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KEY CHALLENGES OF SMART ANTENNAS IN WIRELESS COMMUNICATIONS

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Abstract:

Smart antenna is one of the most proficient and dominant technological innovations for maximizing capacity, improve quality, and coverage in wireless communications systemAn evaluation of the analytical techniques for the theoretical analysis of adaptive beamforming algorithm, level of the system performance optimization approaches has been highlighted. Performance realistic evaluation and implementation cogent parameters areas for the deployment of smart antennas on the performance system in wireless communication systems have been also examined.

Keywords:Antenna arrays, Beamforming algorithm techniques, Direction of arrival, Signal processors, Smart antennas techniques, Wireless communication systems

1. Introduction

Smart antennas array modifies its pattern with dynamism to regulate to noise, prying and multipath. It could be useful in received signal enhancement and as well as beam formation transmission. It puts nulls in the track of interferers by means of adaptive bring up to date of weights associated with each antenna element [1, 5, 6, 16]. Smart antennas can transform its radiation array through an inhouse response controller despite the fact that the antenna system is functioning. Smart antennas offer better capacity and performance advantages over ordinary antennas for the reason that they can be used for the perfect antenna analysis patterns for the fluctuating traffic or Radio Frequency (RF) environments in wireless network[1, 5, 6, 16, 24, 29]. Smart antennas can be distinctly demarcated as a method to Instantaneous Air Interface (IAI) using a Software Defined Radio (SDR). This technology uses various antennas, digital processors, and composite algorithms to adapt the transmit and receive (transceiver) signals at base station [30, 31].

Smart antenna techniques is well suitable for the base stations on account of high system tricky situation and extraordinary power depletion. Therefore, smart antenna techniques have been applied to mobile stations and handsets [1, 6, 30, 31]. It nullifies nearly all the cochannel interference consequential in improved quality of reception and lesser dropped calls [8]. The signal processing in the smart antenna estimates the Direction of Arrival (DOA) [32-34] and formation of Adaptive Beam Forming (ABF) algorithm [8, 11, 35-38]. Bashaet. al. [16] have proposed a beamforming using hybridization of soft computing techniques and later in terms of DOA. The DOA of smart antenna estimates the direction of interferer signalsagainst the desired user [1, 33-37]

2. Brief History of Smart Antennas

The term Smart Antennas (SAs) came in to existence in early 1990s at the time of well built adaptive antenna arrays were used in the military applications to overwhelm interfering signals from the opponent, were carried out by a number of scientists into mobile communications [17]. As a result of the features of smart antennas, its technology was used in military communication systems such as radar, where narrow beams were used with the purpose of interference avoidance rising from noise and other jamming signals [8, 38]. In the last 15 years, this topic has acknowledged extensive attention essentially as a result of the propagation of mobile communication procedures [32]. Generally, smart antennas are used in fixed wireless communication systems as Wireless Local Loop (WLL) and in mobile wirelesscommunication systems to improve coverage, capacity and spectral efficiency [5, 7, 8, 18, 29,39]. Specially, in cellular systems, the use of smart antennas permits lesser cost placements with cells of reasonable enormous size. Encompassing the smart antenna outset, researchers operated on the technology to use it for individual communication engineering to allow more users in the wireless network by means of quashing interference [6, 40]. The introduction of very fast and low cost digital signal processors has made smart antennas practical for cellular land and satellite mobile communications systems [9, 41].

3. Background on Smart Antenna

This research offers a wide-ranging features, overview and futures of smart antennas for wireless communications, and their role in antenna communication systems. The background covers areas that comprises the foundation of the research work. Shivapanchakshari and Aravinda (2017) review the significance of smart antennas in relation to wireless communication systems. The authors clarified various existed smart antenna techniques and methods. Smart antennas have the ability to present nulls in the direction of interferers through updating of the weights by adaptation. This is done so as to mitigate any interferences of signals. This section gives the conceptual description of the Smart Antenna (SA), types and techniques are discussed briefly, while the detailed explanation are given in the subsequent section. At present the smart antennas are utilized in numerouscommunication capacities. Since the unadventurous theory, smart antenna is fundamentally categorized as Switched Beam and Adaptive Array system. The classification of switched beam system is: single beam directional and multibeam directional antenna. Correspondingly, adaptive array system is taxonomy is: single user beam forming and multiuser beam forming.

