3D Radiation Source Localization in Augmented Reality

Ian Fischer, Dhruv Garg, Akshaya Jagadeesh, Kimi Weng
Undergraduates, University of Michigan
Sara Pozzi, Ricardo Lopez, Oskari Pakari
Department of Nuclear Engineering and Radiological Sciences

Introduction and Motivation

- **Radiation source localization** is a difficult yet important task with applications in emergency scenarios, treaty verification, and routine rad safety
- We present developments towards **3D radiation source localization using multiple radiation imagers**
- As an alternative, we explore the use of **neural networks to predict angular incidence** of radiation
- We showcase **visualizations of these data in augmented reality (AR)** using a head-mounted device

Mission Relevance

This work:

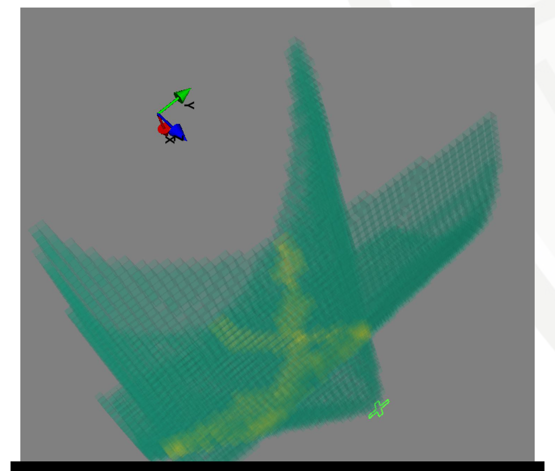
- Supports NNSA in its mission for novel nuclear nonproliferation technologies
- Develops software that improves user experience for radiation perception

MTV Impact

Our team had the opportunity to conduct this research due to the MTV Fellowship.

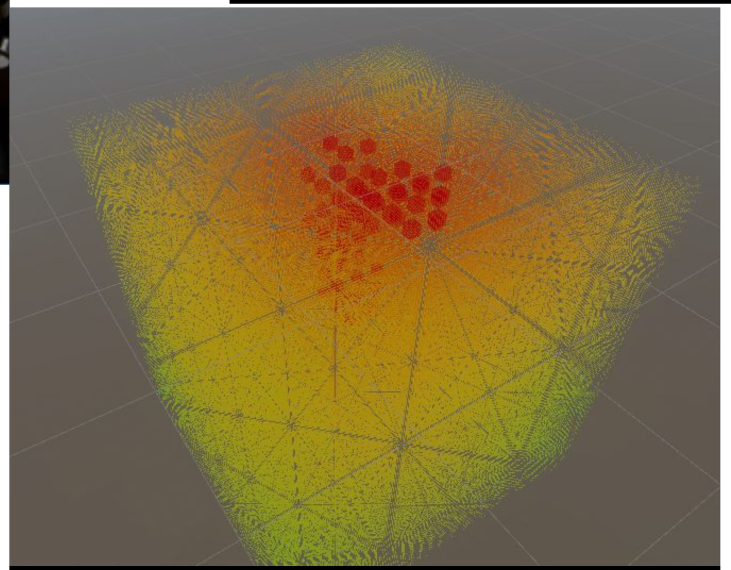
Detector system: H2DPI

- Compact detector system for neutron and gamma ray imaging
- 12 organic glass scintillator ($6x6x50mm^3$)
- 8 CeBr3 inorganic scintillators ($6x6mm^2$)



3D view of two cones

H2DPI (lid open)



Simulated 3D space with source

Technical Approach

Fast Angular Incidence Prediction

- A neural network was trained with MCNP Polimi data
- Utilizing count rates in the detectors as an input, we can now predict the angular incidence of radiation in seconds

