# Matching suitable Feature Construction & Classification for SAR Images based on Particle Swarm Optimization

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## Abstract

Synthetic Aperture Radar (SAR) imaging which is used to create image of objects such as landscapes, remote sensing and mappings. The problem of various methods for improvement in SAR image matching features such as noise interference and deviated edges can be improved by using proposed technique. Particle swarm optimization is the nature inspired computational search and optimization approach which was developed on the basis of behavior of swarm. Recently each and every field of research is utilizing the properties of PSO. One of the popular fields of research is image segmentation and matching features which is also fastest growing field. Taking the advantages of combining PSO with different image segmentation technique many researchers has proposed various research papers with enhancement of various parameters. In this work, we surveyed and used Swarm Intelligence concept to reduce the unnecessary features from the image to get the desired image with all the highlighted features and try to provide recent trends and techniques involved in improvement in SAR imaging matching features with PSO a computational intelligence technique.

The work easily removes the garbage files, which occupies large amount of space, which is responsible for the perfect data cleaning. The PSO methodology can be further enhanced by introducing ACO technique designed for SAR image matching feature for improvement in the images obtained by satellites and more efficiently used in various applications.

***Keywords***—Synthetic Aperture Radar (SAR); Particle Swarm Optimization; Swarm Intelligence; computational intelligence; ACO technique.

## I. INTRODUCTION

Synthetic aperture radar (SAR) is radar based system used to obtain high resolution images from wide area of terrain. SAR was introduced since 1950's ,Carl Wiley first observed that area of image processing he belongs to Goodyear Aircraft Cooperation. SAR is capable of operating under different weather condition ,day and night .Processing of SAR is required to extract relevant features ,such as objects or building. Detection of such objects is based on detection on locally bright pixel, followed by clustering of neighborhood of pixels.

SAR is form of radar which is used to create images of objects such as landscapes, these images can be either 2D or 3D.SAR system illuminate s a terrain with microwave and record both the amplitude and phase of the back scattered radiation making it a coherent imaging process. The intensity of SAR image especially the pixels based calculation done in which pixels depends on the transmitted energy from the surface of the earth and received energy in the form of echo signal which is returned back to radar where an appropriate coherent combination of number of pulse lead to formation of synthetically enlarged antenna so called "synthetic aperture" .In which maximum synthetic aperture is the maximum distance travelled while target is illuminated as strong radar responses the bright pixels and so on.

In order to get high-precision locating results, the synthetic aperture radar (SAR) image matching aided navigation necessitates not only a good performance of the matching algorithm, but also the matching fittingness of matching areas, which is measured by matching appropriate features, aims to promise the successful matching of observed descriptions acquired by the SAR imaging sensor on the raised area during flight and the SAR reference images stored in a record in advance. Therefore, what features shall be adopted to compute the matching suitability of image areas and how to haul out these matching suitable features from the given image areas become core troubles in the study of SAR image matching suitability. To find out a good elucidation, this paper studies the construction technique of efficient matching suitable features of SAR images.

Whether a SAR image area is appropriate to match or not is prejudiced by many factors, therefore, stable matching suitable features should be a amalgamation of many primary matching suitable features (PMSFs). Synthesized matching suitable features (SMSFs) imitate the matching suitability of the image area in an all-round technique, while the primary ones, just partly. The weighted grouping algorithm based on several PMSFs is the present largely used typical SMSF synthesis method. As a variety of higher level of feature selection, complicated feature synthesis has been expansively studied so far. Dash and Liu selected representative features through the four basic steps of subset creation, subset assessment, stopping criterion and result confirmation which have become fundamental standards for feature selection. In recent years, selecting features by means of modern searching process has become an significant development direction, which means benevolent full play to the computer's advantage of mass data processing to absolute the synthesis of high performance features. Computer searching has the compensation of, firstly, overcoming the barrier that personal selection can only pact with limited information based on inadequate experience, and secondly, interpreting an image well despite a shortened understanding of information contained in an image. Depending on evolutionary working out, Yu and Bhanu trained the Gabor wavelet features-based support vector machine to differentiate the different facial expressions. And through the co-evolutionary genetic algorithm of a binary expression tree built based on the primary appreciation features, Lin and Bhanu got synthesized features, which by training, were urbanized into an efficient Bayesian classifier to classify the images of different types of vehicles. These feature synthesis methods, functional to the areas of typical target detection and recognition, have gotten good experiment results.

