International Journal of Scientific and Technical Advancements

ISSN: 2454-1532

Evaluation of the Accuracy of Genetic Algorithms for Object Detection in Industrial Environment

Ankit Sharma[1], Raminder Preet Pal Singh[2], Parveen Lehana[3]

[1]Department of Electrical Engineering, Model Institute of Engineering and Technology, Jammu, J&K, India-181122

[2]Department of Electronics and Communication Engineering, Arni University, Kathgarh, Himachal Pradesh, India-176401

[3]Department of Physics and Electronics, University of Jammu, Jammu, J&K, India-180006

Email adress: [1]svankit@yahoo.co.in, [2]raminder_212003@rediffmail.com,[3] pklehana@gmail.com

***Abstract*—**The last few decades have witnessed the big strides genetic algorithm (GA) have taken to emerge as a potentially reliable and efficient performer in solving complex search and optimization problems in the fields of image processing, machine vision, object detection, and pattern recognition. Especially, in the last two decades, there has been a tremendous upsurge of the well researched techniques and approaches being evolved around genetic algorithms in these areas. In the study of various such approaches, it may be easily observed that a few among them have preferred to use (GA) as a vehicle for another core technique to actually ride on it, i.e., as a hybrid GA in which it is reduced merely to the role of a support foil and the real problem solver is some other technique like bacteria foraging optimization (BFO), particle swarm optimization (PSO), etc. In the present study, we attempt to explore the potential and accuracy of the GA designed to realize object detection in industrial environment not by making it to be used as a vehicle by some other technique but by allowing it to stand on its own and taking complete charge of the problem to achieve the final goal of object detection. The scope of the present work is confined to the experimental evaluation of the potential and accuracy of the GA when used as a standalone GA in realizing object detection. The analysis of the results shows that the genetic algorithm proves itself to be an adaptive, accurate, compact, and efficient candidate for object detection in industrial environment.

***Keywords*—** Object detection; image segmentation; image thresholding; genetic algorithm; selection; mutation.

I. Introduction

Object detection is widely utilized in the machine vision in order to realise inspection, registration, and manipulation of the objects for automation in different industries. Object detection in the real environment has always been one of the most challenging tasks in the area of the machine vision research [1]. Identifying and detecting the objects of a particular class such as a human face, a car, a bird etc. in the static images make it even more challenging [2]. Despite the diverse challenges it has continue to pose, the research in this domain has made tremendous strides in the last two decades since it has been both intensively and extensively researched in the field of machine vision across the scientific and engineering diasporas [3]. Object detection constitutes an indispensable component of modern day intelligent systems which are used across a broad spectrum of disciplines of contemporary human life such as security, health, defence, surveillance, medical diagnostics etc. where the issue of object detection and recognition need to be handled quickly and accurately [4]. The research on object detection and recognition algorithms has led to advances in factory and office automation, assembly line industrial inspection systems as well as chip defect identification systems [5]. It has also resulted in significant advances in medical imaging, space exploration and biometrics. Different researchers over the years have approached the problem of object detection by developing methodologies based upon different techniques. One easily finds some algorithm, inspired by the technique incorporated infusing life into each such method while surveying across the work and documentation available in plenty in this area. The most noticeable among these methodologies which have managed to keep their heads above the herd are image segmentation based approaches [6], [7], the nature inspired techniques such as bacteria foraging optimisation (BFO) based object detection, particle swarm optimisation (PSO) and ant colony optimisation based methods [4], [8], [9]. Artificial neural networks (ANN) which are inspired by simulating the functioning of network of neurons in the human brain for comprehending the details and information for understanding have enriched the domain of object detection to a significant extent [10], [15]. Most of these techniques are target or application specific and exhibit sensitivity to environmental parameters such as illumination, brightness, colour etc. Most of them cater well for the detection of particular classes of objects only such as human face, car, bird etc. and are not without their functional constraints when implemented on the objects of some other class and in inconsistent environmental conditions. Different researchers have been observed to evince a great deal of interest in developing methodologies to realize object detection by fusing evolutionary techniques like PSO and BFO with genetic algorithm (GA) [11-13] which performs the role of a vehicle only on which these techniques ride to realise the ultimate goal of object detection while the GA in such methodologies is reduced in its potential to address a small and subtle component of the problem only and not the problem in totality.

