International Journal of Computational and Electronic Aspects in Engineering
Volume 5, Issue 2, June 2024, pp 54 - 60
https://doi.org/10.26706/ijceae.5.2.2024057

Propose an Object Detection Optimization Algorithm by Using Particle Swarm Optimization (PSO) Based-on Exploration Ability of Grey Wolf Optimizer (GWO)

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Abstract: There are many algorithms that have been designed for the purpose of applying them to the subject of object detection, including Particle Swarm Optimization (PSO), as well as Gray Wolf Optimizer (GWO), and many other algorithms. In this article, I will address the problem of object detection and take advantage of some characteristics of the PSO and GWO algorithms to build an algorithm that is distinguished by the accuracy and browsing of the PSO algorithm, as well as the search speed characteristic provided by the GWO algorithm. The proposed algorithm was called Proposed-Hybrid Optimization (PHO), and a set of functions were defined and three of them were selected to solve the problem of object detection. The accuracy and speed of the results were acceptable and good compared to previous studies that were discussed in a special section.

Keywords: particle swarm optimization (PSO), gray wolf optimizer (GWO), object detection, hybrid optimization

Article – Peer Reviewed
Received: 2 April 2024
Accepted: 18 June 2024
Published: 30 June 2024

Cite this article: Hayder Talib Jawad Al-Sammak, "Propose an Object Detection Optimization Algorithm by Using Particle Swarm Optimization (PSO) Based-on Exploration Ability of Grey Wolf Optimizer (GWO)", International Journal of Computational and Electronic Aspects in Engineering, RAME Publishers, vol. 5, issue 2, pp. 54-60, 2024.
https://doi.org/10.26706/ijceae.5.2.20240507

1. Introduction

Optimization problems are a thorny topic in various fields of mathematics, physics, engineering, and computer science [1 – 4]. The main goal behind the subject of studying optimization problems is to find a set of solutions and choose the best possible solution based on the problem at hand, such as choosing the best path within a group of methods in computer networks, choosing the best accuracy for discovering or extracting an object from a group of predictors, etc. There may be a set of constraints [5, 6]. These constraints may be physical, financial, or operational. Therefore, it is possible to formulate optimization problems as either minimization or maximization problems. It is possible to design most, even the majority, of problems found in the real world as optimization problems. An example of this is reducing the cost of production, increasing the company's profit, or finding the shortest path between two different locations located far away. Accordingly, it can be summarized the main points that can be taken into consideration when wanting to study and implement improvement problems such as objective function, Decision variables, Constraints, Optimization techniques, Sensitivity Analysis [7, 8]. The objective function is the mathematical expression that defines the quantity to be optimized. The decision variables are parameters that can be modified to optimize the objective function. Constraints are the conditions that must be met by the decision variables. While the optimization techniques are available to solve optimization problems, such as linear programming, nonlinear programming, dynamic programming, and genetic algorithms. Finally, the sensitivity analysis which is the study of how changes in input parameters affect the optimal solution to an optimization problem.

Optimization problems are important in many applications, and their solutions can have a significant impact on the performance and efficiency of systems and processes. Therefore, it is necessary to understand the basic concepts and techniques of optimization to be able to address real-world problems effectively [9].

A basic variant of the well-known PSO algorithm is defined by defining an interconnected set (called a swarm) [10 – 12]. This interconnected set is actually a set of candidate solutions (called particles). These particles initially move randomly in the search space based on a set of simple constraints. Then, based on the locations of the particles, a guidance process takes place that monitors the movements of the particles. When the best optimized positions are achieved, detection of the optimized positions will be relied upon to guide the swarm's movements. This process continues by relying on a set of repetitions that are defined in advance (such as a thousand, more, or less than that) until a satisfactory solution and an accurate, convincing result are reached.

