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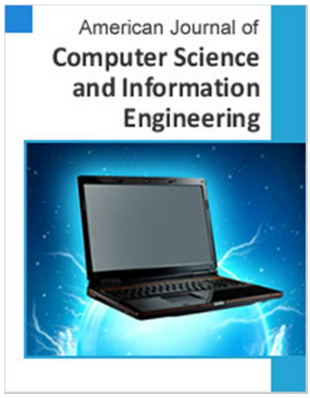

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Cuckoo Search Algorithm and Discrete Wavelet Transform for Iraqi Road Signs Recognition System

Majida Ali Abed[1], Hamid Ali Abed Alasad[2]

[1]College of Computers Sciences & Mathematics, University of Tikrit, Tikrit, Iraq
[2]Computers Sciences Department, Education for Pure Science College, University of Basra, Basra, Iraq

Email address
majida.ali@tu.edu.iq (M. A. Abed), hamid_alasadi@ieee.org (H. A. A. Alasad)

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Abstract
In this article, a Cuckoo Search Algorithm (CSA) is presented as a class of evolutionary optimization technique with classifier Discrete Wavelet Transform (DWT) for generic object recognition. The invariant to rotation, translation or scaling DWT is used for extracting some features, and CSA performs the recognition task. Experimental results show that the proposed for all types of Iraqi traffic signs can give a system highly recognition rate and lower processing computation time of 98%, and 0.3 second, respectively.

1. Introduction

Traffic sign recognition has been a thought-provoking problem for many years. The development of intelligent vehicles is becoming progressively important now. The first work in this area can be traced back to the late 1960s and significant advances were made in the 1980s and 1990s [1]. Traffic sign recognition system could in principle is developed as part of an Intelligent Transport Systems (ITS) [2]. ITS focuses on integrating information technology into transport infrastructure and vehicles. The aim of intelligent transport systems is to increase transportation efficiency, road safety and to reduce the environmental impact with the use of advanced communication technologies. Many evolutionary algorithms have been developed for global optimum solution during last few years. The research in the field of Swarm Intelligence (SI) which deals with studying the behavior of the organisms like fish, ants, bees, cuckoo bird or something like water drops was done [3]. We apply Cuckoo Search Algorithm (CSA) in this article to classify the Iraqi traffic sign in the recognition stage using MATLAB program. This article is organized as follows: Section 1 gives an introduction and Section 2 gives an overview of the Iraqi traffic signs. Section 3, shows the stages of proposed system. Section 4 shows Traffic Sign Recognition. Section 5 shows concepts of the classifier Discrete Wavelet Transform (DWT). Section 6 describes Cuckoo Search Algorithm (CSA). Section 7 shows experimental results of our system for Iraqi traffic sign detection and recognition. Section 8 gives conclusions.

2. Iraqi Traffic Signs

Iraqi traffic signs are designed to be recognized rapidly by Human drivers under a variety of conditions, so their colors and shapes are selected to be significantly different from natural environments. Iraqi traffic signs divide signs into six main classes [4]:

- Warning signs: They are type of traffic sign which indicates a hazard ahead on the road.
- Forbidden signs: They are type of traffic sign which indicates to prohibit certain types of man oeuvres.
- Indicative signs: They are type of traffic sign which indicates to give information about road priority which includes the diamond shaped rectangle.
- Mandatory signs: They are type of traffic sign which indicates to control the actions of drivers and road users.
- Ground Signs: They are type of traffic sign which indicates to the direction in which force you or you need to turn or rotation.
- precedence Signs: They are type of traffic sign which indicates to give the user the way that it is the priority of traffic you or do not you.

Figure (1) show some examples of the six classes Iraqi traffic signs Warning signs, Forbidden signs, Indicative signs Mandatory signs, Ground Signs and precedence Signs, also the Figure show the Shape and color and the action of each sign in every class.

