Государственное образовательное учреждение
высшего профессионального образования
**«Томский государственный университет
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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 27-2

“Polarimetric Radar Contrast”
(«Поляриметрический РЛ контраст»)

Публикации в трудах конференций

Источник: *Digital Library IEEEXplore*
Язык: *английский*
Глубина поиска: *2001 – 2011 гг.*
Дата формирования: *март 2011 г.*
Составитель: *В.И. Карнышев*

Томск – 2011

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"Unsupervised classification for polarimetric Synthetic Aperture Radar image using the fuzzy possibilistic C-means clustering"

The polarimetric Synthetic Aperture Radar (POLSAR) image data has the problems of the noisy pixels and vague category boundaries because of its complex scattering mechanism and statistical property, which strongly influence the classification quality, while the fuzzy possibilistic C-means (FPCM) is robust in detecting the noisy pixels and modeling the uncertainty. Hence, we tried FPCM algorithm combined with the four scattering features (entropy (H), anisotropy (A), scattering angle (α) and total power (SPAN)) to classify the POLSAR data. The feasibility of this approach was tested on the JPL/AIRSAR POLSAR data, and the experiment result shows that the clustering algorithm can perform the classification more effectively in contrast to its counterparts FCM and PCM clustering algorithms. [C1]

"On the detection of marine mammals with ship-borne polarimetric microwave radar"

Collisions between ships and whales are not rare occurrences. Apart from constituting a major cause of death for whale species which frequent busy oceanic areas such as the North Atlantic, such collisions often result in damage to ships. Thus there is keen interest in finding reliable means of detection of whales at sufficient range to ensure successful collision avoidance. In this paper we present the results of experiments aimed at establishing the potential of polarimetric microwave radar to provide such a means. The key element in our approach is the construction of a polarimetric filter which enhances the contrast between the disturbed sea surface around the whale and the ambient sea. The results suggest that detection can be achieved under conditions where conventional uni-polar radars such as those normally found on merchant ships would fail. [C2]

"The Application of Optimal Polarization Theory in Polarimetric SAR Change Detection"

In recent years, SAR is developing to multitemporal, multi-band, high resolution and full polarization. So the study of polarization SAR change detection technology is the trend of the SAR. The traditional change detection methods have disadvantages either low accuracy, serious noise or can't determine changes types. In order to improve the detection accu-racy of polarization SAR data, a new change detection method is presented in this paper. Firstly, we use optimal polarization theory and optimization of polarimetric contrast enhancement (OPCE) theory to enhance change phenomenon respectively. Then, the probability relaxation iteration algorithm is made use of to extract change information automatically. This method can not only improve the accuracy, decrease noise, but also can determine the change type, it is a kind of ideal change detection method. [C3]

"A novel method for ship detection in polarimetric SAR images using gopce"

In this paper, a novel method for ship detection in fully polarimetric SAR images is developed. This method employs the Generalized Optimization of Polarimetric Contrast Enhancement (GOPCE) to maximize the target-to-clutter ratio in an image. For comparison, the traditional OPCE, Polarimetric Matched Filter (PMF) and Polarimetric Whitening Filter (PWF) are also used. Experiments results of the NASA/JPL AIRSAR C-Band image over Sydney Coast show that the proposed method has a considerably improvement as to enlarge the separation of ships and sea clutter, demonstrating a robust detection performance. [C4]

"A new edge detection method of polarimetric SAR images using the curvelet transform and the Duda operator"

A new method for edge detection of polarimetric SAR images is proposed based on the curvelet transform and the Duda operator in this paper. The detection of edge features from SAR images is complicated by the presence of speckle. Firstly, a despeckled polarimetric SAR image is derived by the Polarimetric Whitening Filter (PWF), and then the image is filtered by Lee's method with eight edge-aligned windows to preserve the edge sharpness. The curvelet transform which is a multi-scale representation suited for edge enhancement is applied

to estimate the area including edges approximately. Then the Duda operator, a contrast ratio edge detector to extract linear features, is used to give the positions of the edges precisely. The proposed method is applied to PISAR images to illustrate its effectiveness. [C5]

"The conformity coefficient or how to explore the scattering behaviour from compact polarimetry mode"