Then comes the role of GWO, which is distinguished by its high ability to search and select the desired creature from a group of objects, based on the characteristic of hunting with wolves. There are four main types of hunting, or in algorithmic language, four types of exploration: Alpha, Beta, Delta, and Omega [13, 14].

The combination of algorithms is applied in many optimization problems to increase the speed and accuracy of searching and selecting the desired agent from a group of agents [15, 16].

The topic of object detection is considered one of the vital topics and is considered the most important and basic goals of many applications in the real world, such as traffic and traffic applications, security applications, or applications for knowing the presence among a crowd of people [17]. It is a computer vision application whose purpose is to detect objects of special interest and then determine their exact location with precise mathematical dimensions in an image, in a video clip, or in a live video [18].

There are two main methods that are considered among the modern methods of applying the subject of detecting proxies: applying object detection in one stage, such as applying the YOLO algorithm, or applying a combination of well-known algorithms. As for applying object detection in two stages, this is done by applying computer neural networks [19, 20].

2. Literature Review

There are many studies which are related to PSO and GWO for optimization on object detection. Five very focused and relatively connected to the aim of this article is taken in this section.

Zhang et. al. [21] proposed a well-known method that transforms primitives, which are geometric, based on the expectation property. Then, there is a transition from the prediction stage to the object proposal stage by using mathematical distance equations between the object and the elements. Continuing to repeatedly calculate the distance improves the object suggestions and produces highly accurate results.

Nagarajan et. al [22] utilized the generative adversarial network, in addition to using the deep and sequential convolutional neural network technique, for the purpose of applying it to discovering and identifying liars. As a first step, the networks are trained to know the estimated distance between the actor and the object by using the HAAVO distance equation. As a results from the hybrid model proposed in this study, high accuracy was obtained in detecting liars, as well as accuracy and speed in sending and retrieving commands.

Fang et. al. built a new multimodal network [23], where at least three main components of the proposed network are shown. The Nested Dual Attention Module (NDAM) is used in combination with the well-known RGB color system and taking advantage of its properties. After that, there is an aggregation unit called (AIAM) whose function is to integrate the properties of the neighbors, starting with very high levels, then moving to high levels, then moving to medium levels, and finally reaching low levels. The predictions obtained were highly accurate as results.

Chen et. al [24] proposed a new working model has been built to carry out the task of detecting underwater objects, relying on several hybrid networks with a transformation feature. As a first step, a simple hybrid structure is defined that extracts some variables. As a second step, networks with high speed and accuracy are used in order to overcome the problem of blurring underwater objects. As a third and final step, we continue to repeat the previous processes to obtain acceptable results with high accuracy.

Khoury et. Al. [25] presents a hybrid model based on the well-known image compression algorithm called JPEG 2000, based on the bandwidth of objects and then detecting those objects. The process begins by training on a low-resolution image, and then using the compression and resolution improvement feature found in the JPEG 2000 algorithm. In this study, we focused on the time factor as a response, and an acceptable low response time was obtained.

3. Methodology

In order to improve the accuracy for optimization, there are many algorithms which have different functionality. So, select two optimization algorithms such as Particle Swarm Optimization (PSO) and Gray Wolf Optimizer (GWO) and get benefit from the advantages of accuracy property of Particle Swarm Optimization (PSO) and exploration property of Gray Wolf Optimizer (GWO) to build the proposed hybrid optimization algorithm as follow:

Algorithm 1 Proposed-Hybrid Optimization (PHO) algorithm

```
1:  FunSet: define the number of set functions
2:  Itr.No: maximum number of iterations
3:  PoP.Size: the number of size population
4:  Buff: temporary storage
5:  procedure PHO
6:      Initialize search agent
7:      Initialize Buff = 0
8:      for i = 1 to Itr.No  do
9:          for j = 1 to PoP.Size  do
10:             Apply PSO
11:                         Temporarily storage for the best values of particles and swarms
12:             for m = 1 to 20  do
13:                 for n = 1 to 20  do
14:                     Apply GWO
15:                         Update the values and positions for gray wolves
16:                 end for
17:             end for
18:             Choose best three wolves
19:         end for
20:     end for
21: end procedure
```

