



Project Checkpoint Presentation

Metal Artifact Removal in C-arm Cone-Beam CT

Group 4

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Mission

- Construction of various **brain phantoms** simulating endovascular treatment of aneurysms.
- Phantom CT image acquisition.
- **Quantitative data analysis** and assessment of (a) **image quality** and (b) **metal artifact removal** algorithm accuracy.

Clinical Relevance & Significance

Phantoms will simulate aneurysm treatment by 3 interventional radiography procedures: stent-assisted coiling, clipping and use of liquid embolic system.

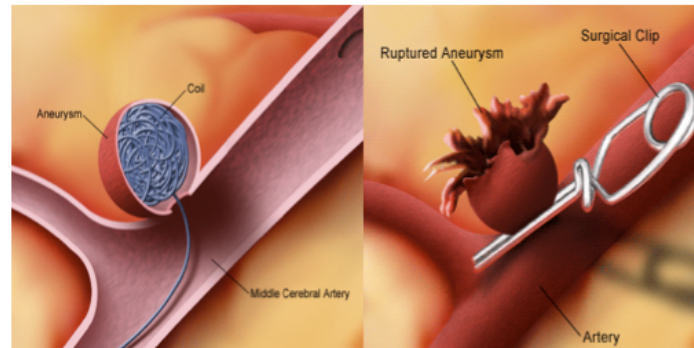


Image from hopkinsmedicine.org

Optimizing and quantifying image quality will ensure a safer, more accurate use of CT imaging in the surgical environment.

Original Plan: Project Stages

- **First Stage (minimum deliverables)**
 - Construction of phantom containing metals spheres
 - Obtain images in Bench CT System (I-Star lab) and Zeego (C-arm CT)
 - Data Analysis of image quality and MAR algorithm
- **Second Stage (expected deliverables)**
 - Construction of phantom containing coils and/or clips
 - Obtain images in Bench CT System (I-Star lab) and Zeego (C-arm CT)
 - Data Analysis of image quality and MAR algorithm
- **Third Stage (maximum deliverables)**
 - Construction of phantom containing liquid embolic system (ONYX)
 - Obtain images in Bench CT System (I-Star lab) and Zeego (C-arm CT)
 - Data Analysis of image quality and MAR algorithm

Original Plan:

Additional Maximum Deliverables

- **Image Acquisition**
 - Writing algorithm capable of transferring data between the Imaging Bench and the Zeego console.
- **MAR Algorithm**
 - Suggest and implement algorithm improvements
- **Data Analysis: MAR Segmentation Accuracy**
 - Segmentation algorithm improvement and suggestions

Adjusted Plan: Major Changes

- We have separated the second stage. There will now be four stages: (1) phantom with metal spheres, (2) phantom with coils & stents, (3) phantom with a clip and (4) phantom with liquid embolus.
- Image acquisition in the bench is not necessary. MAR can only be applied in Zeego workstation.
- We do not have access to MAR algorithm, therefore, improvements in the algorithms are no longer possible.

Completed Progress

- Construction and Image acquisition of first stage phantom:

Number of spheres	Material of metal spheres	Simulated metal object	Diameter (mm)
3	Titanium	Clips / nitinol stents	3.174, 6.35 and 12.7
3	316 Stainless Steel	Coils	3.174, 6.35 and 12.7
3	Tungsten Carbide	Platinum coils	3.174, 6.35 and 12.7

- A total of 9 metal spheres with varying materials and diameters were placed near the clivus individually and in various two-sphere configurations.