In a previous paper, we have investigated the potential of the compact polarimetry mode at longer wavelengths in a space environment for soil moisture estimation. At longer wavelengths, one of the main challenges in dealing with compact polarimetry is the Faraday rotation estimation and correction. One proposed technique relies on bare surface scattering properties. Identifying the bare surfaces can be done using the conformity coefficient. This new coefficient can also be used to discriminate between surface, volume and double bounce scattering. It provides similar results to the Freeman-Durden classification in discriminating bare surfaces. In this paper, the study is pursued to include theoretical approach to the comparison. The potential of the conformity coefficient is benchmarked further against the well-known entropy-alpha-anisotropy classification. The comparison between these techniques is first performed theoretically and the effect of noise is investigated. These techniques are then applied to existing datasets coming from various sources, airborne sensors as RAMSES and AIRSAR and spaceborne sensors as PALSAR data and the results are cross-evaluated. The Faraday rotation can be estimated from full polarimetric data as was proposed by both Freeman and Bickel & Bates. These approaches are not applicable to compact polarimetry data. In a previous paper, it was shown how bare surface behavior can be used to perform this estimation. In this paper, the performance of this estimation is evaluated on PALSAR data and on airborne data where a constant ionosphere is simulated. The results are contrasted with estimates derived from full polarimetric data. [C6]

"Multi-resolution target scattering decomposition for urban feature characterization using polarimetric SARs"

Urban areas include features (buildings) of coherent scattering as well as areas such as parks that manifest partially coherent scattering due to the significant natural variability in the scattering properties. While high-resolution coherent target decomposition(CTD) can be used for characterization of buildings, incoherent target scattering decomposition (ICTD) is more suitable for analysis of partially coherent targets [11]. In contrast to CTD, ICTD preserves the polarimetric information of the latter at the expanse of the requirement for use of coarse-resolution for unbiased estimation of ICTD parameters [9]. The Touzi decomposition [10], [15] permits a unified roll invariant decomposition of both coherent and partially coherent scattering. In this paper, a multi-resolution technique is introduced to adapt the Touzi decomposition to the coherence nature of target scattering. The multi- resolution mixture CTD-ICTD decomposition is validated using polarimetric Convair 580 SAR data collected over Ottawa city. Implications on the use of the new multi-resolution decomposition for the unified analysis of coherent and partially coherent target scattering are discussed. [C7]

"Detection of ships using sub-aperture airborne PolSAR data"

The objective of this paper is to assess the sub-aperture analysis for ship detection using airborne polarimetric SAR data. Three optimal non-normalized coherences can be obtained by tuning the polarization status using the full polarimetric SAR data. These parameters are used to greatly improve the contrast between ships and ocean clutter, since it preserves the intensity and phase information of the coherent target. The airborne polarimetric SAR data is applied to evaluate the results of polarimetric sub-aperture detection for the ships over the ocean. In this way, the improvement in ship detection performance that is realized by using polarimetric information and coherence product is demonstrated in this paper. [C8]

"A new method for polarimetric SAR image classification"

In this paper, the authors propose a new method for supervised target classification of polarimetric synthetic aperture radar (SAR) image, by using the optimization of polarimetric contrast enhancement (OPCE). First, using the idea of the generalized optimization of polarimetric contrast enhancement (GOPCE), the authors modify the model with three polarimetric parameters which are related to the physics of the scattering mechanisms. It leads to enlarge the difference between two categories and improve the classification results. A new classification approach is then proposed, it is similar to a single binary tree, which the misclassification between the classes with a big power difference is minimal. After the classified results are obtained by the combination of Fisher-OPCE and polarimetric parameters, the coefficients of the scattering parameters information of every two adjacent classes will be used as the last discrimination for final classification results. The effectiveness of the proposed algorithm is demonstrated by using a NASA/JPL AIRSAR L-band image over San Francisco. [C9]

"Polarimetric synthetic range profile autofocusing via contrast optimization"

One of the main benefits brought by the use of fully polarimetric radars is the ability to identify the scattering mechanism, which is related to target physical properties. One of the most critical problems in synthetic range profile reconstruction is the distortion induced by the target motion. Radial target velocity and acceleration generate second and third order phase terms in the received signal, which produce range shift and point spread function (PSF) smearing. The distortions induced by the target motion produce, as a consequence, a SNR loss. Recently, a method based on contrast maximisation has been proposed to compensate target radial motions in single polarisation radar. In this paper, an extension of such an algorithm is proposed that exploits full polarisation. [C10]

"Observations and mitigation of RFI in ALOS PALSAR SAR data: Implications for the DESDynI mission"

