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Edge Detection using Memetic Algorithm

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Abstract: ***Edge detection is one of the open issues in image processing. GA, inspired by biological evolution has been typically used for addressing this problem. MA, inspired by biological and / or social evolution, having been tried successfully for many optimization problems, is yet to be tried for this typical problem. Experimental results show the feasibility of the approach in identifying edges in an image. With suitable parameter values, the algorithm was able to successfully identify edges in the test image. It must be noted that the appropriate parameter values depend on the nature of the image, and thus, may vary per application. Experimental result shows that memetic algorithm is slightly superior for finding edges in comparison of genetic algorithm because search technique is incorporated in genetic algorithm and the solution space is better searched. Result indicates that memetic algorithm is extremely powerful technique for edge detection.***

I. INTRODUCTION

Detection of edge is a terminology in image processing and computer vision particularly in the areas of feature detection and extraction to refer to the algorithms which aims at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. The need of edge detection is to find the discontinuities in depth, discontinuities in surface orientation, changes in material properties and variations in scene illumination.

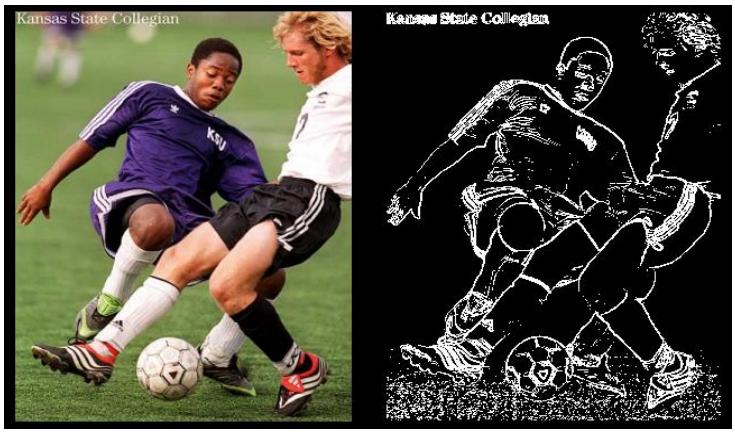

Figure 1.1: Edge Detection [2]

Detection of edge is a critical element in image processing since edges contain a major function of image information [3]. It is a fundamental tool, which is commonly used in many image processing applications to obtain information from images and frames [4]. The separation of the image into object and background is a critical step in image interpretation [5]. An edge may be regarded as boundary between two dissimilar regions in an image. Edge detection is a terminology in image processing and computer vision, particularly in areas of feature detection and feature extraction.

Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The techniques and analyze the performance of the various techniques in different conditions. Discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene.

Classical methods of edge detection involve convolving the image with an operator (a 2-D filter), which is constructed to be sensitive to large gradients in the image while returning values of zero in uniform regions. There are an extremely large number of edge detection operators available,

each designed to be sensitive to certain types of edges. Variables involved in the selection of an edge detection operator include Edge orientation, Noise environment and Edge structure. The geometry of the operator determines a characteristic direction in which it is most sensitive to edges. Operators can be optimized to look for horizontal, vertical or diagonal edges. Edge detection is difficult in noisy images, since both the noise and the edges contain high frequency content. Attempts to reduce the noise result in blurred and distorted edges. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges. Not all edges involve a step change in intensity.

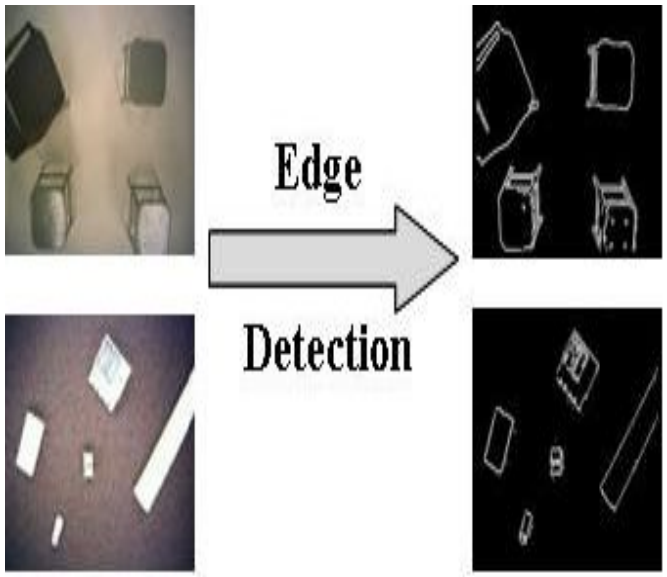

Figure 1.2: Edge detection [6]

Edges in an image provide a representation of object boundaries within that image. Therefore, edge detection is an essential component in many computer image processing operations such as stereopsis, calibration, motion analysis and recognition. From a pixel level perspective, edges can be viewed as the regions of an image where the image values undergo a sharp variation. Normally, such regions form lines, curves and contours, which represent outlines of solid objects, marks on surfaces, and shadows. Moreover, line drawings are common and suggestive images for humans. Notice that image noise too causes intensity variations. Noise is among the most significant obstacles of edge detection. Another factor that complicates the edge detecting operation is digitization. A wide edge in a digital image would have the appearance of a staircase, and might be interpreted as multiple edges.

