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# A Survey on MR Brain Image Segmentation using Hybrid PSO and AFSA

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**ABSTRACT:** Image Segmentation is a substantial tool which divides the images into various regions of similar attributes. Magnetic Resonance Imaging (MRI) is an important technique for medical diagnosis. Brain tumour is diagnosed at advanced stages using MRI. The objective is to develop an efficient clustering based hybrid algorithm using Swarm Intelligent Techniques such as Particle Swarm Optimization and Artificial Fish Swarm Algorithm to detect Brain tumour in MR Brain Images and to utilize the capability of this algorithm to solve difficult problems in image processing.

**KEYWORDS:** Image Segmentation, MRI images, Clustering, Swarm Intelligent Techniques, Particle Swarm Optimization (PSO), Artificial Fish Swarm Algorithm (AFSA).

### I. INTRODUCTION

Swarm Intelligence (SI) [1][2] is a collective behaviour of decentralized, self organized systems, natural or artificial. SI techniques are heuristic stochastic search processes. SI approaches can be generalized as follows: all approaches are initiated with a set of solutions called population, and then in successive steps each candidate of the set learns collectively from other candidates and adapts itself in accordance to the solution space. Strategy incorporated and learning mechanism of these techniques mimics the natural facts and phenomena. Such nature inspired mathematical models can be plugged into one framework [1][3].

Image Segmentation [4] entails the division or separation of the image into regions of similar attributes. Clustering is used to segment the image [5]. Clustering algorithms are part of data mining algorithms that groups the data into various number of given clusters [5]. The goal of the image segmentation process is to get the important features from the image data, from which the description of the image can be given by the machine. Image segmentation results in the group of contours that explains the image in a way that is more significant and effortless to analyse.

In recent years, there has been improved interest in the optimization algorithms for different fields of science [6][7]. Particle Swarm Optimization has the variation of being the simplest algorithms in terms of complexity. It is a population based stochastic approach for continuous and discrete optimization problems. Particle Swarm Optimization simulates the behaviours of bird flocking. The groups of birds are searching for food in a particular area. Birds do not

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know where the food is. But they come to know how far the food is in every iteration. So the best way to find the food is to follow the bird which is nearest to the food [7].

Artificial Fish Swarm Optimization is based on the behaviour of the fishes which prey, swarm or move randomly in search of food sources. AFSA is an evolving method as it results good in optimizing the solution. In this seminar report, AFSA is combined with 2-D thresholding method [8]. It is a stochastic population-based algorithm. AFSA has characteristics that make them suitable for solving NP-complete problems, like scalability, fault tolerance, consistency, higher speed, flexibility and parallelism [9]. AFSA has two important parameters:

- 1) Visual
- 2) Step [9].

Thresholding has attained a lot of attention during last few years. The aim of an effective segmentation is to separate objects from background and to differentiate pixels having nearby values for improving the contrast [10].

## II. RELATED WORK

Particle Swarm Optimization (PSO) is very popular SI algorithm for global optimization over continuous search spaces. Since, its advent in 1995, PSO has attracted the attention of several researchers all over the world resulting into a huge number of variants of the basic algorithm as well as many parameter automation strategies [12].

Solving an optimization problem is one of the common scenarios that occur in most engineering applications. It is a stochastic-based search technique that has its roots in artificial life and social psychology, as well as in engineering and computer science. It utilizes a "population", called particles, which flows through the problem hyperspace with given velocities; in each iteration, velocities are stochastically adjusted considering the historical best position (both of them defined according to a predefined fitness function).

In underwater world, fish can find areas with more food based on their individual or swarm search. Inspired by their characteristics, Artificial Fish (AF) model is represented by Prey, Follow, Swarm behaviours. AFSA searches the problem space by these behaviours. The environment AF lives in, is the problem space. Objective function of AFSA is to find maximum food density. AFSA is a global search state optimized algorithm. The 2-D fisher function criterion thresholding method is good method to image segmentation [13].