The paper applies Lin's evolutionary expression tree strategy in SAR recognition to the synthesis process of matching suitable features. Combining with the distinctiveness of SAR image matching and matching-area selection, an optimal feature synthesis method relying on several especially constructed PMSFs with a special evaluation function of fitness (EFOF) is calculated. Then the optimal synthesized features are taken as SMSFs to forecast the matching suitability of a given SAR image.

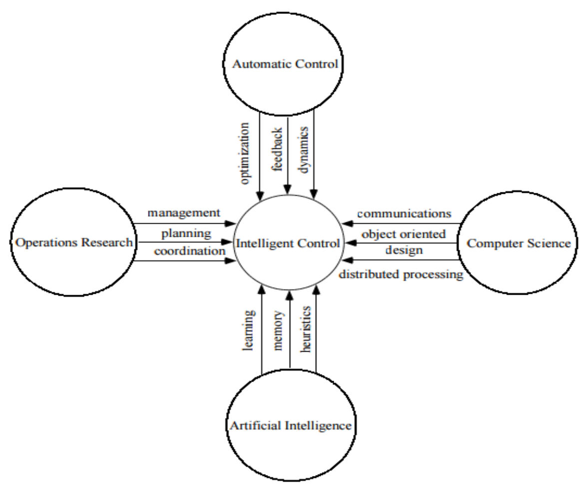


Figure 1 – Technical Computaional Intelligence [ 1 ]

In order to select matching suitable areas in SAR image matching, a set of algorithms for constructing the SMSF of a SAR image are proposed based on the evolutionary strategy at first. Then, several PMSFs are synthesized via the binary expression tree structural model, and then the synthesized feature with the highest efficiency value is selected from the feature space as the SMSF. The following conclusions are obtained via researches and experiments:

(1)Under the condition that the sizes of the reference image and observation image are determined, it is able to obtain the SMSF changing monotonously with the change of the matching probability of a SAR image area via the evolutionary expression tree.

(2)With flexible forms, the SMSF expression tree fully synthesizes the advantages of various PMSFs in different aspects and effectively excavates the potential advantages of PMSFs with poor effect when existing independently.

(3) The method of seeking for the individual with the highest efficiency in the whole synthesized feature space spanned by PMSFs via evolution algorithm can fully adopt while not being limited by expertise, which is good for obtaining an objective and optimal SMSF.

## II. PROBLEM IDENTIFICATION

The Challenge of Feature Selection is described as follows:

Given a set of candidate features, choose a subset that performs the best beneath some classification system. This process can decrease not only the cost of identification by plummeting the number of features that need to be composed, but in some cases it can also offer a better classification correctness due to infinite sample size effects. The word feature selection is taken to pass on to algorithms that output a subset of the input feature set. More broad methods that create new features based on alterations or combinations of the original feature set are called feature extraction algorithms. This work is concerned mainly with the former group.

There has been a renaissance of interest in applying feature selection methods due to the large numbers of features encountered in the following types of problems:

1. Applications where data taken by several sensors are combined. Authors in previous work for have fused both color and shape features to provide the enhanced retrieval accuracy for a trademark image record.
2. Assimilation of multiple models, where the parameters from dissimilar mathematical models are collective for the purpose of classification.
3. Data mining applications, where the goal is to recuperate the hidden relationships among a large number of features.

The goal of this work is to demonstrate the value of feature selection in combining features from diverse data models, and to reveal the potential difficulties of performing feature selection in small sample size situations, due to the nuisance of dimensionality. We present catalog of feature selection algorithms. Several well-known and some freshly proposed feature selection algorithms have been implemented and weathered. Based on these results, the sequential forward oating selection (SFFS) method introduced has been found to be tremendously powerful.

We have applied this technique to a large data set, twisted by pooling features from four diverse texture models, in order to organize SAR satellite images. Feature selection results on this dataset express

(i) the survival of the nuisance of dimensionality.
(ii) that combining features from dissimilar texture models

leads to a better cataloging accuracy than the performance of individual models. The pest of dimensionality phenomenon is further examined by performing the feature selection on artificial data sets of various sizes drawn from two Gaussian distributions, and computing the quality of the chosen subset versus the known most favorable subset.

