Body-Resonance Human Body Communication

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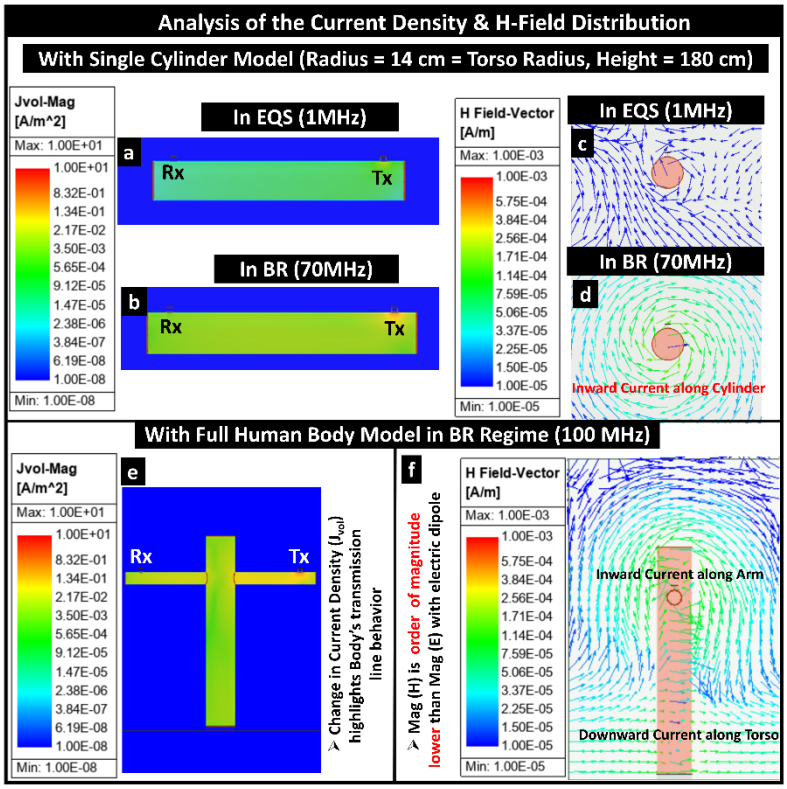
Supplementary Document:

Supplementary Discussion 1: Current Density and H-field Distribution:

We present a comparative analysis of the current density and magnetic field distribution via numerical electromagnetic analysis between the Electro-Quasistatics (EQS) and Body-Resonance (BR) frequency regimes, illustrated in Supplementary Fig. 1. When the operating wavelength (λ) greatly exceeds the maximum possible dimension of on-body channels (i.e., $\lambda >> l_{Body} \sim 2$ m, where l_{Body} represents body channel length) in the EQS regime, a consistent potential (V_{Body}) exists throughout the cylindrical body model, resulting in a uniform current distribution (J_{vol}). Conversely, in the BR regime, where λ becomes comparable to l_{Body}, there exist non-uniform current distribution within the conductor. This variability in current density (ΔJ_{vol}) inside the volume of the human body results in a potential gradient ($V_{Body} = f(z)$) along the dimension of the human body that affirms its conceptual modelling as a distributed conductor, delineated in Supplementary Fig. 1 (b, e).



Supplementary Figure 1: Comparison of current density inside and H-field distribution around the human body

Furthermore, the direction of the H-field indicates the direction of the current carried by the human body. In the EQS regime, the induced H-field is significantly lower than the induced E-field with an electric dipole, allowing us to disregard the influence of the H-field, shown in Supplementary Fig. 1 (c). Nonetheless, the shift in the direction of the H-field vector, as shown in Supplementary Fig. 1 (d, f), confirms the unbalanced, lossy transmission line nature of the human body, with the body as a signal conductor and the earth's ground acting as a ground conductor.

We have included animation plots illustrating the variation in H-field with frequency as Supplementary Movie 2 the variation in the transient response of E-Field as Supplementary Movie 3 with this manuscript:
https://github.com/SparcLab/BodyResonanceHBC