Electrode positions and current patterns for 3D EIT

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Goal: detect targets

H₀

EIT image

select ROI

Frequency distribution of measure

Statistic: $t$ or $z$

$P(\text{error})$

H₁
Detect vs. Distinguish

P(detection) vs. P(distinguish)
Detect vs. Distinguish

\[ z \Rightarrow P(\text{detect}) \]
\[ z = \text{SNR}(\text{target}) \]
\[ z \propto \text{Sensitivity} \]

\[ z \Rightarrow P(\text{distinguish}) \]
\[ z = \text{SNR}(\Delta \text{target}) \]
\[ z \propto \Delta \text{Sensitivity} \]
Detect vs. Distinguish

\[ Z^2 = \begin{cases} \sum_{v \in \text{stim pats}} S^2(v) \\ \sum_{v \in \text{stim pats}} \Delta S^2(v) \end{cases} \]
Stimulation patterns

Distinguishability is determined by:
- current stimulation amplitude,
- the accuracy of voltage measurement,
- stimulation and measurement patterns,
- the number and placement of electrodes.

\[ \Delta_{sm} : \text{Adjacent (} \Delta_{11} \text{)} \]
\[ \text{Opposite (} \Delta_{88} \text{)} \]
How about 3D 2-ring electrodes?

- **Some issues** on 3D EIT and total lung volume estimation.

- **Goal:** to investigate electrode geometries and stimulation and measurement patterns in to improve distinguishability.

- **Questions:**
  - Does the 2-ring electrode system provides any benefit over 1-ring electrode system?
  - Is there any particular electrode geometry?
  - What is the proper distances of 2-ring electrode separation?
Test design

- Simulation Eidors / Netgen.
- Homogenous tank with non-conductive objects.
  - **Volume**: cylindrical tank of 28cm of diameter and 30cm of height.
  - **Target objects**: 1 and two objects
Electrode geometries

Planar-offset

Zigzag

Zigzag-opposite

Planar-opposite

Zigzag-offset

Square
Test protocols

Tank

Simulations

Off-plane is 6 cm above the central-plane
Discussion

• 2-rings are better than 1-ring.
• Adjacent ($\Delta_{11}$) gives large off-plane effect.
• Patterns near opposite better.
• Proper layer spacing is required.

• Limitation: we need to test this on humans.
Warning: FEM simulations of sensitivity can be horrible