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MIMO System Characterization for 5G Applications

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The main objective of this work it to present a multiple input multiple output (MIMO) system characterization for 5G applications, using LabVIEW. In this sense, it is intend to present a characterization system to study the beamforming antenna behaviors in MIMO systems.

Nowadays, the 5G has a prominent role in technological world as well as in radio frequency (RF) field. One of the goals of 5G is to provide higher bandwidth, and for that purpose 5G systems worked at higher frequencies (mmWave) [1]. However, working at these frequencies also has drawbacks, such as higher free space. To compensate for this loss, the use of antenna arrays is a solution, since they allow a greater gain because they perform beamforming. Antenna arrays with more elements result in greater gain and beamforming [2], which allows reducing significantly the energy consumed by targeting individually to the user equipment. For example, in base station without beamforming, the energy is not absorbed in large part by the equipment, but it is also absorbed by the environment, which leads to a waste of energy.

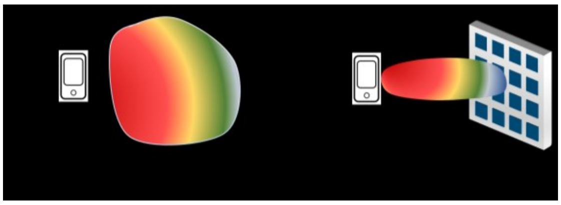

Figure 1. Single antenna scenario vs MIMO with Beamforming.

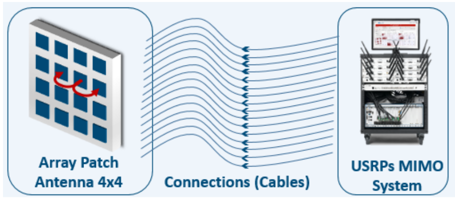

Figure 2. MIMO System characterization for 5G.

Therefore, beamforming allows you to direct energy according to the target, leading to a more efficient transfer. To perform beamforming it is required to have high phase and amplitude accuracy on the signals that are sent to the antenna array elements. Thus, the elements of the antenna array should have precise phase and amplitude differences. In other words, the antenna array should be calibrated, because amplitude errors lead to antenna gain losses and errors in the phase affects the antenna array beam direction. Antennas side by side form the antenna array, which leads to both radiate and absorb. This behavior is the coupling between antennas. One of the ways to solve this problem is to increase the distance between the antennas, but this solution generates antenna arrays of high dimensions, which is not feasible. Consequently, studying and measuring the coupling between the antennas becomes a challenge.

With this in mind, the main goal of this scientific project is to explore and build a MIMO characterization system for antenna arrays. In this regard, it is intend to present a beamforming application in LabVIEW using the NI MIMO system, to characterize antenna arrays and to study the coupler effects between antenna elements. The characterization system is composed by one antenna array (with 4x4 elements) for transmission at 5.8 GHz, by 8 USRPs with 2 transmission channels each and 2 receiving channels each. The transmission of the signal in each antenna element is synchronous and it allows you to configure each signal to send on each element of the antenna in a specific way (power, amplitude and phase). On the receiver side, the system consists of a receiving antenna at the same frequency, where the LabVIEW application aims to observe the frequency spectrum and it presents the information about the receiving signals.

1. W. A. T. Kotterman, C. Schirmer, M. H. Landmann and G. Del Galdo, "New challenges in over-the-air testing," *2017 11th European Conference on Antennas and Propagation (EUCAP)*, Paris, 2017, pp. 3676-3678.

2. D. Reed, A. Rodriguez-Herrera and R. Borsato, "Measuring massive MIMO array systems using over the air techniques," *2017 11th European Conference on Antennas and Propagation (EUCAP)*, Paris, 2017, pp. 3663-3667.