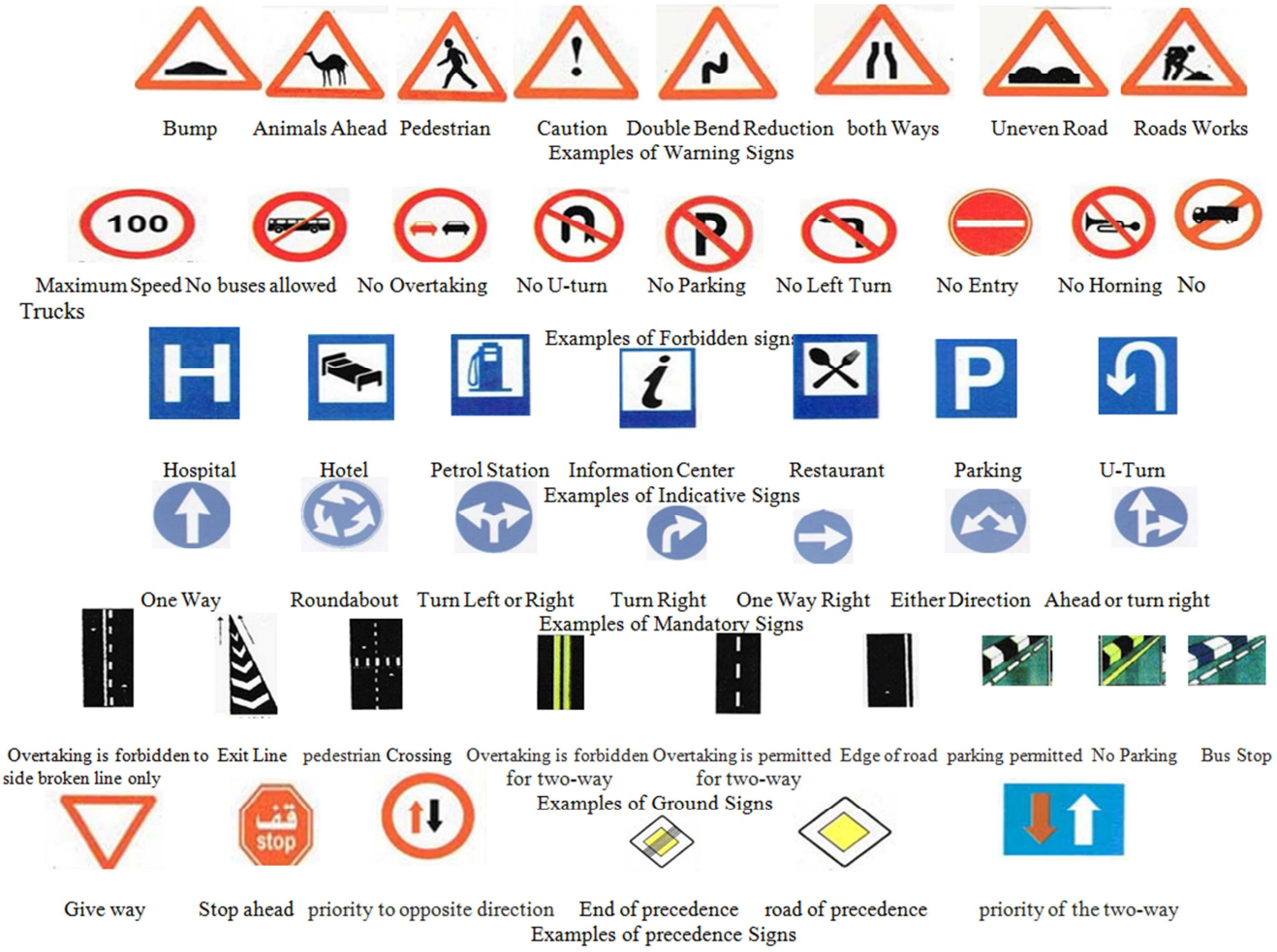

Figure 1. *Examples of Iraqi traffic signs.*

3. Proposed System

A system for traffic sign detection and recognition is presented that has been applied in Iraqi traffic signs. Figure (2) shows the main stages of our proposed system: color filtering (CF), color segmentation (CS) and traffic sign detection (TSD), feature extraction (FE) using Discrete Wavelet Transform (DWT) and traffic sign recognition (TSR) by Cuckoo Search Algorithm (CSA). The stages of the proposed system are described below.

