A Robotic Pattern Measurement System for 60 GHz Antenna Arrays

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The development of millimeter wave (30-300 GHz) antennas leads to major challenges in testing. With wavelengths of just a few millimeters or less, a minor misalignment can introduce major phase and amplitude errors. A robust and precise test setup is needed to perform these types of measurements. The use of a robotic arm for antenna pattern and gain measurements addresses these problems, since it provides flexibility, configurability, repetition, and accuracy. Prior examples (J. A. Gordon et al., in IEEE TAP, 63, 12, 2015) and (L. Boehm et al., EUCAP 2015) have shown robotic arms performing millimeter wave measurements. Both systems have used long robotic arms, hence, affecting the accuracy and repeatability of their position. This paper discusses an approach that uses a smaller robot with better repeatability and better positional accuracy to perform a radiation pattern measurement in the 60-65 GHz band for different PCB antenna arrays. Our approach provides measurements that are more accurate for the millimeter wave antennas with less complexity. Furthermore, this precision measurement is expected to improve near-field analysis. However, this method leads to challenges such as achieving minimum distance required for far-field criteria. Some other challenges include avoiding reflections that affect the measurements and synchronizing the robot's position to the measurement points.

Our measurements are performed using a Fanuc robotic arm, which follows a programmed trajectory around the antenna under test. The arm holds a standard gain horn antenna connected to a vector network analyzer (VNA). A computer connected to this VNA and the robot controller synchronizes the measurement points to the robot's position. The test setup area is strategically covered by absorbers to avoid unwanted reflections affecting the measurements. A first test is discussed with a standard gain horn antenna in the V-Band. Additionally, a measurement is performed on 60 GHz PCB-based antenna arrays with element sizes of 5×5, 7×7 and 20×20, respectively. In these tests, the far-field and near-field pattern is measured in different trajectories with steps along the way. The antenna under test is rotated to perform measurements in both the E-plane and H-plane.