LOW-COST AND PORTABLE MICROWAVE MEDICAL IMAGING FOR STROKE DETECTION

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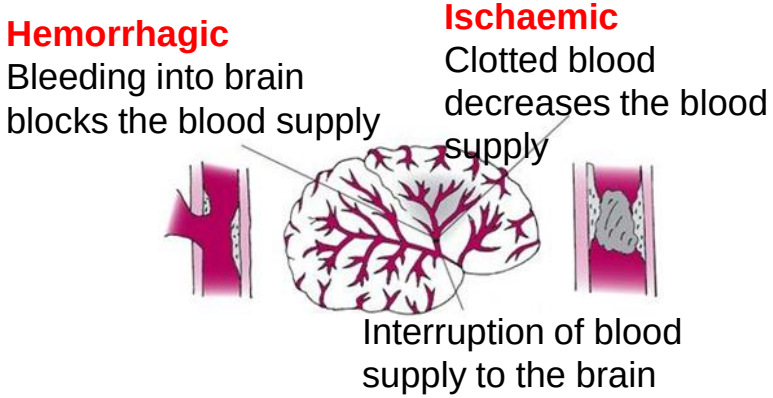
Outline

- Background
- Microwave stroke imaging system
- Numerical human head phantom in COMSOL
- Imaging results
- Measurement setup
- Conclusion

Background

- Two major classifications of strokes:



Current status of strokes

Fast increasing rate in low-medium income countries (e.g., China at 8.7%/year)

Lack of low-cost detection. Ultrasound wave, which is widely used for low-cost application, will be reflected by the skull.

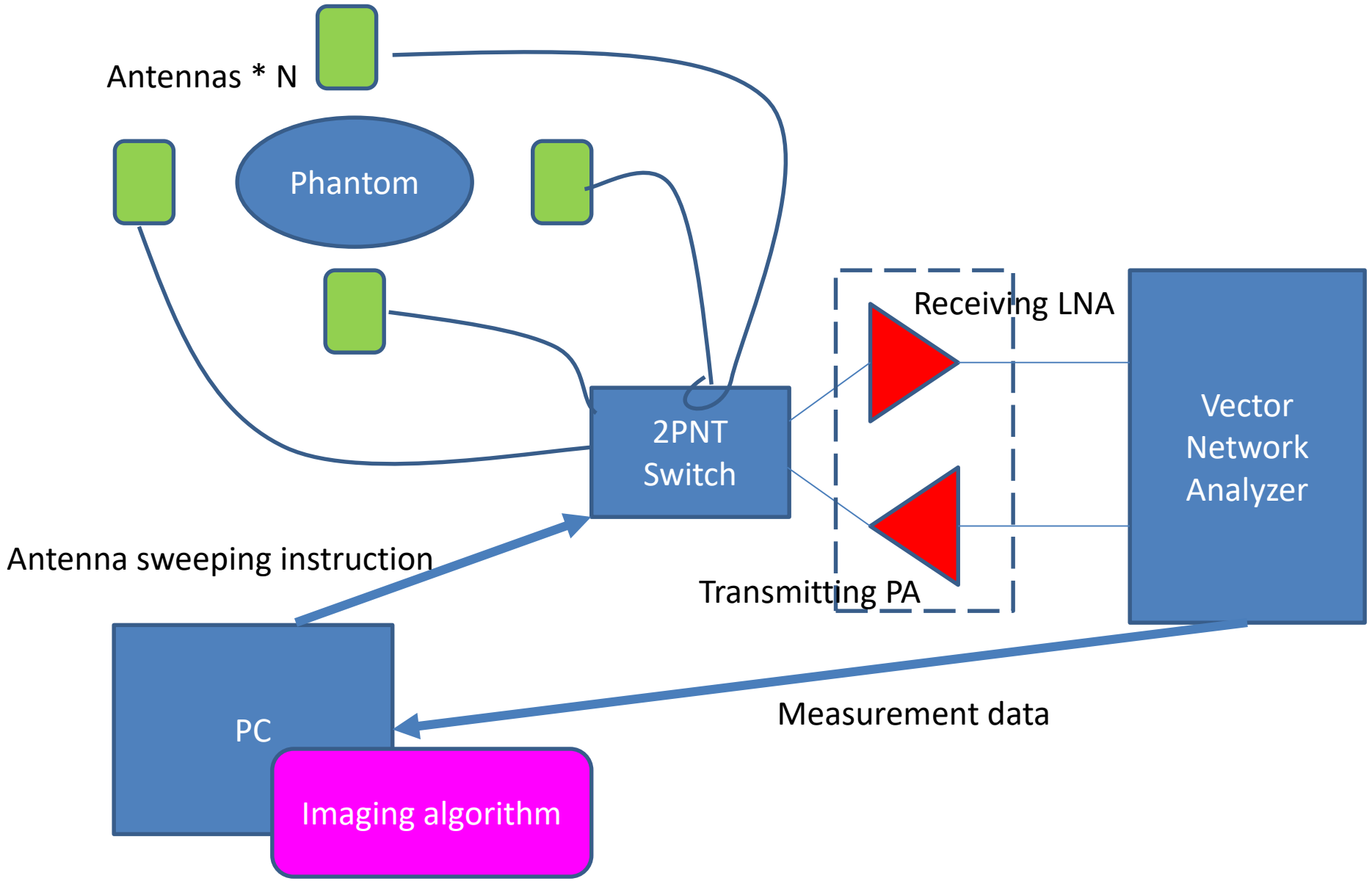
Rely only on CT and MRI technique, which is expensive, radioactive or time-consuming.

