Modeling Multiferroic Antennas

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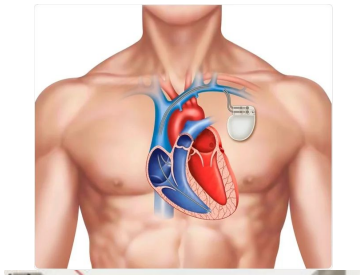
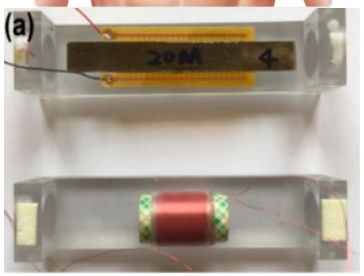
Thrust(s): 2D

MOTIVATION & GOALS

- Need for antennas in lossy environments
  - Medical: human body
  - Communication: sea water
- Multiferroic antennas are more effective in lossy media than conventional antennas
- Goal: Simulate multiferroic antenna in various applications and to understand its multiphysics nature





APPROACH

$$\mathbf{H}_M = \frac{j\Delta z M e^{-r\gamma}}{4\pi\mu\omega r^3} \cdot \left(2\left(1+r\gamma\right)\cos(\theta)\hat{r} + \left(1+\gamma r+\gamma^2 r^2\right)\sin(\theta)\hat{\theta}\right)$$

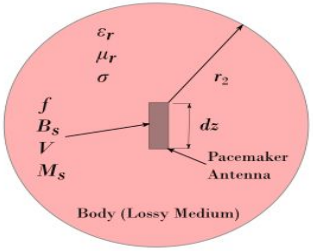
Magnetic Field Strength Equation

$$H_x(t) = |B|\beta_{xx}^T \sin(\omega t) + |B|\left(\frac{1}{\mu_0} - \beta_{xx}^T\right)\frac{\omega/\mathrm{a}}{(1+(\omega/\mathrm{a})^2)}\left\{\cos(\omega t) - e^{-\mathrm{a}t} + \frac{\omega}{\mathrm{a}}\sin(\omega t)\right\}$$

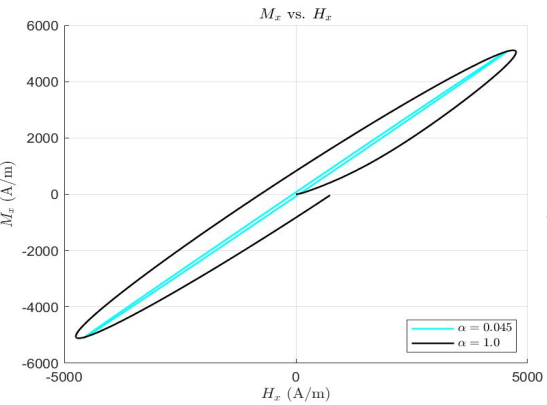
Analytical solution for harmonic magnetic flux in x-direction

DIPOLE ANTENNA

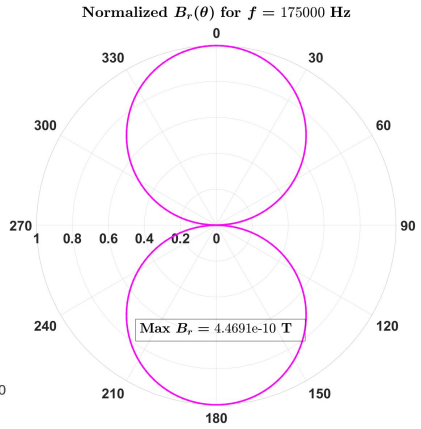
Incorporated properties of the lossy media and antenna to simulate performance in various applications such as in the heart



REPRESENTATIVE RESULTS



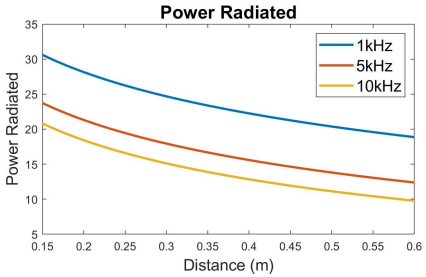
Finite Difference Algorithm of Magnetic Damping



Emitted Radiation Pattern

ACHIEVEMENTS

- Simulated radiation patterns and radiated power of TANMS pacemaker antenna
- Predicted magnetic damping and dissipated energy



FUTURE WORK

- Gauge validity of simulations with experimental data
- Improve FD algorithms by comparison to analytical solutions

EXPERIENCE

- Obtained a lab position over the summer/fall
- Practice with MATLAB
- Introduced to the research process
- Made lasting connections

TANMS