International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 10, Issue 10 (October 2014), PP.44-46

Imaging of Moving Target Using Capon Beam forming Algorithm and Four Channel Transmitter Antenna

Dr. Fathima Jabeen[1,] Puneeth S[2]
[1]*Professor and Head, Department of ECE, KS School of Engineering and Management, Bangalore - 560 062*
[2]*Assistant Professor, Department of ECE, KS School of Engineering and Management, Bangalore - 560 062*

Abstract:- Ultra-wide band (UWB) radar technology is used to detect targets and finds application in different fields such as military, industry, rescue missions, clinicalmedicine, etc. With its wide bandwidth and high spatial resolution, UWB radar can penetrate non-metallic objects, such as bricks, wood, dry walls, concrete and reinforced concrete. This paper presents the application of smart antenna technique and use of the Capon Beam forming Algorithm for imaging of the target through brick wall and in free space at a certain distance.Smart antennas replace mechanically rotated aperture antennas (Synthetic Aperture Antenna) such that radar using a smart antenna can choose direction it wants to send the signal and receives the information instantaneously. Capon Beam forming is one of the earliest adaptive beam forming techniques. It has the potential to provide significantly better resolution and interference rejection capability compared to conventional delay-and-sum beam former. M-sequence UWB radar technology have an ability to penetrate signal through natural and unnatural objects and offers low cost and quality security system.

Keywords:- UWB Radar, Smart Antenna. Capon Beam forming Algorithm

I. INTRODUCTION

In remote sensing system, radar imaging is growing rapidly. Among the numbers of methods in creating landscape images, Synthetic Aperture Radar (SAR) has been played a significant role. Normally, radar can only capture reflections within its antenna beam width. For higher dynamic range, the antenna beam width range should be bigger to achieve the higher and better resolution.

Synthetic Aperture Radar has some disadvantages that antenna has to be rotated at uniform speed, would send impulses, and afterwards receive the reflected signal. Before sending out the next impulse, the radar must wait for the signal to propagate to the maximum range and back, so during reception the radar could distinguish which impulse is reflected. These also have the drawback, that to get new information from a direction, we have to wait until the antenna rotates into that direction. The rotation of an aperture antenna is limited by bulky mechanics.The radiation pattern of an aperture antenna is built in.

Smart antenna can overcome this by radiating signal in the direction of the users to be tracked. This way, the antenna would have gain, and would cause less interference. A smart antenna even has the capability to radiate into several arbitrary directions simultaneously, allowing it to track several users. Smart antennas can be used as replacement of mechanically rotated aperture antennas(Synthetic Aperture Antennas).

The advantages of smart antennas over synthetic aperture antennas as follows:

A smart antenna can completely reshape its radiation pattern in a matter ofmicroseconds.Use of smart antennas for radars can have a separate transmitter and receiver antenna.The receiver antenna could simultaneously receive signals from any direction, andseparate them according to the direction from which they came from. Radar using asmart antenna can choose which direction it wants to send out the next impulse. Thismeans that new information about a certain direction can be received almostinstantaneously. Furthermore, if such a radar receives a weak reflected signal, and cannotdecide easily whether it is a real target or not, it can send more impulses in that direction,allowing it to gain more information from the debated direction, thus enhancing both thesensitivity and accuracy of the system.

The received echo signal is analysed and processedusing a modified Robust Capon Beam forming algorithm and adopted as imaging algorithm because it has superior performance over conventional delay-and-sum beam forming algorithm.

II. BACKGROUND OF THE PAPER

Wall Surveillance is a difficult but important problem because of its perspective wide utilization in fields through the wall imagingduring security reason. This technology help in saving lives during rescue operation, location of terrorists and weapons behind the wall, natural calamities and in detection, localization and tracking of the moving objects behind the wall.

In remote sensing system, radar imaging is growing rapidly. Passive radar can be highpriority in terms of its safety by adding smart antenna and thecapability of combining both antenna andpassive radar makes the radar system moreefficient [1].

