Detection Of Unknown Targets Using DSSS-Imaging RADAR System.

D. Kandar[1] and Rabindranath Bera [1]

[1]Sikkim Manipal Institute of Technology, Sikkim Manipal University,Majitar, Sikkim, India 737132,
E-mail : dkandar @rediffmail.com, Phone: 09932778779; Fax: 03592-246112.

Abstract

The DSSS radar is operational at our Institute using WiFi 'b' adapters and external horn at carrier frequency of 2.4 GHz. The system is able to detect a person, tree leaves, thin rod etc. The radar is tested using Flat plates of different cross sections and it results in a straight line curve will be very much useful in quantifying the target scattering parameters. Even this linear equation can be extrapolated for flat plates of unknown cross section. The Radar should be aimed for the benefits, like antijamming performance, local suppression of Interference, Multipath rejection and also low power consumption.

1. Introduction

The communication system perturbed by the multipath effects due to environments and a fade depth of more than 30dB are more common. This restricts data rate and goal of high end multimedia services are perturbed. For radar based remote sensing case, every target is characterized by its RCS (RADAR Cross Section) function. A target's RCS function represents the amount of energy reflected from the target toward the receiver as a function of the target aspect with respect to the transmitter receiver pair. It is well known that this function is rapidly changing as a function of the target aspect [1]. Both experimental measurements and theoretical results demonstrate that scintillations of 10 dB or more in the reflected energy can occur by changing the target aspect by as little as one milli--radian. These RCS scintillations are responsible for signal fading, which can cause large degradations in the system's detection and estimation performances as shown in Fig.1. The challenges for conventional outdoor RCS measurement technique in the low frequency region of radar operation the problems of clutter, multipath & interference are more severe[2]. Proper technology in radar operation is to be implemented to mitigate those problems. The DSSS (Direct Sequence Spread Spectrum), OFDM (Orthogonal Frequency Division Multiplexing), MIMO (multiple-input multiple-output) are the recent technological evolutions in radio technology which has the potential to dramatically improve the performance of communication as well as radar systems in terms of broad band operation[3, 4]. DSSS will definitely help in reducing the interference to a great extent. This new technology supports the measurements in secured, interference free environment with low probability of Stealth related targets.

2. The DSSS Radar System Set-up

A DSSS BiStatic Radar Transmitter made up of WiFi b PCI adapter fitted inside a PC with a horn antenna as shown in Fig. 2 is operational at SMIT using 2.4 GHz radio carrier. The block diagram of such radar is shown in Fig. 3. The waveforms of the Radar system will be Phase coded Pulse Compression using digital techniques instead of Linear Frequency modulation LFM based analog techniques. Sometimes pulse compression radars have been called spread spectrum radars[1, 5]. Therefore, a DSSS radar system will be aimed for the development.

A transmitting horn is connected to WiFi b adapter fitted inside a PC after removal of the helical omnidirectional antenna as shown in Fig 4. The radio wave is finally radiated through a dish antenna of diameter 6 ft with the transmitting horn at its focus. At the receiver another USB WiFi b adapter is connected to a second horn with another dish. The USB based WiFi b adapter is placed in a metallic chamber. This helps a lot in reducing the direct leakage of the radio waves between the two bistatic units. The leakage level is so low that even a person is detected by the radar as evident from the total radar set up

3. DSSS Radar Setup with different Targets.

In the above experimental setup, a flat plate of dimension 3147.2 Sq.cm size is placed near the DSSS radar and some of the target parameters like its rotational speed, its surface coating etc. are measured. The position of two dish antennas is placed side by side with a distance of 15 ft and they are positioned at the Bistatic mode. Also the two horn antennas are placed at the offset position so as to avoid the blockage the direct beam of radiation by the antennas.

This motivates the SRS group at SMIT to extend the experiment further. The flat plate placed on a rotating platform is allowed to rotate in front of radar. The rotation is being sensed by the radar with the variations in received signal strength. Out of the full rotation, two positions are more important to be noted. Position 1 is the boresight position (shown in Fig. 4) where received signal is maximized to -51 dBm. Position 2 is perpendicular position to boresight position as depicted in Fig. 5 where signal is blocked by the flat plate and the value is reduced to – 62 dBm. Using a stop watch the time elapsed between two consecutive boresight positions are measured and RPM of the flat plate is calculated to be 2.2.