The need for choosing effective feature sets is particularly pertinent in all the problems where a large number of distinct features can be defined. Examples of such troubles are:

- Applications where data taken by numerous sensors are fused;
- Integration of numerous models, where all the parameters from the dissimilar models can be used for classification;
- Data mining applications, where the objective is to recover the concealed relationships among the features.

### *a) Proposed Solution of the Work*

In this paper particle swarm optimization is one of the soft computing techniques. In other words the problem in improvement in SAR imaging on matching feature basis is followed as

PARTICLE SWARM OPTIMIZATION: Actually there is supervised and an unsupervised technique the PSO is unsupervised method.PSO is population based search technique .it is new approach based on evolutionary technique; depend on interaction between independent agents used to find the global maximum of generic function. In PSO the swarm intelligence is used which is the experience accumulated during evolution is used to search the best approach parameter t describe the image feature for matching which improve the SAR imaging.

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The feature of SAR image is general highly application dependent ,which represent the outcome of the event that is condition on some test here ,unsupervised testing is processed by PSO, and the term matching feature understand as the process in imaging type of search there are many unknown type of search there are many unknown factor governing the appearance of image in a given SAR image .The whole process followed that SAR image obtained by Google are optimized to reduce error ,improve the SAR imaging on matching features.

## III. RELATED WORK

Sharma Abhay et al (2015 ) worked on the subject “Recent Trends and Techniques in Image Segmentation using Particle Swarm Optimization-a Survey “ and projected that Particle swarm optimization is the scenery inspired computational search and optimization come within reach of which was developed on the base of behaviour of swarm. Recently each and every field of study is utilizing the properties of PSO. One of the accepted field of research is image segmentation which is also best ever growing field. Taking the compensation of merging PSO with different image segmentation practice many researchers has planned various research papers with improvement of various parameter. In this paper we surveyed some paper and attempt to give recent trends and techniques concerned in image segmentation with PSO.

In this paper the authors have examined several paper and came to termination that the field of PSO greatest growing field in every area. When we mutual PSO with other image segmentation method such as thresholding, fuzzy sets, histogram equalization etc presentation of the method is considerably increased. In short we can say PSO is very powerful method which can be utilized professionally in the field of image processing.

Bhandari A.S. et al ( 2014 ) worked on the topic “ SAR Image Segmentation Based On Hybrid PSOGSA Optimization Algorithm “ and planned that Image segmentation is functional in many applications. It can spot the regions of interest in a scene or gloss the data. It classifies the existing segmentation algorithm into region-based segmentation, data grouping, and edge-base segmentation. Region-based segmentation comprises the seeded and unseeded area growing algorithms, the JSEG, and the fast scanning algorithm. Due to the attendance of speckle noise, segmentation of Synthetic Aperture Radar (SAR) imagery is still a challenging trouble. They also projected a fast SAR image segmentation technique based on Particle Swarm Optimization-Gravitational Search Algorithm (PSO-GSA). In this technique, threshold estimation is regarding as a search procedure that examination for an suitable value in a continuous grayscale gap. Hence, PSO-GSA algorithm is habituated to search for the optimal threshold. Experimental results point toward that our method is greater to GA based, AFS based and ABC based methods in conditions of segmentation accuracy, segmentation time, and Thresholding.

The technique regards threshold assessment as a search process and utilizes PSO-GSA algorithm to optimize it. In order to supply PSO-GSA algorithm with an well-organized fitness function, we put together the concept of grey figure in Grey theory, maximum provisional entropy to get enhanced two-dimensional grey entropy. In essence, the fast segmentation speed of our technique owes to PSO-GSA algorithm, which has an exceptional meeting performance. On the other hand, the segmentation eminence of our technique is benefit from the enhanced two-dimensional grey entropy, for the fact that blast almost completely disappears.

