Low RCS Target Detection: A Review

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Abstract—*Detection of low observable targets is one of the interesting research areas in radar signal processing. In this paper, various target detection techniques are reviewed for the detection of targets with high and low range resolution. Radar detects not only static but also moving targets, which can be accomplished by different techniques. The object to be detected gets measurements from clutter and unwanted echoes that interfere with the detection process of targets. The detection algorithms are meant to classify the target originated and clutter measurements. Some of the efficient methods of target detection are reviewed and analysedhere.*

Keywords —Clutter, RCS, Multistatic Radar, MIMO Radar, SAR

I. INTRODUCTION

The target detection is used to detect all objects of interest within the area of observation. Radar is an object-detection system that uses electromagnetic waves to determine the range, angle, or velocity of objects. A radar system consists of a transmitter that generates electromagnetic waves in the radio or microwaves domain, an emitting antenna, a receiving antenna to capture any reflection from the objects in the path of the emitted signal, a receiver, and processor to determine various properties of the object(s). Radar cross-section (RCS) or radar signature is a measure of how detectable an object is with radar. It is a function of various parameters such as frequency, directions of incidence, target shapes & polarization. A larger RCS indicates that an object is more easily detected and low RCS is the case when the target return is very small. In the case of low RCS targets, the detection is extremely difficult as the probability of detection is very less. In presence of clutter, the detection performance degrades rapidly.

In this paper various detection algorithms like Hidden Markov Model (HMM) based on target detection, CFAR techniques, probability hypothesis density function (PHDF), Particle Swarm Optimization algorithm, Direction Based Data Association (DBDA) algorithm, generalized Radon-Fourier transform (GRFT), expectation-maximization (EM) algorithm are analysed. Section II describes the problem formulation and in section III various detection methods are described. Section IV gives the limitations and scope and conclusion is specified in section V.

II. PROBLEM FORMULATION

Target detection will be easy when a single target is placed in the line of sight of radar with no clutter. But practically targets appear in clutter with multiple reflected echoes from multiple sources. In this situation the detection of targets is complicated. Some of the researchers developed numerous target detection techniques as a solution to the said problem. In the case when the target signature is very less or a target (stealth target) is invisible from the radar range, detection of these targets is a difficult task.

III. TARGET DETECTION METHODS

In this section, several target detection method proposed by various authors for different models are explained. Detection models include multi-static systems, MIMO systems, moving target detection, detection in clutter, detection using SAR images, detection based on the pulse parameters.

