SAR Image Classification by Multilayer Back Propagation Neural Network

Syed Asif Ali
PG Scholar, Department of CSE
Chebrolu Engineering College, Chebrolu

K. Venkata Ramaiah
Assistant Professor & Head, Department of CSE
Chebrolu Engineering College, Chebrolu

***Abstract* - A novel descriptive feature extraction method of Discrete Fourier transform and neural network classifier for classification of Synthetic Aperture Radar (SAR) images is proposed. The classification process has the following stages (1) Image Segmentation using statistical Region Merging (SRM) (2) Polar transform and Feature extraction using Discrete Fourier Transform (3) Neural Network classification using back propagation. This is generally the first step in image analysis. Segmentation subdivides an image into its constituent parts or objects. The level to which this subdivision is carried depends on the problem being solved. The image segmentation in this study is performed using Statistical Region Merging proposed Richard Nock and Frank Nielsen. The key idea of the Statistical Region Merging model is to formulate image segmentation as an inference problem. Here the merging procedure is based on the theorem. Feature vectors as the input for the neural network. Polar transform is applied to segmented SAR image. The rotation problem under the Cartesian coordinates becomes the translation problem under the polar coordinates.**

Keywords: Back-propagation algorithm, feature extraction, MSTAR database, SAR images, SRM segmentation.

I. INTRODUCTION

There has always been a need of protecting the messages that are sensitive in nature. Such messages if exposed to some intruder may pose a threat to nation's security or company's critical decisions. Thus, such information must be secured at any cost and to serve the purpose there has been a trend to encrypt or hide the secret information. Cryptography (derived from Greek work 'kryptos' meaning hidden and 'graphein' meaning to write) is used to encode the text to make itunderstandable. Steganography (composed of Greek word 'steganos', meaning covered and 'graphein' meaning to write) on the other hand, is used to hide the text behind some other media. Cryptography may draw the suspicion of the intruder towards the text that is in encoded format. Steganography do not lures the eavesdropper as it hides the message. Steganography can be classified based on the type of media it uses to hide the text[1]. These are as follows:Synthetic Aperture Radar (SAR) is a coherent radar system that generates high resolution remote sensing imagery. SAR imagery is used in finding comparatively small mobile or immobile targets for military applications. The need is to classify the targets using the SAR images. SAR images containing objects that are small, influenced by speckle still requires efficient classification technique to correctly classify objects. The foci of this study are on providing an advanced classification techniques for SAR images.

II. SYSTEM DESIGN MODEL

The proposed method is used to classify vehicle astank or armed personal carrier of SAR images. Areference database is maintained with the SAR image,which are released by MSTAR database. In proposed method, the SAR image classification is done by employing feature extraction algorithm to extract the stable, repeatable and distinctive features of the SAR image and then by matching these features with the features of reference images. Proposed method introduces a SAR classification method with rotation invariance. The rotation invariance feature is represented by the absolute valueof Fourier coefficients of polar image of the SAR. Then SAR image can be distinguished by feeding those features into a multi-layered BP neural network. The block diagram of proposed method is represented in Fig. 1.

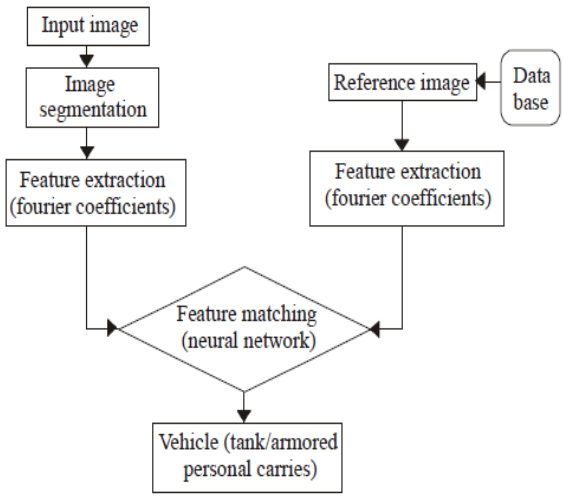

Fig. 1: Block diagram of the proposed method

A. *Image segmentation:*

In this section, a method forsegmenting the object from the SAR image is proposed.Image segmentation is a technique for extractinginformation from an image. This is generally the firststep in image analysis. Segmentation subdivides animage into its constituent parts or objects. The level towhich this subdivision is carried depends on theproblem being solved. The image segmentation in thisstudy is performed using Statistical Region Mergingproposed Richard Nock and Frank Nielsen.