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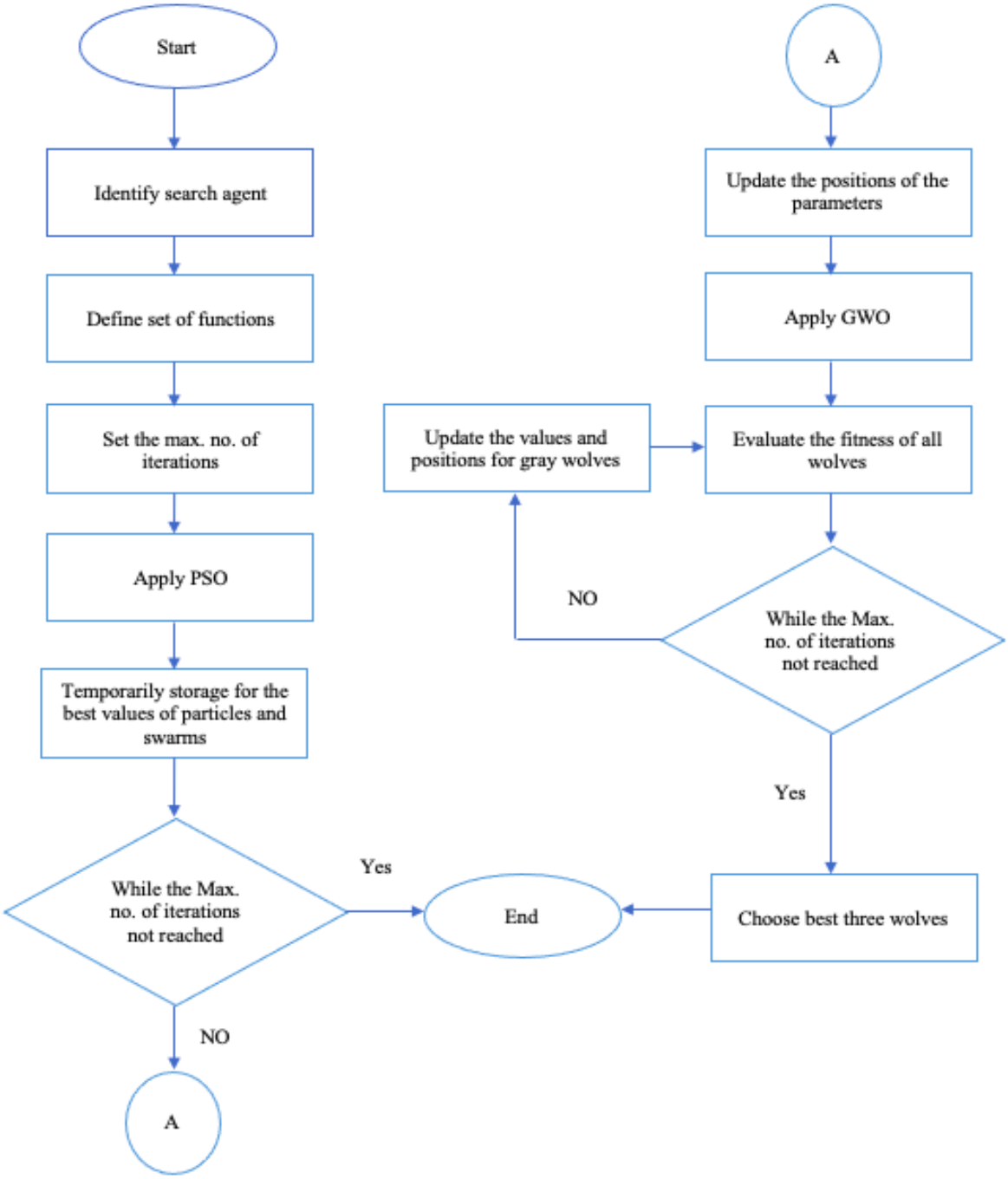