A. Target Detection in Multi-static Radar

S. Tugac et al presented the HMM based on target detection method that avoids any thresholding at any stage of the detection process. The detection was done from the unprocessed radar data available at the output of the sensor underlying assumption of the HMM is that the data samples can be well characterized as a parametric random process and the parameters of the stochastic process can be estimated in a well-defined framework [1]. Bosse et al proposed a centralized single step approach that allows the simultaneous estimation of the target position and velocity using an active radar network by searching the maxima. Since this maxima search is directly performed in the position-velocity space, the data association step does not exist. But, in general, there is no guarantee that the maxima will always correspond to true targets [2]. Feng et al analysed the two non-increasing properties of Cramer–Rao low bound (CRLB) for target location with the help of distributed multiple radar systems and then also proved two theorems with respect to it. They proposed a fast efficient power allocation algorithm applied to cognitive distributed multiple radar systems, which depends greatly on an alternating global search algorithm (AGSA) [3]. Amanipour et al introduced a family of homogeneous CFAR detection algorithms for multistatic radar. It was observed that it is economical to replace an expensive high power transmitter by several lower power transmitters without losing on the performance of radar system [4].A detection method based on a probability hypothesis density function (PHDF) was developed by Bezousek et al where the paper deals with a multi-static radar system consisting of one receiver and several non-cooperative transmitters that process signals scattered of surrounding areas [5]. The receiver receives a direct signal from the transmitter and signals scattered from the surrounding objects. Combining the data of individual sensors, the position, and velocity of each particular target could be estimated. El-Kamchouchy et al proposed system geometry for S-band Multistatic radar for detecting and tracking the small cross-section area and stealthy aircraft. The proposed geometrical structures were studied with different radars spacing to extend the detection coverage over the Monostatic radar used for air surveillance. The radar detection coverage was also studied with all possible stealthy aircraft paths to find the improvement achieved by using this type of radar. The authors proposed two Multistatic radar system geometries for S-band radar to improve the detection coverage of the small and stealthy aircraft [6].The optimum receiver with Gaussian noise and Rayleigh fluctuations of the target echoes are synthesized for a multi-static radar system. Baumgartenanalysed the performance of such a receiver, showing that in certain respects the target-detection characteristics of the multi-static system are comparatively better than those of the monostatic system. The inherent complexity of the multi-static structure may be alleviated by resorting to a simplified scheme i.e. to create a number of peripheral decisions in as many conventional receivers and then make a central decision based on an OR-criterion [7]. D'Addio et al work determined optimum receiving structures for target detection by means of centralized processing of distinct radar observations coming from local sensors. A systematic analysis of the model leads to a unified optimum receiver for signals fluctuating according to Swerling I, II, III & IV models [8]. Chaitanya et al proposed an adaptive method that can be combined with the basic DPCA cancellation to minimize the clutter residue at the processor output and therefore maximize the improvement factor. Displaced phase centered antenna (DPCA) improves the probability of detection for slow-moving targets by minimizing the clutter spectral width [9].Counts et al developed a model where measured data are calibrated so that the direct coupling in the system and the cable effects are removed. Images formed using the beam forming algorithm provide some insight into the quality of the data acquisition [10].

B. Target Detection Using Multistatic Radar

Reddy et al presented a new numerically optimized method of a polyphase coded waveform for orthogonal MIMO radar and the development of radar detection problem to a compound-Gaussian case with the GLRT detection. The transmitted orthogonal waveforms are optimized by Particle Swarm Optimization Algorithm (PSO) [11]. Polarimetric radar systems allow the use of polarized waveforms for transmission that can match the scattering profiles of the target. The advantages of this system can fully be exploited only when the type of target is accurately estimated, which can be expensive. Gogineni et al proposed a polarimetric design scheme for target detection by distributed multiple input multiple output (MIMO) radar. Using a game theoretic framework, they formulated the selection of transmitting polarizations by examining the impact of all possible transmit schemes on the different available target profiles. In this approach, there is no need to extract the exact target properties from the measured data and hence it can be implemented in practice without much cost unlike conventional approaches [12]. Haungetal solved the problem of target estimation in bistatic multiple-input-multiple-output (MIMO) radar via low-rank tensor completion. In this solution, the parameters of a sparse target scene i.e. direction-of-departure and direction-of-arrival were computed jointly, where only partial data are collected at the front-end during multiple pulse periods. A tensor rank minimization algorithm based on the accelerated proximal gradient line-search (APGL) was devised to recover the missing 3-D data at the receiver [13].Baykal proposed new data association methods which are proposed for the frequency-only MIMO radars. The proposed methods use the target position, velocity and direction estimations separately or together to associate the Doppler frequencies with the targets. In the first stage, the number of targets is determined by using the number of estimated Doppler frequencies at each receiver. Because of the frequency-based nature and the MIMO configuration, each target produces different Doppler frequencies at each receiver. Hence, the system can find the number of the targets in a few iterations [14]. The proposed data association methods can accurately associate the Doppler frequencies with true targets, especially for high Pd values. Direction Based Data Association (DBDA) method which uses the target direction estimations with a dynamic threshold (DBDA-DT) that gives better results. It is important that these methods are independent of the target motion parameters and use only twoconsecutive scans at each time instead of all previously stored data.

Gassier et al researched and provided the problem of mobile target detection in multipath scenarios with passive radar using DVB-T transmitters of opportunity. For such emissions, mismatched correlators can be implemented by reducing both the zero Doppler contribution (ZDC) masking effects and the false alarm rate. The reciprocal filter is used to generate a mismatched reference signal. The authors have reinterpreted the reciprocal filter-based correlator as a so-called Doppler channel detector (CHAD). It allows a direct rejection of the ZDC, unifying the main disturbance mitigation and the detector construction. [15].