## III. PARTICLE SWARM OPTIMIZATION

### A. Methodology

Particle Swarm Optimization [4] belongs to the class of Swarm Intelligence technique that are used to solve optimization problems. PSO prompts the behaviour of birds flocking. In an area, a group of birds randomly search for food. Birds are not aware about the location of food. But after recurrences they come to know the distance of the food. So the desirable way to find the food is to follow the bird which is at the minimal distance from the food. While exploring the food, the group of birds imitate the flocking behaviour.

Each particle in PSO is updated by the following two best values:

- pbest- Every particle has its own solution space where it keeps track of its own coordinates associated with the best value (fitness) that has been achieved so far by that particle. This personal best value is known as pbest.
- gbest- The value which is the best among all the neighbourhood particles is called as the global best or the gbest value.

Each particle tries to modify its position using:

- The Current Position
- The Current Velocity
- The Distance between current position and pbest.
- The Distance between current position and gbest.

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After finding the pbest and gbest values, the velocity and position is updated by the particles using the following equation:

$$\text{vel}[] = \text{vel}[] + w1 * \text{rand}() * (\text{pbest}[] - \text{pos}[]) + w2 * \text{rand}() * (\text{gbest}[] - \text{pos}[])$$
$$\text{p}[] = \text{p}[] + \text{v}[]$$

where,

- pos[] : particle position.
- vel[] : path direction.
- w1 : weight of local information.
- w2 : weight of global information.
- pbest : best position of the particle.
- gbest : best position of the swarm.
- rand() : random variable.

### B. Algorithm

Assume,

S = number of swarm particles

$x_i$  = position of particle

$v_i$  = velocity of particle

$p_i$  = best position

g = global best position

A basic PSO algorithm is then:

For each particle  $i=1.....S$  do:

1) Initialize the particles position:  $x_i$

2) Calculate the fitness value for each particle.

3) Initialize the particles best known position to its initial position:

$$pos_i \leftarrow x_i$$

4) If ( $f(p) < f(g)$ )

update the swarms best known position:

$$q \leftarrow p_i$$

5) Initialize the particles velocity.

$$vel = vel + w1 * \text{rand}() * (\text{pbest} - \text{pos}) + w2 * \text{rand}() * (\text{gbest} - \text{pos});$$

$$pos = pos + vel;$$

Until a termination criterion is met (e.g. number of iterations performed, or a solution with adequate objective function value is found), repeat:

For each particle  $i = 1$  to  $S$  do:

Update the particles position:  $x_i \leftarrow x_i + v_i$

If ( $f(x_i) < f(p_i)$ ) do:

Update the particles best known position:  $p_i \leftarrow x_i$

If ( $f(p_i) < f(\text{gbest})$ ) update the swarms best known position:

$$\text{gbest} \leftarrow p_i$$

Now gbest holds the best found solution. The parameters  $\omega$ ,  $\phi_p$  and  $\phi_g$  are selected by the practitioner and control the behavior of PSO method.

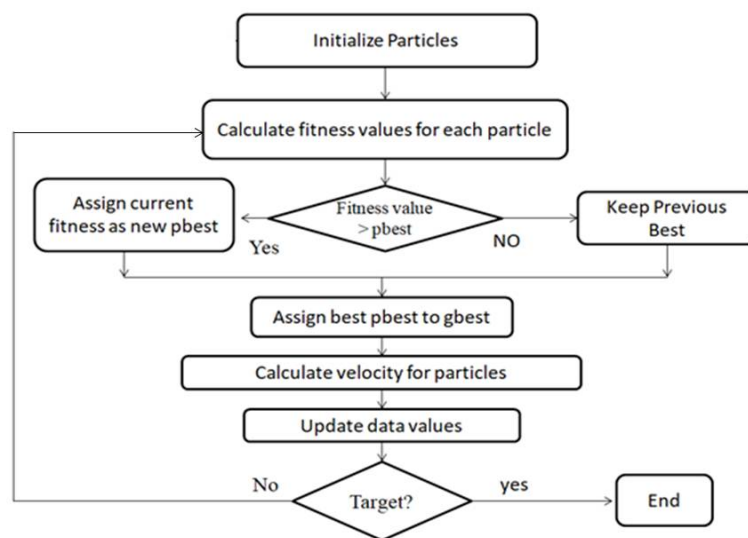
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### C. Flowchart



#### Advantages:

- The concept of PSO gained in popularity due to its simplicity.
- The PSO traditionally has no crossover between individuals, has no mutation and particles are never substituted by other individuals during the run.
- Each particle has a memory function, and adjusts its trajectory according to two pieces of information, the best position that it has so far visited.
- Efficient in global search. (Results are global).

