SEEG4D: An Open-Source SEEG Visualization Tool

TOMORROW

Connor Davey[4], James Evans[1,2], Matthew Bramlet[3,4], Eliot Bethke[1], Aaron Anderson[2,5], Graham Huesmann[2,5,6], Andres Maldonado[7], Jennifer Amos[1,6], Bradley Sutton[1,2,6]

1. Department of Bioengineering, University of Illinois Urbana-Champaign 2. Beckman Institute for Advanced Science and Technology, University of Illinois Urbana-Champaign
3. University of Illinois College of Medicine at Peoria 4. Jump Trading Simulation and Education Center 5. Department of Neurology, Carle Foundation Hospital, Urbana 6. Carle Illinois College of Medicine 7. Department of Neurosurgery, OSF Healthcare, Peoria, Illinois, USA

PROBLEM

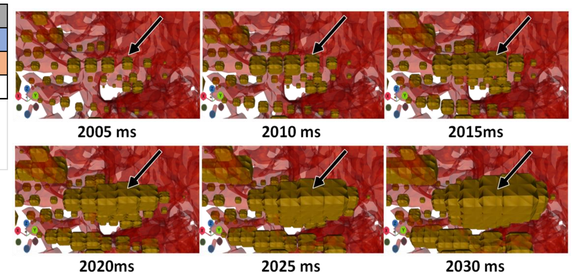
- Epilepsy is a one of the most common neurological conditions affecting over 50 million people worldwide.
- Over a third of patients diagnosed with epilepsy have symptoms which are not controlled by existing medications and are at increased risk of serious adverse events and premature death.
- Effective treatment for these drug-resistant patients is often surgical resection of the seizure onset zone (SOZ).
- Determining the SOZ involves multimodal imaging including: MRI, CT, and SEEG (electrophysiology data with stereoelectroencephalography), with depth electrodes placed into the patients' brain.
- Presently, clinicians manually review the data to from a mental model representation of the seizure for surgical resection. Virtual reality has been shown to improve mental representations of challenging medical models.

OUTCOME

- SEEG4D processed three cases identifying 271 contacts in total. We found that automatic contact detection had good agreement with the ground truth position from trained raters. Clinicians provided feedback indicating that this tool may provide significant impact in reducing the time required to process.

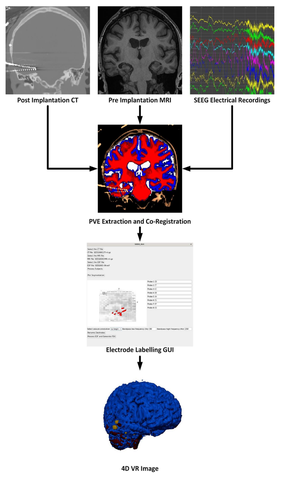
Average Distance per Contact (mm)					
SEEG1		SEEG2		SEEG3	
Rater 1	Rater 2	Rater 1	Rater 2	Rater 1	Rater 2
0.85 ± 0.68	0.71 ± 0.74	0.76 ± 0.60	1.0 ± 0.57	0.61 ± 0.62	1.0 ± 0.71

Raters Distance From Each Other (mm)		
SEEG1	SEEG2	SEEG3
0.94 ± 0.52	0.93 ± 0.40	0.98 ± 0.49



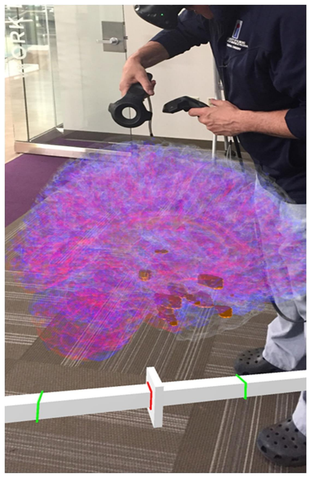
SOLUTION

- **We developed SEEG4D to merge clinical data into a dynamic, 4D (3D + time) model of seizure spread for virtual reality.**
- Our software is split into two components: a Python-based GUI to handle inputs and a Docker container to handle the neuroimaging pipeline and generate models for VR.
- Briefly,
  - SEEG4D registers the pre-implantation MRI to the post-implantation CT using FSL.
  - White matter, grey matter and cerebral spinal fluid are extracted automatically.
  - Then, electrode contact locations are extracted using a series of filters and erosions. Contacts are replaced by a representative of an ideal electrode contact.
  - Contact data is animated based on relative power over a sliding window compared to a global average and animated based on size.
  - 4D model (3D space and time) is viewed in Enduvo or other VR platform.



IMPACT

- We developed SEEG4D to automatically merge spatial and temporal data collected from SEEG studies and generate VR-ready visualizations of electrical activity during seizures. Our software provides the following benefits:
  - SEEG4D is a free, open-source software to facilitate collaboration and growth of the tool.
  - Contacts detected with SEEG4D are generally within 1 mm of ground truth raters.
  - Models generated from SEEG4D are ready to be loaded into virtual reality which better simulates the activity compared to a traditional approach.
  - Our models show signal propagation across electrode contacts.



OSF INNOVATION

OSF HEALTHCARE