C. Moving Target Detection Methods

At high SNR, discrete polynomial-phase transform (DPT) algorithm can be used to detect the echo signal caused by an accelerated target, as it haslow computation complexity and high real-time performance. The disadvantage of DPT algorithm is that it has a large mean square error of the rate of frequency modulation and a low detection probability in case of low SNR. Pang etal analysed the reasons of degradation of the performance detection of the DPT method and proposed a SDPT method, which can improve the detection performance of DPT in low SNR. In this method, the input SNR is improved by a coherent accumulation of the segmented signal then using DPT method to estimate frequency modulation rate parameter [16].Li etaldeveloped two new detectors based on Rao and Wald criteria using an ad hoc design procedure for adaptive detection of moving target with MIMO radar in heterogeneous environments. Firstly, the Rao and Wald tests were obtained by assuming the known target velocity and the known structure of the clutter. Then, the resulting test variables are modified by performing a numerical optimization with respect to the target velocity. At last, by replacing the clutter structure with its estimate from secondary data the adaptive versions are obtained. Finally, the performances of proposed detectors are evaluated through Monte Carlo simulations [17].

Gennarellietal proposed an approach for the localization of moving targets in a three-dimensional (3-D) space by a passive multistatic through-wall radar system. The localization task is undertaken by using an inverse source-based approach, where the unknown targets are estimated as the supports of current distributions induced over their volume/surface. A multi array image fusion strategy is applied to mitigate the lack of resolution associated with the single frequency receiver operation. The change detection is used to detect and localize animate targets in the scene [18]. Huang et al proposed that in the airborne or spaceborne radar applications, by increasing the coherent integration time, the ability of the radar to detect a weak maneuvering target can be improved, whereas the coherent integration performance may degrade due to the complex range migration (RM) and Doppler frequency migration (DFM) effects. The authors have considered the third-order RM and DFM for the detection and motion parameter estimation of a weak maneuvering target. A Keystone transform is applied and the matched filtering processing is performed in the range-frequency and azimuth-time domain to eliminate the residual coupling effects between range and azimuth. At the end, a well-focused image of a moving target is achieved and three motion parameters i.e., velocity, acceleration, and acceleration rate are effectively estimated. As the parameter searching dimension is reduced, there is a decrease in computational complexity which is helpful to acquire a close integration performance. Simulated processing results are provided to validate the effectiveness of the proposed method [19].

D. Ground Moving Target Detection

Yang et al worked for multi-satellite radar systems and proposed a new reduced-dimensional method based on joint pixels sum–difference (Σ−Δ) data for clutter rejection and GMTI. The reduced-dimensional joint pixels Σ−Δ data are obtained by the orthogonal projection of the joint pixels data of different synthetic aperture radar (SAR) images generated by a multi-satellite radar system. In the sense of statistic expectation, the joint pixels Σ−Δ data contain the common and different information among SAR images. Then, the objective of clutter cancellation and GMTI can be achieved by adaptive processing [20]. The discrimination of closely spaced targets is a major challenge in the ground target-tracking domain based on measurements of airborne ground moving target indication radar. Mertens et al implemented into the Gaussian mixture carbonized probability hypothesis density filter based on single and multiple target simulation scenarios [21]. Xu et al worked and described that an efficient shadow detection method based on multi-feature fusion, which improves the shadow detection performance and developed a modified matching strategy to further improve the detection performance of the shadow-aided method. Furthermore, the simulated experiments have been presented to validate the effectiveness of the proposed method for the extended moving target detection. The results demonstrate that the shadow aided method has a better detection performance than the traditional GLRT detector. However, it is also shown that the proposed shadow-aided method suffers from detection performance degradation in the high-SNR region [22]. Giannakis et al propose a regression model which is used to find a real time estimation of the signal-to-clutter ratio (SCR) for landmine detection using ground-penetrating radar. Artificial neural networks are employed in order to express SCR with respect to the soil's properties, the depth of the target, and the central frequency of the pulse [23].

