Electrode mesh refinement in EIDORS

Bartłomiej Grychtol\textsuperscript{1} and Andy Adler\textsuperscript{2}
\texttt{b.grychtol@dkfz.de}

\textsuperscript{1}German Cancer Research Center (DKFZ), Heidelberg, Germany
\textsuperscript{2}Carleton University, Ottawa, Canada

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Outline

1. Effects of electrode refinement in EIT
2. Electrode refinement in EIDORS
Effects of electrode refinement in EIT

Figure: Examples of (a) fine, (b) coarse and (c) refined meshes.
# Models overview

## Table: Mesh characteristics

<table>
<thead>
<tr>
<th>Model</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
</tr>
</thead>
<tbody>
<tr>
<td>global maxh [mm]</td>
<td>6.25</td>
<td>7.14</td>
<td>8.33</td>
<td>10</td>
<td>12.5</td>
<td>16.7</td>
<td>25</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>elec. maxh [mm]</td>
<td>6.25</td>
<td>7.14</td>
<td>8.33</td>
<td>10</td>
<td>12.5</td>
<td>16.7</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>16.7</td>
<td>12.5</td>
<td>10</td>
<td>8.33</td>
<td>7.14</td>
<td>6.25</td>
</tr>
<tr>
<td># elem. per elec. edge</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td># elements</td>
<td>1291473</td>
<td>1254681</td>
<td>633324</td>
<td>230947</td>
<td>160323</td>
<td>79787</td>
<td>19033</td>
<td>1983</td>
<td>3705</td>
<td>7893</td>
<td>14538</td>
<td>17778</td>
<td>23423</td>
<td>31188</td>
<td>38244</td>
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<tr>
<td># nodes</td>
<td>233640</td>
<td>224963</td>
<td>114363</td>
<td>43941</td>
<td>30642</td>
<td>15290</td>
<td>4047</td>
<td>524</td>
<td>874</td>
<td>1712</td>
<td>2956</td>
<td>3601</td>
<td>4692</td>
<td>6098</td>
<td>7436</td>
</tr>
<tr>
<td># elec. elem.</td>
<td>138</td>
<td>110</td>
<td>74</td>
<td>56</td>
<td>36</td>
<td>22</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>22</td>
<td>28</td>
<td>50</td>
<td>72</td>
<td>86</td>
<td>104</td>
</tr>
<tr>
<td>minEL&lt;sup&gt;a&lt;/sup&gt; [mm]</td>
<td>3.37</td>
<td>3.55</td>
<td>3.95</td>
<td>5.53</td>
<td>6.7</td>
<td>9.1</td>
<td>13.9</td>
<td>35.4</td>
<td>17.9</td>
<td>11.9</td>
<td>8.2</td>
<td>6.76</td>
<td>5.34</td>
<td>4.94</td>
<td>4.25</td>
</tr>
<tr>
<td>maxEL&lt;sup&gt;b&lt;/sup&gt; [mm]</td>
<td>15.4</td>
<td>15</td>
<td>19.1</td>
<td>25.2</td>
<td>30.9</td>
<td>41.4</td>
<td>52.3</td>
<td>103</td>
<td>96.1</td>
<td>84.2</td>
<td>85.5</td>
<td>82.7</td>
<td>75.3</td>
<td>73.5</td>
<td>74.4</td>
</tr>
<tr>
<td>minEV&lt;sup&gt;c&lt;/sup&gt; [cm³]</td>
<td>0.00825</td>
<td>0.00888</td>
<td>0.0146</td>
<td>0.0407</td>
<td>0.0565</td>
<td>0.139</td>
<td>0.514</td>
<td>8.03</td>
<td>1.55</td>
<td>0.303</td>
<td>0.123</td>
<td>0.0814</td>
<td>0.034</td>
<td>0.0234</td>
<td>0.0131</td>
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<tr>
<td>maxEV&lt;sup&gt;d&lt;/sup&gt; [cm³]</td>
<td>0.159</td>
<td>0.159</td>
<td>0.405</td>
<td>0.739</td>
<td>1.14</td>
<td>3.62</td>
<td>8.67</td>
<td>71.2</td>
<td>59.7</td>
<td>46.1</td>
<td>28.3</td>
<td>31</td>
<td>25.4</td>
<td>26.5</td>
<td>25.2</td>
</tr>
</tbody>
</table>

<sup>a</sup> length of the shortest edge; <sup>b</sup> length of the longest edge; <sup>c</sup> volume of the smallest element; <sup>d</sup> volume of the largest element.
Simulation

(a) Potential distribution

(b) Sensitivity distribution

Figure: Reference results obtained on model C0.
Sensitivity

Figure: Average sensitivity in the electrode plane in the vicinity of an electrode (ROIs SE and SI). All images use the same color scale.
Sensitivity

Figure: C0
Sensitivity

Figure: C1
Sensitivity

Figure: C2
Sensitivity

Figure: C3
Sensitivity

**Figure:** C4
Sensitivity

Figure: C5
Sensitivity

Figure: C6
Sensitivity

Figure: C7
Sensitivity

Figure: R2
Sensitivity

Figure: R3
Sensitivity

Figure: R4
Sensitivity

Figure: R5
Sensitivity

Figure: R6
Sensitivity

Figure: R7
Sensitivity

Figure: R8
Current near electrode

Figure: Current flow in the electrode plane (ROIs ME and MI). Arrows in each image are scaled individually.
Results

Figure: Errors with respect to model C0.
Electrode refinement in EIDORS 3.7

Functions

- `ng_mk_cyl_models`
Electrode refinement in EIDORS 3.7

Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
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Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
- `ng_mk_gen_models`
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Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
- `ng_mk_gen_models`
- `ng_mk_extruded_models`
Electrode refinement in EIDORS 3.7

Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
- `ng_mk_gen_models`
- `ng_mk_extruded_models`
- `place_elec_on_surf`
place_elec_on_surf
Building the head mesh
Before & After
Before & After
Conclusions

- Electrode refinement improves accuracy
- Electrode refinement decreases computation cost
- But, how much electrode refinement is required?
- EIDORS provides a free tool for electrode refinement on arbitrary shapes
- It’s not ideal, but we have a money-back guarantee.
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