In this research paper, we present our work which is centered around the design and implementation of the GA in a standalone mode and not by fusing it with some other technique such as BFO or PSO to realise the detection of the objects which in our work are the tools of everyday use in industrial work environment such as a screw driver, a plier,

Ankit Sharma, Raminder Preet Pal Singh and Parveen Lehana, "Evaluation of the accuracy of genetic algorithms for object detection in industrial environment", *Journal of Scientific and Technical Advancements*, Volume 1, Issue 3, pp. 105-111, 2015.

adjustable spanner etc. This work is undertaken not as a comparative study but as an experimental endeavour to evaluate the accuracy of object detection in industrial scenario when the GA is designed to work alone on its own, taking complete charge of the problem of object detection, utilising only its inherent evolutionary attributes such as cross-over, mutation and not using it as a vehicle to drive some other technique as a central or core mechanism to realise the purpose of object detection. In this way, this work implements the GA, makes it and relies on it as a core or central tool to realise object detection instead of using it merely as a support foil for wrapping some other technique.

The outline of rest of this paper is structured as follows. Section II highlights some of the relevant research contributions made in the field of object detection and GA which inspired our research. Section III gives major insights into the relevant technical constituents which forms the foundation of the presented work. Section IV gives an analysis of the proposed GA design with regard to its evolutionary attributes and highlights the flow chart of the proposed GA. Section V provides the outline of the salient steps in the sequence of flow of GA. Experimental results and performance evaluation are covered in Section VI. Conclusion and future scope are summarized in the last section i.e. Section VII.

II. Related Research and Contributions

Plenty of informative literature and work documentation are available on different techniques and methodologies developed to realise object detection in diversified scenarios and to address core issues associated with it. Inspirational works by different researchers also provide productive insights into the versatility of GAs when it comes to its applications in variety of real world domains such as business, sciences, medical diagnostics etc. to extract reliable and optimal solutions in optimisation problems associated with such fields. Several such relevant works which played a major role in motivating and guiding us through this work may be grouped into three major categories: object detection, image segmentation, and genetic algorithm.

A. Object detection

Shotton et al. [14] proposed a novel object detection scheme that uses only the contour based features of the objects. The scheme is a two stage scheme comprising of a class specific object detector in the first stage and an efficient new boosting procedure for building an accurate classifier in the second stage. No colour information of the images has been used by the authors. The experiment results were satisfactory for the classes of the input images chosen and the scheme also showed tolerance to clutter, lighting and occlusion.

A simple object recognition method is presented using the singular value decomposition of the object image matrix and a functional link neural network for a bin picking vision system to be employed in a bin picking robotic system. The authors Hema C.R. et al. [15] do not utilize the visual features of the pixels but use Eigen vectors of the image matrix for its analysis and feature extraction. The functional link neural network (FLNN) which was trained as a classifier was observed to be more efficient than conventional neural classifiers.

Scale invariant feature transform based method (SIFT) to successfully recognize the position and the orientation of the objects for an automated pick and place robotic system used in industrial and household applications was proposed by Patil and Chaudhari in their research paper [16]. In addition to reviewing different techniques and algos implemented by different researchers for the purpose of object detection and localization, the authors in their experimental results showed that SIFT outperforms the other methods based on other feature descriptors and emerges as the best method for object localization and recognition in pick and place robotic systems.

The authors O. P. Verma, S. Chabra, A. Jindal et al. proposed an approach which was a combination of BFO algorithm and probabilistic derivative technique inherited from the Ant colony system for edge detection [8]. The authors also compared the performance of the proposed approach with the traditional approaches of edge detection such as Canny, Edison and others. In this approach, the edges were accurately detected but the method lacked in presenting the complete edges. The approach worked with a minimal set of input data to be processed thus making it fast and memory efficient.

B. Image segmentation

A colour image segmentation algorithm based upon BFO technique was presented in their work by Navneet kaur et al. [17]. The basic step in the proposed algorithm was the quantization of the colours in the image without degrading the quality of the colours. The algorithm proposed implemented region growing to obtain the segmentations in the image and these segmentations generate the objects of interest in the image.

In their research paper, the authors Amrinder Singh and Sonika Jindal argued that image segmentation affects the subsequent processes of image analysis such as object classification, scene interpretation [18]. Researchers are continuously trying to improve the quality of image segmentation by fusing BFO with GA and PSO. Their technique used the ANFIS edge detector for edge detection on digital images. It involved a system with the learning capability of neural network and the advantages of rule based fuzzy system.

C. Genetic algorithm

Bajpai and Kumar in their research paper conveyed that GA is quite poular in generating optimal solutions to optimization problems in signal processing, robotic vision systems, medical imaging, object localization, stock market and variety of other fields [19]. They also argued that in order to make GAs more effective and efficient, they should be combined with other good optimization techniques such as BFO etc.