4. Experimental Results

The Experiment is repeated for four different flat plates having different dimensions as shown in Table 1. The plots of Signal Strength (in dBm) Vs Angular Rotation (in degree) for FP1, FP2, FP3 and FP4 are shown in Fig. 6, Fig. 7, Fig. 8, Fig. 9 respectively. A curve is shown in Fig. 10 which is drawn out of those results and it will help in evaluating unknown RCS of targets of similar kind. The DSSS radar is very interesting and is useful for remote sensing application of different targets (even or uneven shapes). The experiment is also conducted using, Plywood & Banana leaf etc.

5. Conclusion

The DSSS radar is operational at SMIT using WiFi ‘b’ Adapters and external horn and large dish antennas at the carrier frequency of 2.4 GHz. The system is able to detect the nearby targets like a person, tree leaves, thin rod, extended surfaces like buildings etc. It can be used a valuable tool for remote sensing application. The radar is tested using Flat plates of different cross sections and it results in a straight line curve will be very much useful in quantifying the target scattering parameters. Even this linear equation can be extrapolated/interpolated for flat plates of unknown cross section. The design & development of RCS Instrumentation Radar at the low frequency band should be aimed for the benefits, like local suppression of Interference due to coded radar waveform and correlation of the received code, high level of Multipath rejection ad also low power consumption due to coding of the baseband pulses
.

6. Acknowledgments

Authors are thankful to the staff of E&C Dept. of SMIT and DRDO for providing support both technically and financially in the form of a project entitled ‘Software Radio System’.

7. References

[1] M. Skolnik, ‘*Introduction to Radar System’,* McGraw-Hill, 3rd edition, 2002.

[2] D. Kandar**,** R. Bera, “Development of a Imaging Radar Instrumentation System Using DS-UWB Wireless Technology”, proceedings of XXVIIIth General Assembly of International Union of Radio Science (URSI).

[3] G.J.Foschini, “Layered space-time architecture for wireless communication in a fading environment whwn using multi-element antennas” Bell Laboratories Technical Journal, vol.1, no.2, pp-41-59, 1996.

[4] P.W.Wolniansky, G.J.Foschini, G.D.Golden, and R.A.Valenzuela, “V-BLAST: an architecture for realizing very high data rates over the rich-scattering wireless channel,” Proc. Of ISSSE, pp. 295-300, Pisa, Italy, Sep.-Oct. 1998.

[5] Knott EF, ‘Radar Cross Section’, second edition, Scitech publishing, Raleigh, NC, 2004.

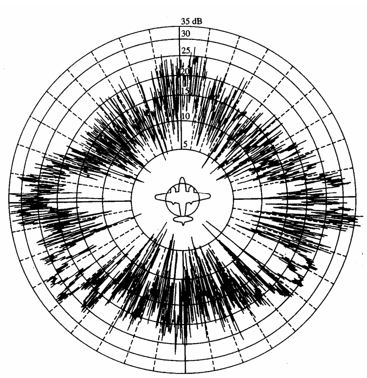


Fig 1. Backscatter as a function of azimuth angle, 10-cm wavelength.

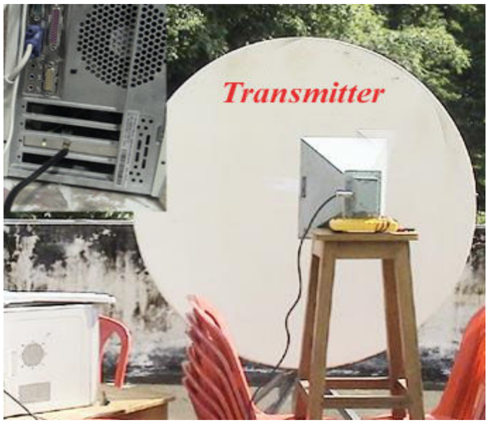


Fig. 2. DSSS Radar Transmitter System.

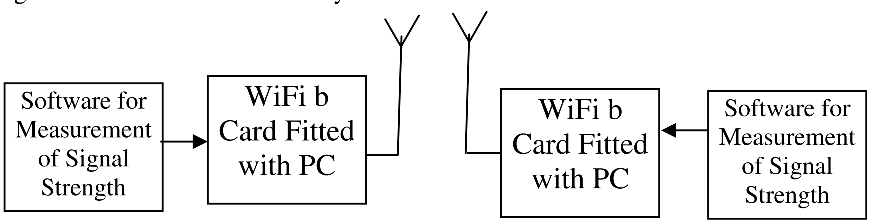


Fig. 3. Block Diagram of a DSSS Radar system.

