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HYBRID SUGGESTED SECURITY MODEL FOR IDENTIFICATION AND VERIFICATION OF ILLICIT OBJECTS THREATS IN SCANNED IMAGES

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Abstract:- Most of the screening means in the important zones are still manually based by an expert employed to detect the threat's objects in the different luggage images. The detection method of unknown objects in luggage scans images plays an important role to reduce the hazards. In different scanned image devices, the scanned images are specified the different threats included hazards. The present model discusses a hybrid security model consist of Artificial Neural Networks (ANN) such as a Kohenen Self-Organizing Map (SOM NN) with Genetic Algorithms (GA) for hazard's and threat's object detection and recognition in X-Ray various luggage scan images. Experimental results show that the efficiency and competence of suggested model detect the details of all luggage in the airport and the trains-lines and private zones using edge detection method to specify the exact type of threat with minimal amounts of false positives. The system was displayed by using different menacing such as Knives, hand grenades, Pistols and Bullets.

***Keywords**: Edge detection; Feature Extraction; Image Segmentation; SOM Neural Network; GA; K-means algorithm; FIR Filter.*

Introduction

Automatic object identification and verification are playing an important role in computer vision and every part of today life and society in modern civilization [1].With development technologies different societies are increasingly dependent on computer for processing and data storage and transmission of information [2]. The user connects with computer device as chief to be a technological revolution that open a new age to enter into the world, commonly known as the technological world [3]. One of the most important goals of computer vision is to achieve visual recognition ability comparable to that of human [4]. Among many identification subjects such as object identification, many interesting applications of object identification and verification from many researchers have been introduced such as in the areas of surveillance, security trading terminals, border port control [5].

Outline of the System

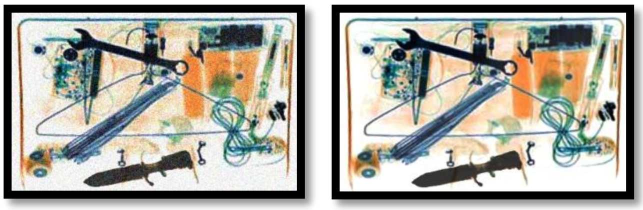
The system completely depends on the X-Ray image enhancement that enhance the whole image with image core. The motivation of suggested system is identifying and verify the danger and threat objects in X-Ray images after image filtering and enhancement (image denoising).

Enhancement During Finite-Duration Impulse Response Filter (FIRF)

The filter used to denoise X-Ray image is Finite-Duration Impulse Response (FIR) Filter. FIR filter is stable digital filter. FIR filter is the perfect filter for using in computer application of the MATLAB environment (eq. 1) [6]. Many X-Ray luggage images suffer from distortion, enhancement, image leads to reduce or eliminate noise from these images. These distortions of X-Ray images can be tracked even in various background after using enhancement filter and FIR filters. The simulation results indicated that FIR filter is more powerful than other filters [7] .

$$\boldsymbol{x(t)} = \sum_{\boldsymbol{i=0}}^{\boldsymbol{q}} \boldsymbol{h(i)y(t-1)} \dots \dots \dots (1)$$

When i= 1,2,3,….. and q is an integer number.



(a) (b)
Fig. 1 Image Enhancement (a) Before (b) After

Digital Image Segmentation (DIS) Process Behavior

DIS is a process to identify homogeneous regions in a given image [8]. It is typically used to locate objects and boundaries (lines, curves, and regions). In order to understand an image, we need to isolate the objects in it and find relationships among them [9]. The goal of segmentation is to make the representation of an image more meaningful and easier to analyze [10]. Image segmentation can be defined as a process that divides an image into different regions. Each region is homogeneous, but the union of any two adjacent regions is not homogeneous [11].

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DIS is one of the most critical tasks of image analysis, and the quality of segmentation affects the subsequent process of image analysis and understanding, such as object representation and description, feature measurement, object classification, scene interpretation, etc. [12]. Moreover, it plays an important role in a variety of applications such as robot vision, object recognition, and medical imaging. It is defined as a bridge between a low level vision subsystem and a high level vision subsystem [13].