Figure 1: Proposed hybrid optimization

First of all, a set of functions are defined, in the proposed algorithm a set of 23 functions are used and five of them are utilized as shown in table 1:

Table 1: Definition and description of the applied functions

Function name	Mathematically expression	Function description	Reference
F13	$f(x,y) = (1-x)^2 + 100(y-x^2)^2$	Resenbrock	
F14	$f(x,y) = -\left[\cos\left((x-0.1)y\right)\right]^2 - x\sin(3x+y)$	Townsend	
F15	$f(x,y) = 4x^2 - 2.1\,x^4 + \frac{1}{3}\,x^6 + xy - 4y^2 + 4y^4$	Gomez and Levy	

4. Results and Discussion

As function F13 is applied as shown in Fig. 2, the parameter space gives a gab space as the detection accuracy of the proposed system is under the standard optimization. This is worest score case.

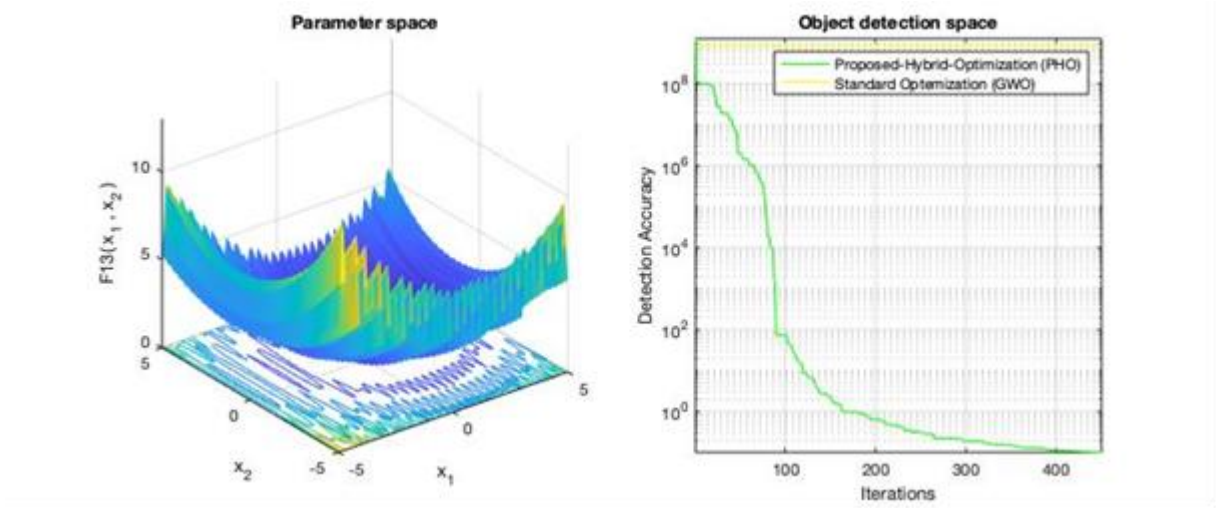

Figure 2: Applying F13 gives worst score.

As function F14 is applied as shown in Fig. 3, the parameter space gives a focus accepted space as the detection accuracy of the proposed system is above the standard optimization after about 50 iterations. This is good score and accepted results.