The authors Karkavitsas and Rangoussi in their research paper presented GA approach to the problem of object registration in the medical images of the blood cells [20]. Their work also highlighted underlying basic mechanisms of work in GA such as parent selection, reproduction etc. The work showed that the success and efficiency of the GA is critically dependant on the choice of the evaluation (fitness) function and an appropriate choice of the parameters.

In their research paper, P. Kanungo et al. [7] proposed a GA based crowding algorithm to determine a suitable threshold value from the peaks and valleys of the histogram with bimodal features which can be used for the purpose of Image segmentation. They conveyed that gray-level thresholding is an important step in any image analysis application. This GA based approach worked well for images with bimodal features but did not perform well for images with trimodal features.

A method in which GA was used on Fourier descriptors which were used to represent the shape descriptive features of an object was presented by the authors Mahmood Ul Hassan et al. [4] in their research paper. The authors also compared the GA based method with the PSO technique in their experiments and observed that GA based technique outperformed the PSO.

III. Technical Approach—Key Components

The major components which constitute the crux of the proposed methodology for object detection in industrial environment are covered in this section. Although the proposed methodology is centered around the design of the GA but for its proper understanding, it can be conveniently partitioned into two key components, image thresholding, the Genetic Algorithm--an overview.

A. Image thresholding

Proper segmentation of an image is the foundation of object detection and recognition in machine vision [21]. The purpose of image segmentation is to locate the edges or boundaries of object in the image which help in feature extraction and finally object detection and recognition. Edge detection is a very important step in image analysis and image segmentation. Object detection and recognition directly depends upon the quality of the edges detected [8]. Image segmentation can be realized by adopting different techniques and approaches. The popular among these are histogram thresholding, edge based segmentation, region based segmentation which itself employs different techniques such as thresholding, splitting and merging, region growing [17].

Gray-level-thresholding is an important first step in any image analysis application whose purpose is to acquire a binary image of a gray scale image, i.e., the image which contains any two pixel values either 0 or 1. In gray-level-thresholding, a gray scale image is divided into distinct components like foreground objects, where pixel value is 1 and background objects, where the pixel value is 0 by partitioning the pixels in the gray scale image into foreground (object) and background classes based upon the relationship between the gray level value of a pixel and a significant gray level threshold parameter selected in that gray level image in a systematic way so as to separate the object from the background in the image [7].

In the proposed methodology, gray level thresholding has been incorporated into the GA design taking due cognizance of this fact that a RGB (True colour) image can actually be resolved into three distinct gray scale images where each of the three gray scale images correspond to the R-component (Red colour), G-component (Green colour) and B-component (Blue colour) image of the actual RGB image. The implementation of the gray level thresholding in the proposed GA results in the binary image of a RGB image shown in fig.1 with the boundaries or edges of the object in the RGB image properly detected and clearly shown outlined in white colour against a black background.

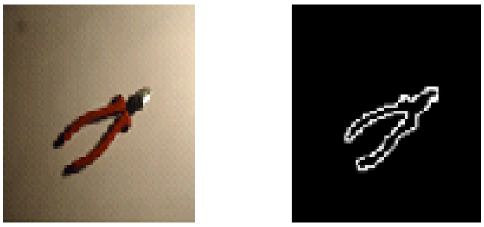

Fig. 1. Preprocessing of the input RGB image. a) RGB image of a plier, b) preprocessed binary image with edges shown in white.

B. Genetic algorithm—an overview

The GAs for the last 20 years have been extensively in use and gained much popularity in the domains of image processing, pattern recognition, machine vision and object detection. GA is a nature inspired search and optimization technique which derives it's functional character from the principles of natural selection and genetics [22]. Today the engineering and scientific community relies on this technique as a potent answer to wide array of real world optimization problems in fields like digital signal processing, robotic vision systems, medical imaging, object detection and recognition just to mention a few [19].

The use of GAs is highly recommended by the researchers in all such problems where an optimal solution is to be extracted from a potentially huge solution space. In such optimization problems, the GAs have been observed to outperform the other traditional optimization techniques such as calculus based optimization, hill climbing, feed forward ANNs (Artificial Neural Networks) [19, 22]. GAs also score over other nature inspired evolutionary techniques like simulated annealing, PSO etc. in a way that GAs work to maintain a population of potential solutions to a problem at any stage and not just one point solution as can be seen in techniques like PSO [4].

The GA is a search heuristic that generates a population of individuals (potential solutions) and allows them to evolve to a state of maximum fitness by following Darwinian rules of natural selection and evolution. Thus the GAs promote the survival of the fittest [22, 24] and this fittest corresponds to the optimal solution of the search and optimization problem.

