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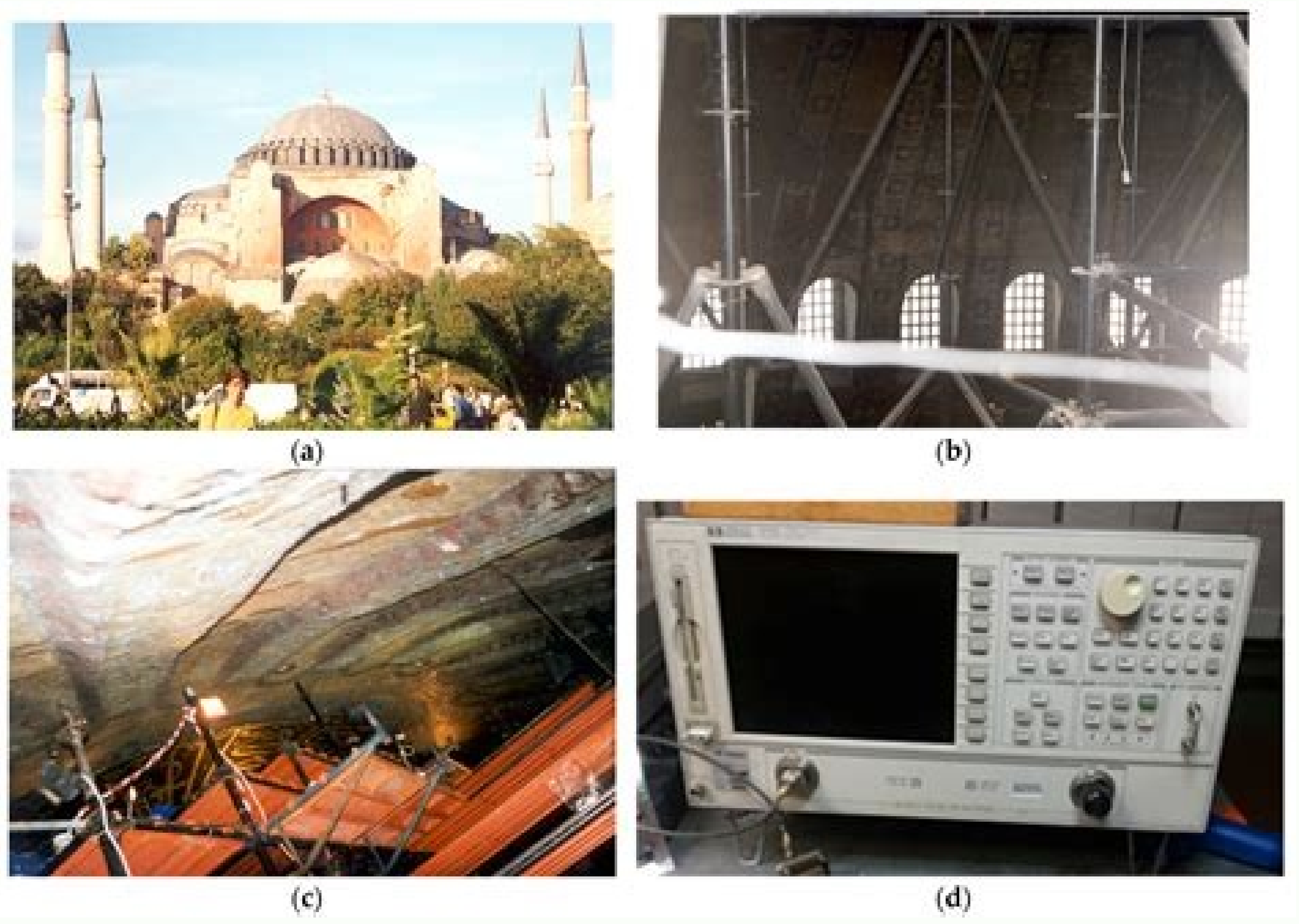