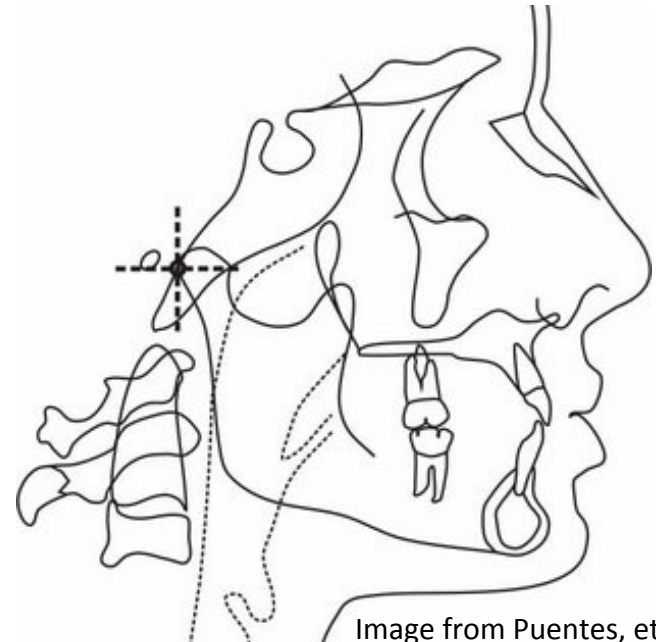
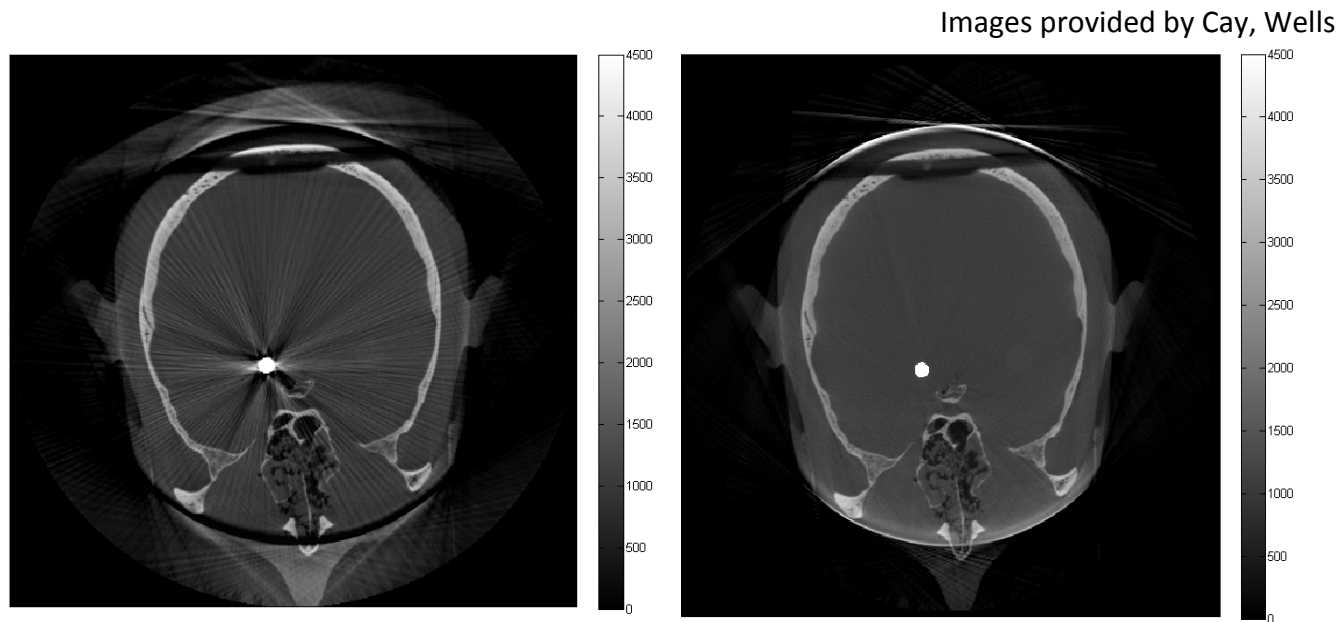


Image from Puentes, et.al.