- Impacts of strokes:
  - Second leading cause to death;
  - Third leading cause to life-time disabilities.

Microwave Stroke Imaging System

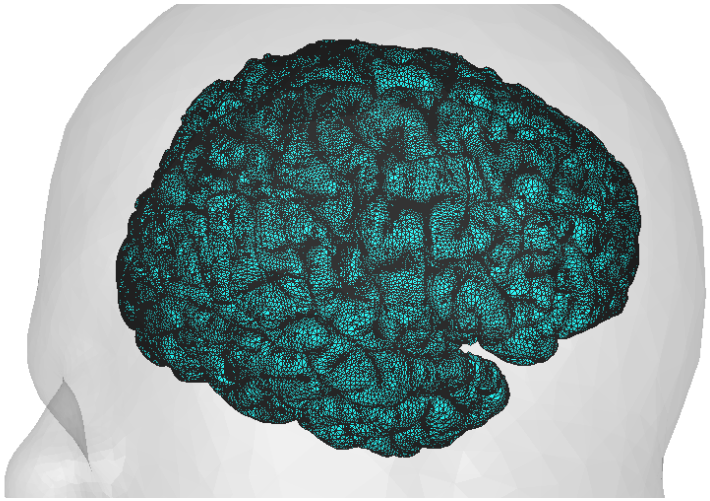
- Advantages:
  - Non-invasive, no ionising radiation;
  - Fast detection, high imaging resolution;
  - Detecting stroke while developing in its early stage;
  - Effectively assisting the conventional diagnostic methods;
  - Portable devices, low cost and easy to use for daily monitoring.
- Research gaps
  - System integration, replacing VNA with other devices for affordable civilian applications;
  - Setting up of the stroke-based neurological models, normalising diagnostic and judging method.