DIS is divided into two categories:

(1) Gray image segmentation, and

(2) Color image segmentation.

Many algorithms and models of gray image segmentation can be modified and applied to color image segmentation [14]. The more popular segmentation approaches are: histogram-based methods, edge-based methods, region-based methods, model-based methods, watershed methods, and fuzzy logic methods [15] [16].

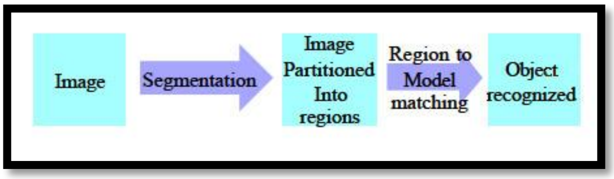
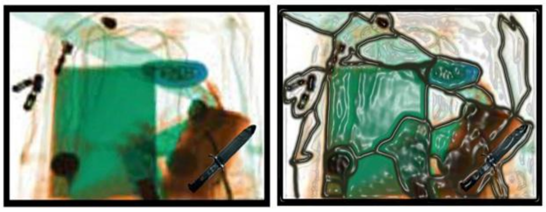


Fig 2. General Recognition Diagram by Segmentation.

In a typical X-Ray luggage scanned image, there will generally be a mix of low density, medium density, and high density objects. In X-Ray images, high density objects soak up more X-Ray photons and arise more intensely than low density objects. Due to these features, an image segmentation algorithm which requires knowledge of the number of partitions in the segmentation still active and efficient [17].



(a) (b)

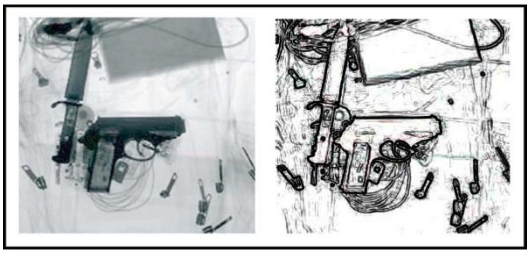
Figure 3. Luggage Images (a) Original scanned Image. (b) Image after segmentation .

SPLIT METHOD (Clustering methods)

The well-known *K-means* algorithm is used to separate the pixels in the image into various small regions based on both their intensity and the relative location of regions. Because the properties of the *K*-means algorithm are simple and fast, several *K-means* algorithm based image segmentation algorithms have been proposed [18]. Due to the gray-level variations of pixels are larger than the coordinate values, pixels in the same split region may not continue. The small regions are filtered out and merged two adjacent regions to cope with this problem. This approach improves the quality of splitting regions without setting thresholds [19].

The *K*-means algorithm is an iterative technique that is used to partition an image into *K* clusters. The basic algorithm is:

1. Pick *K* cluster centers, either randomly or based on some heuristic.
2. Assign each pixel in the image to the cluster that minimizes the variance between the pixel and the cluster center.
3. Re-compute the cluster centers by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (e.g. no pixels change clusters).



(a) (b)

Figure 4. Applied Indoor image. (a) Original Indoor Image. (b) Result regions after *K-means* procedure.

Edge Detection Behavior

Canny Edge Detector (CED) is one of the most commonly used image processing tools. Edge detection is the main section to determine the structures of objects in images. For these reasons, object recognition can be specified by using feature extraction. Edge detection is the popular problem in digital image processing, due to edge defines all boundaries of different objects in digital images (contour of menace and threat objects). To detect edges in a scanned image using a method such as CED, the image is convolved with a kernel to approximate the gradient in a given direction [20]. Detecting edges in a very robust manner. The CED algorithm is known to many as the optimal edge detector [21]. Due to edge defines all boundaries of different objects in digital images (contour of menace and threat objects), edge detection are the popular problem in digital image processing. In this suggested algorithm, the CED is known as the optimal edge detector for menace and threat objects contour [22].

The technical reasons for using CED to improving the edge detection by following criteria:

(1) Edge Points are well Localized (EPL).