Any simple GA incorporates the following five steps in its functioning which are derived from nature's principles of

Ankit Sharma, Raminder Preet Pal Singh and Parveen Lehana, "Evaluation of the accuracy of genetic algorithms for object detection in industrial environment", *Journal of Scientific and Technical Advancements*, Volume 1, Issue 3, pp. 105-111, 2015.

natural selection and genetics. It is incorporation of these principles in it's functioning that imparts GAs its quintessential genetic character. The five primary operations employed by GAs in their functioning are initialization, evaluation and selection, reproduction, cross-over and mutation.

IV. THE PROPOSED GA DESIGN ANALYSIS

The GA which is designed in order to realize the object detection in industrial environment incorporates the same inherent attributes which constitute the foundation of any simple, modified and hybrid GAs. This section presents an overview of the analysis of the GA designed by us with regard to the essential genetic attributes of initialization, evaluation, selection, reproduction, cross-over and mutation.

A. Initialization

Initialization in GA refers to the randomly generated initial population of the individuals (potential solutions) in a search problem [19]. In GA parlance, each such individual is a chromosome which comprises of several genes, i.e., each chromosome can be held as a string of several genes. The proposed GA generates an initial population of ten chromosomes in a search space and each chromosome is assigned nine genes such as intensity, scale etc. of a pixel in the image.

B. Fitness evaluation

To select which individuals in the initial population will be favoured to breed to create the next generation, the fitness of every individual must be evaluated [23, 24]. The proposed GA evaluates the fitness (health) of each of the ten chromosomes in the initial population and arranges them in the ascending order of their fitness through a set of appropriate instructions incorporated in it

C. Selection

In this step of the GA, two individuals depending upon their fitness calculated in the current population are selected as parents to breed a new generation of individuals [19, 22]. Roulette wheel selection and tournament selection are the two popular methods in this context but we implement a random selection method in the GA in which the fittest individual in the current generation and a randomly selected individual from the rest of the nine individuals will be selected to breed in order to reduce the selection time and adding diversity to the population in the solution space.

D. Reproduction

In the reproduction phase of the GA, the population of the next generation is created by implementing the two basic methods, cross-over and mutation [19, 23]. For every new child in the next generation, a pair of parents is selected from which the child inherits it's properties. In the GA proposed, we incorporate both the methods for reproducing the next generation.

E. Cross-over

The cross-over operator of the GA selects genes from the parent chromosomes and creates new offsprings [19, 22, 24]. The simplest way to realize cross-over is to randomly select a cross-over point (The locus position of a gene) and copy everything before this point from the first parent and after the cross-over point copy from the second parent. This is known as single point cross-over which results in two offsprings. Two points, multiple point and other cross-over techniques can also be used in GAs.

A single point cross-over technique is implemented in the proposed GA after allowing it to randomly select it's cross-over point so as to perform the mating of the two parents and exchange their genes across this point to create two new offsprings for the next generation.

F. Mutation

The purpose of the mutation is to enable the GA to explore new areas of the search space and prevents all the solutions in the population from falling in the local optima of the solution space by introducing and preserving genetic diversity [19, 23]. Mutation is incorporated in our GA for those chromosomes which are assigned the two lowest positions of fitness in every generation from the second generation onwards so as to preserve the best chromosomes having the highest fitness in every generation. The mutation of the best chromosomes in every generation is always advised against [22] and a very low percentage of the population in the generation should be mutated.

V. SALIENT STEPS IN ALGORITHM FLOW

The salient steps in the sequence of the algorithm flow as can be observed from the flow chart of the GA shown in fig. 2 above are the following:

1 Randomly generate an initial population P of candidates, each having a desired number of systematically selected genes.
2 Select an appropriate number of generations N.
3 For generations 1 to N do the following. // Main Loop.
3.1 Evaluate the fitness of each candidate in the population P.
3.2 Arrange the candidates in the ascending order of their fitness.
3.3 If the generation limit has reached N then come out of the main loop and return the best fit candidate, otherwise proceed to the next step to create next generation.
3.4 Create the next generation of candidates by following the steps a) to c)
  a) Select the best fit candidate from P and randomly select the other candidate from (P-1) as parents for the cross-over.

Ankit Sharma, Raminder Preet Pal Singh and Parveen Lehana, "Evaluation of the accuracy of genetic algorithms for object detection in industrial environment", *Journal of Scientific and Technical Advancements*, Volume 1, Issue 3, pp. 105-111, 2015.