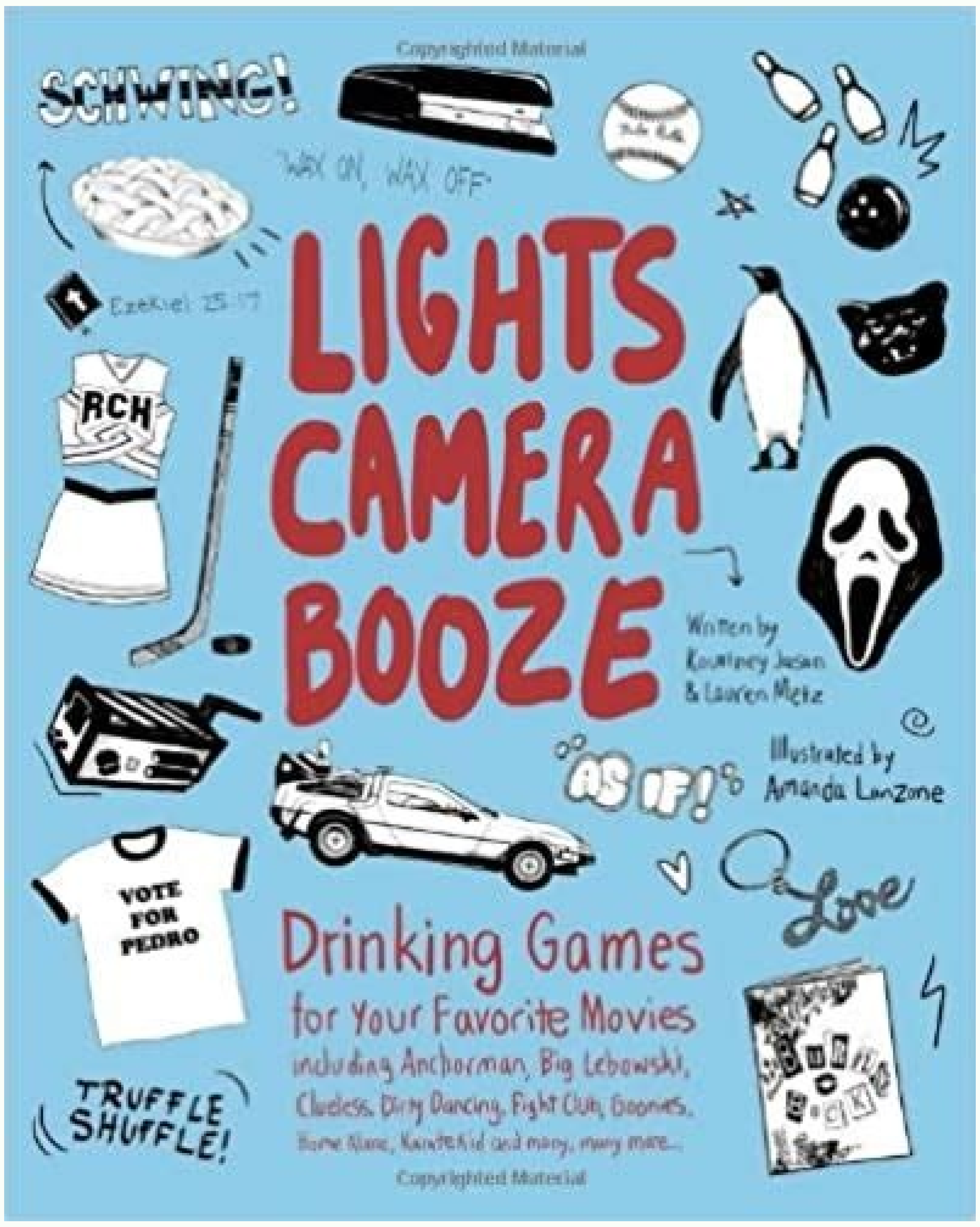

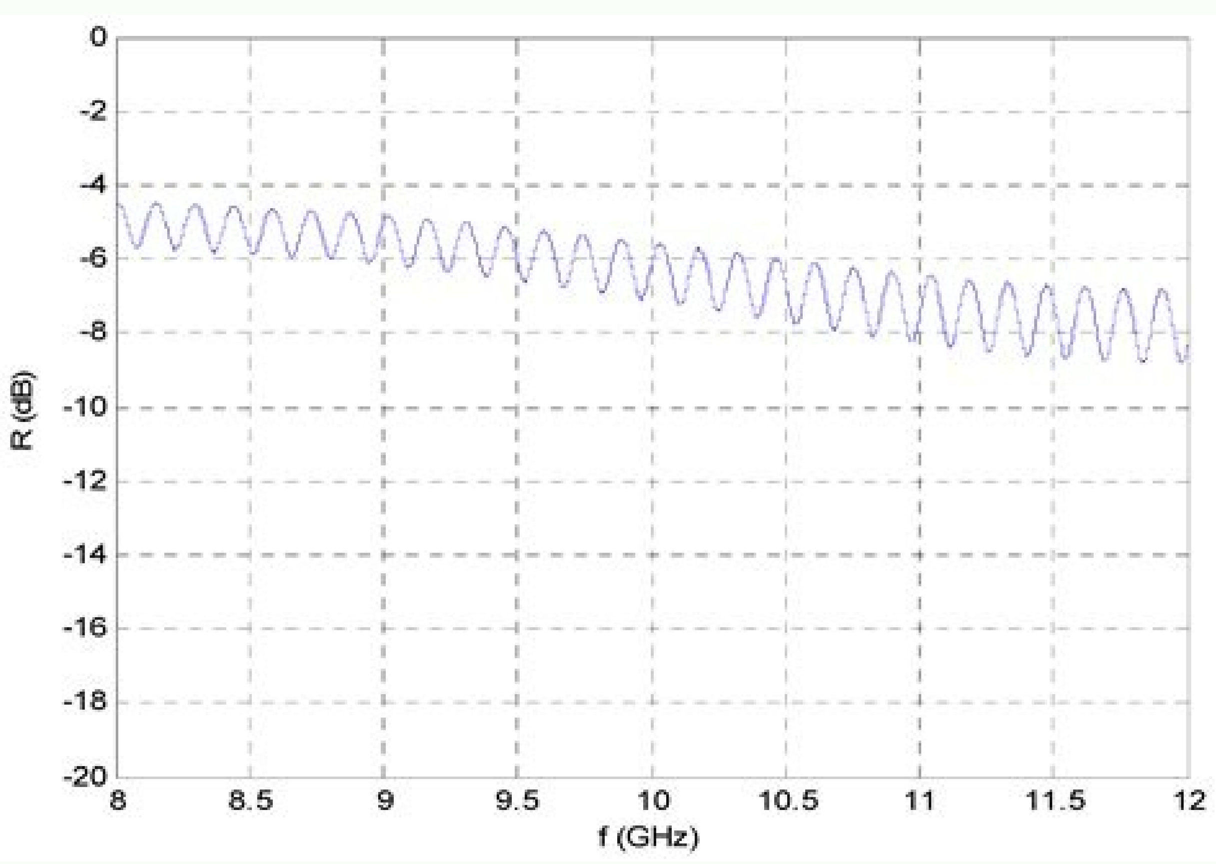

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Preprocess the Photospheric Vector Magnetograms for NLFFF Extrapolation using a Potential Field Model and an Optimization Method

Chaowei Jiang[1], **Xueshang Feng**[1]

Abstract Numerical reconstruction/extrapolation of coronal nonlinear force-free magnetic field (NLFFF) usually takes the photospheric vector magnetogram as input at the bottom boundary. Magnetic field observed at the photosphere, however, contains force which is in conflict with the fundamental assumption of the force-free model and measurement noise which is unfavorable for practical computation. Preprocessing of the raw magnetogram has been proposed by Wiegelmann, Inhester, and Sakurai (2006) to remove the force and noise for providing better input for NLFFF modeling. In this paper we develop a new code of magnetogram preprocessing which is consistent with our extrapolation method CESE–MHD–NLFFF (Jiang, Feng, and Xiang, 2012; Jiang and Feng, 2012a). Basing on a magnetic-splitting rule that a magnetic field can be split into a potential field part and a non-potential part, we split the magnetogram and deal with the two parts separately. Preprocessing of the magnetogram's potential part is based on a numerical potential field model, and the non-potential part is preprocessed using the similar optimization method of Wiegelmann, Inhester, and Sakurai (2006). The code is applied to the SDO/HMI data and results show that the method can remove efficiently the force and noise and improve the quality of extrapolation.

