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USING GREY WOLF OPTIMIZER FOR IMAGE REGISTRATION

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ABSTRACT

In this research paper a new algorithm is proposed for solving the problem of Image Registration. Image Registration involves the different techniques which can be used for the integration of various images. The images that have to be integrated can be taken from different directions, at different time periods or distances and from different sensors having varying configuration. The images collected through any source have to be integrated or combined into a composite image to obtain meaningful information. In present work a new algorithm is proposed to solve this problem. The proposed algorithm is based on the Swarm Intelligence technique called "Grey Wolf Optimization".

Keywords: Affine Transform, Grey Wolf Optimizer, Image Registration, Similarity Measure

I INTRODUCTION

Image Registration is an important concept in the field of Computer Vision. It is used in a variety of areas. It can be used in medical imaging systems. In medical imaging the images of the various internal body organs or body parts are taken with the help of numerous medical instruments and sensors. For a single body part many images may be produced with different viewpoints. The produced images have to be aligned with respect to each other to obtain more meaningful information as compared to the individual images. The same technique is useful in the area of armed forces. In this area image registration can be used for target recognition. This automatic target recognition can be used in aerial vehicles and missiles. It can also be applied on data obtained by individual satellites.

The image registration algorithms align all the images corresponding to a single reference image. The images may be transformed, scaled, rotated or sheared with respect to the reference image. Various techniques and algorithms have been developed previously to solve this problem. Some of the previous techniques are enumerated in Table 1. In this research paper a new algorithm is proposed to solve the image registration problem. In the next section an overview of the technique which inspired the proposed algorithm is given.

II GREY WOLF OPTIMIZER

This technique was proposed by Mirjalili et al. in 2014 [1]. It imitates the hunting behavior of grey wolves. The algorithm classifies the grey wolfs into 4 classes:-

Table 1: Techniques for Image Registration

Techniques	Features
Correlation Based	These methods compare the intensities of the source image and the reference image. The intensity can be compared by using various correlation metrics. These can register entire images as well as some part or sub-regions of an image [2].
Feature Based	These methods register the images by considering characteristic features of an image like points, lines or contours. The features selected for registering should be free from any local distortion [3].
Contour Based	These methods use high statistical features. Here color image segmentation is used for finding distinct regions. The mean is calculated for color of interest in the image. Pixels of the image can be classified as whether they have the color of interest or not. After the classification the two classes of image are colored in black and white to obtain segmented image. Contours are extracted for the binary images for performing image registration.
Multi-modal Methods	These methods register the images taken by different sensors having different configuration. The images obtained may vary enormously in resolution, color, depth, contrast etc.
Wavelet Transform Based	These methods preserve the spectral characteristics of images. Different wavelets can be applied to the images and the coefficients can be computed. Examples of wavelets used are Daubechies wavelet and orthogonal wavelets [2].
Hotelling Transform Based	In this method principal component analysis is used for image alignment. It is based on the statistical properties of vector representation.
Curve Based	In these methods the process of curve matching is used to register images.
Atlas Based	When one image is taken from a ‘patient’ and the other images from ‘normal subjects’ then such registration is called atlas registration. It has an enormous use in medical diagnosis.
Soft Computing Based	Soft computing techniques like artificial neural networks, support vector machines, fuzzy sets and optimization algorithms are also used to register images.

a) Alpha
b) Beta
c) Gamma
d) Delta

The grey wolf optimizer is a meta-heuristic technique [4]. Meta-heuristic techniques are used to find solutions for optimization problems. These techniques find the best solution to a problem with the constraints of the time required and the amount of information known. Nowadays, these techniques are very popular in many disciplines. These techniques are known for their simplicity, flexibility and the ability of finding the optimal solution. They are applicable to a variety of problems without changing their basic structure.

In the grey wolf optimizer algorithm the best solution is termed as alpha, the second best solution is called beta and the third best solution is called gamma. The rest of the solutions are termed as omega. The solution construction mechanism of this algorithm consists of three phases. The first phase consists of searching for the solution i.e. tracking, chasing and approaching the prey in terms of grey wolves. The second phase consists of exploiting the search space for finding better solution's i.e. pursuing the prey. The last phase consists of solving the problem based on the best solution i.e. attacking the prey. This is a new technique related to swarm intelligence. In swarm intelligence, unlike other problem solving techniques a set of agents simultaneously construct solutions. It is an iterative approach to problem solving. The grey wolf optimizer is a new approach and has not been applied in many areas.

III PROPOSED ALGORITHM

A new algorithm is proposed based on grey wolf optimizer for solving the image registration problem. A typical registration problem consists of the following steps:-

1) Assigning the reference tag to an image: A single image from the database is taken as the reference image. All the other images will be aligned with respect to that image.
2) Making the initial transformation on the source image: The image which has to be aligned with respect to the reference image is called the source image and an initial transformation is applied on it.
3) Improving the initial transformation: The first transformation obtained is not always perfect, as such a procedure for improving the initial transformation is also present.
4) Final registration corresponding to the best transformation obtained.