International Journal of Scientific and Technical Advancements
ISSN: 2454-1532

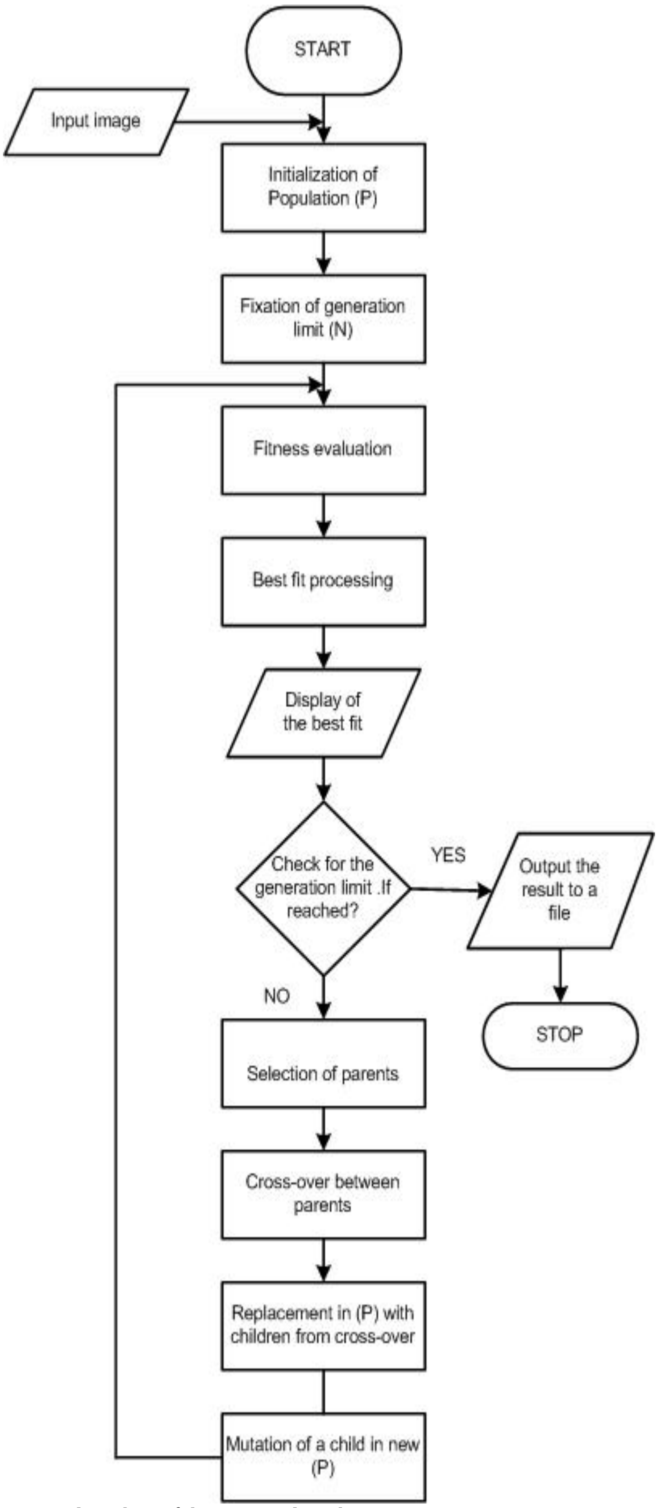

Fig. 2. Flow chart of the genetic algorithm.

b) Perform the single point cross-over after randomly selecting the cross-over point between the parents selected in the step a)
c) Replace the two lowest fit candidates in P with the two children from cross-over to create the next generation.

3.5 Perform the mutation on one of the two randomly chosen child in the new population acquired in step c)
3.6 Proceed to the step 3 above for the repetition of all the steps from 3.1 to3.5 with the new population.

VI. Experimental Results and Performance Evaluation

A. *Test images*

Images of the various industrial objects that are frequently used in industrial work environment such as screwdriver, plier, adjustable spanner, open-ended spanner etc. are first captured with Sony's DSCW320 14MP digital camera under different light shades (colours) such as red, yellow, blue and white. Each object image is a JPEG image of 4320 X 3240 pixels resolution which is then resized and converted into BMP image of 100 X 100 pixels which reduces the cost of processing in terms of time and memory requirements multifold, since processing an image with a higher pixel resolution will consume more time and can prove to be quite a heavy burden on the memory [25].