4. Benefits of Smart Antennas in Wireless Communication Systems

More specifically, the benefits derived from a smart antenna system can be described as following three ways:

Schemes for Coverage and Capacity Enhancement (SCCE):

Smart antennas upsurges the coverage range and capacity of a wireless communication system [1, 5, 7, 42]. The coverage range is merely the range of likely communication between mobile and base station [31]. Its capacity is quantify by the number of users that a system can support in a particular area [1, 39, 43].

Range Extension

In thinly occupied zones, lengthening coverage is frequently imperative than increasing capacity. In such zones, the gain obtained by smart antennas can lengthen this range of a cell to cover a larger area.

Various techniques have been proposed through research to reduce the sidelobe level in switched beam antennas are:

- Chou and Yu [55] have examined a switch beam in which the transmitting antenna switches beams to search for the receiving antennas from a spot to another as those conceptually introduced in the conventional far-field smart antennas. The author used one dimensional beam switching device in the antenna design with the other dimensions to ensure that focused fields are radiated in the designated near zone
- The technique of increasing the number of radiating elements and using power dividers to obtain amplitude taper across the antenna array. This requires an increase of antenna aperture and consequently narrower beams are accomplished and there is a reduction in beam crossover.
- The technique in which two separate feeding networks are used for generating all beams, which results in the need of switching between feeding networks or doubling the aperture size [56, 86].

5. Modeling of RF Security Using Smart Antennas

Smart antennas are applied in various areas of communications. One of its applications is in RF security systems reported by Oluwole and Srivastava [89]. The work introduces an analysis about how RF can be secured using smart antenna arrays. To receive radio signals, an antenna is required for signal propagation. Nevertheless, as the antenna will take up thousands of radio signals simultaneously, a radio tuner is indispensable to tune into a precisefrequency. In the research analysis, three antenna elements array was used. The first antenna element is used for the transmission/reception (transceiver) of RF signal. The transceiver was purposely used for transmitting virtual information signal far away from the mobile station. (ii) The remaining two antenna elements at the mobile station are being used as descrambler against any illegitimate activities. Wireless networks transmit their data at any layer of the open systems interconnection protocols stack using RF or optical wavelengths. Signal transmission through free space offers opportunities for interlopers and hackers that come from any direction. A foremost problem to secure communication systems is the probability of unlicensed penetration. The unlicensed penetration of this kind is

popularly known as hacking. Numerous techniques have been employed to overcome the problem of hacking. This refers to a person/software that breaks into or interrupts computer systems or networks to manoeuvre data or generate havoc by uploading malicious code. HackRF provides an assessment equipment module for RF associated research and measurements which apply to a frequency range from 1 MHz to 6 GHz, and spread over many registered and unregistered as well as ham radio bands. Hacker may possibly target the RF modulation plane with customary electronic warfare, the objective could be congested with adequate RF power or echo attacks could possibly be used. Hacks could be away from modulation in binary level. This conveys that any signal received by the radio is sufficient to hack the system

Smart antennas combines the antenna arrays elements of the transceiver and that of the antennas at the mobile station for the optimization of radiation beam pattern, with smart signal processing algorithms used to recognize spatial signal

identity/signature to track and identify whenever hacker wants to intrude on the transmitted signal. As the antennas at mobile stations communicate with each other using RFs between 1 GHz and 7 GHz, neighboring channels can only receive signal at frequency below 1 GHz but not secured. If the neighboring channels receive signal at the specified/ designed frequency and hacking is ON, there will be no alarm in the system which are illustrated in fig. 13. Research on smart antenna security is a new research in smart antennas, hence Oluwole and Srivastava [89] discovered on how smart antennas can be used for security against hackers as demonstrated in this and previous sections. The diversity effect in smart antenna refers to the transmission and/or reception of manifold RF waves to increase the data speed as well as to diminish the error rate [6, 16]. Smart antennas employ two different combining schemes:

(i) Diversity combining (combines the signals from multiple antennas in a way that mitigates multipath fading, exploits the spatial diversity among multiple antenna signals, and achieves higher performance when multiple antenna signals are less correlated).
(ii) (ii) Adaptive combining (adjusts the antenna weights dynamically, suppressing

interference signals, add multiple antenna signals, performs better for correlated antenna signals).

