Mitigation of Mutual-coupling Effects in Millimeter-wave Automotive Radars

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Increased utility of millimeter-wave (mmW) technology for autonomous vehicle navigation is leading to key improvements in decision making through signal fusion and significantly reduced hardware costs, enabling wide scale adoption. Navigation and collision-avoidance radars operating in the mmW bands have become standard equipment in modern passenger cars, saving countless lives and ushering unprecedented safety features. Radars based on electronic beam steering phased-array architectures have enabled compact, self-contained hardware that can be inconspicuously installed behind the grills and the bumpers. Arrays of simple patch antennas fabricated on low-loss substrates are often the first choice to implement the radiating front end and the plastic cover is utilized as a simple radome to protect the radar from the environment. However, the mutual coupling between patch elements in close proximity can result in undesired pattern ripple which is detrimental in overall radar performance. In fact, mutual coupling reduction in patch arrays is an active research area.

In this paper, we present a simple slot-based array design as an alternative to an existing patch array for automotive radar applications. The proposed array is based on double-slot antennas that exhibit much lower mutual coupling, thus improving the overall field of view and the performance of the radar. We study the active element patterns of transmit and receive arrays and demonstrate the improved pattern ripple, as a result of the reduction in mutual coupling. In addition, the effects of the finite array substrate are studied and methods of mitigating edge diffraction artifacts are discussed. The end goal of this work is a radar array sensor with 76-81GHz coverage for short and long range sensing applications.