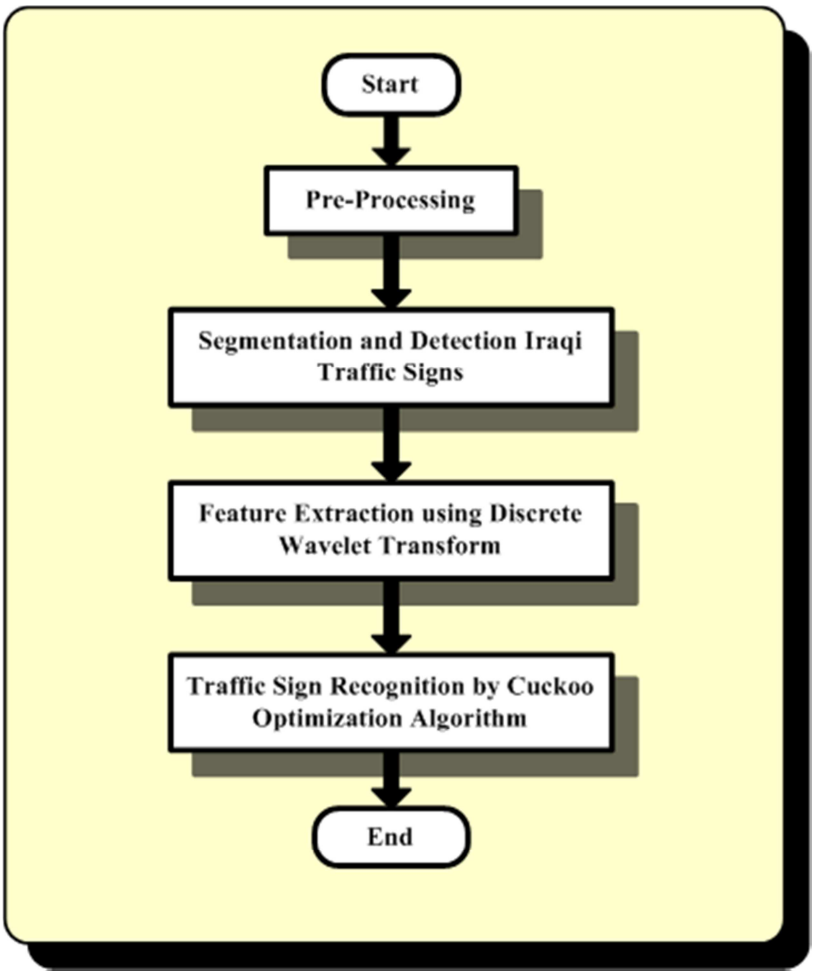

Figure 2. *Stages of traffic sign detection and recognition system.*

3.1. Pre-processing

High-resolution digital camera is used in this paper to get an input image of traffic signs. Images are taken in different Background, lighting conditions, and at various distances from the camera to traffic signs as shown in Figure (3) and Figure (4). The obtained image is first converted into gray scaled image then converted to the binary image consisting of only 1's and 0's. The aim of gray scale image processing is to modify the three components with red, green, yellow. For simplifying the extraction of the traffic signs, blue for color image Conversion to gray scale image [5-10].