Initial examination of ALOS PALSAR synthetic aperture radar (SAR) data has indicated significant radio frequency interference (RFI) in several geographic locations around the world. RFI causes significant reduction in image contrast, introduces periodic and quasi-periodic image artifacts, and introduces significant phase noise in repeat-pass interferometric data reduction. The US National Research Council Decadal Survey of Earth Science has recommended DESDynI, a Deformation, Ecosystem Structure, and Dynamics of Ice satellite mission comprising an L-band polarimetric radar configured for repeat-pass interferometry. There is considerable interest internationally in other future L-band and lower frequency systems, as well. Therefore, the issues of prevalence and possibilities of mitigation of RFI in these crowded frequency bands are of considerable interest. RFI is observed in ALOS PALSAR in California and Hawaii, USA, and in southern Egypt in data examined to date. Application of several techniques for removing it from the data prior to SAR image formation, ranging from straight-forward spectral normalization to time-domain, multi-phase filtering techniques, are considered. Considerable experience has been gained from the removal of RFI from P-band acquired by the GeoSAR system. These techniques applied to the PALSAR data are most successful when the bandwidth of any particular spectral component of the RFI is narrow. Performance impacts for SAR imagery and interferograms are considered in the context of DESDynI measurement requirements. [C11]

"A BPM Two-Scale Contrast Model"

This paper describes a new two-scale polarimetric contrast model based on the Boundary Perturbation Model (BPM). The damping of the short gravity-capillary surface waves by small slicks is modelled by the Marangoni damping coefficient. The surface slick is supposed to modify both the short wave part of the sea surface spectrum intensity and the wind input. The model has been validated over SIR-C/X-SAR Multi Look Complex (MLC) L- and C-band Synthetic Aperture Radar (SAR) data. [C12]

"Comparison of Polarimetric Change Detection Methods on ALOS PALSAR Images over Finland"

Six polarimetric change detection indices were tested on L band ALOS PALSAR data over Kuortane, Finland. Tests included quantitative evaluation of change indices compared to reference change maps, and qualitative evaluation by visual inspection. Results suggest an additional accuracy using fully polarimetric data in change detection. Contrast Ratio and the Wishart test gave the best results among the tested indices. [C13]

"Enhanced Military Target Discrimination using Active and Passive Polarimetric Imagery"

Surveillance operations often make use of electro-optic (EO) imaging systems to detect civilian and military targets. To increase the overall target detection performance, such active/passive EO sensors could exploit the polarization of light as additional information to discriminate man made objects against different backgrounds. The target contrast enhancement obtained by analyzing the polarization of the reflected light from either a direct polarized laser source as encountered in active imagers, or from natural ambient illumination, can be used for such target discrimination scheme. This paper reports results from field experiments exploiting polarization-based imaging sensors to enhance the detection of man made objects. Active and passive polarimetric signatures of objects have been acquired at wavelengths in the near and long-wave infrared bands. Results demonstrate to what extent and under which illumination and environmental conditions the exploitation of active/passive polarimetric images is suitable to enable target discrimination. [C14]

"Comparison and evaluation of polarimetric change detection techniques in aerial SAR data"

This article aims at providing a comparison of polarimetric change detection indices from a practical point of view. Six polarimetric change detection indices were tested on L band EMISAR data over Norway. Tests included quantitative evaluation of change maps compared to a ground truth of changes, and qualitative

evaluation by visual inspection. Contrast ratio and the Wishart test gave the best results among the tested indices. [C15]

"Polarimetric analysis of maritime SAR data collected with the DSTO ingara X-Band radar"

Fine resolution spotlight synthetic aperture radar (SAR) imagery collected on a circular flight path is used to investigate the variation in ship detection performance with respect to three fundamental radar parameters: the transmit/receive polarisation combination, the incidence angle and the azimuth angle. The polarisation combinations examined are HH, HV, VV, RR and cross-slant 45deg. Three different incidence angles are considered-50deg, 60deg and 70deg-corresponding to collection geometries for high altitude maritime surveillance systems. Performance is assessed using a simple target-to-background contrast measure. Results are compared with preliminary results from a four component decomposition of the Mueller matrix. While the latter and cross-slant 45deg show promise, in general HH is shown to have the best performance. [C16]

"Comments on hybrid-polarity SAR architecture"