Synthetic Aperture Radar (SAR) technology produces high-resolution images of the earth surface in all-weather conditions using M-sequence UWB (Ultra-Wideband) radar signals with moving antennas and SAR algorithm for positioning and imaging of the target. Among a number of techniques of image retrieval in Synthetic Aperture Radar, Global back Projection (GBP) algorithm is presented [2].

Smart antennas can replace sector antennas in duplex systems. When communication to be established with moving users, sector antenna would irradiate a large area containing the users such that slight part of the irradiated power is useful, the rest only causes interference in other systems. If a smart antenna would be used, and the user's direction would be tracked, the antenna could radiate mainly in the direction of the users and has advantage of less interference. A smart antenna even has the capability to radiate into several arbitrary directions simultaneously, allowing it to track several users. Smart antennas can replace mechanically rotated aperture antennas (Synthetic Aperture Antenna), the property of which makes smart antenna excellent for radar [3].

Adaptive Beam forming is a widely used technology in array signal processing finds application in Radar and Sonar systems, Smart Antenna systems for wireless communications, and Medical imaging methods. Capon Beam forming [5][6] is the adaptive beam forming technique which provides better resolution and interference rejection capability compared to conventional delay-and-sum beam former.

III. ROBUST CAPON BEAM FORMING ALGORITHM

Conventional Beam forming methods such as delay-and-sum beam forming have gained wide use in many applications including medical imaging. It is simple, robust and easy to implement in software or hardware. Its drawbacks include poor resolution and high side lobe levels, sensitive to model errors, such as array steering vector errors including array calibration errors and imprecise knowledge of direction of arrival (DOA) of Signal of Interest (SOI). Many algorithms have been proposed to mitigate this problem, and one of them being the Robust Capon Beam forming (RCB) Robust Capon Beam forming algorithm belongs to diagonal loading class and its diagonal loading level can be calculated exactly according to the uncertainty set of array steering vector. Moreover, its computational complexity is comparable to that of Capon beam former [5].

Capon Beam forming capable of adaptively calculating the required weight vector based on sample covariance matrix obtained from array output data, which passes the SOI in an undistorted manner while placing deep nulls in directions of interferers resulting in strong interference suppression. [6] Here slight deviation between the assumed steering vector and the true steering vector of SOI may cause a significant degradation of performance for Capon Beam former, because in this case the beam former treats SOI as an interfering signal. Therefore, numerous algorithms have been derived to improve the robustness of Capon beam forming

The RCB algorithm deals with narrow-band complex-valued array signals. The algorithm assumes that the true steering vector of SOI can be estimated within an uncertainty set based around the assumed steering vector of SOI [7][8].

IV. OBJECTIVE OF THE PAPER

This Paper presents the application of smart antenna technique and use of the Robust Capon Beamforming Algorithm for imaging of the target through brick wall and in free space at a certain distance.Smart antennas replace mechanically rotated aperture antennas (Synthetic Aperture Antenna) such that radar using a smart antenna has the freedom and can choose direction it wants to send the signal and receives the information instantaneously.