Then in each such BMP image, the boundaries of the object are marked because of the various advantages associated with the use of markers in image segmentation [26]. It is used primarily to achieve gray-level segmentation using a single global threshold for the purpose of detecting the edges of the object and to take out any shadows and noise accompanying the object in the image and which can be caused due to the use of light in specific position.. These BMP images are then submitted to the image database which contains 60 images comprising of test images of various industrial objects captured in different light shades to be used in experiments, images of the objects other than the industrial objects to test the quality and efficiency of the GA design and to evaluate whether these images are able to deviate the GA from following it's desired course and a few synthetic (handcrafted) images in order to add more variety to the image database and pose more challenges to the GA. The purpose behind capturing the images of industrial objects in different light shades is to determine whether the GA design shows any sensitivity to the light colour in the process of object detection since the actual industrial environments are also sometimes exposed to the lights of different colours.

B. *Performance and results*

Experiments were conducted using different images of the industrial objects as the test images for the GA. The test images are of the same industrial objects whose images are kept in the image database but captured in an environment which differs slightly from the environment in the images of these industrial objects kept in the image database. The environment of test images is deliberately altered from the environment of database images of the similar objects in terms of brightness, contrast, object orientation etc. by a small extent just to confirm that whether an inconsistent environment is able to influence the accuracy of the GA. These test images are then provided as inputs to the GA in several experiments. It was observed that in most of the experiments, the GA behaved reliably well and performed as per expectations. It succeeded in accurately detecting the object in the test image by finding a perfect match with the image of the same object kept in the database. In these successful experiments, the GA was observed to arrive at the correct result by evolving less than half of the preset maximum number of generations. In few experiments, the GA did not perform as per expectations and gave undesired results. In these experiments, it is observed after analysis that if desired object image is positioned in the database quite far from the position of the last image in the database and which is also not one of the starting positions of the database. Then GA was observed to get stuck on an undesired object which was usually positioned at the start of the database and from which it could not recover. To overcome this problem, the GA was made to evolve its initial population with the number of candidates much higher than used in earlier experiments in order to give it a fair amount of chance to arrive at the correct result. With this modification, the GA was really able to turn around its performance in all these experiments.

In all the experiments conducted, the test images of various industrial objects captured in different light colours were used. It was observed that the various light colours did not have any effect on the performance of the GA.

It was also observed that the expansion of the image database to 100 or more than 100 images will pose a much bigger challenge for the GA in the detection of the desired object. The visual illustrations of the performance of the GA in three of the several experiments conducted are highlighted in Fig. 3. The test image column of the Fig. 3 shows the test images of different industrial objects captured in different light shades (colours) and used as input images for the GA in experiments. The next column of intermediate matched image shows the match of the object in the test image with same object found in one of the suitable images kept in the database after processing by the GA at the intermediate stage during its iterations. The last column of the Fig. 3 shows that object in one of the suitable images in the database with which the GA has found a perfect match of the object in the test image. Note the slight difference in the environments of the test images and the corresponding database images with which the GA has matched the test images.