Recent work on compact polarimetry is reviewed in the context of the fifty-year history of polarimetric diversity. One promising form of this genre is hybrid-polarity (CL-pol), in which a synthetic aperture radar (SAR) transmits circular polarization and receives on two orthogonal mutually-coherent linear polarizations. The CL-pol technique is compared and contrasted to alternative compact polarimetric schemes. Useful characteristics that are unique to the hybrid-polarity architecture are described, especially rotational invariance and polarimetric calibration. [C17]

"Polarimetric ISAR autofocussing techniques: Comparison of results"

This paper briefly describes a number of scalar, partially polarimetric, and fully polarimetric ISAR image autofocusing approaches that are based upon the PPP and ICBA autofocusing techniques. All approaches are then compared and contrasted using real world data provided by the Defence Science and Technology Organisation of Australia. From this analysis the ICBA approach results in an improved image focus as defined by the image contrast, image entropy and image peak measures, whereas the performance of the PPP based approaches are mixed at best. [C18]

"Image contrast and entropy based autofocusing for polarimetric ISAR"

In recent studies the possibility of extending autofocusing techniques to fully polarimetric ISAR systems has been proposed. The image contrast and entropy based autofocusing techniques have been proposed in the last decade as some of the most common techniques for obtaining well focused single polarisation ISAR images. In this paper, the two techniques are extended and applied to fully polarimetric ISAR data. A performance analysis is then provided and compared to single polarisation ISAR using real data. [C19]

"The boosting algorithm with application to polarimetric SAR image classification"

The boosting algorithm is a powerful tool to combine a set of classifiers for improving classification performance. There are two issues to be considered for classification in polarimetric SAR image analysis: (1) how to choose the measurement with discriminability on various categories with different scattering characteristics; (2) how to combine the classifier sets with minimum loss of performance. For solving both the problems, the authors propose a supervised classification method. Firstly, the result of the optimization of polarimetric contrast enhancement (OPCE) is employed as the distance measurement. Then the measurement is translated to a confidence rate, which describes the decision of a "weak" classifier on a refined scale. These classifiers are generated and combined to a powerful classifier under the boosting framework. This proposed method takes advantages of both the specific characteristics of polarimetric SAR image and of the powerful machine learning algorithm. Using polarimetric SAR image, the authors demonstrate the effectiveness of the proposed method. [C20]

"Automatic Change Detections from SAR Images Using Fractal Dimension"

It is very difficult to detect changes from SAR images because of two major difficulties associated with SAR, which are the removal of speckle noise and the registration of information between images. Speckle is a chaotic phenomenon because that the scattering signals within a resolution cell are summed up coherently. Therefore, SAR signal can be modeled by a spatial chaotic system and characterized by its fractal dimension. Then, simplified procedures for SAR image change detection are proposed because that the process of image despeckling is unnecessary. The proposed approach is applied to multitemporal polarimetric SAR images for change detections. The experimental results of using a simple image difference (DI) technique, the principal

component analysis (PCA), and the proposed (Fractal) approach are compared. The effects of misregistration for different approaches are also presented. Simulation results reveal that misregistration affects less and less as SNR is increased. When SNR is low, by using DI or PCA methods, the overall performance of change detection is degraded by spurious differences due to misregistration. On the contrary, Fractal method can tolerate misregistration effect at low SNR. In addition, when the difference between changed classes is small, it is fail to detect changes by using of either DI or PCA method. In contrast, the Fractal method can still effectively detect land cover changes. [C21]

"Methods to Increase Polarization Contrast of Radar Objects"

The scope of this work is to analyze methods for increasing radar-contrast between different scattering object surfaces. Methods for radar contrast enhancement by polarization analysis of the scattered signal, i. e, radar contrast control, orthogonalization and polarization compensation methods are analyzed in this paper for deterministic and stochastic cases, and compared with conventional RCS radar analysis. The results of the analysis show that radar contrast obtained by using polarimetric methods is enhanced compared to conventional RCS analysis, and indicate that to enhance contrast it is necessary to control the receive -transmit antenna polarization according to changes in the polarization state of the transmitted and the received waves. [C22]

"Dry snow extent monitoring using multi-frequency and multi-temporal polarimetric indicators"