Yanlong Bu et al ( 2013 ) worked on the “Matching suitable feature construction for SAR images based on evolutionary synthesis strategy " ,In the work, a set of algorithms to create synthetic aperture radar (SAR) matching suitable facial appearance are firstly projected based on the evolutionary synthesis approach. During the process, on the one hand, the indexes of main matching suitable features (PMSFs) are intended based on the distinctiveness of image texture, SAR imaging and SAR matching algorithm, which is a process involving expertise; on the other hand, by designing a manufactured operation expression tree based on PMSFs, a much more elastic expression form of synthesized features is built, which greatly enlarges the construction space.

Then, the hereditary algorithm-based optimized searching procedure is working to search the manufactured matching suitable feature (SMSF) with the highest competence, largely improving the optimized penetrating efficiency. In addition, the investigational results of the carried by the wind synthetic aperture radar ortho-images of C-band and P-band show that the SMSFs gained via the algorithms can reproduce the matching appropriateness of SAR images precisely and the matching prospect of selected matching appropriate areas of ortho-images could reach 99 ±0.5%.

S.Ren, et al ( 2011 ) worked on the topic "SAR Image matching method based on improved sift for steering system ". In order to ensure that SAR scene matching aided steering system can obtain the position errors and yawing error concurrently, we suggest an image matching algorithm based on Scale Invariant Feature Transform (SIFT). However, the SIFT is planned for optical image, and its presentation degrades when used in SAR image. To improve the adaptableness of SIFT, two ways are engaged. One is the application of a preprocessing on image pairs ahead of matching. The other is the establishment of a scale and rotation control criteria on tie-points after SIFT matching. Compared with other matching method, experiment consequences show that the projected method is much more appropriate for SAR image and successes in matching presentation improvement. Furthermore, the method can convene the real-time requirement.

Liu Jhing zheng and Yu Xu chu ( 2008 ) worked on the topic "Research on SAR Image Matching Technology based on SIFT " and projected that Image matching is one of the key technology in remote sensing picture fusion and steering. Image matching of Synthetic Aperture Radar (SAR) is a procedure to find association of pixels in many SAR images, which honestly absorb and influences the application of SAR image in many areas such as mapping, incorporated navigation and image fusion. In order to get better the searching speed in matching, pyramid approach is used. Considering the feature of low S/N ratio in SAR image, curve let is introduced in preprocessing SAR images. For the great metamorphoses between SAR images, direct Scale Invariant Feature Transform (SIFT) is used in identical of destination image and referenced image which are alike with each other in grayscale. Edge withdrawal is implemented in SAR images obtained at different times and on different orbits by using Canny operator, and then SIFT key points is removed to match the images. Combined with association coefficient controlling method, mistake matching points are wiped off and good result is obtained.

