A New Method for Edge Detection Using Imperialist Competitive Algorithm

A. Z. Bozorgi, B. M. Sadeghzadeh, C. S.J. Mirabedini

Department of computer engineering, Dezful Branch, Islamic Azad University, Dezful, Iran
zaynab.bozorgi@yahoo.com

Department of Computer, Mahshahr Branch, Islamic Azad University, Mahshahr, Iran
Sadegh_1999@yahoo.com

Department of Computer, Tehran Markaz Branch, Islamic Azad University, Tehran, Iran
jvd2205@yahoo.com

Abstract

In this paper, a method for extracting edges from Imperialistic competition evolutionary algorithm is used. The edges of this method are obtained in two distinct ways: The first method of imperialistic competitive algorithm for optimizing the parameters of a decision threshold. The method is useful to derive the standard Sobel edge operator and improved Sobel operator productivity. The second method uses two-dimensional image structure on the edge of the neighborhood will be defined so that each entry in the data represents the position of each pixel. Simulation results show the proposed method can solve edge detection problem with relatively good quality. The review indicated the proposed method is robust against noise.

Keywords:Edge detection, Imperialistic competitive algorithm, Sobel, Noise, Evolutionary approach

I. Introduction

Edge detection in images is an important problem in image processing. Many edge detection techniques so far proposed scope and frequency space. The edge detection of an image can be considered as an optimization problem of determining the optimum parameters such as threshold decision making and determining edge detection operator with an objective in mind, hence the need to look at this problem with applied something inevitable, yet difficult. So many search algorithms used in different domains are created philosophy. Evolutionary algorithms are optimal algorithms in the category of stochastic optimization algorithms which are random in nature, the law of evolution in order to optimize the use. These algorithms are usually used to solve optimization problems. Formal parameters are other methods that can be used to solve them fail. Recently, a new algorithm called Imperialistic competitive algorithm (ICA) in the field of evolutionary computation, presented by Atashpaz, Gargari and Lucas in 2007 is not a natural phenomenon but a social phenomenon that has inspired human behavior (Hueckel, 1971). The study is used imperialistic competitive algorithm for edge detection.
Rest of the paper is organized as follows: In the second section, related works with edge detection are presented. In the third section, the proposal is submitted. Section IV contains the experimental and simulation results, and Section V concludes the paper is done.

II. Related works

In this section, we review some new articles on the edge detection. Known early works done in this category include algorithms developed by Sobel, Prewitt, Kritch, Robinson and Frei - Chen. However, the classical methods of smoothing do not use a separate module, but that attempt to solve this problem by calculating the mean of the image. A derivative of the estimate calculated using a large set of adjacent pixels when compared to using only two pixels are more likely to tolerate the noise. Following this idea, several functions have been proposed, some of them expanded version of a $3 \times 3$ are detected.

In (WenshuoGao, 2010), The shock wave with a soft threshold is used to eliminate noise and Sobel edge detection is used to detect the edge. Using this technique, we can very well be able to do edge detection and noise can be efficiently removed.

C. Lopez-Molina et al, 2011 presented an edge detection method based on Gaussian smoothing and edge detection. In this paper we lay the basis for scaling and edge detection is conducted and the similarity between the different scale. The edges at all scales are extracted and combined the results and finally get an image of edges.

A new method based on morphological edge detection and multi-structured components image synthesis suggested by Shihu Zhu (2011). Edges using four different SE (structural components) are detected for all structural angle, $0^\circ$, $45^\circ$, $90^\circ$ and $135^\circ$ and the final edge image obtained by combining the entropy weight method. The proposed method can not only efficient way to remove the image noise, but also can be useful for efficient data storage can take the edges. In the article (Naga Raju, 2011)an edge detection algorithm based on multi-structure elements morphology is proposed. In this method by using morphological gradient algorithm, eight different edges are detected and final edges using combined weighting are obtained.

The scheme (Liang et al, 2012) to extract edges and smooth cross is presented that first a Gaussian filter is applied on the image. Then the multi-scale filter violet is designed.