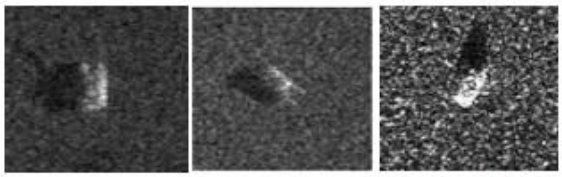

Fig. 2: (a) T72-Tank (b) BMP2-armored personnel carriers (c) BTR60- armored personnel

The keyidea of the Statistical Region Merging model is toformulate image segmentation as an inference problem.Here the merging procedure is based on the theorem'The independent bounded difference inequality'. It isthe reconstruction of regions on the observed image,based on image on which the true regions we seek arestatistical regions whose borders are defined from asimple axiom. Second, the model shows the existenceof a particular blend of statistics and algorithmic toprocess observed images generated with this model, byregion merging, with two statistical properties. Theregions in the query image are merged using the SRMsegmentation procedure to obtain the object regionfrom the image. The segmentation procedure outputwas shown in (Fig. 2) which shows the region mergedimage and the shows the segmented output.

B. *Polar transform:*

The segmented SAR image isconverted from Cartesian coordinates to logarithmicpolar coordinates. The rotation problem under theCartesian coordinates becomes the translation problemunder the logarithmic polar coordinates. The imagetransform from Cartesian to logarithmic polar coordinates is introduced.

C. *Feature extraction:*

Feature vectors as the input for the neural network. Polar transform is applied to segmented SAR image. The rotation problem under the Cartesian coordinates becomes the translation problem under the polar coordinates. Then the Fourier transform applied to the output of the polar transform. Then the feature vectors will be obtained as shown in Fig. 3.

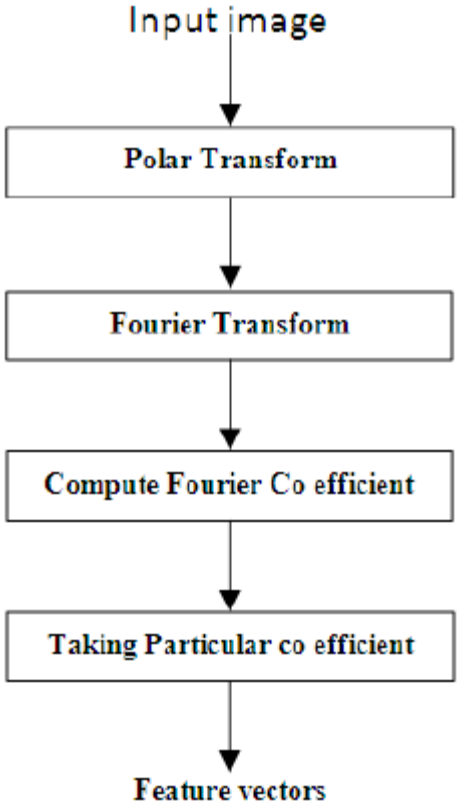

Fig. 3: Feature vector computation

D. *Fourier transform:*

The output of the transformation represents the image in the Fourier or frequency domain, while the input image is the spatial domain equivalent. The absolute value of Fourier coefficients will not change after the image is rotated. The absolute values of Fourier coefficients are used as feature vectors, then the feature vectors are rotation invariant. The Fourier coefficients can be used to reconstruct the image under the logarithmic polar coordinates. The number of Fourier coefficients maybe be infinite, but with increasing frequency, the amplitude of the coefficients will be reduced significantly. So the Fourier coefficients above a certain frequency can be ignored. Here fifteen co efficient used as feature vectors.

E. *Neural network training and classification:*

Multilayer back propagation neural network is taken as the network architecture for the present application. After choosing the network, the number of neurons in each layer has to be decided. The number of neurons in the output layer is fixed. the neural network input is Fourier co efficient. By applying polar transform to the segmented image and then applying Fourier transform to that, feature vectors are obtained. The number of hidden layers in the network and the number of neurons in each layer is chosen by trial and error

method based on the performance function until it reaches the specified goal.

III. Simulation Results

The proposed method is required to find the feature vectors. The database contains 3 images. BTR60, BMP2, T72 are used as the reference for experimentation. In this study, SAR ATR experiments were performed using the MSTAR database to classify three targets as shown in Table 1. The image data are composed of SAR images chips roughly centered on three types of military vehicles: the T72, BTR60 and BMP2 (the T-72 is a tank and the other two vehicles are armored personnel carriers) as shown in Fig. 2.The segmented image and Neural Network Analysisas shown in Fig. 5. Based on the features extracted from the SAR images, fifteen parameters of Fourier coefficients values are given as input to train the network as shown in Table 2. These input values are compared with those image feed into the network. Then the matching is performed. The network is trained with the parameters corresponding to three types of SAR image, to their respective targets. After training the performance function reaches the goal for all the samples.

