Matlab Based Ultrasound Imaging Simulations
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Background and Introduction:
Ultrasound Imaging Techniques
- Ultrasound waves used are typically in the range of 1-20 MHz
- As US waves travel through tissue they are partly reflected, transmitter, scattered, and transformed to heat. The amount of echo back is determined by the tissue property, Acoustic impedance.
- The intensity of the echo reflected is determined by the difference in acoustic impedance of two different tissue surface, thus forming an image boundary at tissue boundaries with large acoustic impedance differences such as bone and tissue.

Objective: Theoretically analyze the imaging process and propose improvement techniques, then verify the effectiveness of techniques using computer simulations in Matlab.

Why is it important?
- To improve current Ultrasound Imaging techniques for breast cancer diagnosis and analysis
- Using simulations in Matlab, we can test the effectiveness of techniques and measure the improvement in practice.

Sample simulation code in Matlab:
```
% 2-D simulation part
field = randn(500, 500); % field = padarray(field, [1 1], 0); %
field = 0.5 * field + 0.5; % field = field + field; %
for i = 1:100
    field = field + field; %
end
w = 0.25 * field; %
W = w.* w; %
```

Results:
- Learned how to use Matlab to simulate ultrasound waves in 2-D and 1-D
- Use of Matlab to perform complex calculations of data generated
- Understand the different types and techniques related to Ultrasound imaging

Future Work:
- Simulate 3-D ultrasound signals in Matlab
- Make phantoms in Matlab to measure the improvement in practice

Acknowledgements:
- 'ECE 472 course notes', Michael L. Oelze

<p>| Table 2.1: Acoustic impedances of different body tissues and organs. |</p>
<table>
<thead>
<tr>
<th>Body tissue</th>
<th>Acoustic impedance (10^6 Rayl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>0.0004</td>
</tr>
<tr>
<td>Lung</td>
<td>0.18</td>
</tr>
<tr>
<td>Fat</td>
<td>1.34</td>
</tr>
<tr>
<td>Liver</td>
<td>1.65</td>
</tr>
<tr>
<td>Blood</td>
<td>1.65</td>
</tr>
<tr>
<td>Kidney</td>
<td>1.63</td>
</tr>
<tr>
<td>Muscle</td>
<td>1.71</td>
</tr>
<tr>
<td>Bone</td>
<td>7.8</td>
</tr>
</tbody>
</table>

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