The article (Baterina et al, 2010) presents a procedure for edge detection based on the optimization of ant nest. Ant colony optimization (ACO) is an optimization algorithm based on the real behavior of ants and insects are inspired from natural behavior. The proposed algorithm creates a pheromone matrix that represents the edge information at each pixel location of the image. In this way, ants are sent to the local variations of the values obtained on the image to move the image size. This matrix was created and defined by a threshold on the edge of the image matrix of pheromone form the edges.

In the work presented by (Kumar, 2010) a new approach for fault diagnosis based on cellular automata is proposed. The corresponding algorithm is proposed for gray scale image edge detection. The proposed conception is a cellular automaton for k gray level of digital images based on two-dimensional cellular automata. The results of cellular automata for gray images at different levels of the satisfactorily performed better in compared to Canny, Prewitt, Roberts and Sobel edge detection operators.
III. The proposed method

In this paper an evolutionary algorithm for edge detection in images called as Imperialistic competitive algorithm (ICA) has been used in two distinct phases. In each phase, optimization the parameters of Imperialistic competitive algorithm is employed.

A. Imperialistic competitive algorithm to optimize the parameters of the threshold

This method uses the standard operators, including operator Sobel edge detection and improved Sobel edge detection operators on picture. The Imperialistic competitive algorithm is for extracting the optimal threshold value to be used. Steps are as follows:

- **Cost function**
  
  In this paper an edge detection algorithm based on Imperialistic, global threshold method is applied to an image "M" of size \( m \times n \) and the intensity values are in the range of \( \{0, 1, ..., L-1\} \). The threshold "t" pixel values are grouped based on two categories: \( c_0 = \{0, ..., t\} \) and \( c_1 = \{t+1, ..., L-1\} \). Square error of the two class's \( c_0, c_1 \) is calculated as follows:

\[
(1)
\]

Here "t" is threshold, \( \omega_0(t) \) is the number of pixels whose intensity value in the image is less than the threshold "t", \( \omega_1(t) \) is the number of pixels whose intensity value in the image is greater than the threshold "t", \( \mu_0(t) \) represents the average pixel intensity value which is less than the threshold. \( \mu_1(t) \) represents the average pixel intensity value which is higher than the threshold. T values that create the greatest value for \( \sigma^2 \) is chosen as the threshold.

- **Construction initial empires**
  
  The optimization objective is to find an optimal solution in terms of variables. We will create an array of variables that must be optimized. Here it is called a country. In a matter of \( N_{var} \)-dimensional optimizing problem, each country is an array of size \( 1 \times N_{var} \). Since the objective of problem of making optima is to obtain the optimum value for the threshold parameter value, we set \( N_{var} = 1 \). Variable rates in a country are represented as integers between 0-255. To start the algorithm, the number of states (the number of countries algorithm) are created. The random matrix is formed in the whole country. Then all of the best threshold values of the pixels will be studied and then, the variance will be calculated and acquire the greatest amount of variance. Clearly, determining the optimal threshold based on the required search is expensive, thus an optimization algorithm to determine the optimal level is necessary.

\[
(2)
\]

Then the value (cost) of each of the countries shall be below 3 below to get the cost function.
\[ cost_i = f(country_i) \]  

We follow the best of (the threshold) return. The algorithm introduced in this paper, the production of a set of threshold values and classified them into colonies and Imperialistic policies of assimilation into the Imperialistic Competition between the Imperialistic empires and the search for the best deals.

To start the algorithm, we construct \( N_{\text{country}} \) initial country. \( N_{\text{ipm}} \) of the best individuals of the population (countries with the highest cost function value) is elected as the imperialism. Countries which retained \( N_{\text{cal}} \) of countries that are belonging to each of the Imperialistic empires are considered. The primary colonies divided between the imperialists, the imperialists, the number of colonies that number in proportion to its power, we will. To do this, the cost of all imperialists, the normalized cost them to consider the following:

\[ P_n = \left| \frac{C_n}{\sum_{i=1}^{N_{\text{emp}}}} C_i \right| \]

I have a high regard for \( C_n \) costs are imperialists. From a different angle, an imperialist power normalized ratio by which the imperialist Imperialistic administration. The initial number of colonies for an imperialist will be equal to:

\[ N_c = \text{round}(p \times N_{\text{cal}}) \]

With the initial states of all the empires, Imperialistic competitive algorithm starts. The development is located in a loop until a stop criteria is met, continue.