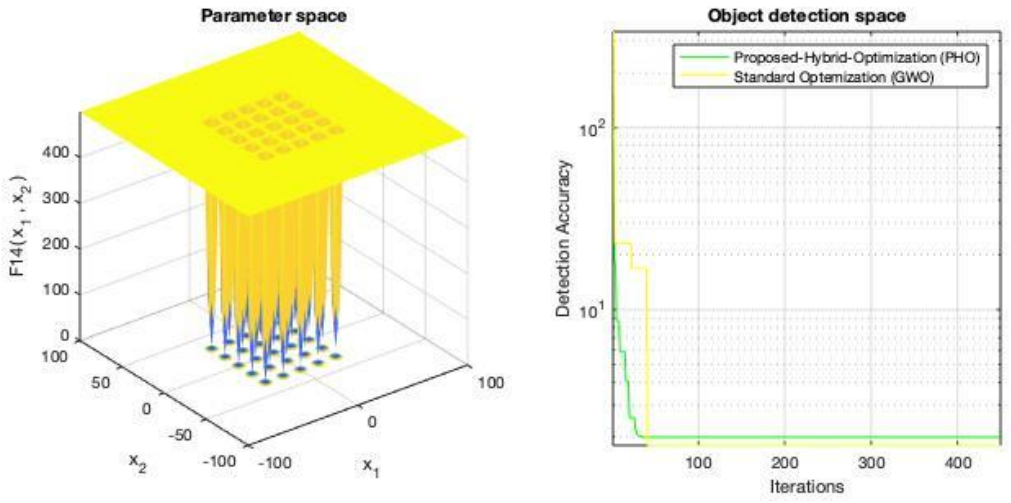

Figure 3: Applying F14 gives best score.

As function F15 is applied as shown in Fig. 4, the parameter space gives a focus balanced space as the detection accuracy of the proposed system is close to the standard optimization till about 240 iterations. This is good score and accepted results in some cases but still the results in Fig. 4 expressed as best result.

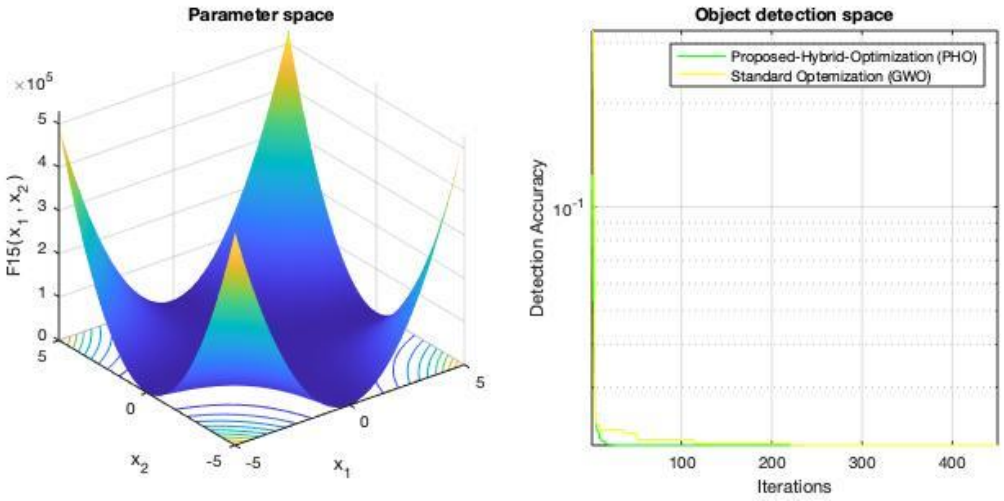

Figure 4: Applying F14 gives balanced score.

5. Conclusion

Choose a suitable model is expressed the main important point while wanting to apply any algorithms on object detection manner. The use for Fine-tune the proposed model and augment the data used in the testing phase. Utilizing hybrid algorithms as PSP and GWO with some improvements by gaining advantages from these two algorithms in terms of accuracy, speed and exploration are gave best and accepted results. The system proposed in this article can be applied in integrating the flow derivative into real-time visitation monitoring systems by integrating the flow derivative into visitation monitoring systems, city planners can improve visitation flow and reduce congestion in real time. For example, if a bottleneck is detected, the flow derivative can be used to adjust traffic signals to relieve congestion.

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