algorithm has the best time efficiency of all algorithms mentioned above. Time for execution of this algorithm is 0.01 second.

Conclusion

Fuzzy edge detectors very reliably detect edges of the object. Their advantage is detection without any preprocessing, but drawback is big time consuming with using of toolboxes from MATLAB or LabVIEW. For this reason the edge detection using fuzzy logic in MATLAB or LabVIEW is not suitable for real time image processing which has to be used in Preciosa Company. One possibility for decreasing of the execution time would be implementation of FIS on my own.

References

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