- **Attracting Policy**
  In this part of the optimization algorithm, colonies are moving toward the imperialist in the colonization process, the colonies movement towards imperialist countries is modeled. The colony size \( x \) of the line to the Imperialistic filed move and moves to a new position. This replacement is done according to the distance \( d \) between colonizer and colonized.

\[ \text{6) } \]

The problem of edge detection and threshold parameters should be determined after the country's imperialistic policies of assimilation such as the maximum pixel values do not exceed 255.

- **Displacement of colony and Imperialistic position**
  After the capture of the country's imperialistic policies using the above we derive the objective function. It is possible as a result of imperialistic policies to attract some of the higher cost (higher status) than the colonies can achieve, The colonizer and the colonized must change their place of work, and the algorithm continues with the new colonizer.

- **Determine the total power of empires**
  Equal to the total power of an empire, the imperial power and the percentage of total power from its imperialistic empire is shown.
\[ T.C_n = \text{cost}(\text{imp}_1) + \xi \times \text{mean}(\text{cost}(\text{colonies of imp})) \]  

\( \xi \) as a parameter shows the effect of the imperialistic empire power that is usually a value between zero and the implementation of \( \xi = 0.05 \) is considered.

- Imperialistic competitive
Every empire that can increase your strength and power will lose its competitiveness in the imperialist competition, will be removed. To model the fact we assume that the removal of empire, the emperor is weakest. Thus, the algorithm is repeated one or more of the weakest colonies of the weakest empires and taken to seize the colonies of competition among all empires. To obtain the probability of obtaining these colonies, we have:

\[ Q = \frac{1}{1-e^{-\xi}} \]  

For this purpose the probability vector corresponding to each of the Empire, a cumulative distribution in the interval \([0,1]\) is created. Then create a random number in the interval, the corresponding number in the range of cumulative distribution take any of it to its colonies, the empire is allocated. The probability interval is larger and more powerful empires more chance to seize colonies are Imperialistic competition.

- Remove weak Empire
During the imperialist competition weak empires and colonies gradually leis into the group of more powerful empires. The proposed algorithm can be considered an empire once removed completely loses its colonies. Consequently, due to the loss of all the colonies, no longer compete and must be removed from the rest of the Empire.

- convergence
The algorithm converges to the fulfillment of a condition, or until the total number of iterations is continued. After a while, all imperialists, and only one empire will collapse and the remaining units are placed under the control of the empire. Convergence condition is usually as follows: If \( |f^{(1)} - f^{(1-1)}| > \epsilon \), the algorithm needs to be repeated there. (In this equation, \( f \) is the cost of the Empire at every stage).Otherwise, the decision to end the best answer, as we consider the decision threshold.

B. Imperialistic competitive algorithm for optimization of edge structure in the image

- Initialize
In the optimization problem, since the objective is to obtain the optimum value of edge image, we set \( N_{\text{var}} = 1 \). Each pixel is considered as a country. The variable rates in a country are represented as integers between 0-255. Starting algorithms for these countries (the number of countries algorithm) are created.
Cost function and the construction process

A crucial parameter is $\eta_{ij}$ that is determined by the manufacturing process. Than as a cost function to determine the value of this parameter countries we use. This parameter is used to determine the amount of local information on the position of the equation we use:

\begin{equation}
\eta_{ij} = \sum (|I_{i-2,j-1} - I_{i+2,j+1}| + |I_{i-2,j+1} - I_{i+2,j-1}| + |I_{i-1,j-2} - I_{i+1,j+2}| + |I_{i-1,j+1} - I_{i+1,j-1}| + |I_{i-1,j-1} - I_{i+1,j+1}|)
\end{equation}

(9)

(10)

