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A Review Paper on Synthetic Aperture Radar Engineering

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Abstract: *It is a high-resolution radar imaging is interdisciplinary and has wide interests among many various areas.In it remote sensing, Synthetic Aperture Radar images are widely usually used to map the land of the terrain.in defense industry, it type of radar imaging of moving objects is an important tool for automatic target recognition. In this review paper, we provide a comprehensive review of recent developments in the field of Synthetic Aperture Radar (SAR) engineering. First we give brief introduction about Synthetic Aperture Radar (SAR), and then proceed with its designs. Finally, we will discuss recent work done in the area of Synthetic Aperture Radar.*

Keywords: *Synthetic Aperture Radar(SAR),EM Fields,Polarimetric SAR.*

I. Introduction

In 1970, by Skolnik, Radar has long been used for military and non-military purposes in a wide variety of applications such as imaging, guidance, remote sensing and global positioning.Development of radar as a tool for ship and aircraft detection was started during 1920. In 1922, the first continuous wave radar system was demonstrated by Taylor[10]. The radar system operated at 930 MHz, used a Yagi antenna with real aperture beam width of 100 m. During the late 1950s, and early 1960s, classified development of SAR systems tookplace at the University of Michigan and at some companies. At the same time, similar developments were conducting in other country such as France, Russia and United Kingdom.SAR designers seek to fly the smallest antennas compatible with best image quality. A classic inequality specifies the minimum antenna area needed to minimize aliasing at full resolution for a given viewing geometry [10]-[12]. It takes into account the ground reflectivity and the viewing geometry. The proposed technique allows the achievement of better performance compared to the uniform weighted value. In particular, it permits the system designer to relax the choice of the pulse repetition frequency,which is an over-constrained parameter, from the ASR constraint, kept under control by a proper design of the antenna radiation pattern.

II. Antenna Mask Design For Sar Performance Optimization

In this paper, an effective technique for synthetic aperture radar (SAR) antenna mask design is presented for optimizing the system performance of an active phased array SAR. The SAR antenna radiation pattern has an important effect on the system performance. So, the authors derived the quantitative equations for the SAR antenna main lobe and side lobe mask design on the basis of the system performance measures such as the range-to-ambiguity ratio (RAR), the noise-equivalent sigma zero (NESZ), and the radiometric accuracy.

The antenna mask template should be designed to minimize the ambiguous signals reflected from the antenna side lobes and maximize the system sensitivity, i.e., the NESZ, determined by the antenna main lobe. The simple iterative method such as random-mutation hill climbing was utilized to successfully assign the side lobe level at each ambiguous area using the derived equations. Finally, the antenna patterns were synthesized with reference to the optimized antenna mask templates using the particle swarm optimization, and the swath width, RAR, and NESZ performances were evaluated in order to confirm the effectiveness of the proposed technique[13].

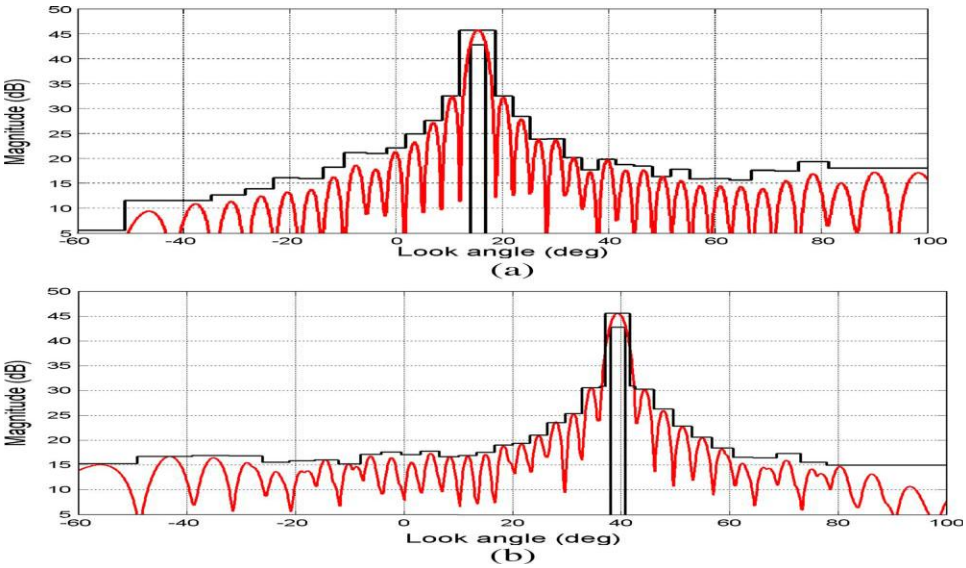

Figure 2.1.1(a) & 2.1.1(b)

Fig. 2.1.1(a) and 2.1.1(b) shows the final antenna patterns synthesized using PSO with the final amplitude and phase weights inset at the end of the 6000 iterations for the swath width defined at look angles of 13.6◦–17.3◦ and 38.8◦-40.2◦, respectively.