Edges are places in the image with strong intensity contrast. Edges often occur at image locations representing object boundaries; edge detection is extensively used in image segmentation when we want to divide the image into areas corresponding to different objects. Representing an image by its edges has the further advantage that the amount of data is reduced significantly while retaining most of the image information.

II. EXPERIMENT

A. Objective

Image processing usually refers to digital image processing. The acquisition of images is referred to as imaging. The typical objectives of edge detection are as under:

- Make an image better, i.e., image sharpening and image restoration.
- Measure the interesting objects in an image: Pattern measurement.

- Distinguish or recognize the objects in an image, i.e., image recognition or image understanding.
- Search for the image of interest, i.e., image retrieval.
- To see objects which are not seen, i.e., visualization.

In addition to these standard objectives of edge detection, the current work is also going the meet the following objectives:

- Application of evolutionary techniques (GA, MA, etc.) for edge detection problem.
- Comparison of these techniques keeping the parameters same.

B. Problem Formulation

Edge detection is used to identify the edges in an image, i.e., a technique for marking sharp intensity changes, and is important in further analyzing image content. Traditional edge detection approaches always result in broken pieces, possibly the loss of some important edges.

The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be that under general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to:

- discontinuities in depth,
- discontinuities in surface orientation,
- changes in material properties and
- Variations in scene illumination.

In the ideal case, the result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings as well as curves that correspond to discontinuities in surface orientation. In an image, an edge is a curve that follows a path of rapid change in image intensity. Edges are often associated with the boundaries of objects in a scene.

An edge detection algorithm to an image may significantly reduce the amount of data to be processed and may filter out information that may be regarded as less relevant, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent task of interpreting the information contents in the original image may be substantially simplified.

III COMPARISION AND RESULTS

In this paper we optimize response of an edge detection using memetic algorithm (MA). The experimental result clearly indicates that MA gives better result as compared to GA for edge detection.

In the current work, problem formulation for ED as discussed in chapter 3 is addressed by two of the evolutionary computation techniques GA & MA. The typical parameters taken for this work are derived from the experimental study of different researchers for similar kind of problem and are as under:

Standard parameters of GA are as under:

Number of generations, N = 1000

Population size, N = 100,

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Probability of crossover (P_c) = 0.4,

Probability of mutation (P_m) = 0.003.

Then Different parameters of MA are as under:

Number of generations, N = 100,

Population size, N = 100,

Probability of crossover (P_c) = 0.4,

Probability of mutation (P_m) = 0.003,

Probability of local search (P_{ls}) = 0.1

5.2 Comparison

Here we are taking a gray scale test image of a photographer and then compare the edge detection technique using GA and MA resp.

Figure 5.1: Gray Scale Test Image

Figure5.2:Edge Image using GA-based Optimization.

Figure5.3: Edge Image using MA-based Optimization

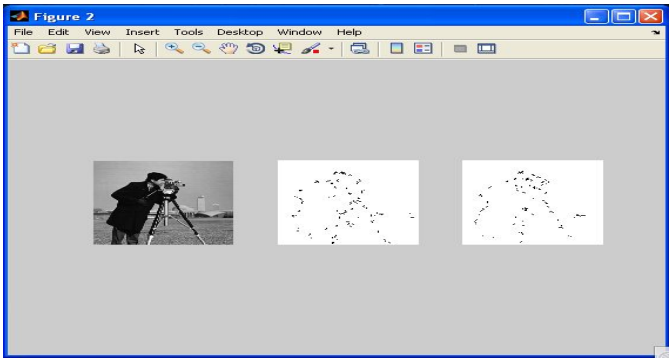

Figure5.4: Comparison.

5.3 Results

From the above figure it is concluded that Memetic Algorithm for finding edges is more robust and effective than finding edges for genetic algorithm. The figure 5.4 confirms the above said statement. The genetic operators (selection,

crossover, mutation etc.) are good enough to find the edges of any image. However, the addition of local search operator refines the results. The extent of refinement is limited as the local search operator needs to be judiciously applied as it make the algorithm more complex in terms of time and there is every possibility that algorithm may become sluggish.