E. Detection of Multiple Targets

Sobhani et al proposed a new pixel-based localization technique using constant false alarm rate

(CFAR) detector for multiple target cases. In this approach, the surveillance area is divided into pixels, and then the energy of the received sample at each receiver corresponding to that pixel is calculated and then CFAR thresholding is performed. The final estimated position will be the pixel for which most of the receivers have experienced a threshold exceeding. The paper also compared the proposed technique with the conventional direct method of localization using CFAR detector [24]. Bethel et al presented a new approach to the real-time single and multiple target detection and tracking problems with measurement input data. The new approach marks the measurement uncertainty-of-origin issue by recording all measurement input data information in the Bayesian conditional probability density function (PDF), used in the recursive propagation of the rear target detection and tracking information from PDF over time via Bayesian and Markov PDF updates [25].

F. Target Detection in Clutter

Most of the existing radar algorithms are developed under the assumption that the environment (clutter) is stationary. However, in practice, the characteristics of the clutter can vary enormously depending on the radar operational scenarios. As a solution to this problem, Akcakaya et al developed a data-driven method for target detection in non-stationary environments. In this method, the radar capture the changes in the environment and accordingly adapts to these changes by learning the new statistical characteristics of the environment and by intelligibly updating its statistical detection algorithm [26]. Shtarkalev presented two single data set (SDS) MIMO algorithms for target detection in coloured Gaussian clutter. The strength of the algorithm is that they do not require prior knowledge of the spectral support or power of the background interference as inner access to secondary data as in and thus can operate blindly in any environment. Each receiver platform in the modified algorithms operates simultaneously using the space– time adaptive processing (STAP) technique which boosts radar performance when dealing with ground clutter returns. The main focus of this work is the cooperation between widely spaced transmitters and STAP receivers. Thus the maximum likelihood (ML) estimation and detection of a single target in such a multi-static surroundings are derived where the whole radar network works on the joint detection decision [27].In the state space at each scan is divided into a number of grids (possible values). An auxiliary parameter contains the true reflectivity of targets at each grid location. In general, the grid reflection vector is sparse in nature since most of the grids contain no target. The proposed DGSSMP algorithm together with TBD scheme can effectively distinguish true targets from clutter using data from multiple scans. Namely grid reflection is attached to each grid. When a grid is set by a target, its grid reflection parameter is set as the reflection coefficient of the target; otherwise, it is set as zero. All the grid reflection parameters are mapped into a vector, namely grid reflection vector [28]. Cui et al analysed distributed targets detection with a Polarimetric MIMO radar against compound-Gaussian clutter dominated scenario with the unknown covariance matrix. Initially, the general Polarimetric detecting problem of the distributed targets is developed to the MIMO radar, and then the fully adaptive Generalized Likelihood Ratio Test (GLRT) is well-devised according to the two-step design procedure. Space–time coding MIMO model was focused and developed it to the cases of two different Polarimetric channels, MDS target model, and compound-Gaussian scenario. It was assumed that the clutter of every Polarimetric channel was modelled as the Gaussian random vector with unknown power level and they were independent of each other [29].