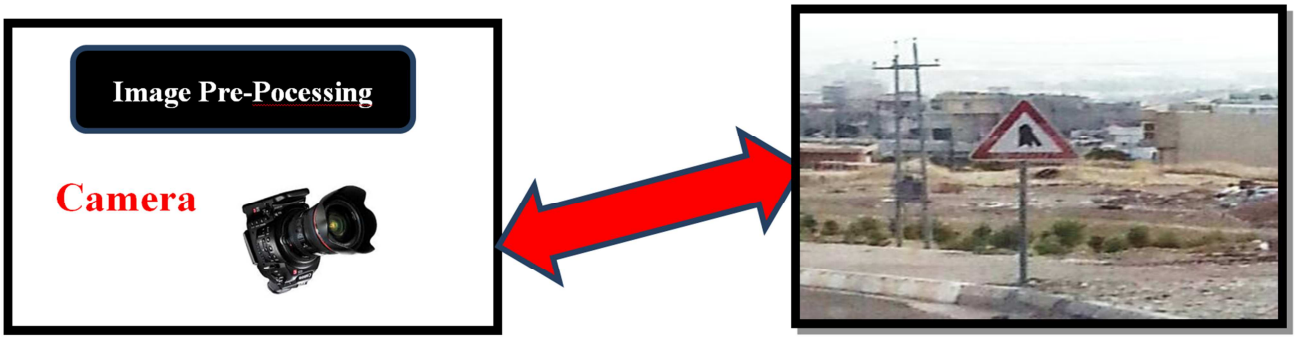

Figure 3. *Pre-processing stage of our system.*

3.2. Segmentation and Traffic Sign Detection

The obtained image which is converted into gray scaled image then converted to the binary image consisting of only 1's and 0's and gray scaled segmentation s applied in order to find the contour of the traffic sign. After that, checked the size of binary image of traffic signs if the size is small or if it is not, then the image will be discarded [11-14]. Therefore, a traffic sign is detected by this process. Figure (6) shows examples of an image after the gray scaled segmentation and traffic sign detection stage.

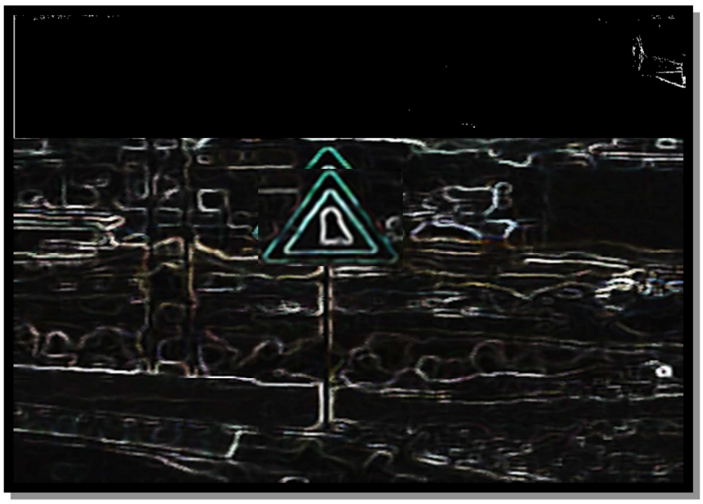

Figure 4. *Stage of color segmentation and traffic sign detection.*

3.3. Feature Extraction

In this stage, a gray scaled image of the traffic sign is cropped and resized to 120 x 120 pixels in order to recognize with images in a database of our system containing: 27 red signs, 18 blue signs. Figure (5) shows examples of the database used in our system and Figure (6) shows an example of a gray scaled image of the traffic sign and cropped image at feature extraction stage. A method for feature extraction is presented in this article for traffic sign recognition using a discrete wavelet transform (DWT) [15]. The objective of this method is to enhance the performance of our proposed system by introducing more features from the sign Wavelet transform is applied to the traffic sign where the input the traffic sign is decomposed into various frequency channels using the properties of wavelet transform. Feature extraction methods based on the discrete wavelet transform in an attempt to identify the best method.