A new method to discriminate dry snow in alpine regions is presented. Due to the wide variety of Alpine environments, the scene under study is first segmented into surface and forested area classes from L and C-band summer polarimetric SAR data. Dry snow is then discriminated over each class using adapted methods. A new polarimetric multi-temporal optimization procedure, named PCVE, is proposed to increase the slight polarimetric contrast due to the presence of snow over surfaces. Snow covered forests are discriminated using performing polarimetric indicators resulting from a decomposition of incoherent matrix representations. The effectiveness of this method is demonstrated over a French alpine test site using SIR-C L and C-band polarimetric SAR data [C23]

"PCA-ICA neural network model for POLSAR images analysis"

The POLSAR images are modeled by a mixture model that results from the product of two independent models, one characterizes the target response and the other characterizes the speckle phenomenon. For scene interpretation, it is desirable to separate between the target response and the speckle. For this purpose, a PCA-ICA neural network model is proposed. Based on its rigorous statistical formulation, a neuronal approach for the simultaneous diagonalisation of the signal and noise covariance matrices using a PCA transform is proposed. The PC images are uncorrelated and having an improved SNR. However, the speckle is a non-Gaussian multiplicative noise, the higher order statistics contain additional information about it. The ICA method is used to separate the speckle from the PC images and provide new IC images that have an improved contrast. The method has been applied to real POLSAR images. The extracted features are quite effective for the scene interpretation. [C24]

"Multi-frequency polarimetric snow discrimination in Alpine areas"

This paper presents a new method to map dry snow in Alpine areas. A supervised discrimination algorithm, based on polarimetric contrast, is proposed to enhance multi-temporal and/or multi-frequency polarimetric behavior variations over snow-covered areas. This technique is shown to be more robust with respect to topography and underlying media diversity than classical contrast enhancement approaches. The effectiveness of the proposed method is demonstrated using SIR-C L and C-band polarimetric data sets [C25]

"A method for characterizing a target in polarimetric radar remote sensing"

A method for characterizing a target is proposed in this paper, based on the eigenvalue decomposition of a scattering matrix. From this method, a set of parameters is derived. The parameters are not only independent of the spans of the scattering matrices, but also independent of the target orientation angles. With these parameters, we enhance the contrast between the road and forest of a SAR image, demonstrating the effectiveness of the proposed parameters. [C26]

"Generalized optimization of polarimetric contrast enhancement"

The optimization of polarimetric contrast enhancement (OPCE) is one of important problems in radar polarimetry. The traditional OPCE is to choose optimal polarization states for enhancing a desired target versus an undesired target/clutter. The contrast enhancement enables us to discriminate or distinguish the desired target from

background or from the undesired target. We propose a generalized OPCE (GOPCE). For the GOPCE problem, we need to find not only three coefficients such that the ratio of two factors associated with the desired target and clutter is maximal, but also optimal polarization states such that the received power ratio of the target and clutter is maximal. Both the factors consist of three parameters, i.e., the Cloude entropy (Cloude, S.R. and Pottier, E., IEEE Trans. Geosci. Remote Sensing, vol.35, p.68-78, 1997) and two special similarity parameters (Yang, J. et al., Electron. Lett., vol.37, p.193-4, 2001). The optimal coefficients of the GOPCE are obtained by solving an eigenvalue problem. Using an example, we demonstrate that the GOPCE can be employed for detecting roads in a forest area by using polarimetric SAR data. [C27]

"Processing of polarimetric infrared images for landmine detection"

Infrared (IR) cameras are often used in a vehicle-based multi-sensor platform for landmine detection. Additional to thermal contrasts, an IR polarimetric sensor also measures surface properties and therefore has the potential of increased detection performance. We have developed a polarimetric IR setup, which has to be used in a forward-looking manner. This paper describes all the steps to reach detection performance. The first step is the acquisition of the polarimetric IR image data. The next step is the pre-processing to (re)construct polarimetric images. A subsequent segmentation step is made to identify objects. Features, like intensity, reflectivity and shape, of these objects are measured. For independent performance analyses, the data set is divided into a training and evaluation section. A classifier is trained on the training section and evaluated on the classification section. The detection performance of the forward-looking IR camera is shown in receiver operator characteristics (ROC) curves. [C28]

"Processing and analysis of polarimetric ground penetrating radar landmine signatures"