Microwave Stroke Imaging System



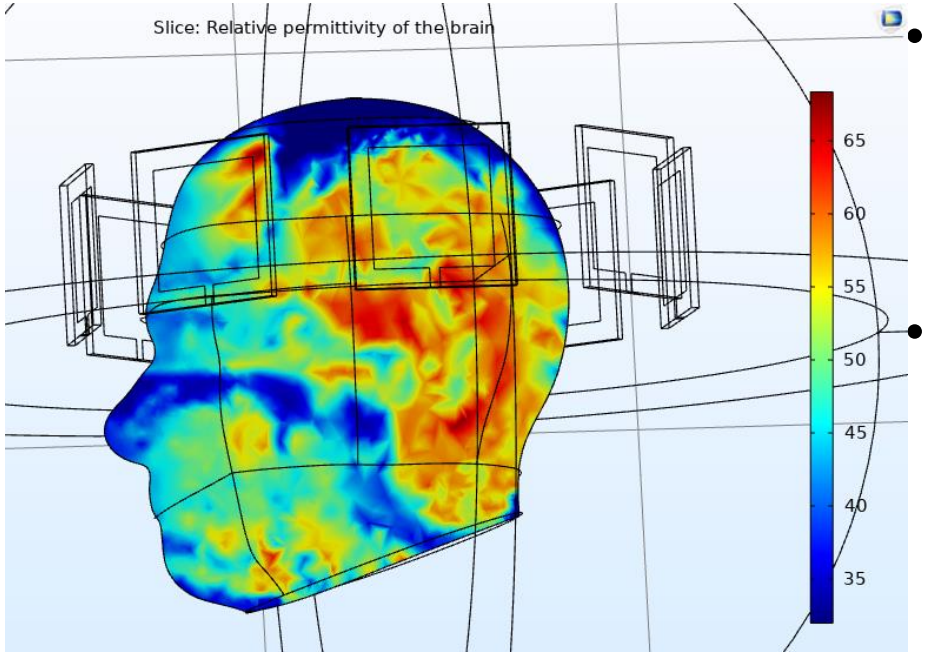
Numerical human head phantom in COMSOL

- Because of the complexity of human brain, it is computational expensive to do simulation with 3D model with numerous mesh cells.



Numerical human head phantom in COMSOL

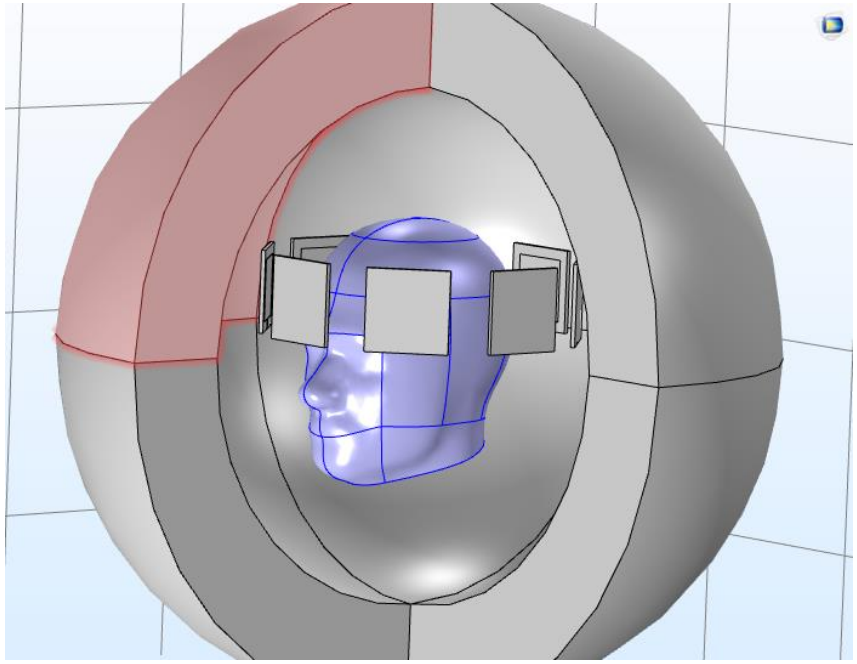
- Instead, by employing interpolation function in COMSOL, we could model a numerical phantom with different permittivity, but avoid complex meshing.



- The model samples material parameters with a volumetric interpolation function that estimates the variation of tissue type inside the head.
- That data file was created from a magnetic-resonance image (MRI) of a human head; these images contain 109 slices, each with 256-by-256 voxels: http://graphics.stanford.edu/data/voldata/