(2) Low Error Rate (LER). LER means edges occurring in images should not be missed. During a process, the CED first smooths the image to eliminate the noise (denoising), then finds the image gradient to highlight regions with high spatial derivatives [23].

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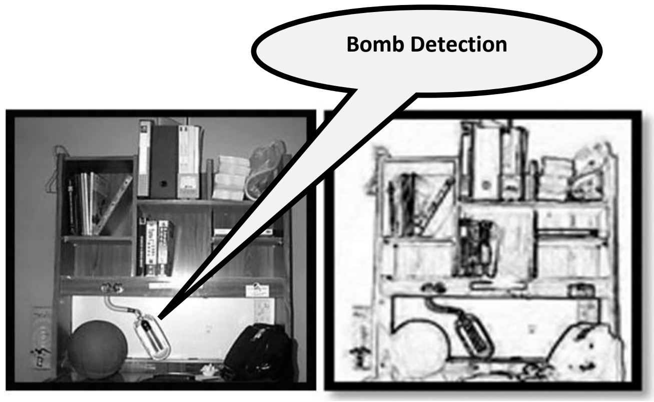

(a) (b)

Figure 5. Original Image. (a) Before applying Canny Filter. (b) After applying Canny Filter.

Edge Detection contain four steps, namely: Filtering, Enhancement, Detection and Localization. The overview of the steps in edge detection is as follows:

- *Filtering* – Filter image to improve performance of the Edge Detector .[24]
- *Enhancement* – Emphasize pixels having a significant change in local intensity [25].
- Detection – Identify edges – thresholding [26].
- Localization – Locate the edge accurately, estimate edge orientation[27].

Genetic Algorithm (GA) Overview

GA are algorithms for optimization and machine learning based loosely on several features of biological evolution. They require five components:

1. A way of encoding solutions to the problem on chromosomes.
2. An evaluation function which returns a rating for each chromosome given to it.
3. A way of initializing the population of chromosomes.
4. Operators that may be applied to parents when they reproduce to alter their genetic composition.
5. Parameter settings for the algorithm, the operators, and so on [28].

Given these five components, a GA operates according to the following two steps:

1. Initialize the population using the initialization procedure, and evaluate each member of the initial population.
2. Reproduce until a stopping criterion is met. Reproduction consists of iterations of the following three steps:

(a) Choose one or more parents reproduce. Selection is stochastic, but the individuals with the highest evaluations are favored in the selection.

(b) Choose a genetic operator and apply it to the parents.

(c) Evaluate the children and accumulate them into a generation. After accumulating enough individuals, insert them into the population, replacing the worst current members of the population [29].

The general procedure of GA can be described below:

Initialize population with random solutions.
Evaluate the fitness of the population.
While (stopping criterion not met)
Forming new population.
Select sites in the search area.
Random Iteration selected sites & evaluate fitness.
Select the fittest population (PE or iteration) from each patch.
Assign the remaining iteration to search.
Randomly and evaluate their fitness.
End While.

The GA is based on natural selection and genetic recombination. The algorithm works by choosing solutions from the current population and then applying genetic operators – such as mutation and crossover – to create a new population. The algorithm efficiently exploits historical information to speculate on new search areas with improved performance. When applied to optimization problems, the GA has the advantage of performing global search. The GA may be hybridized with domain-dependent heuristics for improved results. [30]

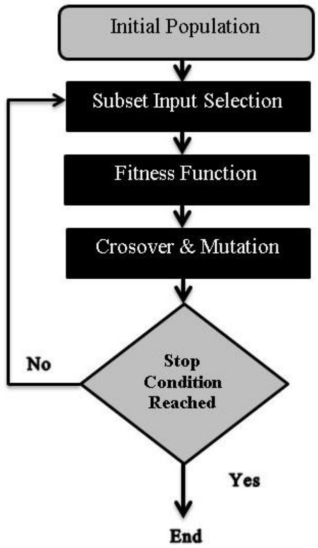

Figure 6. The basic structure of a GA.