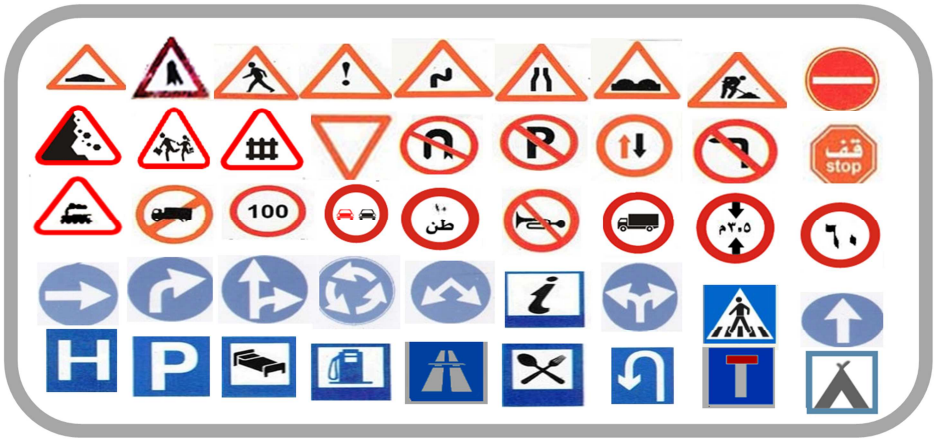

Figure 5. *Examples of database of our system.*

Figure 6. *Example of gray scaled cropped image at feature extraction stage.*

4. Traffic Sign Recognition

Recognition of traffic signs is one of the important fields in the reliability Intelligent Transport Systems which build a accessibility and safety environment based on advanced technologies like computer vision and artificial intelligence. Computerized traffic signal system, traffic incident management, transportation systems management and Recognition of traffic signs are the fields in the reliability Intelligent Transport Systems which build an accessibility and safety environment based on advanced technologies like

computer vision and artificial intelligence. Traffic sign recognition can be attained by two basic stages; detection and recognition. In the detection stage, the sign is detected according to the sign's color information; features can be extracted and introduced to a certain classifier to decide the type of the sign according to the pictogram, the method for feature extraction is presented in this article for traffic sign recognition using a Discrete Wavelet Transform (DWT) [16]. The objective of this method is to enhance the performance of our proposed system by introducing more features from the sign Wavelet transform is applied to the traffic sign where the input the traffic sign is decomposed into various frequency channels using the properties of wavelet transform. Traffic sign recognition requires classification techniques in order to identify each Iraqi traffic sign The aim of this article is to evaluate whether the Cuckoo Search Algorithm (CSA) of our system is the well-organized for Iraqi traffic sign recognition. First we explain a review of Discrete Wavelet Transform and the Cuckoo Search Algorithm (CSA) in the following sections.

5. Discrete Wavelet Transform

The DWT Wavelet transform forms a general mathematical tool and with many applications in signal processing. The wavelet theory applications as diverse as wave propagation, signal and image processing, pattern recognition, computer graphics [17]. Its basic use includes time-scale signal analysis, signal compression and decomposition. The idea of the wavelet transform is introduced by French engineer Jean Morlet in 1982. In DWT, the energy of the signal concentrates to specific wavelet coefficients [18]. Wavelets (the three types Orthogonal, Biorthogonal and Non-orthogonal, has good spatial and spectral quality) convert the image into a series of stored wavelets. In DWT, by using digital filtering techniques a timescale representation of the digital signal can be obtained. The analyzed signal is passed through filters with different cut-off frequencies and scales. Wavelet transforms are based on small waves called wavelets of varying frequency and limited duration. The function being expanded is sequence of numbers like samples of continuous function (n), resulting coefficients are called discrete wavelet transform (DWT) of (n). DWT transform pair is given by the following equations:

$$W_{\varphi}(j_0, k) = \frac{1}{\sqrt{M}} \sum_n f(n) \varphi_{j_0,k}(n) \quad (1)$$

$$W_{\Psi}(j, k) = \frac{1}{\sqrt{M}} \sum_n f(n) \Psi_{j,k}(n) \quad (2)$$

For $j \geq j_0$ and the parameter M is a power of 2 which range from 0 to j−1. The function (n) can now expressed as:

$$f(n) = \frac{1}{\sqrt{M}} \sum_n W_{\varphi}(j_0, k) \varphi_{j_0,k}(n) + \frac{1}{M} \sum_{j=j_0}^{\infty} \sum_k W_{\Psi}(j, k) \Psi_{j,k}(n) \quad (3)$$

Where

$f(n), \Psi_{j,k}(n), \varphi_{j_0,k}(n)$ are functions of discrete variable n = 0, 1, 2 … $M-1$. Coefficients defined in equation (1) and (2) are approximation and detail coefficients respectively. $\frac{1}{\sqrt{M}}$ acts as a normalizing factor.

