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AI to Predict Natural Disasters like Earthquakes using ESC Extraction and SVM

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Abstract: Due to its capability of weather-independent imaging and sensitivity to target scattering and geometric properties, Polarimetric Synthetic Aperture Radar (PolSAR) offers crucial support for the built-up areas (BA) information analysis. However, labelled BA samples with unique orientations are hard to come by, and PolSAR BA with wide orientation angles is frequently mistaken for vegetation. Additionally, the trained models and labelled BA samples hardly ever perform well in the cross-domain BA analysis of PolSAR data. This article describes a PolSAR BA extraction method that combines subspace alignment with eigenvalue statistical components (ESC) and PU-Learning (PUL) to achieve cross-domain BA extraction (SA). Building orientation effects and the roll invariance of the eigenvalues of the coherency matrix are examined first. Regional statistical information is then obtained by using the Wishart-Eigen value unsupervised classification.[1-2] In our previous paper titled "Machine Learning Approach for Predicting Earthquakes in a Geographic Location" Machine Learning Approach was used with lower accuracy. In this paper key methods of pre-processing were used to increase the accuracy of SVM.

Keywords: Machine learning, eigenvalue, Polarimetric Synthetic Aperture Radar (PolSAR), PU-Learning (PUL), and eigenvalue statistical components (ESC).

I.INTRODUCTION

Accurate and timely built-up areas (BA) information analysis provide valuable supports for many applications, such as the evaluation of ecological environment, urban expansion and planning fast response to natural disasters etc. With the ability of weather-independent imaging and sensitivity to targets' scattering and geometric characteristics, Polarimetric Synthetic Aperture Radar (PolSAR) has demonstrated its potential in BA extraction.

However, due to the high complexity of BA structure composition and the orientation angle problems extracting BA accurately from PolSAR is still a challenging task. For most supervised PolSAR BA extraction methods, labelling enough positive BA samples with special orientations is difficult and time consuming. Also, the negative labels for BA tasks are usually unavailable, since the background categories are always uncertain. Furthermore, the labelled BA samples and trained models can hardly work well in cross-domain BA analysis tasks.

These problems impede the further development of accurate and timely BA extraction and change monitoring applications from PolSAR data. An earthquake is an example of a catastrophic occurrence that harms both human interests and the environment.[3][4][5] Earthquakes have always caused immeasurable damage to structures and other assets, and they have also resulted in millions of fatalities around the planet. To decrease the effects of such an incident, numerous national, international, and transnational organisations adopt various disaster warning and prevention initiatives.[5] When it comes to allocating the organization's resources, managers face a variety of difficulties due to time and resource limitations. Machine learning can be used to calculate the degree of earthquake-related structure damage.

This is accomplished by categorizing these buildings according to a degree of damage severity based on a number of elements, including their age, foundation, number of floors, kind of material used, and others.[6-7] Then, ward-by-ward in a district, the number of families and the likely casualties are considered. This enables the proportionate distribution of relief forces by ward and their prioritizing according to the severity of the damage. Such models can contribute to the fastest possible lifesaving and prove to be a successful and affordable option. It can be further enhanced by include the

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distribution of goods like food, clothing, medical care, and money in accordance with the number of fatalities among people and the degree of structural damage. The polarimetric eigenvalues are used in the proposed frameworks to get beyond the BA misdetection brought on by large orientation angles. We employ region-based eigenvalue Wishart statistics to express the polarimetric and regional properties of BA since BA has regional characteristics and contains a variety of complicated man-made targets.

Then, to lessen the need on extensive sample labelling, BA is only extracted using a few clearly positive samples using the PUL classifier. Additionally, the ESC-PUL-SA minimises variations brought on by sensors and imaging scenes by facilitating reliable unsupervised cross-domain PolSAR BA extraction and expansion analysis. One of the most catastrophic natural disasters is an earthquake. They generally happen without warning and give people little opportunity to react.[9] Therefore, earthquakes have the potential to result in major injuries and fatalities, as well as massive building and infrastructure destruction and significant economic loss. The ability to predict earthquakes is obviously important for safety.