An initial population of individuals is created. The creation of the individuals depends on the encoding strategy

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and does not necessarily represent a functional neural network. The initial population is evaluated, which includes a certain number of NN training cycles. This number is restricted by a pre-defined maximum, but there may be less training, if a target error is reached before completion. The fitness of an individual is defined by the following equation:

$$Fitness=\frac{Actual\ \ Training\ Epochs}{Maximum\ Training\ Epochs}\times Network\ \ Error \ldots(2)$$

Self-Organizing Map Neural Network (SOM NN)

ANNs are parallel networks of processing elements (PE) or nodes that simulate biological learning. Each node in an Artificial Neural Networks can be performed Primary computations. Learning is achieved through the adaptation of the weights assigned to the connections between nodes.

ANNs represent a paradigm for machine learning and can be used in a variety of ways for IS. The most widely applied use in medical imaging is as a classifier, where the weights are determined using training data, and the ANNs are then used to segment new data. Because of many interconnections used in a NN, spatial information can easily be incorporated into its classification procedures. SOM is one of the most fascinating topics in the neural network field. In SOM, the weights changed themselves at every learning step[31]. The change depends up on the neighborhood of the input pattern and the probability pattern, with which the permissible input pattern is offered. NN can be classified as a network transfer of electrical signals from a higher dimensional space to a one-way Unidirectional or two dimensional units neurons. The NN of self-training organization of input and understandable data to the groups of similar patterns, according to the criterion of similarity. Such as neural networks are able to discover the learning organization, as well as the connections between inputs and adjust their future response according to these inputs. Topographic representation of the neural network is to save the relations between network inputs that are mapped in a manner where the inputs neighboring space entry is planned to neighboring neurons in the space of the map. This is means that process of activation will activate neurons neighboring [32].

Kohenen SOM NN is considered connecting weights between the elements of the sample spot entered for specific neurons, such as the level is set at 2D (I, j). Here we can represent the weight vector values between Ni, j and Wi,j. The map preserves topological relationships between inputs in a way that neighboring inputs in the input space are mapped to neighboring neurons in the map space. In Kohonen's NN model, the neuron with minimum distance between its weight vector wij and the input vector X is first identified by using the following criterion:

$|X\text{-}Wki|\text{-}\ Mini \le j < n\ (Mini \le j < n\ |X\text{-}Wi,j|\ )$.....(3)

After the (k, l)th neuron in the 2-D plane is located, the weights of its neighboring neurons are adjusted by using the following:

$$Wij(t+1)=Wij(t)+\alpha|\ X\text{-}Wij\ | \ldots\ldots\textbf{(4)}$$

until the weight vector reaches equilibrium, this is means:

$$Wij(t+1)=Wij(t) \ldots\ldots\textbf{(5)}$$

The general algorithm of SOM NN applied in suggesting a model described below:

(1) Randomize the map's nodes' weight vectors .
(2) Extract an input vector.
(3) Pass any node in the map:

a. Use Euclidean distance formula to find similarity between the input vector and the map's node's weight vector. The distance between two points in the plane with coordinates (x, y) and (a, b) is given by

$$dist\ ((x,y),(a,b)=\sqrt{(x-a)^2+(y-b)^2} \ldots\ldots\ldots.(6)$$

Note that, the Euclidean Distance (ED) is the "ordinary" distance between two points that one would measure with a ruler, and is given by the Pythagorean formula. By using this formula as distance, Euclidean space (or even any inner product space) becomes a metric space. The Euclidean distance between points p and q is the length of the line segment pq .In Cartesian coordinates, if p = (p1, p2,..., p_n) and q = (q1, q2,..., q_n) are two points in Euclidean n-space, then the distance from p to q is given by:

$$d(p,q)=\sqrt{(((p1-q1)^2+(p2+q2)^2}+\ldots.$$
$$(pn\text{-}\ qn)=\sqrt{(pi-qi)^2} \ldots\ldots\ldots\ldots\ldots\ldots.(7)$$

b. Track the node that produces the smallest distance (this node is the best matching unit).