Anywhere the normalized factor $I_{ij}$ equal to the pixel value at image position $(i, j)$. Also $V_c$ function is a function of the Local Group and its value depends on a variety of pixel intensity values of pixels in the image. To determine the amount of practice we $V_c$ below:

\begin{equation}
V_c(I_{ij}) = f(|I_{i-2,j-1} - I_{i+2,j+1}| + |I_{i-2,j+1} - I_{i+2,j-1}| + |I_{i-1,j-2} - I_{i+1,j+2}| + |I_{i-1,j+1} - I_{i+1,j-1}| + |I_{i-1,j-1} - I_{i+1,j+1}|)
\end{equation}

(11)

To determine the function $F$ in this study can be used in one of four ways:

\begin{equation}
f(x) = \lambda x, \text{ for } x \geq 0
\end{equation}

(12)

\begin{equation}
f(x) = \lambda x^2, \text{ for } x \geq 0
\end{equation}

(13)

\begin{equation}
f(x) = \begin{cases} 
\sin \left( \frac{\pi x}{2\lambda} \right) & 0 \leq x \leq \lambda \\
0 & \text{else.}
\end{cases}
\end{equation}

(14)

\begin{equation}
f(x) = \begin{cases} 
\sin \left( \frac{\pi x}{2\lambda} \right) & 0 \leq x \leq \lambda \\
0 & \text{else.}
\end{cases}
\end{equation}

(15)

After initialization and other stages of the production process based on the cost function algorithm for the creation of competing colonial empires, we have:

1. Construction of empires
2. Move the colonies toward the imperialist countries (assimilation policy).
3. If a colony in an empire, there is a cost that is lower than that of imperialism, colonies and imperialism rather than with change.
4. The cost to count an entire empire (with regard to imperial and subsistence costs).
5. Pick a colony from the weakest empire and its imperial takeover is the most likely, bad.
6. Remove weak empire.
7. If only one empire is left, stop, otherwise go to 2.
IV. Experimental and simulation results

The simulation software MATLAB and USC-SIPI image database has been used. No part of this bank in terms of image processing and computer vision applications is very collected. The woman USC is supported. The images in this database are based on the properties of several species have been classified. Imperialistic competitive algorithm parameters to optimize threshold parameters are presented in Table I.

<table>
<thead>
<tr>
<th>Table I</th>
<th>VALUES OF PARAMETERS IN IMPERIALISTIC COMPETITIVE ALGORITHM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First method</td>
</tr>
<tr>
<td>R*C</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>R*C-20</td>
<td>90</td>
</tr>
<tr>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

In this table R, C represents the image dimensions.

In order to compare the output of edge detection based on intuitive ways to access articles on a common image (image Lena) is presented. Respectively, from the top left of the image output polymorphism and multidirectional approach (Naga, 2011), the output of ant colony algorithm (Batervina, 2010), bottom left, therefore Fuzzy Logic (Barkhoda, 2009), using HTB (Nasir et al, 2009) and the results show the method proposed is given.

![Comparison of proposed method with other methods](image_url)

**Figure 3.** Comparison of proposed method with other methods

One characteristic of an edge detection algorithm is robust against background noise or Lena purposes of illustration; we dipped into salt and pepper noise. Then perform edge detection on
the image using the proposed method we do, the results are shown in Figure 5. The proposed method shows robustness against noise.

Figure 5. Results of robustness against noise (initial image, noisy image and edge image after adding noise)

V. Conclusion and future research
In this study to derive edge, the Imperialistic competitive algorithm was used as an evolutionary methodology. One of the crucial factors in edge detection threshold parameter is set to determine the optimal value for this parameter requires a careful look at the issue. The method for deriving the standard edges is Sobel and improved Sobel operators. Then the threshold is set to detect edges and non-edges. By local variations in the intensity of the edge of the image can be controlled. Simulation results showed that the method of edge image quality can be achieved partial edges. In the future, we can offer include: 1) an optimal single-Imperialistic competitive algorithm builder. By combining this method with other methods of smart evolutionary algorithm, better results can be achieved. Among the smart way to ant colony, fuzzy system and fuzzy - neural cited. 2) The use of image processing algorithms later.

References


