Cognitive Radio Antennas that Learn and Adapt Using Neural Networks

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Cognition added to RF/antenna systems has extended software defined radio (SDR) communication systems into cognitive radio systems. Software defined radio has been established as a key enabling technology to realize cognitive radio. Thus a cognitive radio is an SDR that is aware of its environment, and autonomously adjusts its operations to achieve the designated objectives. A cognitive radio system is able to sense, reason, learn and be aware of its environment. A dynamic communication application such as cognitive radio requires antenna researchers to design software controlled reconfigurable antennas. The tuning ability of such antennas and the switching time are important to satisfy the requirements of continuously changing communication channels. Neural Networks (NNs) arose as a perfect candidate to control these antennas through Field Programmable Gate Arrays (FPGAs). NNs represent a perfect solution to add learning and reasoning to the cognitive radio antenna systems.

In this work, a NN is applied on a reconfigurable antenna where switches are used to connect and disconnect the different parts of its structure. Reconfigurable antennas are potential candidate for cognitive radio since they are able to change their operating characteristics based on the channel activity. Applying NNs to such antennas result in the association of different antenna configurations with the various frequency responses. This association allows training the NN to be able to configure the antenna and regenerate switch combinations/frequency responses on demand. The NN is built and trained in Matlab Simulink and a Xilinx system generator creates the NN VHDL code to be transferred to the FPGA. The FPGA now controls the switches that are incorporated within the reconfigurable antenna structure.

The application of NN on cognitive radio antenna systems allows such systems to react swiftly to any change in their environment. The cognitive radio antennas will regenerate the appropriate switch combinations using NN previous training. This will allow communicating over the unoccupied parts of the spectrum which are called white spaces. The dynamic changes that occur in the spectrum require a robust and fast antenna software control. Thus NN prove to be a valid and necessary technique to employ on CR antennas.