G. Target Detection in Sea Clutter

It is difficult to detect small targets (like small icebergs) for a marine radar system since they protrude only about a meter or so above the sea surface level. Islam et al proposed a detection method for small targets using cross-correlation instead of statistical decision theory. In this method, the radar signal is transmitted and noise is added. Then the received signal is correlated to take the detection decision. Using the result of cross-correlation, the transmitted signal is recovered by the matched filter. In this method, detection of small marine targets and receiving of transmitted signal in addition white Gaussian noise is dealt and algorithms were proposed based on cross-correlation and matched filter respectively [30]. Chungang et al used the radar echo model of the LFM radar to extract the weak target from the complicated background of the sea clutter. A target detection model was used to calculate the prediction error of radar echoes. In this model, firstly the pure sea clutter data is taken as input and then the 3D-IFS algorithm is used to calculate the prediction sequence of the discrete echoes sequence. If the prediction satisfied the effective prediction, then the sea clutter with the target was taken as input. The prediction error was computed by the trained scale parameters. At last, the error is processed and judgment is taken. A comparison is done between 3D-IFS and the adaptive 3D-IFS algorithm in the condition of different polarization models [31]. The transmission of dynamic adaptation of waveforms by active radar has been synchronized by the availability of waveform-agile sensors. In a study, Sira et al proposed a method to employ waveform agility to improve the detection of targets on the ocean surface having a low radar cross section (RCS) where the signal-to-clutter ratios are low due to high sea states and low grazing angles. Expectation-maximization (EM) algorithm is a methodology to adapt the transmitted waveform on-the-fly, based on an online estimation of sea clutter statistics for improved target detection. Here, the statistics of the clutter at different ranges are calculated using the expectation-maximization (EM) algorithm and after that, it is used to design a phase modulated (PM) waveform for the next transmission that improves the SCR [32]. Chen et al worked on paper which mainly deals with the detection problem of the target with low Radar Signature in heavy sea clutter with unknown Power Spectral Density (PSD). Since the traditional single-scan detectors degrade in detections as the target of interest is smaller and weaker, three adaptive detectors, based upon a two-step design procedure, are proposed within the structure of the multiple-scan signal model. Firstly, the Multiple-Scan Detectors (MSDs) are derived according to the Generalized Likelihood Ratio Test (GLRT). Secondly, three strategies are resorted to calculating the unknown PSD, and their Constant False Alarm Rate (CFAR) properties are assessed. Finally, numerical simulation results show that the adaptive MSDs perform better than the traditional single-scan detector using Monte Carlo method. In HR radar scenario, the sea clutter is generally modelled as the compound-Gaussian distribution described as SIRP. In the heavy clutter, the performance of single-scan detectors degrades, and hence the optimum MSD based on NP criterion is presented. Obviously, the MSDs can availably reduce the effect of clutter outlier in a single scan, and also allow the target to be detectable with the smaller values of SCR across multiple scans [33]. The detection of ship wakes on SAR (Synthetic Aperture Radar) images or in track-before-detect scan-to-scan algorithms are examples of its successful application in different scenarios Heuristic processing scheme has been introduced that performs the detection step on the Radon domain. Based on observations from real data measurements, it exploits certain properties of high-resolution sea clutter. CWLFM radar was used to record low grazing angle sea clutter data at the south coast of Spain. The radar’s transmitted bandwidth was 1 GHz between 28 and 29 GHz and thus a range resolution of around 15 cm was achieved. Statistical analysis of the experimental sea clutter data (to be published) shows a very good agreement with the compound-Gaussian model. Specifically, a good fit has been obtained by matching the empirical PDF to the K-distribution [34]. When a ship is surrounded by sea clutter, the detection/tracking function of its navigation radar will have difficulty in detecting small boats. There are two ways to improve the detection process i.e. pulse to pulse integration and scan to scan integration. The number of pulses that can be integrated with one scan depends on the antenna beamwidth and the scanner rotation rate. In the whole integration process, the sea clutter will also be integrated, so this becomes useful when targets are at ranges where the sea clutter is lower. When the rotation rate of the radar is increased, this will increase the numbers of scans that can be integrated. A standard navigation radar will rotate from 24 to 30 rpm. The scanner motor of the navigation radar can be modified, so that one can test what combination of rotation rate, the number of scans and the number of pulses to integrate that will be needed for the different scenario. In fact, Rutter Technologies now combined the radar systems with the Sigma interface as the control system and the CPF navigation radars could easily be integrated into the card and it gets benefitted from the built-in display and tracking features it deals [35]. The exact position of the source ship is difficult to detect for the radar system when the bistatic platform is a submarine. In that case, the position of the source ship can be obtained acoustically from the direct blast. The overt nature of low-frequency active sonar (LFAS) operations could give the potential initiative to an opposing submarine. This potential risk can be significantly reduced with the use of multi-static sonar techniques. Tactically, multi-static radar systems can lead to larger the detection area. Secondly, combining the results of more receivers, the target detection and classification may improve and provide useful information [36].