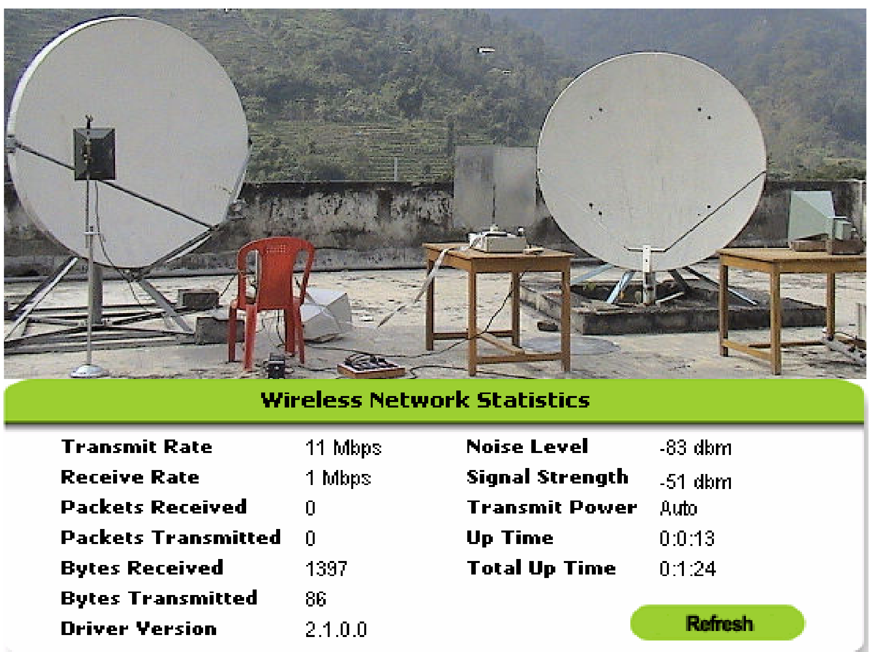
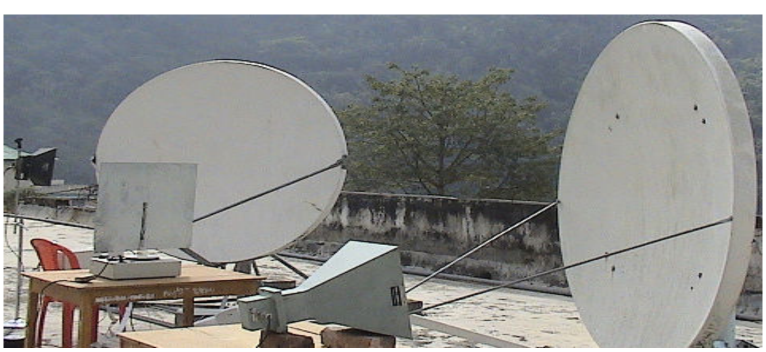


Fig. 4. (Position 1) the boresight position of the flat plate (b) Received signal Strength



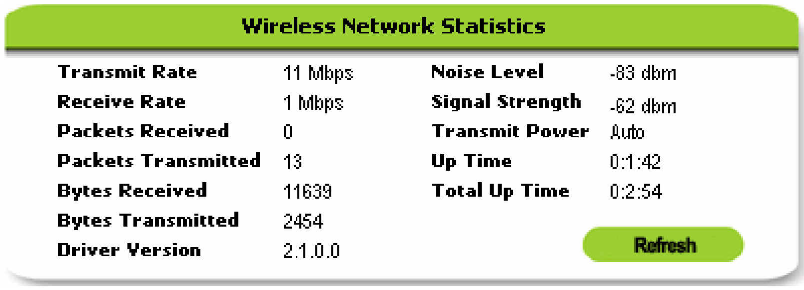


Fig.5. (Position 2) the non- boresight position of the flat plate (b) Received signal Strength.