## IV. METHODOLOGY

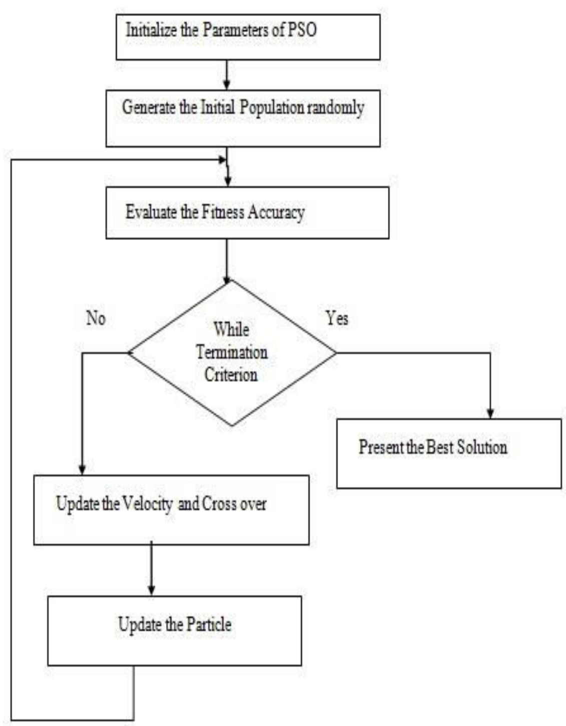


Figure 2 – Feature Selection Module

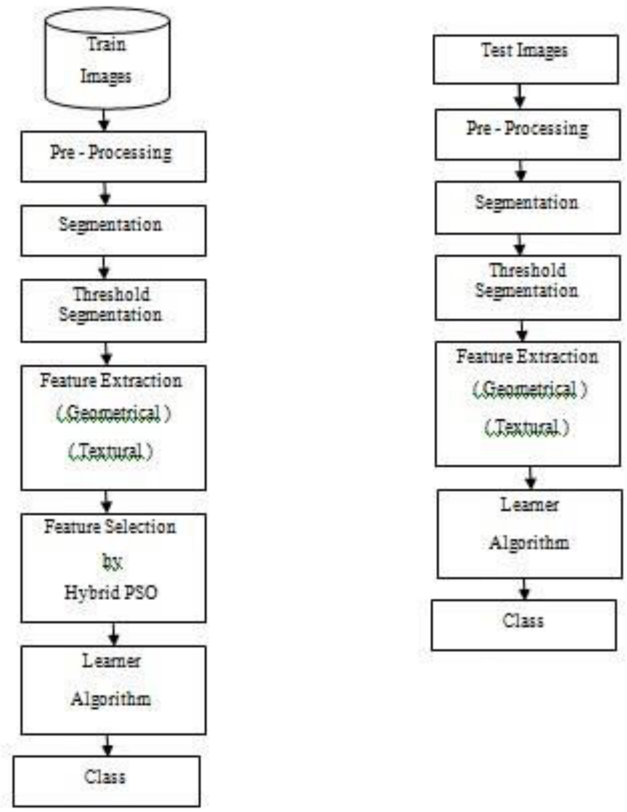


FIGURE 3 – BLOCK DIAGRAM OF FLOWCHART

**Step by Step Detailed Methodology –**

Step 1:- Initialize the Parameters of PSO

- PSO is an unsupervised method. PSO is population based search technique. It is a new approach based on evolutionary technique, depending on the interaction between the independent agents used to find the global maximum of generic function.
- In PSO, the swarm intelligence is used which is the experience accumulated during evolution is used to search the best approach parameter t describe the image feature for matching which improve the SAR imaging.
- Initialise the parameters of PSO, which are required.
- The parameters have to be used in the PSO Algorithm for further processing.

Step 2:- Generate the Initial Population randomly

- Initialize the size of the population.
- It includes the declaration of the capacity of the data or information.

Step 3:- Evaluation of the Fitness Accuracy

- Evaluate the fitness value through decision tree classifier.
- Decision Tree Classifier is a easy and extensively used classification method. It applies a straight forward thought to solve the classification problem.
- Decision Tree Classifier has a series of carefully created enquiries about the attributes of the test record.
- Each time it obtains an answer, a follow-up question is asked in anticipation of a conclusion about the class label of the documentation is reached

**PSO ALGORITHM**

```
initialize the swarm;
while ( mission on )
get sensor readings;
if (no object is found) then
move in spiral;
else
evaluate the target position;
report the target position to the host;
set pso on;
while (pso on )
get sensor readings;
update local best;
update global best;
report to host the current position and
get global best;
move to the next best position;
avoid obstacle if present;
if ( target reached ) set pso off;
end ( while pso off)
end if
if ( mission completed) set mission off;
end
```

Step 4:- Initialize the velocity

- Now, initialize the velocity of the datasets.

Step 5: Update the velocity

- Update the velocity of the dataset by using the formulae –

  $V_{id} = w * v_{id} + c_1r_1 (P_{best} – x_{id}) + c_2r_2 (c_{1best} – x_{id})$Where $V_{id}$ = calculated velocity
  $c_1 =$ weighing coefficient
  $c_2 =$ weighing coefficient

Step 6:- Update all the parameters

- Update each and every parameter , i.e. $X_{id}$
  $X_{id} = X_{id} + V_{id}$

Step 7:- Updation of the Velocity

- A centroid of the circle shows the current state. Radius of the circle represents velocity value possessed by the current state.
- The velocity calculation in the MSPSO algorithm is different compared with the original PSO algorithm due to pbesti (k,d) , and si (k, d) in the form of state. With regard to the PSO algorithm, a particle has three movement components; the inertia, cognitive, and social component.

