VOL. 10, NO. 22, DECEMBER 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences


www.arpnjournals.com

PERFORMANCE ANALYSIS OF SMART ANTENNA BASED ON MVDR BEAMFORMER USING RECTANGULAR ANTENNA ARRAY

Suhail Najm Shahab[1], Ayib Rosdi Zainun[1], Nurul Hazlina Noordin[1], Ahmad Johari Mohamad[1] and Omar Khaldoon A.[2]
[1]Faculty of Electrical and Electronics Engineering, Universiti Malaysia Pahang, Pahang, Malaysia
[2]School of Computer and Communication Engineering, University Malaysia Perlis, Malaysia
E-Mail: 68suhel@gmail.com

ABSTRACT

The performance of smart antenna system greatly relies on the beam forming technique that forming the main lobe beam pattern to the desired user direction and place null in the direction of undesired interference source. This paper investigates the implementation of Minimum Variance Distortionless Response (MVDR) Adaptive Beam-Forming (ABF) algorithm on Rectangular Antenna Array (RAA) is discussed and analyzed. The MVDR ABF technique performance is studied in accordance with varying the number of array elements, spacing between the array elements, the number of interference sources, noise power label, and the number of snapshots. The MVDR performance is compared on the basis of output radiation pattern and SINR. Computer simulation results show that the performance of the MVDR improved as the number of elements get more. This mean MVDR strongly depends on the number of the element. 0.5λ is considered the best spacing between adjacent antenna elements, the performance degraded as the noise power label increased, and more accurately resolution occurred when the number of snapshots increased.

Keywords: beamforming, minimum variance distortionless response, rectangular antenna array, smart antenna.

INTRODUCTION

Most beam forming techniques have been considered for using at the base station (BS) since antenna arrays are not feasible at mobile terminals due to space limitations [1].

The Long Term Evolution (LTE) as defined by the 3rd Generation Partnership Project (3GPP) is a highly flexible radio interface, its initial deployment of LTE is in 2011. LTE is the evolution of 3GPP Universal Mobile Telecommunication System (UMTS) towards an all-IP network to ensure the competitiveness of UMTS for all next ten years and beyond. LTE was being developed in Release 8 and 9 of the 3GPP specification. According to Maravedis anticipates that 3 LTE-TDD and 59 LTE- FDD networks will be operational worldwide by the end of 2011. There will be 305 million LTE subscribers by 2016, which is about 44 million (14%) will be TDD-LTE users, and the rest 261 million (86%) will be FDD-LTE. [2]. With increasing trend of the number of subscribers and demand for different services in wireless systems, there are always requirements for better coverage, higher data rate, improved spectrum efficiency and reduced operating cost. To fulfill these requirements, beamforming technique able to focus the array antenna pattern into a particular direction and thereby enhances the signal strength.

Interference is one of the significant obstacles in wireless communications. The interference can be caused by the signal itself or by other users [3]. The signal can interfere with itself due to multipath components, where the signal is gathered with another version of the signal that is delayed because of another propagation path. The fundamental principle of ABF is to track the statistics of the surrounding interference and noise field and adaptively search for the optimum location of the nulls that can most significantly reduce the interference and noise under the constraint that the desired signal is not distorted at the beamformer's output [4].

The basic idea of the MVDR algorithm is to estimates the beamforming coefficients in an adaptive way by minimizing the variance of the residual noise and interference while enforcing a set of linear constraints to ensure that the desired signals are not distorted [4]. The authors in [5] proposed an enhanced model of MVDR algorithm by changing the position of the reference element in steering vector to be in the middle of the array with an odd number of elements. Simulation results showed that modified MVDR has a realistic behavior, especially for detecting the incoming signal's direction and outperforms the conventional MVDR. The signal to interference plus noise ratio (SINR) maximization is one of the criterion employed in joint transmitter and receiver BF algorithms [6, 7]. In [8] mentioned that the element spacing must be $d \leq \lambda/2$ to prevent spatial aliasing. In [9] the author presents a comparative study of minimum variation distortionless algorithm and Least Mean Square (LMS) algorithm. Results indicated that LMS is a better performer.

Smart antennas (SA) include signal processing capabilities that perform tasks such as the direction of arrival (DOA) estimation of a signal and then the SA can adjust the antenna itself using beamforming (BF) techniques to achieve better transmission or reception beam pattern, which increases SINR by mitigating co-channel interference present in wireless communication system. A SA that is held in the BS of a mobile system comprises an array of antennas where the amplitudes are accustomed to a group of complex weights using an adaptive beamforming algorithm. The ABF algorithm improves the output of the array beam pattern in a way that it maximizes the radiated power where it will be produced in the directions of the wanted mobile users. Moreover, deep nulls are