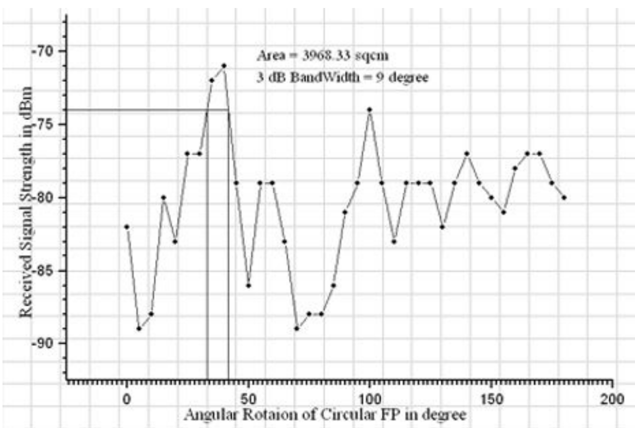


Fig. 6 Plot of Angular Rotation of FP1

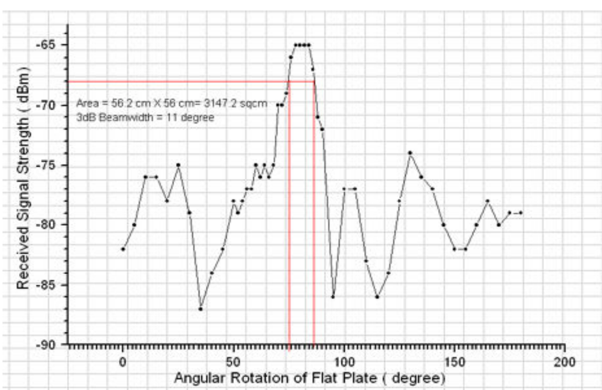


Fig.7. Plot of Angular Rotation of FP2

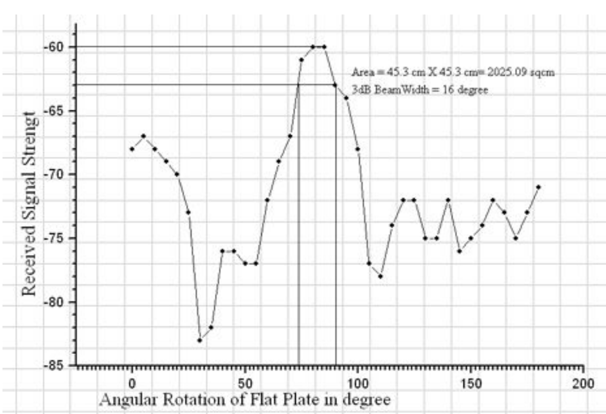


Fig.8 Plot of Angular Rotation of FP3

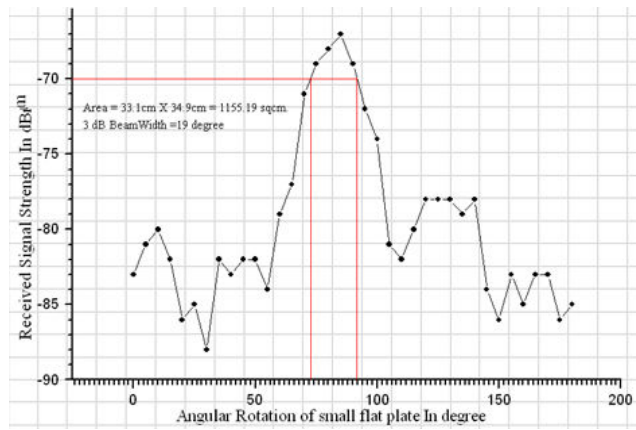


Fig.9. Plot of Angular Rotation of FP4

Table 1: Measured 3 dB Beamwidth for Different Flat Plates(FP).

Target Name	Physical Cross Section (Sq. cm)	Measured 3 dB Beamwidth in degrees
FP 1	3968.33(circular)	9
FP 2	56.2 X 56=3147.2	10.5
FP 3	45.3 X 45.3=2025.09	16
FP 4	33.1 X 34.9=1155.19	19

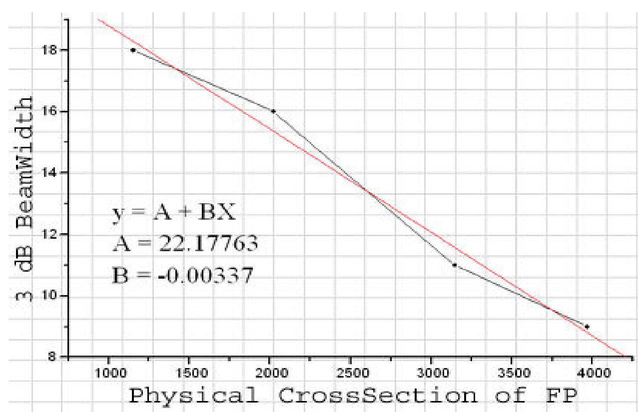


Fig.10 The Curve for RCS measurement for FPs.