Electrode Registration Error

1. Inputs:

   $\boldsymbol{scalpmesh}$: M mesh modes $(\boldsymbol{x_{Mesh,i}}, \boldsymbol{y_{Mesh,i}}, \boldsymbol{z_{Mesh,i}}), i = 1{:}M$
   $\boldsymbol{elecposition}$: $\boldsymbol{N}$ electrodes location $(\boldsymbol{x_{elec,j}}, \boldsymbol{y_{elec,j}}, \boldsymbol{z_{elec,j}}), j = 1{:}N$
   $M > N$

2. Purpose of electrode registration: best fitting electrode cap on scalp or minimize the distance between electrode cap and scalp

Error calculation algorithm

{

First, we need to find nearest mesh nodes corresponding to each electrode

For j=1: N
$\boldsymbol{argmin_i}$ **mean find the '$\boldsymbol{ith\ mesh\ point}$' which minimizes the phrase in** {…}
$$\boldsymbol{argmin_i}\left\{\sqrt{(x_{Mesh,i} - x_{elec,j})^2 + (y_{Mesh,i} - y_{elec,j})^2 + (z_{Mesh,i} - z_{elec,j})^2}\right\}, i = 1, \dots, M\ ,$$
$$(\boldsymbol{x2_{Mesh,j}}, \boldsymbol{y2_{Mesh,j}}, \boldsymbol{z2_{Mesh,j}}) = (\boldsymbol{x_{Mesh,i}}, \boldsymbol{y_{Mesh,i}}, \boldsymbol{z_{Mesh,i}})$$
End

$(\boldsymbol{x2_{Mesh,j}}, \boldsymbol{y2_{Mesh,j}}, \boldsymbol{z2_{Mesh,j}})$, $j = 1{:}N$

Error is calculated in two ways: distance_error and rms_error

- ✓ **distance_error : calculate mean (average) of all distances between electrode-mesh pairs**

$$\boldsymbol{distance\_error} = \left(\sum_{j=1}^{N}\sqrt{(x2_{Mesh,j} - x_{elec,j})^2 + (y2_{Mesh,j} - y_{elec,j})^2 + (z2_{Mesh,j} - z_{elec,j})^2}\ \right)/N$$

- ✓ **rms_error: calculate RMS error between electrode-mesh pairs**

$$\boldsymbol{rms\_error} = \sqrt{\frac{\sum_{j=1}^{N}(x2_{Mesh,j} - x_{elec,j})^2 + (y2_{Mesh,j} - y_{elec,j})^2 + (z2_{Mesh,j} - z_{elec,j})^2}{N}}$$

}

- ✓ **Rms_errror (matrix form definition)**

  $\boldsymbol{scalpmesh}$: $\boldsymbol{M * 3}$ mesh nodes

  $\boldsymbol{elecposition}$: $\boldsymbol{N * 3}$ electrode locations

%first find corresponding nearest mesh node to each electrode

For j $= \mathbf{1}$**: N**

$\boldsymbol{argmin_i}\{|\mathbf{scalp} - \mathbf{mesh}(\mathbf{i},:) - \mathbf{elecposition}(\mathbf{j},:)|^2\}$, **i=1: M** % | | *is abs*

$\boldsymbol{selected - scalpmesh(j,:) = scalpmesh(i,:)}$

$\boldsymbol{End}$

$\boldsymbol{P1 = elecposition}$ $\%\boldsymbol{N * 3}$

$\boldsymbol{P2 = selected - scalpmesh}$ $\%\ \boldsymbol{N * 3}$

%second: calculate root of mean of square of error

% error: distance or difference between two <u>locations</u> , $\boldsymbol{P1}$, $\boldsymbol{P2}$

$\boldsymbol{rms - error_{(p1,p2)} = \sqrt{sum_{:row}(sum_{:columns}(\ |p1' - \ p2'|^2)\ )/N}}$ **% ′ means transpose**