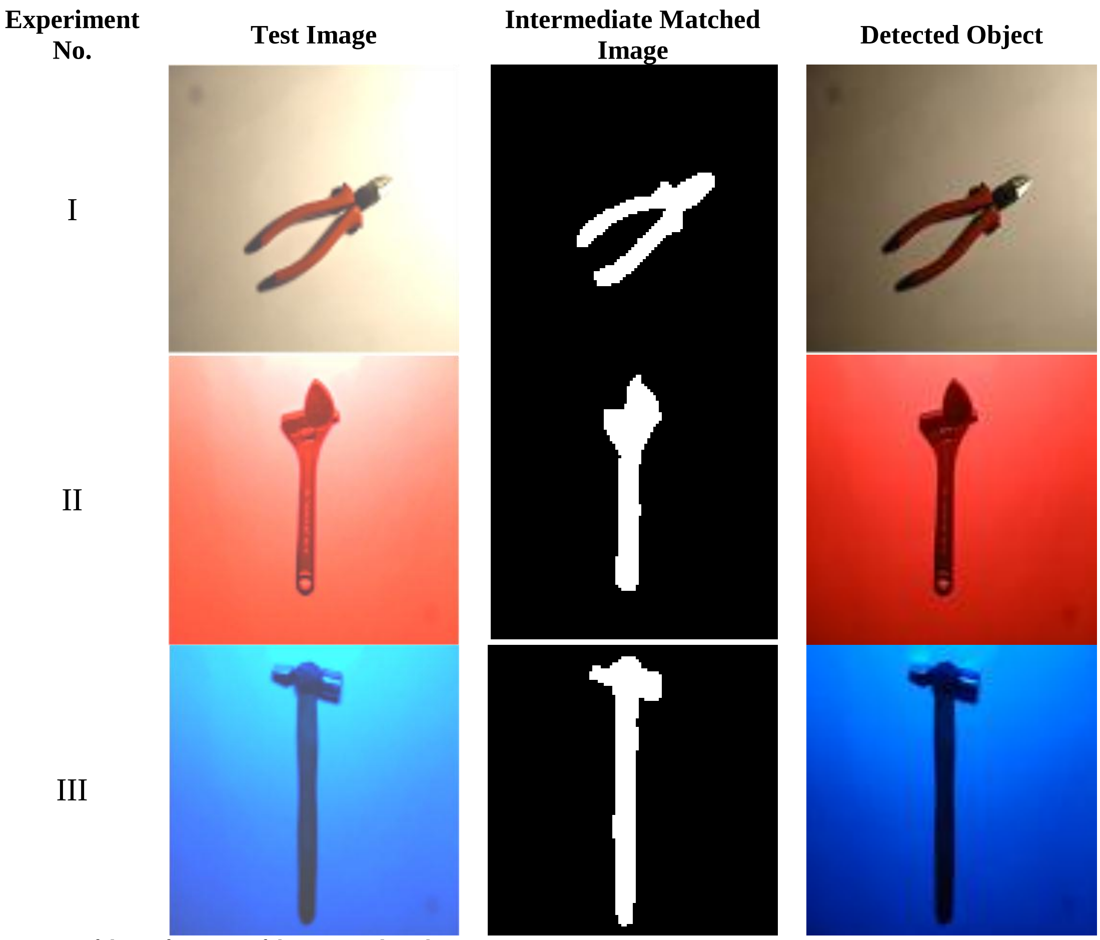

Fig. 3. Visual illustrations of the performance of the genetic algorithm.

VII. Conclusion and Future Scope

In this paper, efforts have been made to address the problem of object detection in industrial work environment using stand alone GA and to evaluate its accuracy. In the

Ankit Sharma, Raminder Preet Pal Singh and Parveen Lehana, “Evaluation of the accuracy of genetic algorithms for object detection in industrial environment”, *Journal of Scientific and Technical Advancements*, Volume 1, Issue 3, pp. 105-111, 2015.

proposed methodology, The GA is designed not to drive some other technique but it drives its own self to take complete charge of the problem relying solely on its evolutionary attributes to achieve the goal of object detection. In its implementation in several experiments conducted as part of this evaluation, the GA design is observed to adapt quickly to the different shapes of the industrial objects (tools) without any prior training and learning, shows immunity to the effects of various light colours red, blue, white and yellow used in the test images, converges to the optimal solution with a high degree of accuracy without requiring a high number of generations to evolve, say above 100 which has been observed to be a case come true if the image test pool is expanded to 100 or more than 100 images. In a nutshell, this GA can be heralded as an adaptive, accurate and efficient in design for an appropriate choice of GA parameters. But at the same time, it will be pertinent to mention that it also shows some functional constraints in a few cases.

The future work will be focussed on modifying the design of GA not only to iron out the little weaknesses it exhibited in a few cases but also for the accurate estimation of orientation, object localization and scale estimation based object detection. Attempts will also be made to address the problems of multiple objects in images, to detect and recognize overlapped objects in images, to detect and recognize occluded objects in images. The GA will also be modified to address the problems of detection and recognition in cluttered scenes. The GA design in its current form can be taken to fuse with some other core technique which has a proven track record of reliability and efficiency to address the core problems in the aforementioned areas as hybrid GAs have been observed to perform better and reliably well in most of these areas.

REFERENCES

[1] J. J. Yokono and T. Poggio, "Rotation invariant object recognition from one training example," *Massachusetts Institute of Technology-Computer Science and Artificial Intelligence Laboratory*, Cambridge, 2004.

[2] A. Mohan, C. Papageorgiou, and T. Poggio, "Example based object detection in images by components," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol.23, pp. 349-361, 2001.

[3] K. Grauman and B. Leibe, Visual Object Recognition, San Rafael, California (USA): Morgan and Claypool Publishers, 2011.

[4] M. ul Hassan, M Sarfraz, A. Osman, and M. Alruwaili, "Object recognition using particle swarm optimization and genetic algorithm," *International Journal of Computer Science Issues*, vol. 10, pp. 55-64, 2013.

[5] A. Andreopoulos and J. K. Tsotsos, "50 years of object recognition: Directions forward," *Journal of Computer Vision and Image understanding*, vol.117, issue 8, pp. 827-891, 2013.

[6] M. Singh and A. Misal, "A survey paper on various visual image segmentation techniques," *International Jounal of Computer Science and Management Research*, vol. 2, pp. 1282-1288, 2013.

