BIOSSENSOR DESIGN: INTRACRANIAL TUMOR TREATING FIELDS

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REU
PRESENTATION AGENDA

• ASU Training
• Problem Statement
• Proposed Solution
• Results
• Future Research
• Reflection
ASU TRAINING

```matlab
new = abs(fft(s1));
new1 = abs(fft(s2));
for k = 1:K
    % Compute indices for current frame
    m = (1:N)+(N*(k-1));
    % Signal 1
    subplot(211);
    plot(n,m,s1(m),'b','n,e(n),',r');
    msg=sprintf('%s Frame %d',infle1,k);
    title(msg);
    ylabel('Normalized Amplitude');
    xlabel('Sample index');
    % Signal 2
    subplot(212);
    plot(n,m,s2(m),'b','n,e(n),',r');
    msg=sprintf('%s Frame %d',infle2,k);
    title(msg);
    ylabel('Normalized Amplitude');
    xlabel('Sample index');
    % Pause between frames, waiting for keypress
    pause
end
```

Signal Reconstruction Analytically for $\omega_s = 2B$

\[
h(t) * x(t) \leftrightarrow H(\omega)X_s(\omega)
\]

\[
h(t) = \frac{1}{2\pi} \int H(\omega)e^{j\omega t}d\omega = \text{sinc} (Bt)
\]

\[
x(t) = \text{sinc}(Bt) \sum_{n=-\infty}^{\infty} x(nT)\delta(t-nT)
\]

Remark: Note that the reconstruction filter interpolates between the samples with sinc functions - hence the name interpolation filter.
PROBLEM STATEMENT

- Tumor treating fields are alternating electric fields that are a relatively new way to treat cancer (glioblastoma).
- When properly applied, these fields disrupt macromolecular protein structures thought to possess large dipole moments.
- Higher frequency/field strength is better, but the skull gets in the way (pain/heat).
- Problem: How to design a TTF system that allows for a stronger field?
PROPOSED SOLUTION

Metrics:
- Electric field strength
- Electric field directionality
- Thermal Effects
- Material properties
## RESULTS

<table>
<thead>
<tr>
<th>Metric</th>
<th>SR Remodeling</th>
<th>COMSOL</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Field Strength</td>
<td>1-3 V/m</td>
<td>3 V/m</td>
<td>Achieved using EM module – run current through</td>
</tr>
<tr>
<td>(V/M)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Field Directionality</td>
<td>MRI based array location</td>
<td>Fields Visible</td>
<td>- Need fields to change; location - Scan integration</td>
</tr>
<tr>
<td>Thermal Effects</td>
<td>Skin Rash</td>
<td>Unclear – SAR</td>
<td>- Encouraging results - Anatomical accuracy</td>
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MPh

Pythonic scripting interface for Comsol Multiphysics

Comsol is a commercial software application that is widely used in science and industry for research and development. It excels at modeling almost any (multi-)physics problem by solving the governing set of partial differential equations via the finite-element method. It comes with a modern graphical user interface to set up simulation models and can be scripted from Matlab or its native Java API.

MPh brings the dearly missing power of Python to the world of Comsol. It leverages the Java bridge provided by JPytype to access the Comsol API and wraps it in a layer of pythonic ease-of-use. The Python wrapper covers common scripting tasks, such as loading a model from a file, modifying parameters, importing data, to then run the simulation, evaluate the results, and export them.
REFLECTION

• First, thank you to the faculty that made this experience possible!
• Special thank you to Daniel Gulick and Professor Christen
• Experienced doing research in an academic setting
• Learned about an interesting method to develop biocompatible systems
• Increased my familiarity with the application of ML to sensor data problems
REFERENCES