Step 8:- Updation of The Swarm

- Particle Swarm Optimization (PSO) based on the analogy of swarms of birds and fish schooling .
- Swarm behavior can be modeled on a few simple rules. Fishes and swarms with birds can be modeled on simple models.
- The behavior rules of each individual (agent) are the behavior of the swarm
- Simulation of bird flocking in a two-dimension space. optimizes a certain objective function .Each agent knows its best value so far (pbest) and its x, y position his information is an analogy of the personal experiences of each agents. Each agent knows the best value so far in the group (gbest) among pbests.
- This information is an analogy between the knowledge of the other agents around the performed.

Step 9 – Updation of the Velocity and Swarm

- Update the Velocity value
- Update velocity and position for each particle in the population according to the given values.
- If the populations meet exchange conditions, particles will be implemented exchange operation (According to fitness sort, populations are randomly selected to exchange particles).
- When the particles meet re-initialization conditions, in accordance with the previous method to initialize the particles.
- The Swarm selection is on the random basis , which helps in selecting the best 35 features out of 41.
- The velocity is updated with the following equation :-

  vid = w * vid + c1r1 (pbest – xid ) + c2r2 ( gbest – xid )

Step 10 – Estimate the fitness value again through the decision tree

- Now, Calculate the Fitness Value of the decision tree again and check whether the criteria meets accordingly or not.

Step 11 – Check If the Criteria is Active or not

- Check whether all the criteria are right or not. so calculate run
- There were 41 features to find the accuracy rate, which has been decreased to 35 features to improve and enhance the accuracy rate.
- These 35 Features are the best features out of those 41 Fetaures.
- If the Criteria is Active, then while run vanishes, otherwise again Estimate the fitness value.

## V. RESULTS AND DISCUSSIONS

Based upon the steps discussed in the Methodology, the graphical user interface is designed in MATLAB, which makes the task easier.

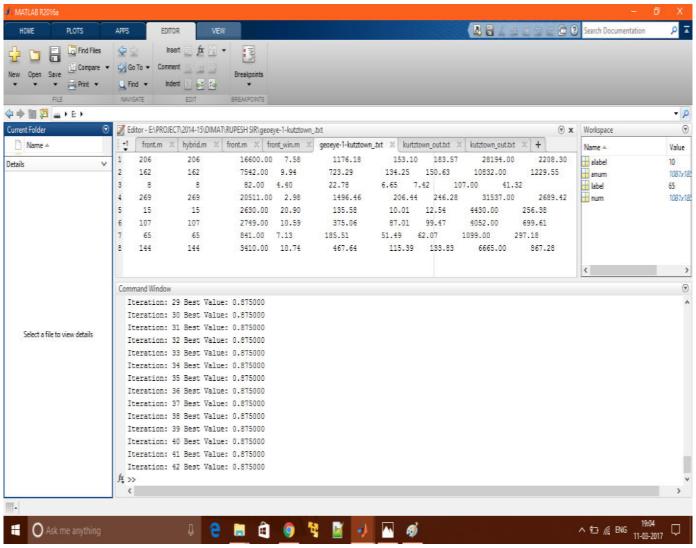

Figure 4 - Getting the Best value after the termination criterion as 0.875


Figure 5 - Regional Maxima of Opening and Closing by the process of Reconstruction. Geometrical and Textural Features are extracted from the figure and are selected to undergo Hybrid PSO.

## VI. CONCLUSION AND FUTURE WORK

In this work, we observe the matching feature of SAR image and the improvement in the image quality is done with the help of soft computing under computational intelligence techniques i.e. Hybrid PSO using Swarm intelligence concept .The advantages of PSO algorithmic initial condition are not required but it performs a globalized searching for solution where as other clustering procedures performs a localized searching according to overall accuracy. PSO has high classification precision and can be used in SAR images classification efficiently. The Web mechanism removes the unnecessary logs files, and cleans it by further reducing the size of record. Our experiments have estimate data preprocessing importance and our methodology's effectiveness. It is not only to reduce the size of the image file but also increases the quality of the data available. The work easily removes the garbage files, which occupies large amount of space, which is responsible for the perfect data cleaning.

The PSO methodology can be further enhanced by introducing ACO technique designed for SAR image matching feature for improvement in the images obtained by satellites and more efficiently used in various applications.

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