6. Cuckoo Search Algorithm

Cuckoo search algorithm is a new approach for global meta-heuristic optimum algorithm is introduced by Xin-She Yang and Suash Deb in 2009 [19]. In order to solve the road sign recognition problem, many methods have been proposed in [20]. In this paper, we present a modern metaheuristic optimization algorithm (CSA) imitating animal behavior for road sign recognition in Iraq. The CSA is a nature inspired metaheuristic algorithm which is inspired by the obligate brood parasitism of some Cuckoo bird family, by laying their eggs in the nests of host birds. Each egg in a nest represents a solution, and a cuckoo egg represents a new solution [21-24]. The process of Cuckoo Search Algorithm (CSA) is described as follows in the Figure (7):

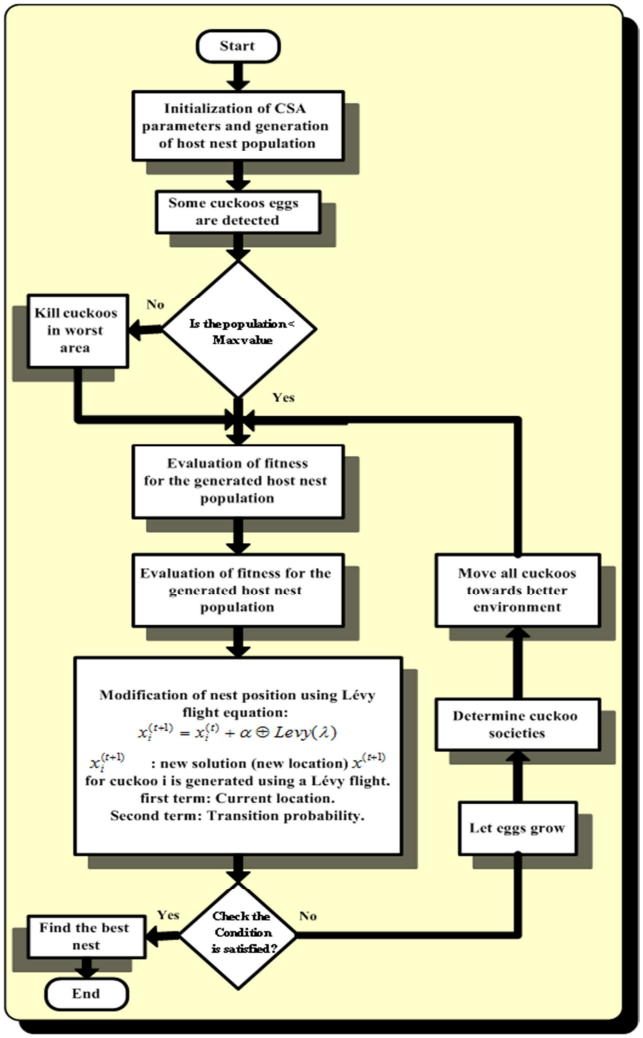

Figure 7. *Flow Chart of Cuckoo Search Algorithm (CSA).*

7. Results and Discussion

Sample of 63 Iraqi color traffic sign images (red and blue)

is used as an input to the proposed system, which are acquired by a camera to verify the recognition system by DWT and CSA before testing. The Figures 8 and 9 shows an example of the processes of Iraqi traffic sign detection and recognition of a sign in the red and blue group. Figure (8) and Figure (9) show some input Iraqi traffic sign images in color space, Segmentation and Detection Iraqi traffic signs stage, respectively.

Figure 8. *Some examples of Iraqi traffic sign image.*

Figure 9. *Segmentation and Detection Iraqi traffic signs.*

Figure (10, 11, 12, 13), shows some examples of the stages of the proposed system.. Input image in color (red, blue) mode, Segmentation and Detection Iraqi traffic signs stage, cropping image and final shows the output from the traffic sign recognition by Cuckoo Search Algorithm (CSA).