[7] P. Kanungo, P.K. Nanda, and U.C. Samal, "Image segmentation using thresholding and genetic algorithm," *Image Processing and Computer Vision Lab, NIT, Rourkela*, 2010.

[8] O. P. Verma, M. Hanmandlu, P. Kumar, S.chhabra, and A. Jindal, "A novel bacterial foraging technique for edge detection," *Journal Pattern Recognition Letters*, vol. 32, issue 8, pp.1187-1196, 2011.

[9] D. Yadav, M. Vatsa, R. Singh, and M. Tistarelli, "Bacteria foraging fusion for face recognition across age progression," *Proceedings of the 2013 IEEE Conference on Computer Vision and Pattern Recognition Workshops*," pp. 173-179, 2013.

[10] H. A. Rowley, S. Baluja, and T. Kanade, "Neural network-based face detection," *IEEE Transactions on PAMI*, vol.20, pp. 23-28, 1998.

[11] D. H. Kim, A. Abraham, and J. H. Choo, "A hybrid genetic algorithm and bacterial foraging approach for global optimization," *Information Sciences*, vol.177, pp. 3918-3937, 2007.

[12] M. Nazir, A. Majid-Mirza, and S. Ali-Khan, "PSO-GA based optimized feature selection using facial and clothing information for gender classification," *Journal of Applied Research and Technology*", vol.12, issue1, pp. 145-152.

[13] K. Subramanian, "Face recognition using eigenface and support vector machine," *International Journal of Innovative Research in Computer and Communication Engineering*, vol. 2, issue 7, pp. 4974-4980, 2014.

[14] J. Shotton, A. Blake, and R. Cipola, "Contour-based learning for object detection," *Proceedings of the Tenth IEEE International Conference on Computer Vision*, vol.1, pp. 503-510, 2005.

[15] C. R. Hema, M. Paulraj, R. Nagarajan, and S. Yaacob, "Bin object recognition using image matrix decomposition and neural networks," *Iraq Journal Electrical and Electronic Engineering*, vol. 3, no. 1, pp. 60-64, 2007.

[16] G. Patil and D. Chaudhari, "SIFT based approach: object recognition and localization for pick-and-place system," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 3, issue 3, pp. 196-201, 2013.

[17] N. Kaur, R. Singh, and R. K. Tulli, "Bacteria foraging based image segmentation," *International Journal of Engineering Sciences*, vol. 6, pp. 141-150, 2012.

[18] A. Singh and S. Jindal, "A systematic way for image segmentation based on bacteria foraging optimization technique," *International Journal of Computer Science and Information Technologies*, vol. 5, issue 1, pp. 130- 133, 2014.

[19] P. Bajpai and M. Kumar, "Genetic algorithm-an approach to solve global optimization problems," *Indian Journal of Computer Science and Engineering*, vol.1, no. 3, pp. 199-206, 2010.

[20] G. Karkavitsas and M. Rangoussi, "Object localization in medical images using genetic algorithms," *International Journal of Signal Processing*, vol. 1, no. 4, pp. 204-207, 2004.

[21] P. Pachunde, V. R. Ingle, Mahindra, and A. Gailwad, "Segmentation of colour images using genetic algorithms-A survey," *IOSR Journal of Electrical and Electronics Engineering*, vol. 1, issue 6, pp. 09-12, 2012.

[22] R. L. Haupt and S. E. Haupt, *Practical Genetic Algorithms*, River Street, Hoboken, New Jersey: John Wiley & Sons, Inc., 2004.

[23] A. Masum, M. Shahjalal, M. Faruque, and M. Sarker, "Solving the vehicle routing problem using genetic algorithm," *International Journal of Advanced Computer Science and Applications*, vol. 2, No. 7, pp. 126-131,2011.

[24] K .S. Tang, K. F. Man, S. Kwong, and Q.He, "Genetic algorithms and their applications," *IEEE Signal Processing Magazine*, vol.13, no. 6, pp. 22-37,1996.

[25] D. Kumar, "Implementation of bacteria foraging optimization for colour image quantization and its evaluation for various file formats," *International Journal of Computer Science and Communication Engineering*, vol. 2, issue 1, pp. 36-42, 2013.

[26] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, Upper Saddle River, New Jersey: Prentice Hall, 2004.

Ankit Sharma, Raminder Preet Pal Singh and Parveen Lehana, "Evaluation of the accuracy of genetic algorithms for object detection in industrial environment", *Journal of Scientific and Technical Advancements*, Volume 1, Issue 3, pp. 105-111, 2015.