In case of SW-3, SW-4, SW-6, SW-7, and SW-8 among the initial antenna patterns, there are no margins at the near and far edges of the swath; however, the optimized antenna patterns in SW-3, SW-4, SW-6, SW-7, and SW-8 have been entirely improved over the overall swath width. Because the swath width was defined over the incidence angle of 15◦–45◦, SW-11 has the limited swath width to meet the full RAR requirements over the full access coverage.

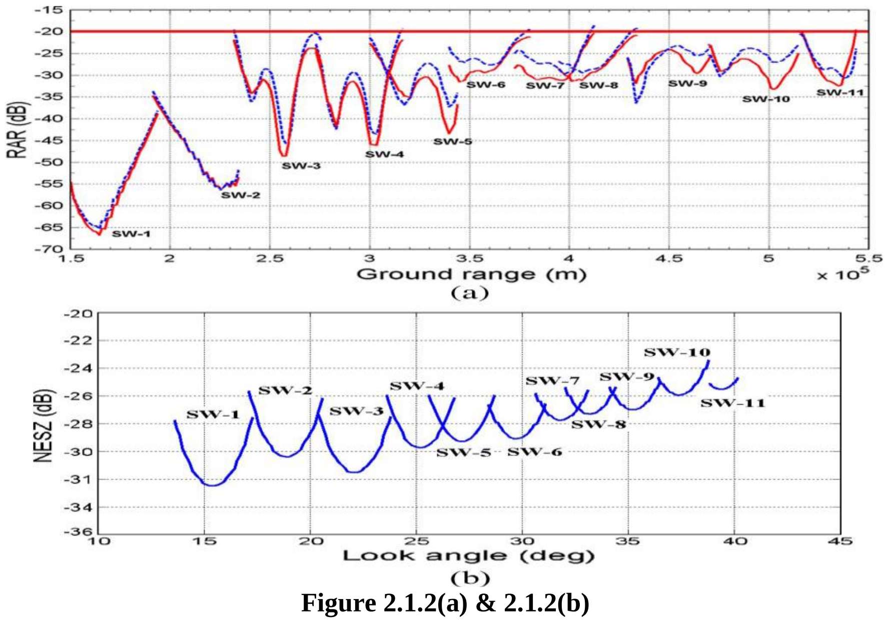

Figure 2.1.2(a) & 2.1.2(b)

Fig. 2.1.2(a) and 2.1.2(b) shows that all beams meet the NESZ requirement over the full coverage using the optimized antenna masks.

III. Literature Review

M. Kim, et al., (2015) In general, game theory is a framework for optimizing the multi-objective and multi-disciplinary problems. It substitutes the notion of optimum, irrelevant when more than one criteria is under consideration with the introduction of equilibrium. There are many definitions of game equilibria, depending on the nature of the game and the most known is the Nash equilibrium, classically accepted as solution to static with complete information games. Game theory was originally used in economic field for a long time, lets just mentioned the application of distributed control system by the partial differential equation is a novel field. Game theory is very suitable for processing against standards.

Shridhar D. Jawak,et al.,(2015) presented SAR is an ideal RS technology, which works in all-weather and day and night situations in the remote cryospheric regions on the Earth, and gives the useful unprecedented spatial information. We reviewed about the evolving nature of SAR in the cryosphere, and highlighted various components of the cryosphere and the classification and applications of SAR in the cryospheric studies. SAR technology is very effective to monitor changes of ice sheets, ice shelves, glaciers, sea ice, snow, blue ice, etc. to study the relationship between polar regions and global climate change.

Skolnik,et al.,(1970) Discovered the overview of Radar has long been used for military and non-military purposes in a wide variety of applications such as imaging, guidance, remote sensing and global positioning.Development of radar as a tool for ship and aircraft detection was started during 1920s. In 1922, the first continuous wave radar system was demonstrated by Taylor. The first pulse radar system was developed in 1934 with operating frequency 60MHz by Naval Research Laboratory (NRL), US. At the same time, radar systems for tracking and detection of aircraft were developed both in Great Britain and Germany during the early 1930s.