The paper presents an analysis of landmine signatures acquired with a polarimetric ground penetrating radar (GPR). First, preprocessing was applied to isolate the target signatures from other reflection events. This included a frequency-wavenumber (f-k) filter to remove unwanted side reflections, followed by background subtraction to remove the direct wave and the ground reflection. The obtained polarimetric signatures of the landmines indicated that these can contain significant cross-polar components, which is in contrast to expectation for a target with a cylindrical casing and most likely a result of internal structure. Making use of the reciprocity property of the scattering matrix, the polarimetric signatures were transformed into the target frame, yielding signatures that are independent of target orientation. From the transformed signatures target impulse responses were estimated using a newly developed deconvolution algorithm. The novelty of the deconvolution algorithm lies in the fact that it computes impulse responses, which adhere to a physical model. Accordingly, the computed impulse responses can be related to mine properties such as size and dielectric permittivity. An interesting application of this is the estimation of a mine's permittivity from its impulse response and the impulse response of a calibration target, of which an example is given. [C29]

"Ultra wideband endfire synthetic aperture radar for landmine detection"

The detection of landmines is an important and challenging application for remote sensing technologies. The use of ground penetrating radar is an established technique but requires close coupling between the antennae and the ground and generally suffers from a poor area coverage rate. In order to clear mines rapidly along a route using a vehicle mounted system, a forward looking sensor is required that can operate effectively in a stand off configuration and detect surface laid, flush and buried mines. Reliable detection is required against a background of vegetation and other, surface and buried mines. Reliable detection is required against a background of vegetation and other, surface and buried, clutter. The Remote Minefield Detection System (REMIDS) is a technology demonstration programme funded by the UK Ministry of Defence designed to use an Ultra Wideband Synthetic Aperture Radar (UWBSAR) and a polarimetric infrared camera. The UWBSAR is a 3GHz bandwidth impulse radar with onboard data collection and offline image processing. The UWBSAR has been successfully trialled against landmines. Previous trials have mounted the radar on an airship and employed a conventional side-looking imaging geometry. In contrast, for the trials reported in this paper, the radar was amounted on a trolley to simulate a ground vehicle and operated in a forward-looking mode. The resulting use of an endfire synthetic aperture radar rather than the more conventional broadside aperture is the principal development reported in this paper. This coarsens the resolution and introduces a left-right ambiguity into the data. Previous trials have also highlighted the lack of a comprehensive data set containing controlled targets and a range of clutter conditions. The current trials were therefore conducted on a purpose built 80m test track which contained five different soil types, a range of surface conditions and over 200 targets of varying types and burial depth. The trials campaign collected over 500 data sets by varying the conditions of data collection in terms of polarisation, antenna height, antenna separation, incidence angle, power levels and pulse repetition frequency. The experimental configuration allowed the track of the platform to be repeated to sufficient accuracy to allo- w the synthesis of multiple baselines in the vertical and horizontal. The principal conclusions from the trials analysis are

1) that the data set collected is of good quality and comprehensive in terms of targets and background; 2) the endfire synthetic aperture configuration worked as anticipated; and 3) the left-right ambiguity can be resolved if a suitable antenna configuration is used. [C30]

"Prescreening algorithm assessment within the analysts' detection support system"

This analysts' detection support system (ADSS) contains a suite of target detection algorithms for wide area aerial surveillance using synthetic aperture radar (SAR) imagery. The ADSS provides a framework to combine the operation of these algorithms in user-specified configurations. This paper compares and contrasts the performance of the various prescreening algorithms singly and in combination within the ADSS framework on a broad range of SAR imagery. The algorithms include adaptive threshold, K-distributed CFAR, average grey absolute difference magnitude map, and segmenting K-distributed CFAR. The performance of these algorithms is compared on polarimetric imagery to assess the contribution of polarimetry to target detection. [C31]

"Target discrimination in the S.A.R. systems by using radar polarimetry"

For a SAR system that coherently transmits and receives both signals from an orthogonally polarized antenna pair, the elements of the resulting scattering [S] matrix can be measured. As a result, polarimetric processed imagery is visually much clearer than single-polarization channel imagery. In addition, fully polarimetric SAR imagery improves the performance of an ATR system, compared to the performance achieved by using single-polarization channel imagery. This paper gives a brief description of some polarimetric tools and techniques used to analyze and process polarimetric data. Several polarimetric discrimination results are displayed, demonstrating the potential capability of characteristic polarization imaging and the usefulness of polarimetric radar in the target discrimination process. [C32]

"Unsupervised learning rules for POLSAR images analysis"