Completed Progress

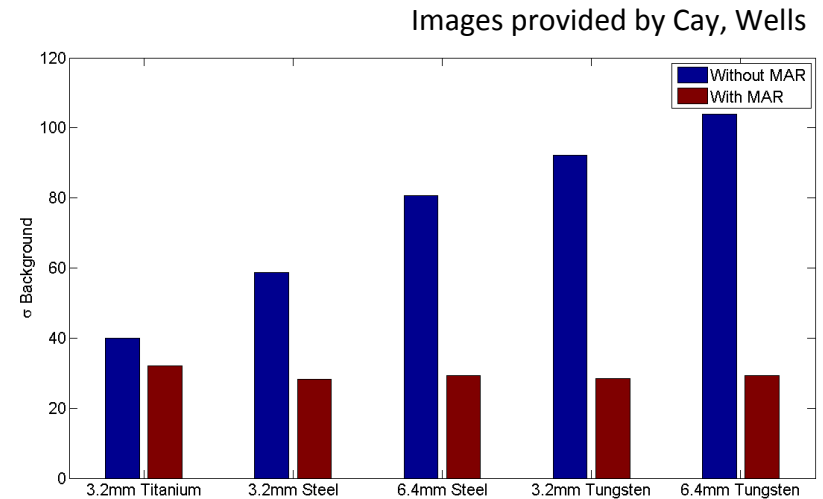
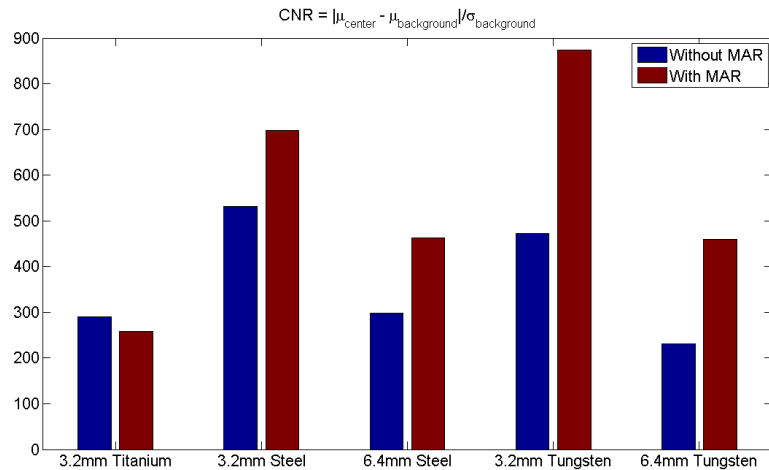
- MAR algorithm application of first stage phantom:



- 6.35 mm tungsten carbide sphere CT image before and after MAR algorithm application.

In-Progress

- Image quality and MAR algorithm analysis:



- Image Quality: Contrast-to-noise of various spheres

- MAR analysis: background noise before and after MAR correction

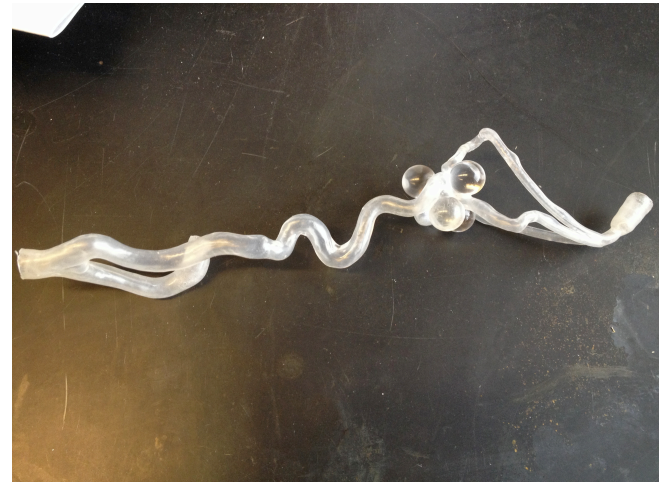
In-Progress

- Construction of second stage phantoms :

Images provided by Cay, Wells



- Cylinder phantom that contains varying iodine concentrations.



- Aneurysm vessel model and simulated blood clots.

Original Schedule

Task Name	week dates/number														
	2/17-2/23	2/24-3/2	3/3-3/9	3/10-3/16	3/17-3/23	3/24-3/30	4/1-4/6	4/7-4/13	4/14-4/20	4/21-4/27	4/28-5/4	5/5-5/11	5/12-5/14		
	4	5	6	7	8*	9	10	11	12	13	14	15	16		
1. First stage															
1.1 construction of phantom: metal sphere															
1.2 image acquisition: bench															
1.3 image acquisition: zeego															
1.4 data analysis															
2. Second stage															
2.1 construction of phantom: coils and/or clips															
2.2 image acquisition: bench															
2.3 image acquisition: zeego															
2.4 data analysis															
3. Third stage															
3.1 construction of phantom: ONYX															
3.2 image acquisition: bench															
3.3 image acquisition: zeego															
3.4 data analysis															
4. CIS course key dates															
4.1 project plan															
4.2 seminar															
4.3 project checkpoint															
4.4 poster session															
4.5 final report															