IV. CONCLUSION

Edge detection is one of the open issues in image processing. GA, inspired by biological evolution has been typically used for addressing this problem. MA, inspired by biological and / or social evolution, having been tried successfully for many optimization problems, is yet to be tried for this typical problem. Experimental results show the feasibility of the approach in identifying edges in an image. With suitable parameter values, the algorithm was able to successfully identify edges in the test image. It must be noted that the appropriate parameter values depend on the nature of the image, and thus, may vary per application.Our experimental result shows that memetic algorithm is slightly superior for finding edges in comparison of genetic algorithm because search technique is incorporated in genetic algorithm and the solution space is better searched. Result indicates that memetic algorithm is extremely powerful technique for edge detection.

The proposed work can also be a template and ready reference for a novice researcher in the field of image processing to use MA for other problems in image processing field.

FUTURE DIRECTION

We intend to extend our work described in this paper in the following areas: (i) parallelization of the MA based approach to edge detection, (ii) The results of above evolutionary technique compared with different techniques gives a clear cut idea in interpretation (iii) Then the parameters of the GA and MA may be fine tuned after experimentation for further improving the results.

In conclusion, we feel that memetic algorithm-based optimization techniques have a major role to play in image processing and computer vision. With the use of suitable parallel hardware, memetic algorithms can be used to design robust processing techniques for most vision applications.

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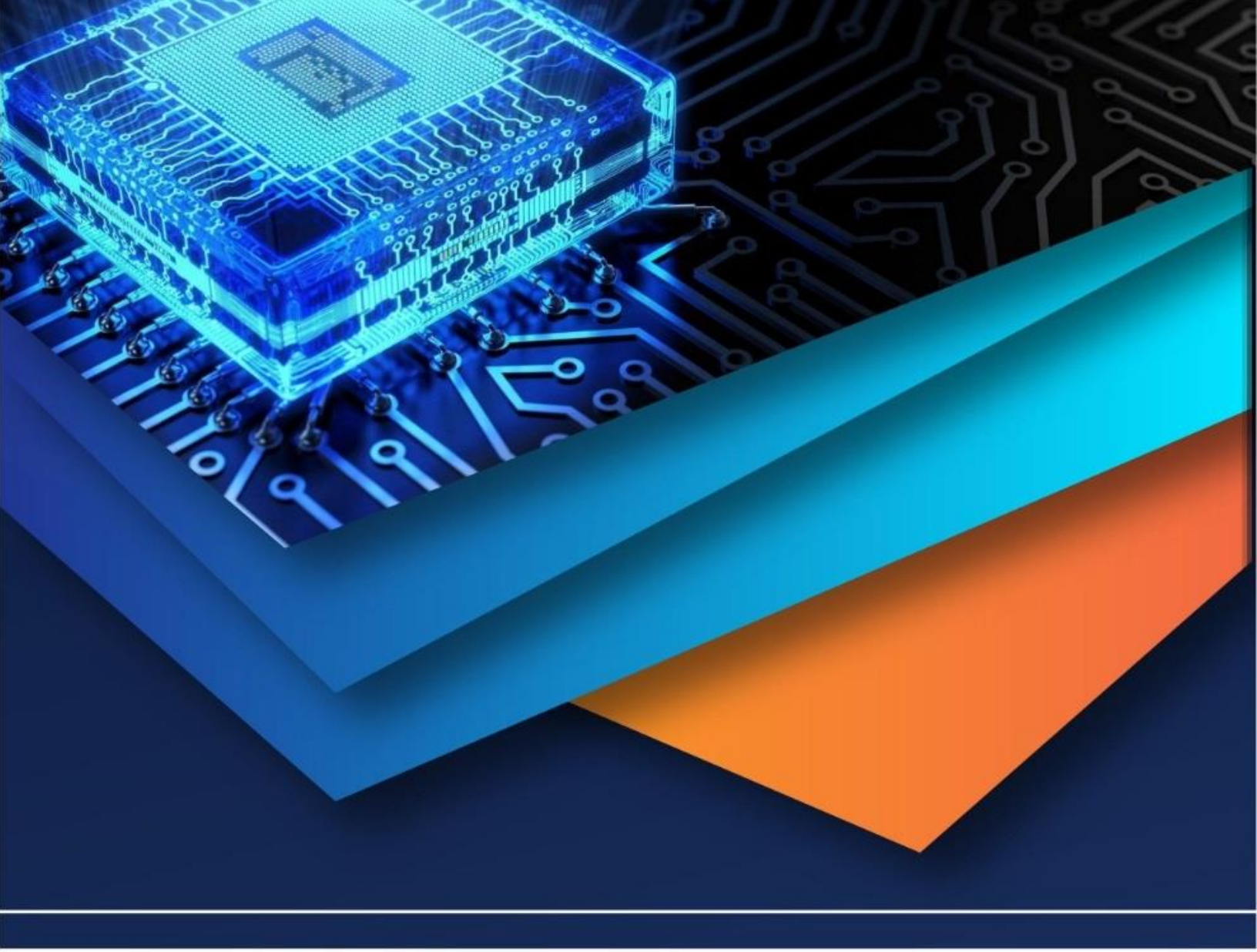

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