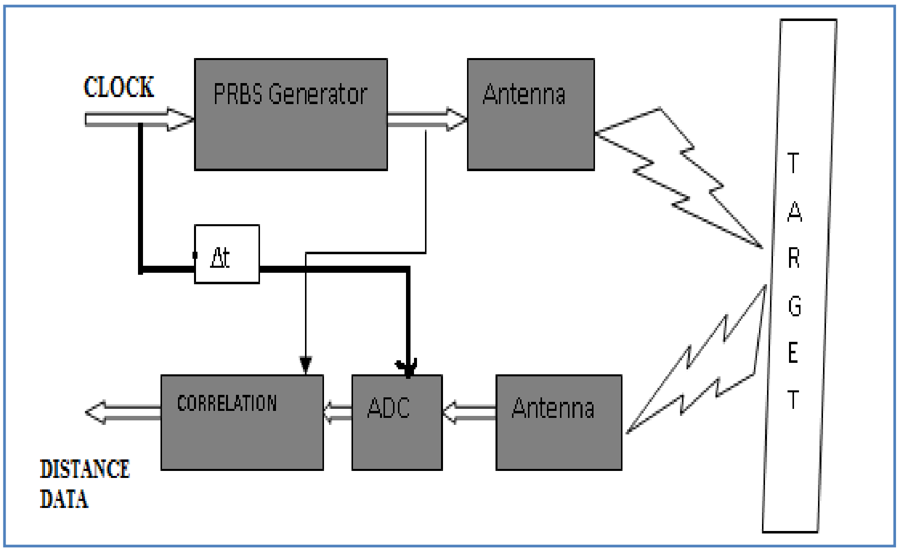
Robust Capon Beamforming is one of the earliest adaptive beam forming techniques. It has the potential to provide significantly better resolution and interference rejection capability compared to conventional delay-and-sum beam former. Correlators are used to enhance the image quality by using the erosion and dilation of the incoming signal.

V. PROPOSED SYSTEM

UWB radar can provide higher resolution for operations because of short pulse usage which leads to higher bandwidth of the system and PRBS signal. The system consists of a clock, a PRBS generator at the transmitter end, an analogue to digital converter (ADC), and correlation filter at the receiver end. The proposed Paper helps inaddressing the problem of Wall Surveillance which is a difficult but important problem because of its perspective wide utilization in fields through the wall imaging during security reason and in detection, localization and tracking of the moving objects behind the wall.

This Technology help in saving lives during rescue operation, location of terrorists and weapons behind the wall, natural calamities. This Paper presents the application of smart antenna technique in place of existing Synthetic Aperture Radar (SAR) and use of the Capon Beamforming Algorithm for imaging of the target through brick wall and in free space at a certain distance.

Propose Paper uses Smart antennas which replace mechanically rotated aperture antennas such that radar using a smart antenna can choose direction it wants to send the signal and receives the information instantaneously. Capon Beamforming is one of the earliest adaptive beam forming technique. It has the potential to provide significantly better resolution and interference rejection capability compared to conventional delay-and-sum beam former. The schematic is as shown in figure below.



REFERENCES

[1]. Quyen, T. C., Duong, B. G., Fortier, P., & Anh, P. (6-9 Oct. 2008). "An approach for Passiveradar using a smart antenna system". IEEE Xplore pp. 266-269. Hanoi: AdvancedTechnologies for Communications, 2008.

[2]. Binodshrestha & Madhava Reddy Kota."Global BackPaperion for Imaging of Targets Using M-sequence UWB radar system". Master's Thesis, HOGSKOLAN IGAVALE, September 2013.

[3]. LeventeDudas, Peter Kovacs, Arpad Drozdy, Rudolf Seller."Smartantenna Phase controlled linear antenna array".AARMS Vol. 7, 2008 pp187–213, Department of Broadband Infocommunication and Electromagnetic Theory,Budapest University of Technology and Economics, Budapest, Hungary.

[4]. Guan Xin."Experimental Study of Thermo acoustic Imaging System".A Dissertation of Doctor of Philosophy, University Of Florida- 2012.

[5]. J. Li, P. Stoica and Z. Wang, "On Robust Capon Beamforming and Diagonal Loading," IEEE Trans. Signal Processing, vol. 51, no. 7, pp. 1702-1715, Jul 2003.

[6]. X.Guan, H.Zmuda, etc, "FPGA Implementation of Robust Capon Beamforming", SPIE 2012 Medical Imaging Conference, Feb 2011.

[7]. J. Li and P. Stoica, "Robust Adaptive Beamforming," Wiley, 2006.

[8]. B. D. Van Veen and K. M. Buckley, "Beamforming: A Versatile Approach to Spatial Filtering," IEEE ASSP Magazine, pp. 4-24,1988.