(4) Update the nodes in the neighborhood of BMU by pulling them closer to the input vector (5) Increment t and repeat from 2, while t < λ . [33]

The ANN learning start by putting an X-Ray image as a block, each block (iteration) consist of 8×8 matrix elements (PE) by multi iterations to suggested net [34][35]. The first iteration puts into the net as an input block and applying feedforeword, ANN compares the result with desired output to take the best solution, if there is solution, then pass it to the next level GA to complete the processing, otherwise (an error) ,the adjust weights phase and repeat training to achieve optimal accuracy and coverage , at this time picking this solution as a good population that represent the optimal solution (desired output) [36]. The below prototype describe all the learning process by NN and GA start with the input pattern as chromosome [37] [38]:

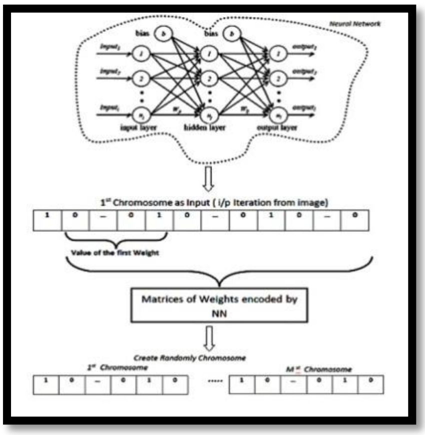

Figure 7. Sample Iteration Learned by GA and NN.

During genetic process:

1. Create M Neural Network according to the chromosomes of the current generation.
2. Compute the fitness value of each chromosome from creating Neural Network.
3. Apply three genetic operators on all the chromosomes
   - *Selection.*
   - *Crossover.*
   - *Mutation.*
4. Return to step (1) until the terminal condition .

The Suggested Algorithm

The proposed algorithm for hazards and threat objects detection and recognition system in the X-Ray luggage scanned images have a below steps and showing on a complete graph in figure (5):

1. Image Acquisition from different devices
   - *X-ray Images (XRI);*
   - *High Resolution Camera Images(HRCI);*
   - *Huge Dataset Images (HDI) with various formats .*
2. Read the input image *(HRCI or XRI)*.
3. Detect Image parameters.
4. Original images resizing to 150 ×140 pixels fit (the desired size).
5. Image filtering (Enhancement) using FIR filters (Image Denoising).
6. Grayscale image detection .
7. Applied CANNY edge detection to detect a threat contour .
8. Apply SOM neural network (start iterations training) .
9. Choose the desired output as GA's inputs.
10. Apply Genetic Algorithm (GA) over NN's parameters
11. If the image parameter (x, y), Matching (Detection-fit to Dataset), then step 13.
12. Detect Not Result : Goto 2 .
13. Image Segmentation (IS).
14. Feature Extraction (FE).
15. Recognition threat (Vision).
16. Stop Training.

During the training and learning in the proposed NN, the NN learning begins with putting an X-Ray image as iterations one by one, each iteration consist of 8×8 matrix elements (PE) by multi iterations to the SOM network. During the training process, the weights of the nodes are adjusted to achieve optimal accuracy and coverage. Below, a complete diagram of the proposed security algorithm described with details:

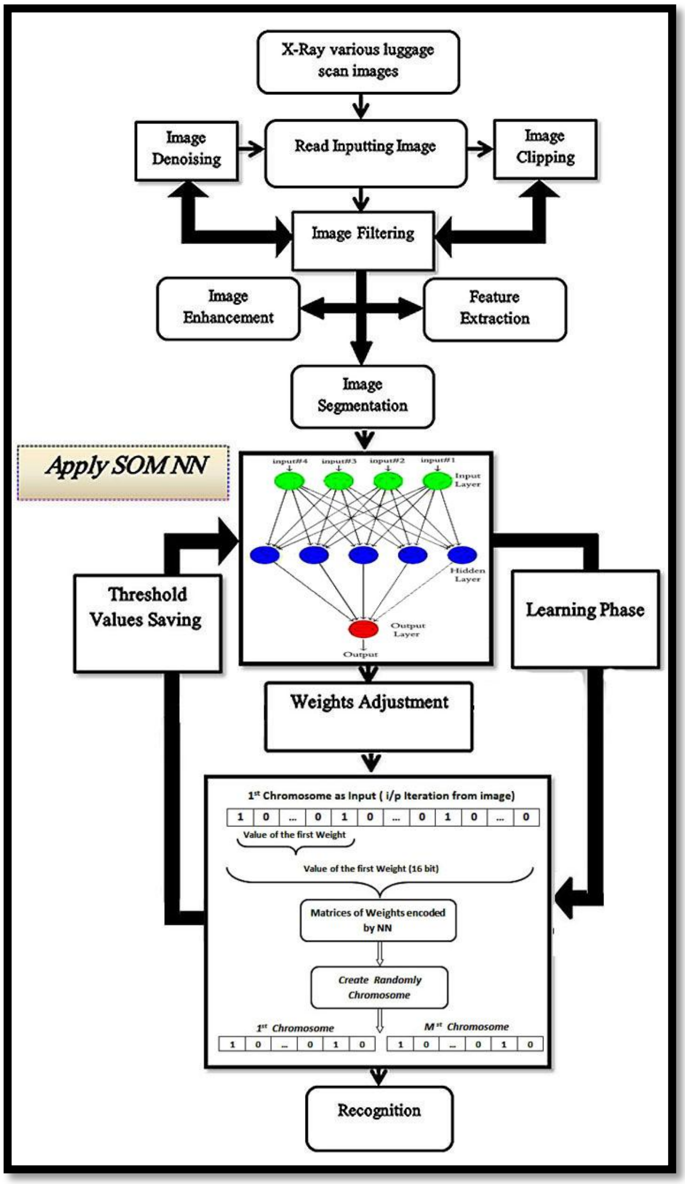

Figure 8. A Complete Diagram of Proposed Algorithm.

Experimental Results:

A network structure was trained with the parameters applied by MATLAB and listed in Table (1) below:

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Table 1. MATLAB output for Settings Parameter for training in Hybrid Model

Parameters of method	Main Parameters of Hybrid Model	Value
GA parameters	Generation No.	150
	Population	35
	Chromosome Length	15
	Selection Operator	Roulette
	Fitness Normalization	Rank
	Crossover	Pc=0.7, Two Points, Uniform
	Mutation	Pm=0.1, Gaussian mean=0.0
Total ANN parameters	Neural Network Architecture	Kohenen SOM Neural Network
	Nodes of hidden layer	Range: 3-15, Optimized Value=12
	Initial weight range	[0, 0.05]
	Number of input nodes	3
	Number of hidden nodes	2
	Learning rate between input and hidden layers	0.5
	Num. of output classes	24
	Momentum term between input and hidden	0.7
	Momentum term between hidden and output	Range
	Stopping criteria	10 epochs

Table 2. Shows the system experimental results characteristics of suggested model by MATLAB. With this model, we have tested 50 different images of X-Ray luggage scan images applied to the above discussed algorithm.

No. of Epochs	No. of Learning Patterns	Elapsed Time	Error Rate (ER)	Recognition Rate (RR) %	Accuracy on the Testing Set
80	105	2.3s	1	87.6	88%
130	125	1.8s	1	91.1	91%
1200	148	2.61s	4	91.1	86%
1600	105	2.45s	3	91.9	90%
2200	100	1.8s	2	86.7	75%
3000	100	2.00s	4	80.5	88%
5000	104	1.7s	3	79.2	90%

CONCLUSION

Image Segmentation IS plays a key role in digital image processing and self-discover the details of objects in important areas. A new system for detection of dangerous objects in x-ray luggage scan images has been suggested. In this present paper, a security model of dangerous objects using the concept of SOM Neural Networks and GA with digital image processing has been discussed. The results of model that was built by using only SOM Neural Networks proved that the maximum efficiency of threat's object recognition is 77.20%. Moreover, the results of the system that was built by only GA proved that the maximum efficiency of threat's object recognition is 80.7%. The present hybrid system proves that the maximum efficiency and accuracy of threat's object recognition is 85.17%.

The efficiency of suggested model can be increased depending on better image scanner, high resolution images scanned devices, efficient technique of edge detection and feature extraction of the threat's objects in the luggage's image.

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