Characterization of Body Perturbation Effects on the Sensitivity of a Body-Borne Radio Direction Finding/Geolocation System

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Abstract

As an increasing number of commercial and military technologies incorporate RF functions, a corresponding demand has been growing to generate solutions that identify and locate these devices. Some examples include laptops and wireless networks or personnel beacons for search and rescue applications. However, as they develop, there are also simultaneous trends towards the miniaturization, portability, and increased bandwidth of these electronics. While conventional direction finding systems require three sensors to unambiguously produce a direction finding solution and identify the angle of arrival of an incoming system, a two-element antenna system is evaluated for application to broadband (100-750 MHz) body-borne radio geolocation. Specifically, we will demonstrate how the body's presence near just two sensors generates a perturbation of the electric fields that can be exploited to improve the accuracy and reduce the ambiguities in a two-antenna direction finding system. This is accomplished by using the phase and amplitude of the detected signals independently to distinguish proper detections and ambiguities

Computer simulations of the antenna/body system are performed with both method of moments (MoM) and finite element method (FEM) to generate free-space and body-borne data, and are compared to measurements of prototypes. These data are used to evaluate the impact of the human body on the amplitude and phase of the detected signal. Sensitivity studies are conducted on several geometric variables, including the antenna-body spacing, the shape and size of the body phantom, the electrical properties of body phantom, and the antenna size and baseline separation. These studies are used to establish detection thresholds for using phase and amplitude to generate direction finding solutions.

Using these thresholds, calibration techniques are established to characterize the direction finding performance with two metrics: accuracy and false alarm/error rate. We will show that the presence of the body as a scatterer provides a marked improvement in direction finding accuracy and reduction of false alarm rates. Finally, these principles will be applied to notional non-human test cases to characterize the extension of the approach, as well as its implications for range determination using platform dynamics.