Numerical human head phantom in COMSOL

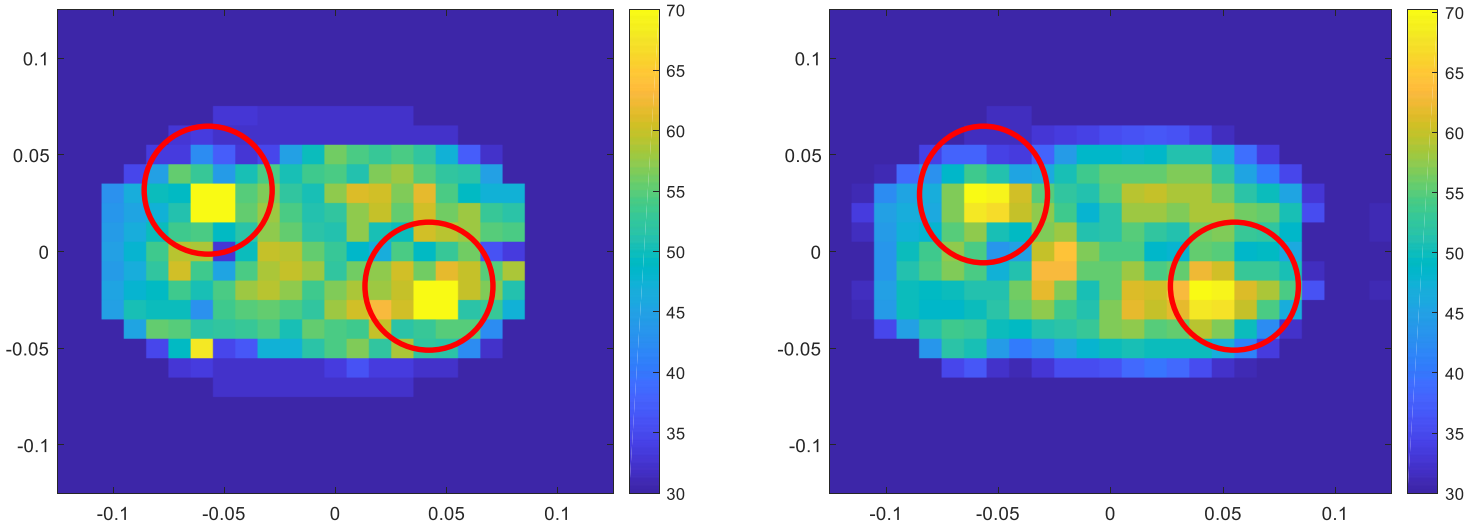
- By arranging 8 antennas around the numerical head phantom, we could simulate a 8 × 8 S-parameter matrix.



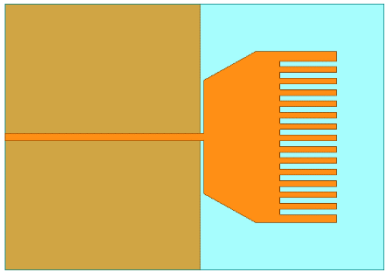
-0.37530+0.91766i	0.0017122-0.0032306i	0.0015134-0.0027765i	-7.0027E-4+6.5693E-5i	5.9618E-4-7.6118E-5i	1.6242E-4+1.7098E-4i	2.1122E-4+2.4925E-4i	6.8074E-4+3.5531E-4i
0.0017122-0.0032306i	-0.37431+0.91570i	-7.6067E-4+8.7308E-5i	0.0023966-0.0042167i	2.9744E-4+3.2922E-4i	6.0649E-4-7.7272E-5i	7.4809E-4+6.2843E-4i	1.6574E-4+1.6847E-4i
0.0015134-0.0027765i	-7.6066E-4+8.7287E-5i	-0.37581+0.91709i	-2.7070E-4-3.4580E-4i	-0.0019271+0.0030635i	7.5342E-4+6.2800E-4i	5.0216E-4+5.3680E-5i	2.1173E-4+2.5356E-4i
-7.0028E-4+6.5692E-5i	0.0023966-0.0042167i	-2.7070E-4-3.4580E-4i	-0.37151+0.91278i	8.2438E-4+8.4525E-4i	-0.0023959+0.0042525i	2.8554E-4+3.3162E-4i	7.1954E-4-6.1061E-5i
5.9619E-4-7.6113E-5i	2.9744E-4+3.2923E-4i	-0.0019271+0.0030635i	8.2438E-4+8.4525E-4i	-0.37480+0.91693i	-3.1016E-4-3.1903E-4i	0.0019235-0.0030696i	-5.9834E-4+8.0750E-5i
1.6242E-4+1.7098E-4i	6.0649E-4-7.7262E-5i	7.5342E-4+6.2800E-4i	-0.0023959+0.0042525i	-3.1016E-4-3.1903E-4i	-0.37484+0.91540i	-7.9996E-4+8.9234E-5i	0.0016698-0.0032939i
2.1123E-4+2.4925E-4i	7.4811E-4+6.2843E-4i	5.0216E-4+5.3687E-5i	2.8554E-4+3.3163E-4i	0.0019235-0.0030696i	-7.9996E-4+8.9225E-5i	-0.37511+0.91736i	0.0014736-0.0027928i
6.8075E-4+3.5531E-4i	1.6575E-4+1.6847E-4i	2.1173E-4+2.5356E-4i	7.1954E-4-6.1061E-5i	-5.9834E-4+8.0752E-5i	0.0016698-0.0032939i	0.0014736-0.0027928i	-0.37539+0.91757i