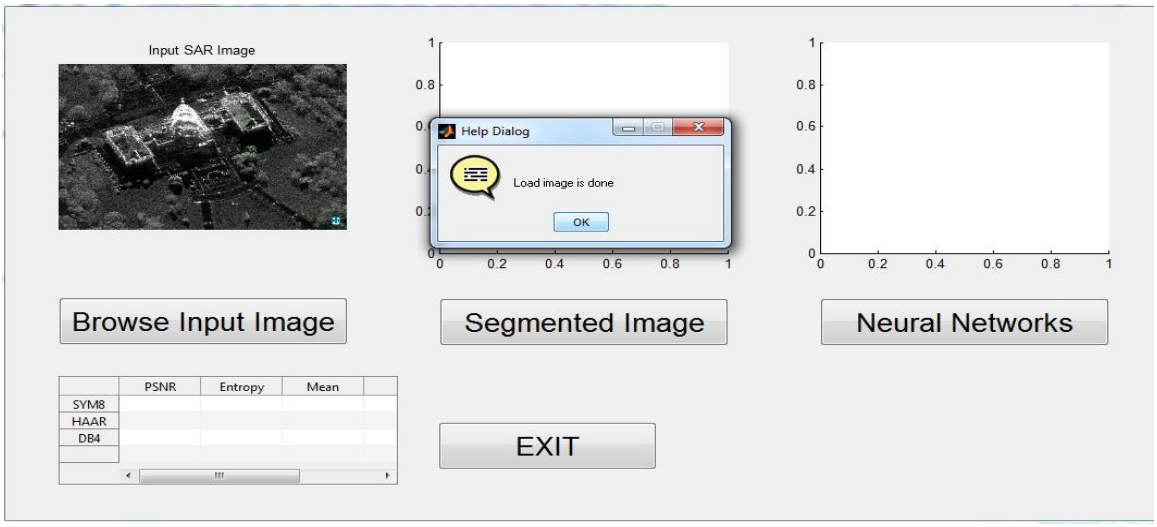

Fig. 4: a) Original Image b) segmented image

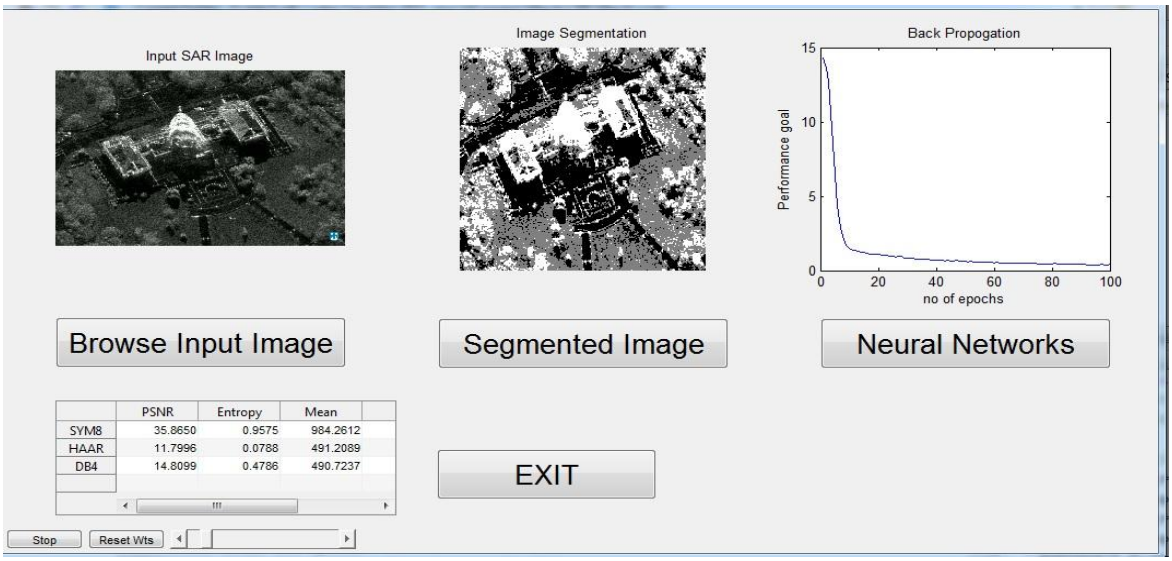

Fig. 5: a) Original Image b) segmented image c) Neural Network Analysis.

CONCLUSION

In this study, a new SAR image classification method has been proposed. The image of the SAR is acquired using a MSTAR database. Then the SAR image of the BTR60, BMP2, T72 (armored personnel carriers & Tank) has been subjected to the segmentation process. The Image is segmented using the Statistical Region Merging (SRM) method. After that the feature vectors are extracted using Fourier descriptor and it given in to the neural network. Neural network will trained in to the three types of SAR Images. The DWT based SYM wavelet coefficients perform the better quality in the image with more than 35dB in Peak Signal to Noise Ratio. The classification rate of the proposed algorithm is around 88%. The future study is to Automatic target recognition of SAR images with reduced time.

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