H. Stealth Target Detection

The characteristic of RCS (Radar Cross Section) amplitude, target and phase modulation are made to acquire the signal having the same frequency as the echo pulse with the opposite phase. This signal nullified the radar echo signal. The radar detection probability is effectively and efficiently controlled through the interaction between the cancellation of signal and echo signal. The echo gain can be reduced by using the cancellation system. The high-speed microelectronic devices, computer processing, and phased-array antenna techniques have made active cancellation stealth techniques more effective and practical [37]. Barbary and Zong introduced a novel detection technique for stealthy target model F-117A with a higher aspect vision by using the stratospheric balloon-borne bistatic system. The stations were set up in the stratosphere about 21 km above the Earth atmosphere and kept stable in a range of radius of 0.5 km. To achieve high location accuracy for a stealthy target, the process involved physical optics method (PO) to predict the real RCS of a stealthy target which represented the actual situation of the stealthy target detection better. In the paper, the stratospheric balloon positional instability due to random wind was considered and finally, it was found that the proposed system has better performance at almost all time intervals [38]. The authors also proposed a non-parametric detection technique for stealth target model F-117A based on time difference of arrival (TDOA) and Legendre orthogonal polynomials methods is proposed. The main advantage of TDOA is the localization of stealth target accurately that is based on the real stealth RCS data which predicted by Physical Optics (PO) approximation method to improve the performance of netted radar, while to reconstruct the pdf of stealth target RCS data the Legendre orthogonal polynomials are used. The proposed method improves RCS measurement accuracy and follows the stealth target position based on maximum likelihood (ML) estimation. Simulations demonstrate that the new detection method gives much higher estimation accuracy of stealth target model and reduces detection errors comparing to the traditional TDOA that using a theoretical model which have analytical expressions. A scheme has been proposed for stealth target detection where a nonparametric method for statistical model based on a real RCS data which predicted by PO method. It improves the performance of netted radar system against stealth technology [39]. Zikidis et al showed a brief history of the development of stealth aircraft and a short presentation of the most important stealth fighters of today. It will continue to explore and enhance the basic concepts of low observable principles, mainly reduction of RCS – Radar Cross Section. Focusing on the F-35 stealth aircraft, there will be an attempt to calculate the expected detection ranges for multiple numbers of radar systems, taking into account an open-source estimation of the F35 fuselage RCS. Considering all such anti-stealth proposals, it is nearly clear cut that no systems alone can deal with the providing protection: a suitable combination of radar, sensors, weapon systems, tactical data links, as well as tactics, should be employed to effectively counter stealth threats [40].

I. Image Processing Techniques based Target Detection

Hartmann et al described the Target Detection techniques used for building an Autonomous UAV. In this technique the target is detected using image processing algorithms written in Python. The algorithm uses the blob and shape detection on Hue, Saturation, and Value (HSV) colour space to ensure detection under various conditions of lighting, shadows, and distance. The algorithm then tested in multiple situations that account for variance in shape detection and lighting. To increase the robustness of this method it was assumed that there may be multiple targets of the same colour; however, these objects will be of somewhat different shapes. It was also assumed that no object will be blocking the onboard cameras field of view of the target at the entrance of the target area. The algorithm sometimes fails to distinguish the shape of the target when the target is so far away [41]. Liu etal proposed that the target detection by using the information measurement of super pixels in high-resolution synthetic aperture radar (SAR) images. This study aims to transform the basic cell of SAR images from pixel to patch through the superpixel algorithm. Moreover, by taking advantage of the rich statistical character of the patch, an information measurement, including self-information and entropy, which is utilized to measure the statistical difference between patches for gathering more information. Self-information is utilized to measure the relative information value of patches, while entropy is used to describe the change in degrees of statistical characteristics between the surroundings and its patch. In this way, the proposed approach is more stable for SAR images with different intensities of speckle noise because it is more difficult to measure speckle noise with damaging information. Information on distributed targets in high-resolution SAR images can be measured via super pixel-based pixel clustering instead of by single pixels. Therefore, the proposed method can utilize more information to achieve target detection [42]. Tu et al proposes a novel target retrieval theory based on deep learning and multi-scale particularly important for large-scale and high-resolution SAR imagery. Initially, the multi-scale saliency approach is introduced into the target detection stage for salient regions pre-selection, which makes our scheme more efficient. Then, a deep network as the feature mapping function is able to effectively facilitate the learning of our scheme in a lot of training samples of SAR imagery. Thus, the preselected salient chips can be classified accurately and efficiently with the well-trained deep network at last. Most importantly, the whole target theory can work automatically itself and because of its good performance in the experiments, it demonstrates that it is feasible and efficient in target retrieval for large-scale SAR imagery [43]. Suwaetal addressed Inverse synthetic aperture radar (ISAR) which is one of the radar techniques used to observe 2-D images of a remotely based target using radio waves. If we keep surveillance on the target and consecutively collect multiple ISAR images, which we call an ISAR movie, the target image varies proportionally due to the motion of the target. The authors have proposed an algorithm for the make over a 3-D target shape from an ISAR movie; however, the algorithm requires a priori knowledge of the relative motion of the target [44].