#### Disadvantages:

- Slow convergence in refined search stage.
- Weak local search ability. (Search area local).

## IV. ARTIFICIAL FISH SWARM ALGORITHM

### A. Methodology

Artificial fish-swarm algorithm (AFSA) is a kind of optimization algorithm based on the simulation of fish-swarm behaviour. The algorithm imitates fish behaviour such as prey, swarm and follow by constructing a single fishes behaviour, to achieve global optimum value from all the local optimization[11].

The environment in which the fishes lives becomes the problem space. Fishes search food where the density of food is maximum. AFSA algorithm imitates the behaviour of fishes which are in search of food.

AFSA is an intelligent optimization algorithm which is designed as per the behaviour of the fishes i.e prey, swarm and follow. It is a local optimum search algorithm and avoids premature convergence.

Finding the maximum food density is the objective function. Current position of fishes is shown as  $X = (X_1, X_2, X_3, \dots, X_n)$ .

Behaviours exhibited by the fishes in search of food:

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- 1) Prey: It is a general step included is both the behaviours i.e. Swarm and Follow. Here the fishes stroll at random. As they find food they start moving towards that particular food source.
- 2) Swarm: Swarm is actually a group of fishes that are in search of food. Here the distance between the fishes is calculated using companion's moving direction.
- 3) Follow: When one fish of the fish-swarm discovers more food, the other fish will quickly find the food by dangling after it.

### B. Algorithm

Assume,

- S= Population of fish
- $X_i$ : Position of Fish
- $X_j$ : Next Position
- rand() : Random function in the range[0,1]
- V : visual distance of AF.
- $X_i^{i+1}$  : AF's next state
- $X_i^i$  :current state;
- $X_c$  : Center of near companions moving direction.
- $X_{min}$  :minimum among all ones in its current neighbourhood.
- Dist (ij)=  $\|X_i X_j\|$  Euclidean Distance (Distance between two fishes)

- 1) Initialize the population.
- 2) Select behavior of fish:
  - a) Prey:  $X_j = X_i + \text{rand}() * V$   
if  $f(X_i) < f(X_j)$ , then AFs state at the next iteration is calculated by following equation:  
$$X^{i+1} = X_i^i + \text{rand}() * \text{step} * (X_j X_i^i) / (\|X_j - X_i^i\|)$$
  - b) Swarm:  
$$X^{i+1} = X_i^i + \text{rand}() * \text{step} * (X_c X_i^i) / (\|X_c - X_i^i\|)$$
  - c) Follow:  
$$X_i^{i+1} = X_i^i + \text{rand}() * \text{step} * (X_{min} X_i^i) / (\|X_{min} - X_i^i\|)$$
- 3) Update the value of food source.
- 4) Check for convergence and if found greater than the previous source go to step 2.
- 5) End

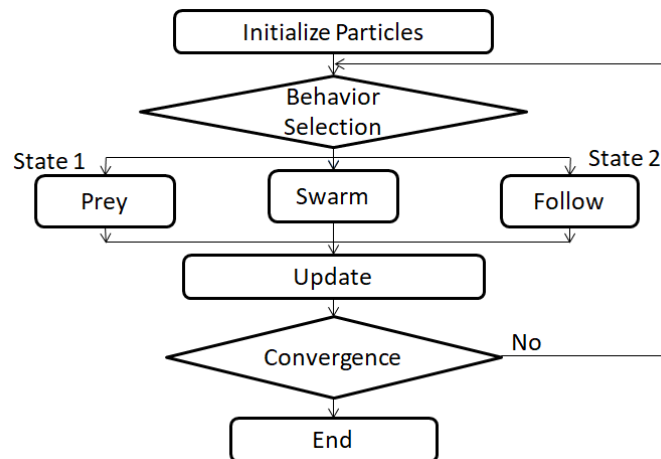
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### C. Flowchart