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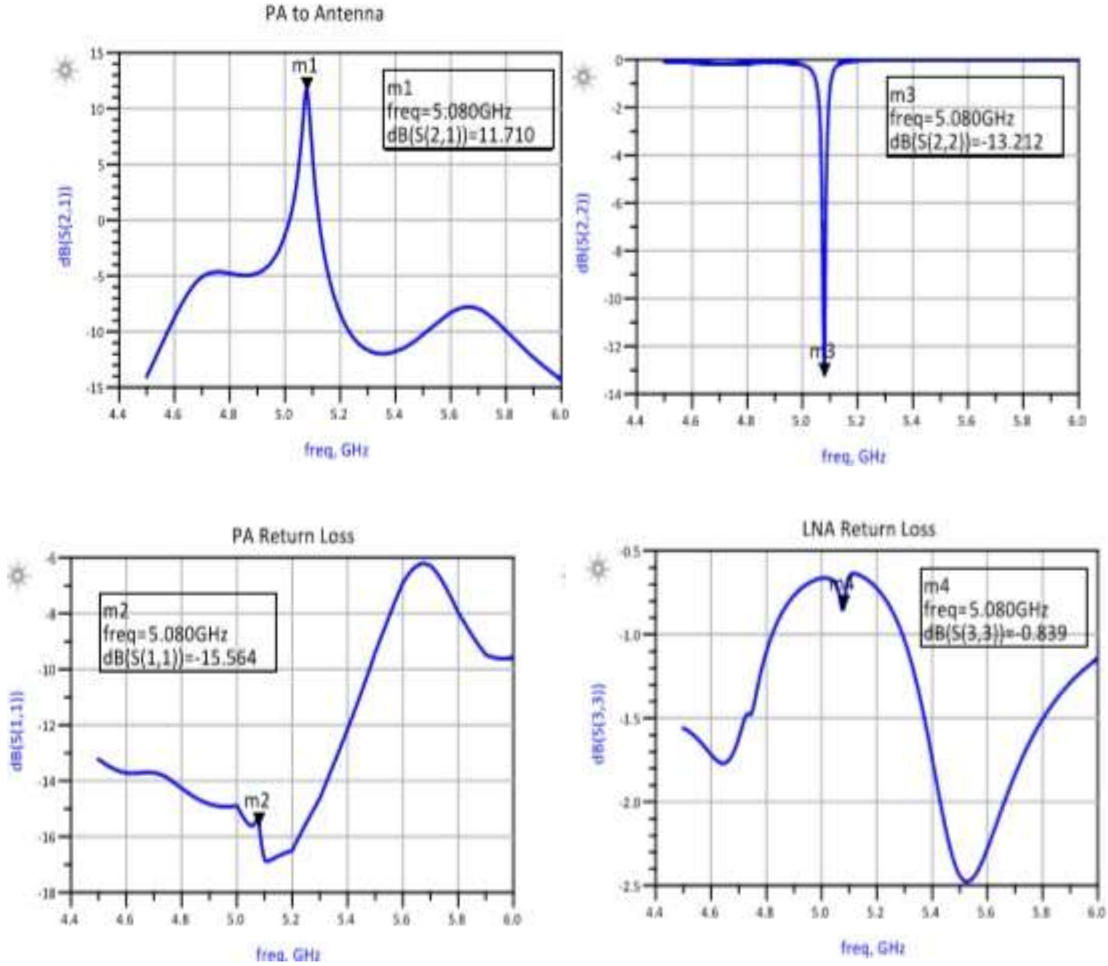

Fig.1: Results of RF transceiver antenna [89]

6.Conclusions and Future Aspects of Smart Antenna

for example reconfigurability to variable channels transmission and linkage situations, cross-layer optimization, and multipleuser diversity modus operandi. In addition, responsibilities such as the design of a suitable replication methodology and the exact validating of channel physiognomies, interference, and presentation losses have needed to be accessible in conjunction with flea market propensities, future projections, and the expectable profitable influences of smart antennas application. Furthermore, approximately imminent projections of different disciplines in smart antenna research are given and are highlighted in this manner.

• The knowledge of smart antenna is in performance a dynamic starring part in communication system. Smart antennas display numerous advantages in coverage development, statistics rate improvement, spectrum effectiveness improvement, interference decline, which determines the dynamic features in improved wireless communication.

• In areas of bandwidth, the ongoing research in this area by Oluwole and Srivastava, increases the performance of the antenna in terms of bandwidth, and looks into a way by which the quality and productivity which is vital to Orthogonal Frequency Division Modulation (OFDM). Consequently, this research will improve the efficient distribution of signal in OFDM systems.

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