In the proposed algorithm a linear transformation model will be used namely the 'Affine transformation' to perform the appropriate transformation. The affine transformation has many advantages. The affine transformations preserve the collinearity condition and ratios of distances. These use a combination of various operations like: Rotation, Translation, Reflection, Shear and Similarity Transformations [5]. The framework of the algorithm is shown in the Fig.1. As the first step a sample image will be taken as the reference image. The image that has to be registered will be called the source image. The number of agents or grey wolfs that will search for solution will be proportional to the size of the reference image. The criterion for the proportionality is shown in (1).

$$Number\ of\ agents\ = \log_2(Size\ of\ Image\ in\ Kb) \qquad Minimum\ agents = 5 \tag{1}$$

The agents will use random affine transformation values to find the initial solution. After the first iteration the quality of the transformation values obtained by different agents will be calculated. This quality will be based on the similarity measure w.r.t. the reference image given by [6]. This similarity measure is used because it gives a good speed performance tradeoff as compared to other approaches. The similarity measure used is given below:

$$EC = E\left[\left(e^{O(x)-\mu_O}-1\right)\left(e^{T(x)-\mu_T}-1\right)\right]^2 \tag{2}$$

Where E[.] is the Expectation operator, T(x) is the target image, O(x) is the image to be registered, μ_O is the image average of O(x), μ_T is the image average of T(x) and EC is the Exponential Correlation Similarity measure.

After calculating the similarity metric for all the agents the best three agents will be selected. After this step all the other agents will transform the matrix obtained by the best three agents thereby exploiting the search space around the best solution. In the next iteration the three best agents will compute new random matrix from the source image (exploring). This process continues till the source image is completely registered with the target image i.e. it has the maximum similarity value possible. In terms of probability and statistics the value of a correlation metric lies in the interval [-1, +1]. As such the maximum value possible for the best solution is +1. After all the iterations are completed we will get an optimized image registration.

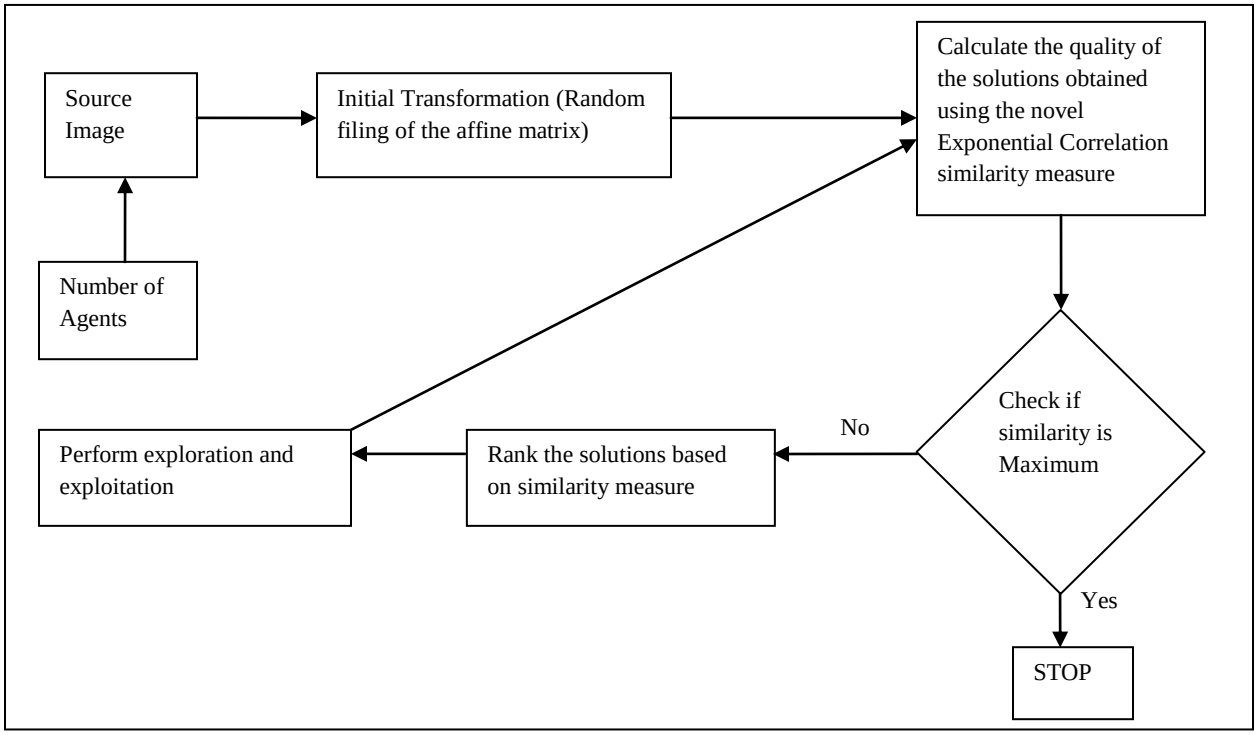

Figure 1: Framework of the proposed Algorithm

The pseudo code of the algorithm is also presented in Fig. 2. In the pseudo code the overall functioning of the algorithm is presented. The main function calls the CheckSimilarityValue function to compute the similarity of the solutions corresponding to the reference image.

```
Begin
Select Image as Reference image and Source image
Calculate the Number of Agents
Find Initial Solution
CheckSimilarityValue()
If (Alpha is similar to Reference) then
Exit
Else
Do {
Delta = Transformation on Alpha, Beta and Gamma
Alpha,Beta,Gamma=Random transformation on source image
CheckSimilarityValue()
} While [alpha similar to reference image]
End

CheckSimilarityValue()
{
Apply Equation (2) to calculate Similarity Value
Rank the Solutions
Alpha=Best solution
Beta=Second best solution
Gamma=Third best solution
}
```

Figure 2: Pseudo-code for the Algorithm

IV CONCLUSION AND FUTURE SCOPE

In the present research work a new algorithm is proposed for solving the problem of image registration. An entirely new technique using Swarm Intelligence is proposed. Presently only the basic structure and pseudo code for the algorithm is presented. As a future work the algorithm needs to be implemented and compared to the other approaches. The various parameters of the algorithm like number of agents and similarity factor can also be adjusted to check for the best value of the parameters. The algorithm can also be extended to deal with uncertain data and multimodal images.

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