II.ESC EXTRACTION

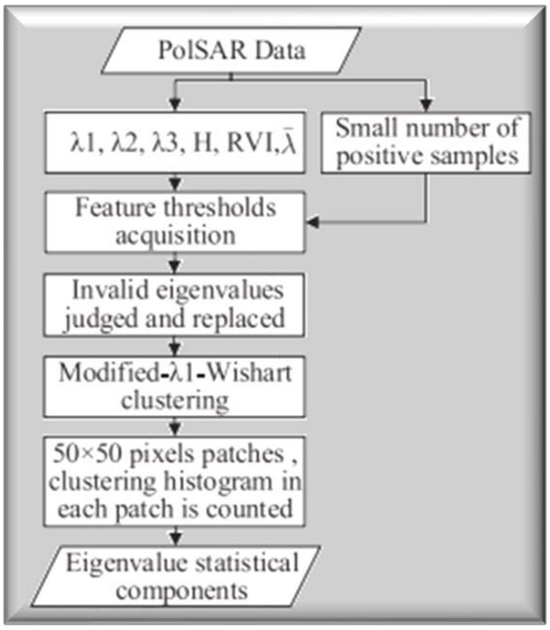

Figure 1 shows the ESC Extraction process.

The flowchart as shown in figure 1 yields the applied ESC. First, the derivative parameters and some invalid eigenvalues are evaluated and substituted before extracting the roll-invariant eigenvalues.

Then, taking into account the regional peculiarities of BA, modified unsupervised classification is used at the picture patch level, effectively utilising both regional statistical data and roll-invariant properties. In more detail, λ1, λ2, λ3, RVI, H, λ^{-} are first retrieved. Some invalid λ1 values are then assessed and substituted by the relationship between λ1, λ2, λ3.

Then, as the regions with these features do not fit the criteria and are inevitably random and noisy, the eigenvalues with high RVI, low H, or low λ^{-} values should also be changed. The labelled positive samples can be used to determine the relevant thresholds judged these regions.

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III. SVM CLASSIFIER

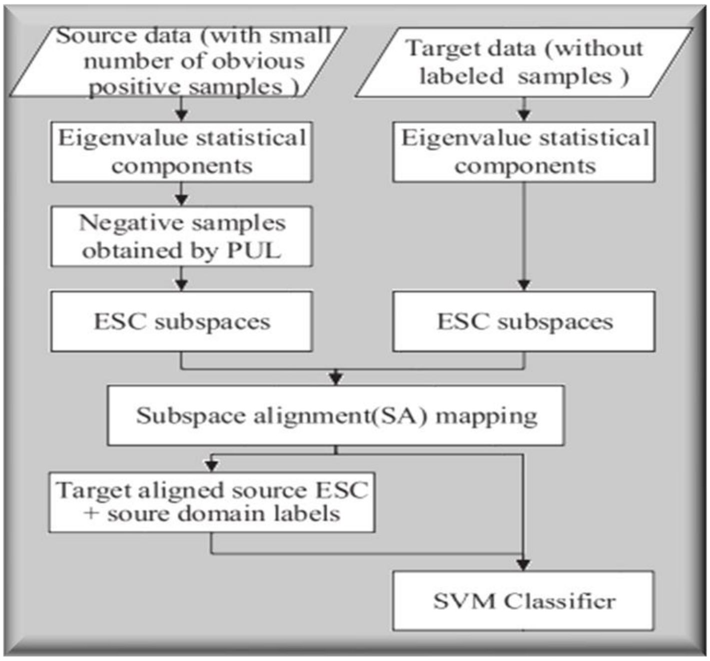

Figure 2 shows the PolSAR BA method before SVM Classification.

Feature extraction entails a pre-selection process of several statistical aspects of data and production of a group of seismic parameters that correspond to linearly independent coordinator within the feature space.Numerous pattern recognition algorithms are frequently used to analyse the earthquakes inside the type of statistic. This extraction technique is often carried out using statistical or pattern recognition methods. This provides insight into the mining of scientific data.[10]

IV. SOFTWARE REQUIREMENT SPECIFICATION

i. Anaconda Navigator 2.3.2
ii. Jupyter Notebook 6.0.3
iii. MATLAB 9.13
iv. OpenCV
v. Language: Python 3.7
vi. Environment: Keras and Tensorflow environment
vii. OS: Windows 7 or higher/ UBUNTU/ MAC OS
viii. Spyder 4.1.4
ix. CMD.exe Prompt 0.1.1