Keywords: Magnetic fields, corona; Magnetic fields, photosphere; Nonlinear force-free field (NLFFF); Preprocessing

1. Introduction

Magnetic field extrapolation is an important tool to study the three-dimensional (3D) solar coronal magnetic field, which is difficult to measure directly (Sakurai, 1989; Aly, 1989; Amari *et al.*, 1997; McClymont, Jiao, and Mikic, 1997; Wiegelmann, 2008; DeRosa *et al.*, 2009). The models being used most popularly for field extrapolation are the potential field model, the linear force-free field model, and the nonlinear force-free field (NLFFF) model. These models are all based on the same assumption that the Lorentz force is self-balancing in the corona, but adopt different simplifications of the

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On the theoretical research of radar signal classification, Gini et al. The design surface can be well restored to the ideal surface in orbit. A hysteretic quantizer is employed for data quantization in the controller-actuator channel to decrease the communication rate and prevent the chattering phenomenon caused by the logarithmic quantizer. Future Research Trends and Challenges Based on the MultidisciplinaryThe progress and development of radar technology cannot be separated from the promotion of multidisciplinary basic research, such as optics [128, 129], measuring means [130–132], imaging [133], experimental observation [134], algorithm improvement [135], and model optimization [136]. The construction and formation of this value system is based on information recognition. Grima et al. [76] classify the received pulse train with the use of sliding windows to clearly detect submodes. Finally, an example is shown to validate the effectiveness of the proposed finite-time tracking controller.Research Article09 May 2022Xiaowei Fu | Jindong Zhu | ... | Sili LiThe UAV pursuit-evasion strategy based on Deep Deterministic Policy Gradient (DDPG) algorithm is a current research hotspot. Radar signal processing for vehicle speed measurements promotes the development of driverless and intelligent transportation [94], and the RS performance improvement aspect through processing is listed in Table 3.Processing methodsPerformance improvement aspectDetailsModel-based frequency algorithms [166]Resolution enhancementFourier transformationCoherent processing [167]Integrate target energyLinear transformationsCoprime sampling [168]Power spectrum densityAmbiguity function of matched filterCoherent fusion scheme [169]Range resolution with low sidelobesEstimate the phase differenceThe allocation requirement radar resources must be executed efficiently by a process method to optimize the performance of the overall radar system [95], which forced the research methods of signal processing to develop toward multidisciplinary and multiplan.4.1. Adaptive Radar Signal ProcessAdaptive radar signal process is a self-adaptation method which can adjust the sequence, parameters, boundary conditions, or constraints according to the characteristics of the processing RS data [96], which can make the signal adapt to the statistical distribution and structural characteristics of the processed data to achieve the best processing effect [97]. Other functions are constantly strengthened and developed to form a more complete database and analytical response methods.3.2. Radar Signal TypeIn the process of signal application, an effective method is to set up new radar classes. The received signal consists of a number of identical target signatures where each provides information about target shape, size, and orientation. These classification methods synthesize the research methods of many disciplines, such as system control [67, 73], heat transfer [69], and mathematics [68, 77]. The extended target is illuminated by a sequence of short rectangular pulses. The design method of radar signal and the corresponding signal characteristics are compared in terms of performance improvement. [114] to solve the pulse compression problem by Hamming scan optimization. The (the first criterion is the percentage measurement of the clutter power) comparisons of the adapted filter and the filter coefficients depend the filter order , 10, and 15 are listed in Figure 14 which illustrated that decreases with the increase of filter order. The conclusion was obtained that a coherent pulse train can provide an alternative to single-frequency signals with good immunity against mutual interference or jamming. Setting up new radar types requires comprehensive consideration of various problems, especially the technical means and application methods of competitors. In the face of increasingly complex information resources, single signal recognition has become very simple and the actual use effect is not very good [59, 60]. Frequency subband processing and feature analysis of forward-looking ground-penetrating can remarkably enhance the diagnostic judgment rate of the landmine detection [93]. Real-time parallel implementation of pulse Doppler radar signal processing chain was designed by Klilou et al. Using Doppler beam sharpening technology to obtain high resolution, high-resolution