Near Field Wireless Power Transfer (WPT) between Helical Antennas under Different Conditions of Orientation and Ground Plane Construction

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Our early measurements of WPT between identical helical receivers and transmitters in the 10 to 15 MHz range show that for identical ground planes, optimized pitch angle, and optimized height above ground, we are able to achieve a 66% power transfer at a distance of 15 cm for collinearly placed antennas. This investigation takes a closer look at WPT in conditions that not so ideal; where orientation of antennas with respect to each other varies and where ground plane construction of the platforms are of different size and shape.

Our first study involved looking WPT when the elements are collinear and the receiving antenna is rotated in steps through 360 degrees about its axis. While measured data shows slight variation in S21, simulations run by 3-D solver does not. We attribute this to either a small measurement error or an impact of the feeding structure. In conclusion both measured and simulated data seemed to indicate that as long as both antennas are collinear, we do not need to worry rotational orientation. It is also important to note how WPT can be impacted when the receiving antenna hovers around in the plane perpendicular to the longitudinal axis of the receiver (XY-plane). Simulations indicate, moving around in the X or Y direction by a couple of centimeters does not make that much of a difference in transferred power; however, moving more than a few centimeters will make a difference as expected. This indicates that a hovering platform will need to be properly aligned during the charging phase.

In in our experimental setup, both receiver and transmitter ground planes are rectangular and have different sizes; we investigated through simulation whether some WPT improvement could be made by using the same shape and size for both ground planes. The two shapes investigated were square and circular. Based on simulation results, the best coupling occurred for a ground that was circular in shape since fewer higher order modes would be generated in this case as a result of symmetrical boundaries. As a result of the study we are going to be using circular ground planes in our WPT experimental setups for the future.

Our work in past has helped in optimizing WPT systems that employ helical antennas; previously insights were gained in the optimal design of pitch angle and height above ground plane. The current investigations take this further by providing a better understanding of ground plane design and additional insights that relate to orientation.