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Deep Learning-Driven Beam-Steering for Dual-Polarized 28 GHz Antenna Arrays in 5G Wireless Networks
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Abstract
This study explores the development of a 28 GHz array antenna with beam-steering capability, consisting of four elements with dual linear polarization at ±45 degrees. We propose a method for synthesizing the array antenna's radiation pattern using an active element pattern-deep neural network (AEP-DNN). Beam-steering has become an attractive feature for researchers, as it enables users to move freely without affecting signal strength. An array analysis was conducted using a feedforward deep neural network (DNN) to generate a radiation pattern that achieves the desired steering angles. The proposed method takes radiation patterns as inputs and outputs the corresponding phase values for the antenna elements. The training dataset for the array antenna consisted of 6,859 radiation patterns, generated by adjusting the antenna element phases, which were then used to train the DNN model with minimal complexity. The radiation pattern was computed using AEP method since it is faster and less complex compared to full-wave modelling methods. The DNN model was initially tested using radiation patterns from an ideal square shape. After training, the model was evaluated by inserting desired beam-steering angles of 5 and 10 degrees, and it was found that the radiation pattern produced by the DNN closely matched the intended input pattern. The DNN learning process takes approximately 2 to 3 minutes in terms of processing time. The training and validation Root Mean Square Error (RMSE) and loss values converge to a minimum range of 1.3 to 2.3. Furthermore, the AEP-DNN method was successfully validated using the pattern multiplication method, full-wave modelling, and measurement methods to verify the feasibility and reliability of the training and validation data, as well as the resulting radiation pattern. This antenna, incorporating AEP-DNN technology, holds significant potential for various applications, particularly in mobile communications. © 2013 IEEE.

Author Keywords
28 GHz frequency; 5G wireless communication; active element pattern; beam-steering; deep neural network; Dual-polarized antenna arrays; millimeter-waves

Index Keywords
Beam forming networks, Cellular radio systems, Radio access networks; 28 GHz frequency, 5g wireless communication, Active element patterns, Array-antenna, Beam-steering, Dual polarized antennas, Dual-polarized antenna array, GHz frequencies, Neural-networks, Wireless communications; Steerable antennas

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