V. METHODOLOGY

A set of labelled training data is used to create input-output mapping functions by the supervised learning technique known as the support vector machine (SVM). The classification function, or category of the input data, or the regression function can both be used as the mapping function. Nonlinear kernel functions are frequently employed in classification to transform input data into a high-dimensional feature space, where the input data are more easily separable than in the original input space. Then, maximum-margin hyperplanes are made. The model generated in this manner is only dependent on a portion of the training data close to the class borders. Similar to this, any training data that is sufficiently near to the model prediction is disregarded by the SVR model.[11-13] Figure 3 shows the library sci-kit learn which is imported for creating train/ test split. Figure 4 shows the SVC library being imported. A particular random state is set. Here, the random_state =1. The Support Vector Machine Algorithm is applied on the ESC extracted dataset. The dataset is split into train data and test data in the ratio 71:29. Figure 5 shows the confusion matrix of the assignment. Accuracy and F1 score can be calculated using the matrix.

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In [1]:
import pandas as pd
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
df=pd.read_csv(r"C:\Users\DELL\Desktop\earth.csv")
```

Figure 3 shows the sci-kit library being imported

```
from sklearn.svm import SVC
svm = SVC(random_state=1)
svm.fit(X_train.T,Y_train.T)
acc= svm.score(X_test.T, Y_test.T)*100
accuracies['SVM']=acc
print("Test Accuracy of SVM Algorithm: {:.2f}%".format(acc))
```

Figure 4 shows the SVM algorithm being applied

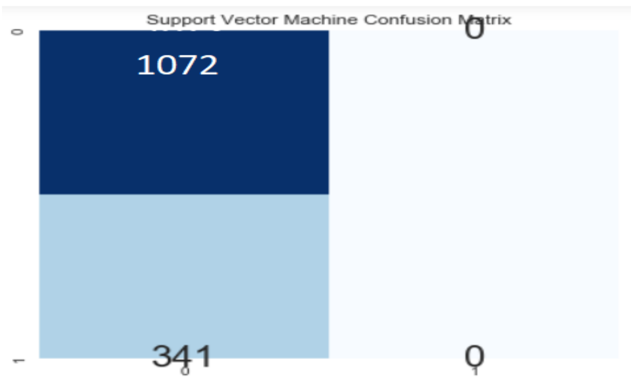

Figure 5 shows the confusion matrix of our model

VI. CONCLUSIONS AND FUTURE WORK

With just positive samples from the source domain available, the eigenvalue statistical data and PUL were further extended to the unsupervised cross-domain BA analysis. SVM accuracies were between 89.64% and 95.53%. With a few promising examples from the source data, it not only confirms the efficacy of suggested features and PUL for the BA analysis but also offers strong evidence for BA expansion and change analysis from multisource and multitemporal PolSAR data. A follow-up study will concentrate on building density, classifying urban functional areas, and extracting more precise building change information from PolSAR data.

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BIOGRAPHY

VISHESH S (BE(TCE), MBA(e-Business)) born on 13th June 1992 hails from Bangalore (Karnataka) and has completed B.E in Telecommunication Engineering from VTU, Belgaum, Karnataka in 2015. He also worked as an intern under Dr. Shivananju BN, former Research Scholar, Department of Instrumentation, IISc, Bangalore. His research interests include Embedded Systems, Wireless Communication, BAN and Medical Electronics. He is also the Founder and Managing Director of the corporate company Konigtronics Private Limited. He has guided over a thousand students/interns/professionals in their research work and projects. He is also the co-author of many International Research Papers.

He has recently completed his MBA in e-Business and PG Diploma in International Business. Presently Konigtronics Private Limited has extended its services in the field of Software Engineering and Webpage Designing. Konigtronics also conducts technical and non-technical workshops on various topics. Real estate activities are also carried out under the guidance of Siddesh B S BE (civil). Vishesh S along with his father BS Siddesh has received various awards and applauses from the scientific and entrepreneurial society.

He was appointed as the MD of Konigtronics Pvt Ltd (INC. on 9th Jan 2017) at an age of 23 years. His name is indexed in various leading newspapers, magazines, scientific journals and leading websites & entrepreneurial forums. He is also the guide for many international students pursuing their Masters.