3D Source Localization Algorithm

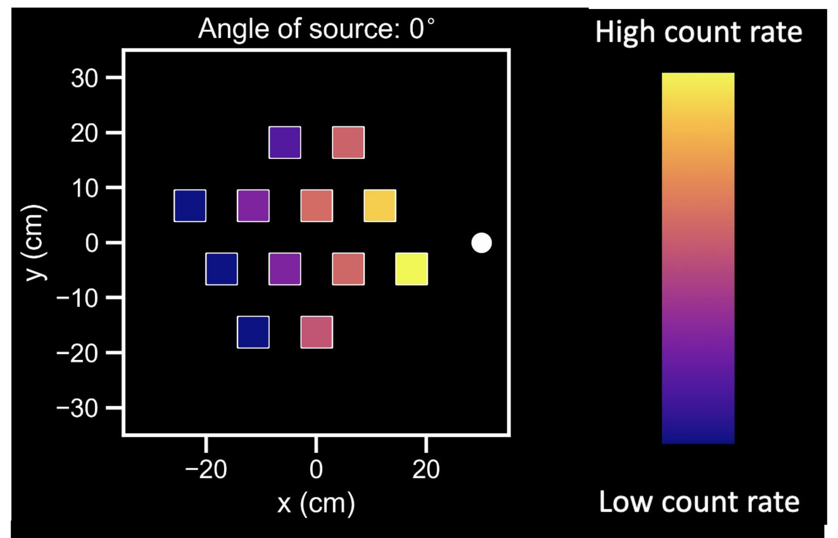
- Double scatter events describe cones, intersections of cones indicate source location
- Randomly sample cones to account for event uncertainty
- Favorable weighting of intersection zones to boost localization precision

Angular incidence AR Visualization

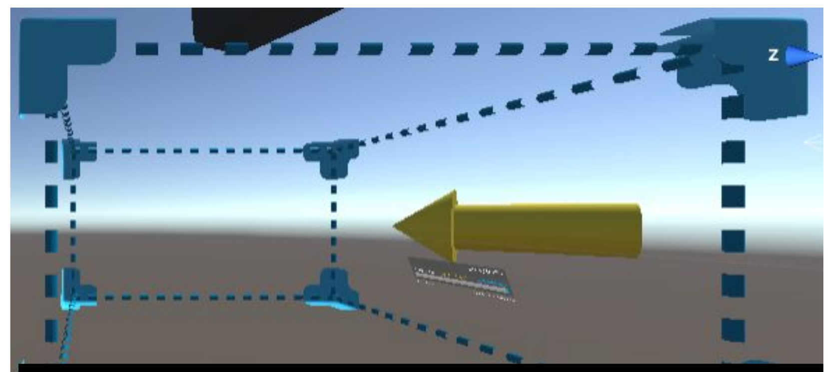
- Output of neural network is a vector pointing at the predicted source incidence angle
- In AR, we display the vector as an arrow, guiding the user towards a source

3D AR Visualization

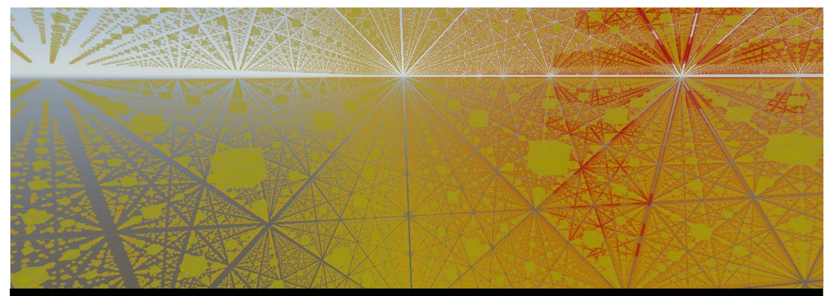
- Retrieve cone data as 3D coordinates and construct 3D space for visualization
- Localize 3D structure in AR
- Create user experience that conveys radiation informatively