It has been shown (see Chitroub, S. et al., Signal Processing, vol.82, no.1, p.69-92, 2002) that the model for POLSAR (polarimetric synthetic aperture radar) images is a mixture model that results from the product of two distributions, one characterizes the target response and the other characterizes the speckle phenomenon. For scene interpretation purpose, it is desirable to separate between the target response and the speckle information. We propose here to use some unsupervised learning rules for POLSAR images analysis via a PCA-ICA neural network model. Based on its rigorous statistical formulation (see Chitroub et al., Intelligent Data Analysis International Journal, vol.6, no.2, 2002), a neuronal PCA approach for the simultaneous diagonalization of the signal and noise covariance matrices is proposed. The goal is to provide PC images that are uncorrelated and have an improved SNR. Speckle is a non-Gaussian multiplicative noise, and the higher order statistics contain additional information about it. ICA is used to separate the speckle from the PC images and providing new IC images that have an improved contrast. The method has been applied on real POLSAR images. The extracted features are quite effective for scene interpretation. [C33]

"Comparison of forest parameter estimation techniques using SAR data"

It is important to monitor forests in order to understand the impacts of global climate changes on terrestrial ecosystems. To characterize forest changes, it is useful to parameterize a forest using several parameters, such as biomass, basal area, tree density, tree height, and trunk diameter. These parameters are not independent and some of them are related by allometric equations. Remote sensing data can be used for estimating some forest parameters and others may be retrieved using allometric equations. Many researchers reported algorithms to estimate forest parameters using polarimetric SAR data. However, these algorithms cannot be applied to all types of forests without additional information on the forest type and environmental conditions since radar measurements depend on the tree structure, incidence angle, and environmental conditions. The backscattering cross section also saturates as forest parameters, such as biomass and the tree height, increase. Forest parameters also have been estimated using SAR interferometry. Specifically, the interferometric correlation coefficient has been used to estimate the angular range of volume scattering. In this paper, we compare and contrast polarimetric and interferometric approaches to understand their advantages and limitations using NASA/JPL AIRSAR data [C34]

"The scattering polarimetric response contrast between two wind-generated rough sea surfaces"

Polarimetry for SAR applications is an excellent technological method to extract more information about wind-generated rough sea surface according to the scattering mechanisms. With the use of the scatter matrix, i.e. Mueller matrix, and Stokes vector operator, the paper describes a comparison between the polarimetric responses of two types of wind-generated sea surface offshore Baogang, Hainan Province. It gives representative results for the polarimetric response of backscattering electromagnetic field from the rough sea

surface and the characteristics of Mueller matrices' traces. The long wavelength sea surface and the short one can be determined by their polarimetric responses. The traces and determinant values of scattering matrices are related to the wind conditions. Some heuristic conclusions are given upon the results [C35]

"Ship-sea contrast optimization when using polarimetric SARs"

The polarization information was investigated in Touzi (2000) for ship detection using calibrated polarimetric Convair-580 SAR data that were collected within the incidence angle range of 45° to 70°. It was shown that at operational satellite SAR incidence angles (lower than 60°), there is a significant improvement of ship-sea contrast when the full polarimetric information is used instead of the information provided by the (scalar) one channel polarization (HH, VV, or HV). In this paper, the investigation is extended to lower incidence angles, and the robustness of the polarimetric discriminators used for ship enhancement, is assessed at various wind conditions (7, 14 and 20 knots). Polarization channel phase information is also investigated. It is shown that the information contained in the HH-VV channel phase difference, looks to be very promizing for ship enhancement, mainly when a dual-polarized SAR is used [C36]

"Target-to-clutter contrast enhancement using radar Doppler polarimetry"

The connection between Doppler and polarimetric characteristics of targets is studied. It is shown that the Doppler polarimetric formalism provides more complete radar object description. These conclusions are supported by the model of simple compound object as well as by the radar observations of ground clutter. It is also shown that the clutter suppression which is based on Doppler polarimetric object description gives better contrast enhancement than the polarimetric optimization techniques [C37]

"Electro-optical systems for image recognition"

Detection and classification of targets by means of electro-optical sensors has been of interest for both defense and civilian applications for a number of years. In this presentation we emphasize two areas: extraction of more information from the sensors by polarimetric and frequency diversity, and reducing the processing and storage requirements by exploiting invariant attributes for detection and classification [C38]

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с использованием специализированного программного модуля (ПИО ТУСУР)