The first imaging radar, developed during World War-II, used the B-Scan which produced an image in a rectangular format. The nonlinear relation between angle and distance to the side of aircraft produced great distortions on the display. This distortion was greatly improved by development of Plan Position Indicator (PPI). Its antenna beam was rotated through 360◦ about the aircraft and a image of ground was produced. In the 1950s, the Side Looking Airborne Radar (SLAR) was developed. Scanning had been achieved with the SLAR by fixed beam pointed to the side with aircraft's motion moving the beam across the land. The early versions of SLAR systems were primarily used for military reconnaissance purposes. Until mid 1960s, the first high-resolution SLAR image was declassified and made available for scientific use.

Y. K. Chan,et al.,(2008) The radar was operated at a wavelength of 24.5 cm (L-band) and had a 4-lookresolution of about 10m by 10m. In July 1985, the CV- 990 together with the SAR instrumentation was destroyed by fire during an aborted takeoff from March Air Force Base in Southern California. After the disaster, a new imaging radar (AIRSAR) was built at JPL and this system incorporates all the characteristics of the last CV-990 L-band SAR. Fig.3.1 shows the block diagram of the CV-990 system. The CV-990 system employed two separate antennas, one horizontally polarized and the other vertically polarized. Full polarization can be achieved by transmits a pulses train through the switching circuitry. The pulses are transmitted through horizontal polarized antenna and received signal from both antenna. Then followed by transmits vertical polarized pulse and received by both antenna. Circulators permit a single antenna to be used for both transmission and reception. The CV-990 radar has served as the prototype for all other currently operating imaging radar and for the spaceborne system proposed by NASA for operation in 1990s.

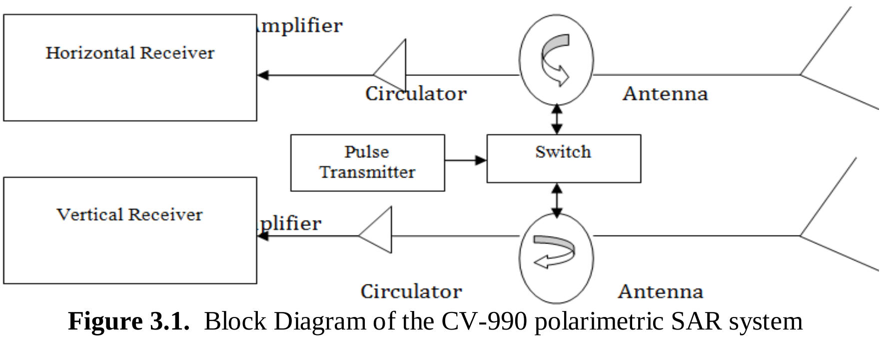

Figure 3.1. Block Diagram of the CV-990 polarimetric SAR system

The AIRSAR system was built based on CV-990 L-band SAR and extended to include P-Band (440 MHz) and C-band (5300 MHz). The new system is capable of producing fully polarimetric data from all 3 frequencies simultaneously. It collects HH, HV, VH and VV data at all 3 frequencies with approximately 10m resolution.

J. K.Weissel,et.al.,(2004) Presented A new radar-based techniques for efficient identification of surface changes generated by lava and pyroclastic flows, and apply these to the 1996 eruption of Manam Volcano, Papua New Guinea. Polarimetric L- and P-band airborne synthetic aperture radar (SAR) data, along with a C-band DEM, were acquired over the volcano on 17 Nov. 1996 during a major eruption sequence. The L-band data are analyzed for dominant scattering mechanisms on a per pixel basis using radar target decomposition techniques.A classification method is presented, and when applied to the L-band polarimetry, it readily distinguishes bare surfaces from forest cover over Manam volcano. In particular,the classification scheme identifies a post-1992 lava flow in NE Valley of Manam Island as a mainly bare surface and the underlying 1992 flow units as mainly vegetated surfaces.The Smithsonian's Global Volcanism Network reports allow us to speculate whether the bare surface is a flow dating from October or November in the early part of the late-1996 eruption sequence. This work tells that fully polarimetric SAR is sensitive to scattering mechanism changes caused by volcanic resurfacing processes such as lava and pyroclastic flows. By extension, this technique should also prove useful in mapping debris flows, ash deposits and volcanic landslides associated with major eruptions.

IV. Conclusion

In this paper, It is well known that SAR can provide several times better image resolution than conventional radars. At present time with the advancement of technology it is possible to overcome the design weakness of a segment by another. a simple and effective technique for SAR antenna mask design in an active phased array has been presented. The quantitative equations for SAR antenna main lobe and side lobe mask design have been derived to optimize the system performance such as RAR and NESZ.so we can say that it is very useful Technique to achieve good image by using Synthetic Aperture Radar (SAR).

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