Count rates in detector array

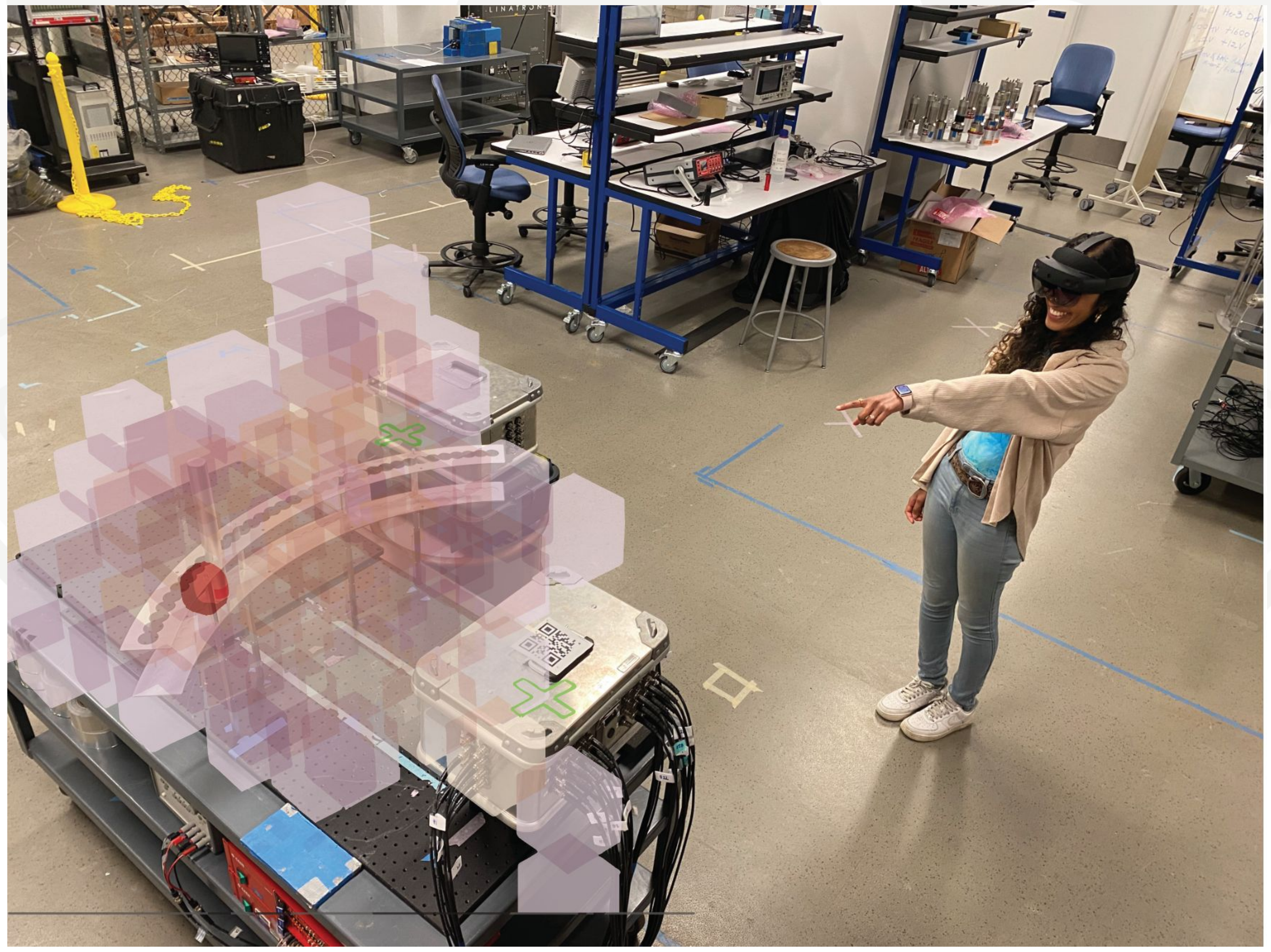


Angular incidence in AR



Simulated first person AR view

Results



Visualizing radiation source localization with Microsoft HoloLens2

Conclusion

- Developed algorithms that localizes radiation sources in 3D and displays results in AR
- Utilizing the neural network, achieved 98% location accuracy on dense simulated data and around 70-80% accuracy on sparse experimental data

Next Steps

- Validate with experiments
- Tune the parameters (score boost, # samples / event) of source localization algorithm
- Create data pipeline for real time intuitive 3D source localization in AR

This work was funded in-part by the Consortium for Monitoring, Technology, and Verification under DOE-NNSA award number DE-NA0003920

National Nuclear Security Administration