Verzeilberg proposed another new approach to multi-static ISAR is the incoherent combination of multiple ISAR images. This concept is called 2D ISAR and allows the creation of high-resolution images with MTI radars and low-resolution surveillance. The main idea behind 2D ISAR is seeing the target from different angles, so the amplitude of the summation of scatters will be higher than that of the side lobes, which allows estimating the overall target dimensions. The main idea behind 2D ISAR is imaging targets with systems that do not make use of a large transmission bandwidth. The loss of resolution in down-range can be partially compensated by second radar that sees the target under a different angle. Combining the two images incoherently, the amplitude at the position of the scatters will increase more than the other parts of the image. This way a better estimation of target size and shape can be made. When the angle between two observations becomes too large, the target itself is no longer coherent. This can be due to the fact that different scatterers are imaged by different radars [45]. Synthetic Aperture Radar (SAR) sensors are more preferably used for surveillance of flood affected areas rather than visible band sensors because of their ability to penetrate the cloud that is often present at times of flood and to image during the dark night as well as during the daytime. There are two main reasons why SARs are important for the detection of urban flooding. The ability to obtain a synoptic overview of the extent of urban and rural flooding during day and night even in the presence of cloudy sky that means, the relief task can be done without any hindrances. Secondly, SAR data may be used as calibration, validation and assimilation data for urban inundation models. Such models are very much effective for the prediction of risk and creating awareness before the time from flooding in urban areas. They are called hydraulic models that solve the shallow water equations at each node of a regular or irregular grid covering the river channel, drainage system and floodplain, subject to boundary conditions that include the input flow rate to the domain [46].

IV. Limitations and Scope

This work presents different types of methods that can be used to detect a target in different situations. It also describes how different types of radars are useful to enhance the detecting ability of the target. In most of the methods, computational complexity is cubically increased with a number of transmitters, while the calculation volume of an NP problem is exponentially increased. Most of the existing radar algorithms are simulated by assuming that the environment (clutter) is stationary. However, in practical, the characteristics of the clutter can vary enormously depending on the radar-operating environment. If unaccounted for, this non-stationary variability may drastically hinder the radar performance. In most of the cases, it is difficult to detect small targets (like small icebergs) for a marine radar system since they protrude only about a meter or so above the sea surface level. Very high-resolution maritime radars can potentially detect extremely small targets: the resolution cell is small and therefore the average RCS (radar cross section) of surface sea-clutter is low. However, there is an important drawback: as the size of the range bin decreases, the statistical properties of sea clutter depart from being Gaussian and uncorrelated, to heavily tailed and correlated. In most of the times, it is observed that some of the algorithms are unable to distinguish the shape of the target when it is in far away.

V. Conclusion

In this study, the various target detection algorithms are reviewed along with the advantages and many applications. As so many researchers tried this problem with different methods but still some of the limitations of the above techniques exist, which are analysed and represents the research area where the solution is yet to develop.

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