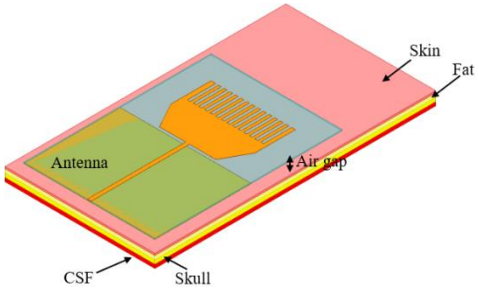
Imaging results

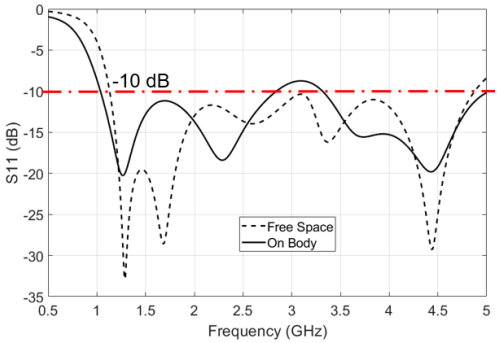
- In the numerical experiment, we have two 1 mm square bleeding point in the head (original data in the **left**). Through SOM inverse imaging algorithm, these two bleeding point is clearly shown in the reconstructed image (reconstructed data in the **right**).



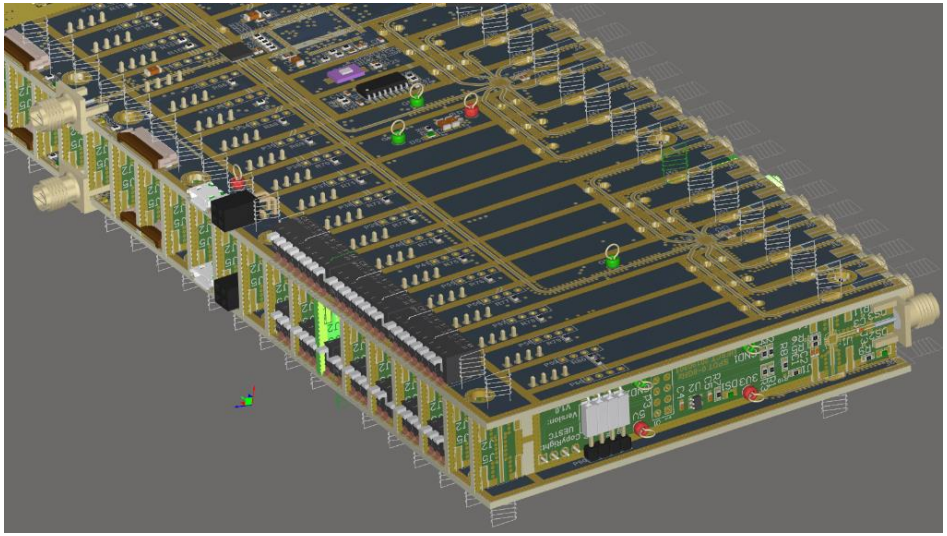
Measurement setup (up to come)







Antenna



Switch Matrix

Lab equipments

Conclusion

- Microwave imaging provides a feasible way to low-cost detection of strokes.

- COMSOL is a powerful simulation tool with much flexibility.