map mapping and high-resolution local magnification mapping can be provided in air-to-ground applications [124, 125] and dense formation targets can be distinguished by judging the state of air-to-air enemy. [75] completed the derivation of the joint maximum likelihood estimator of complex amplitude and Doppler frequency, which used the method of a radar target signal embedding in correlated non-Gaussian clutter modelled as a compound-Gaussian process. It can be concluded that radar signals will become more common and stable in future applications. The recognition rate comparisons of frequency under different linear discriminant analysis (LDA) and support vector machine (SVM) are listed in Figure 9 which suggested support vector machine approach is an effective radar signal classification method with high recognition and correct rate. The corresponding objectives are different, and different design methods can be adopted with their respective design focus and highlights.RS should be based on high range and speed of the resolution and then be designed with multidisciplinary algorithms [49, 51]. ConclusionWith the increasing energy shortage [154–158], pollutant generation [159–163], and the rapid development of large-scale integrated circuits, the application of radar has gradually changed from military to civilian [164, 165]. [55] focused on the cognitive waveform optimization design for radar imaging and designed a waveform optimization method maximum the receiving signal-to-clutter ratio under dual constraints including transmitting energy constraint and range profile constraint. The experimental results show that when predicting 1 hour SCB based on a 12 hours SCB data, the prediction accuracy of the BSO-BP model is the best, with an average accuracy of 0.064 ns. Direct or indirect acquisition of high-quality and stable radar signals is the main research focus of researchers [171–173]. Effects of nonuniform beam filling on the propagation of RS at X-band frequencies were conducted to verify signal attenuation in vertical and horizontal directions. Especially in complex combat environment, once the problem of nonstandardized signal recognition is encountered, it will directly restrict radar synthesis ability. The single and two aspects of library correlations for wheeled and tracked vehicles radar signals are displayed in Figure 10 under the angle of 0°, 30°, 60°, 90°, 120°,150°, and 180°. Pulse compression signals include linear frequency modulation signal, nonlinear frequency modulation signal and phase-coded signal, and so on. They proposed a systematic approach with the central moments of a range profile and a Bayes classifier to yielding very small dimensional feature vectors, which is an available technique skill to diversity in radar signal processing [66].3.3. Classification of SignalPotential applications requiring classification of unknown radar signals include maritime barrier operations aimed at preventing illegal immigration [3, 10], arms and drug smuggling [11, 18], illegal fishing, and piracy [6, 14]. The work done in this paper can effectively help promote the stability of radar signal which is essential to image resolution of coherent imaging, data transmission, and radar receive. Based on uniform filter banks, the spectrum and variance estimation of atmospheric radar signal were studied by Reddy and Reddy [120] to find wind speed at an altitude of 18 kilometers which made the SNR improvement of about 6 dB at low SNR regions. Normalized signal application will exert tremendous influence in practice. Overall, high-performance radar signals processed by multidisciplinary hybrid algorithm are available.RS design modeCharacteristicPerformanceOrthogonal frequency multiplexing [51](1) Optimised ambiguity function(2) Low peak-to-average power ratio(1) ACF SLL↓ from -15 to -20 dB(2) Nonsinusoidal RS design [52](1) Stealth targets(2) Pulse compression with Barker codes(1) Sidelobe free interval↑ (2) with time Heisenberg nilpotent Lie group [53](1) Phase discontinuity of Fourier(2) Chirp waveforms of microoptics(1) FEB recaptured(2) Transmitted at the rate of 2 W/sAmbiguity function design [50](1) Discrete frequency-coded(2) Synthesised polyphase(1) increases from 3 to 6(2) Transmitted at the rate of 2 W/sMultidisciplinary algorithms [51, 52] have been innovatively applied to radar signal design, such as thumbtack range-velocity resolution functions and Hamming scan algorithm [53] which have been achieved significant results. The quality of radar signal depends on the signal transmission loss, the interference degree of other signals, and the influence of transmission mode [41, 42].2.2. Information ScreeningInformation screening is important function of RS recognition. Based on the desideratum of the merit factor, bialphabetic pulse compression radar signal algorithm was designed by the research team of Pasha et al. Reconfigurable computing application can significantly improve the working efficiency of high-performance front-end radar signal processor [92]. Proposed adaptive algorithm method needs more computing time (

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