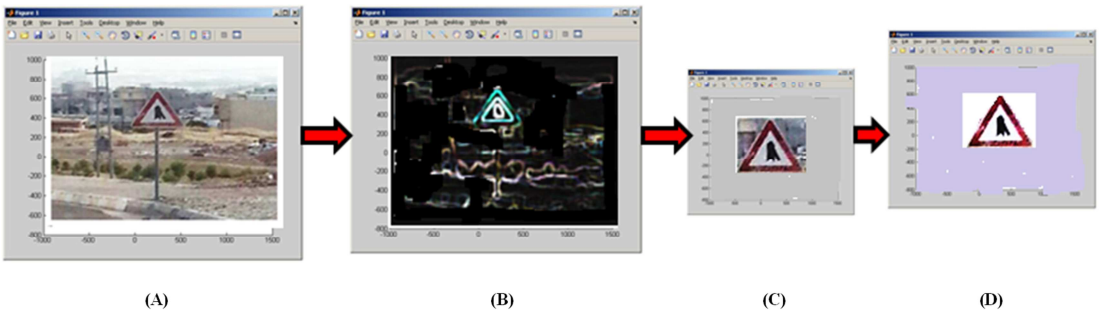

Figure 10. *A: Input image in red color mode. B: Segmentation and Detection signs. C: Cropping image. D: Output image.*

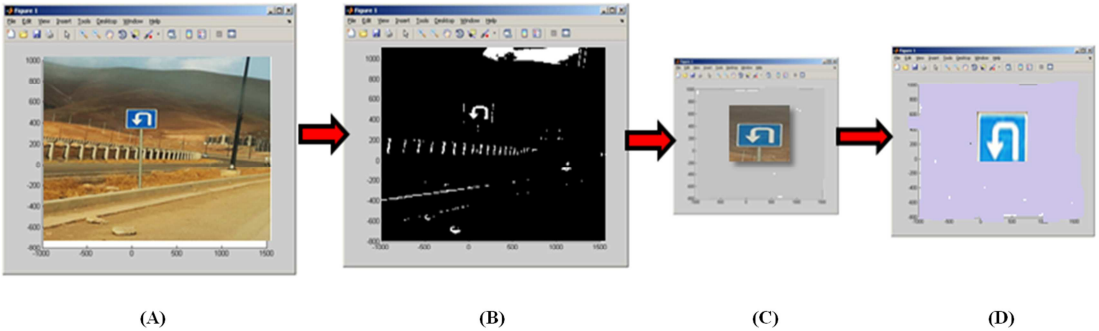

Figure 11. *A: Input image in blue color mode. B: Segmentation and Detection signs. C: Cropping image. D: Output image.*

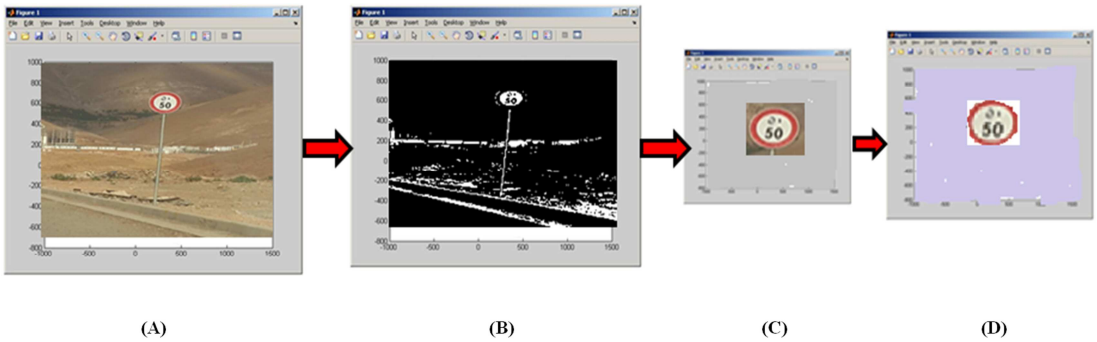

Figure 12. *A: Input image in red color mode. B: Segmentation and Detection signs. C: Cropping image. D: Output image.*