#### Advantages:

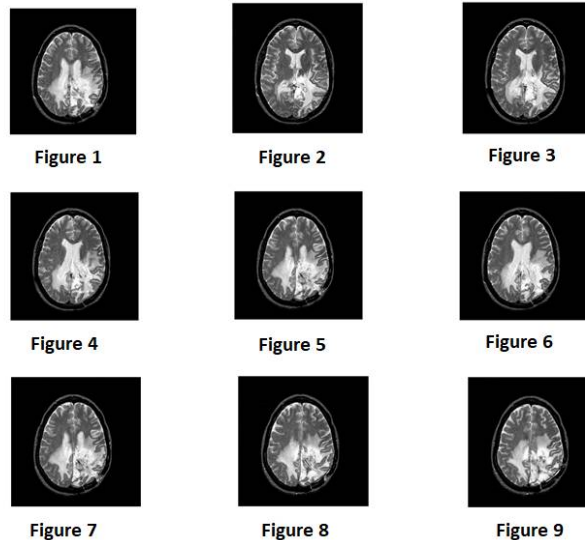
- Global search ability.
- Tolerance of parameter setting.
- Good robustness.

#### Disadvantages:

- Higher time complexity.
- Lower convergence speed.
- Lack of balance between global search and local search.

## V. PROPOSED SYSTEM

### Data Set:



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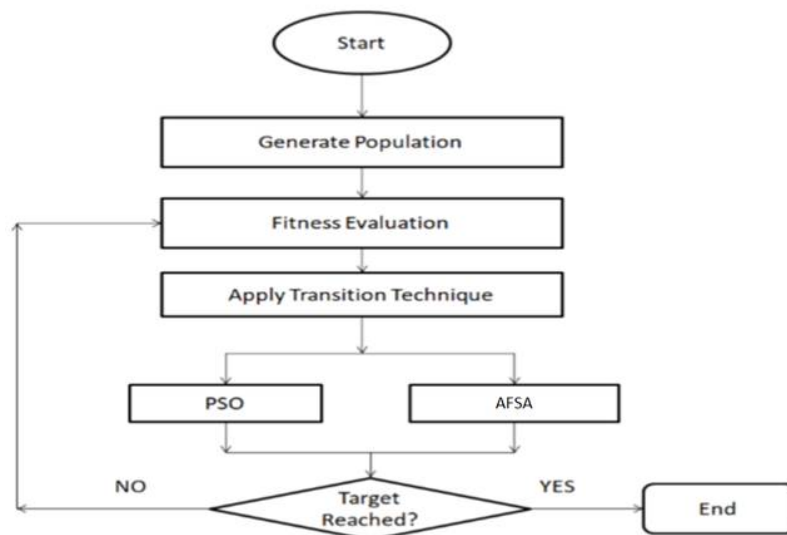
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The scope for PSO and AFSA is, it is one of the pillars of Swarm Intelligence, is a remarkable for at least two reasons:  
1) It has a simple formulation to Hybridize.

2) It is a constant source of complex and emergent phenomena, which are at the essence of swarm intelligence. Many people around the world are exploring PSO and its applications.

The idea is to combine PSO and AFSA. The proposed algorithm will run PSO for sometimes and then transit to AFSA. The objective is to utilize the capabilities of Swarm Intelligent Technique using AFSA and PSO to detect brain tumour in MR Brain Images. Thus, the proposed work is to generate a hybrid algorithm using PSO and AFSA algorithms to detect brain tumours in MR Brain Images with more accurate and efficient results.

Flowchart of the Proposed System:



## VI. CONCLUSION

In this paper, PSO algorithm which characterizes bird flocking and AFSA, which is based on the behaviour of swarm of fishes are studied to detect the brain tumour in MR Brain Images with high accuracy. Every particle makes use of its own memory and knowledge gained by the swarm as a whole to find the best solution. The proposed algorithm will be used to solve the issues in detecting brain tumour and in future it can be efficiently applied to solve other optimization problems.

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