Angle of Arrival Estimation Techniques and Modelling and Design of a Novel Miniaturized Reconfigurable Antennas

R Asif, M Alsadoon, A.A. AlAbdullah, K.W.H. Hameed and R.A. Abd-Alhameed
Fculty of Engineering and Informatics, University of Bradford,United, Kingdom
r.asif1@bradford.ac.uk, r.a.a.abd@bradford.ac.uk

The angle of arrival estimation of multiple sources plays a vital role in the field of array signal processing as MIMO systems can be employed at both the transmitter and the receiver end and the system capacity, reliability and throughput can be significantly increased by using array signal processing. Almost all applications require accurate direction of arrival (DOA) estimation in order to localize the sources of the signals. Another important parameter of localization systems is the array geometry and sensor design which can be application specific and is used to estimate the DOA.

In this work various array geometries and arrival estimation algorithms are studied and then a new scheme for multiple source estimation is proposed and evaluated based on the performance of subspace and non-subspace decomposition methods. The proposed scheme has shown to outperform the conventional MUltiple SIgnal Classification (MUSIC) estimation and ESPIRIT estimation techniques. The new scheme has a better performance advantage at low and high signal to noise ratio values (SNRs).

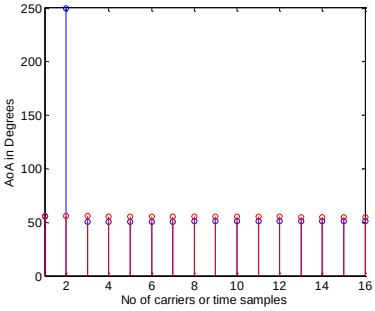

Fig. 1a: AoA versus the number of carriers or time samples at 0.5MHz bandwidth and 16 OFDM carriers

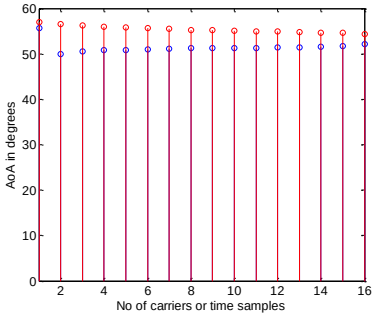

Fig. 1b: AoA versus the number of carriers or time samples at 1.0MHz bandwidth and 16 OFDM carriers

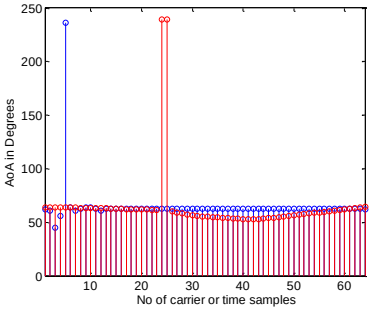

Fig. 1c: Fig. 2a: AoA versus the number of carriers or time samples at 10MHz bandwidth and 64 OFDM carriers

The research work also studies different array geometries for both single and multiple incident sources and proposes a geometry which is cost effective and efficient for 3, 4, 5, and 7 antenna array elements. This research also considers the shape of the ground plane and its effects on the angle of arrival estimation and in addition it shows how the mutual couplings between the elements effect the overall estimation and how this error can be minimised by using a de-coupling matrix.

At the end a novel miniaturised multi element reconfigurable antenna to represent the receiver base station is designed and tested. The antenna radiation patterns in the azimuth angle are almost omni-directional with linear polarisation. The antenna geometry is uni-planer printed log-spiral with striplines feeding network and biased components to improve the impedance bandwidth. The antenna provides the benefit of small size, and re-configurability and is very well suited for the asset tracking applications.

Samples of the results are shown in Fig 1 a to c, in which a number of OFDM carriers are extended over different bandwidth. A 25 multi-paths were considered at three elements receiver from one transmitter at the centre frequency 400GHz using Wireless Insite software. The AoA for a signal transmitted OFDM signal at around 60 degrees was estimated over each carrier and time sample. The frequency and time samples show good matching of AoA estimation.