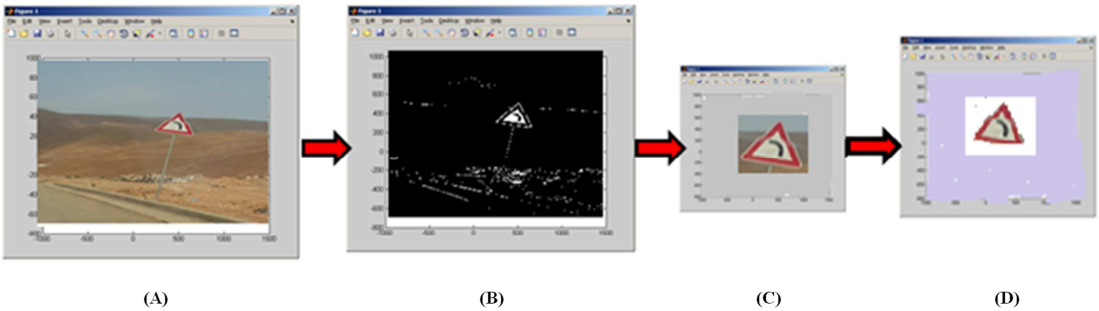

Figure 13. *A: Input image in red color mode. B: Segmentation and Detection signs. C: Cropping image. D: Output image.*

Performance of the Iraqi traffic sign recognition using (CF), (CS) and (TSD), feature extraction (FE) using (DWT) and traffic sign recognition (TSR) by (CSA), are achieved for different test samples on the above described system. The Iraqi traffic sign images show the signs in variable condition, lighting, rotation and size. A group of Iraqi traffic sign images was input to the systems are equal to 36 and 27 for the type of red sign and blue sign, respectively. The results of the testing are as follows in Figure (14) which shows the performance and the test result s of traffic sign recognition by the Cuckoo Search Algorithm (CSA) has an accuracy of approximately 98%.

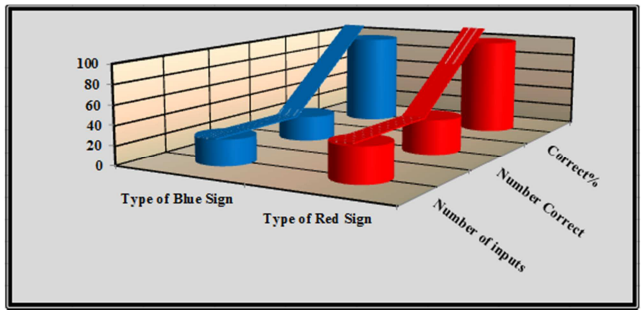

Figure 14. *Test result of traffic sign recognition.*

Figure (15) shows the processing times of traffic sign recognition by Cuckoo Search Algorithm technique. Average processing time for traffic sign Recognition by Cuckoo Search Algorithm is 0.3 second. It is clear that traffic sign recognition by Cuckoo Search Algorithm (CSA) not only requires lower computation time but it also has higher correct recognition rate.

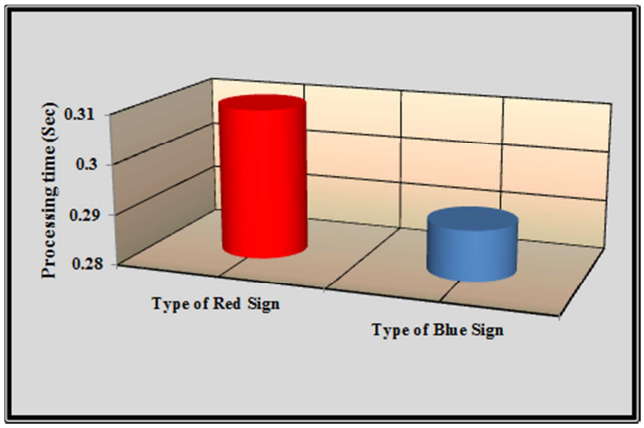

Figure 15. *Processing time of traffic sign recognition.*

8. Conclusion

In this article, an overview of Iraqi traffic sign detection and recognition system is given. Processes of Iraqi traffic sign detection are discussed. Successfully classification performances using Cuckoo Search Algorithm (CSA) for Iraqi traffic sign. The experiments have been carried out on original Iraqi traffic sign images and show that the algorithm can successfully detect and recognize all types of traffic signs used in Iraq namely, Warning signs, Forbidden signs, Indicative signs, Mandatory signs precedence Signs, and Ground Signs (red or blue). The experiments indicate that the Cuckoo Search Algorithm (CSA) for all types of Iraqi traffic signs has a higher accurate recognition rate and fewer computers processing time.

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