Adjusted Schedule

Task Name	week date/number							
	3/24-3/30	4/1-4/6	4/7-4/13	4/14-4/20	4/21-4/27	4/28-5/4	5/5-5/11	5/12-5/14
	9	10	11	12	13	14	15	16
1. First stage								
1.1 construction of phantom: spheres								
1.2 image acquisition: zeego								
1.3 data analysis								
2. Second stage								
2.1 construction of phantom: coils								
2.3 image acquisition: zeego								
2.4 data analysis								
3. Third stage								
3.1 construction of phantom: clip								
3.3 image acquisition: zeego								
3.4 data analysis								
3. Fourth stage								
3.1 construction of phantom: ONYX								
3.3 image acquisition: zeego								
3.4 data analysis								
4. CIS course key dates								
4.3 project checkpoint								
4.4 poster session								
4.5 final report								

Unplanned Dependencies

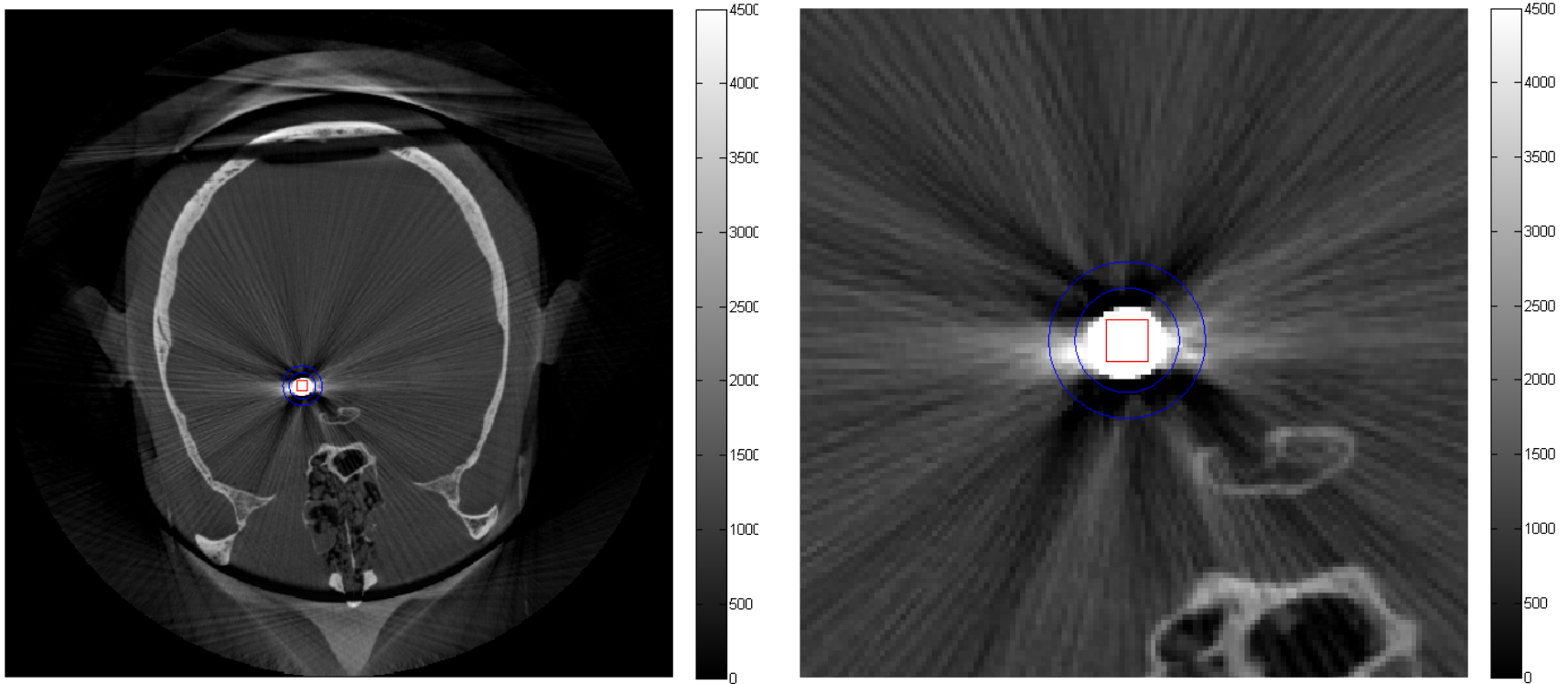
- Zeego C-arm was not calibrated. This introduced geometric artifacts in image. Had to be re-calibrated and images reconstructed.
- MAR algorithm application license expired, and algorithm implementation problems.
- Coiling, Clipping and ONYX procedures will each claim a vessel model.
- Heavily dependent on time with Dr. Radvany instead of Zeego.



Thank you

Questions?

ROI selection in 6.35 mm steel sphere



Images provided by Cay, Wells