Development of a Novel Random Coded Aperture Mask

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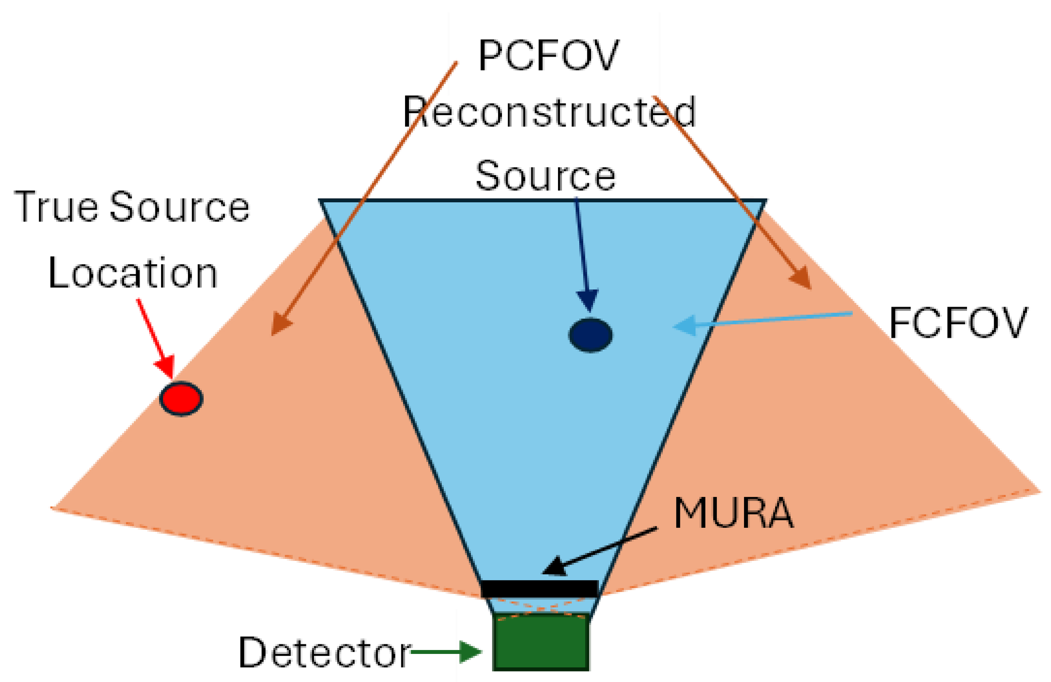
Introduction and Motivation

- Modified uniformly redundant array (MURA) masks are one of the most utilized coded-aperture masks due to their mask anti-mask symmetries, high resolution capability, and quick/cheap localization capability.
- MURA's have problems with ghost artifacts in the partially coded field of view (PCFOV).
- Develop a new pseudo-random coded aperture mask while retaining the MURA benefits and eliminating the problem in the PCFOV.

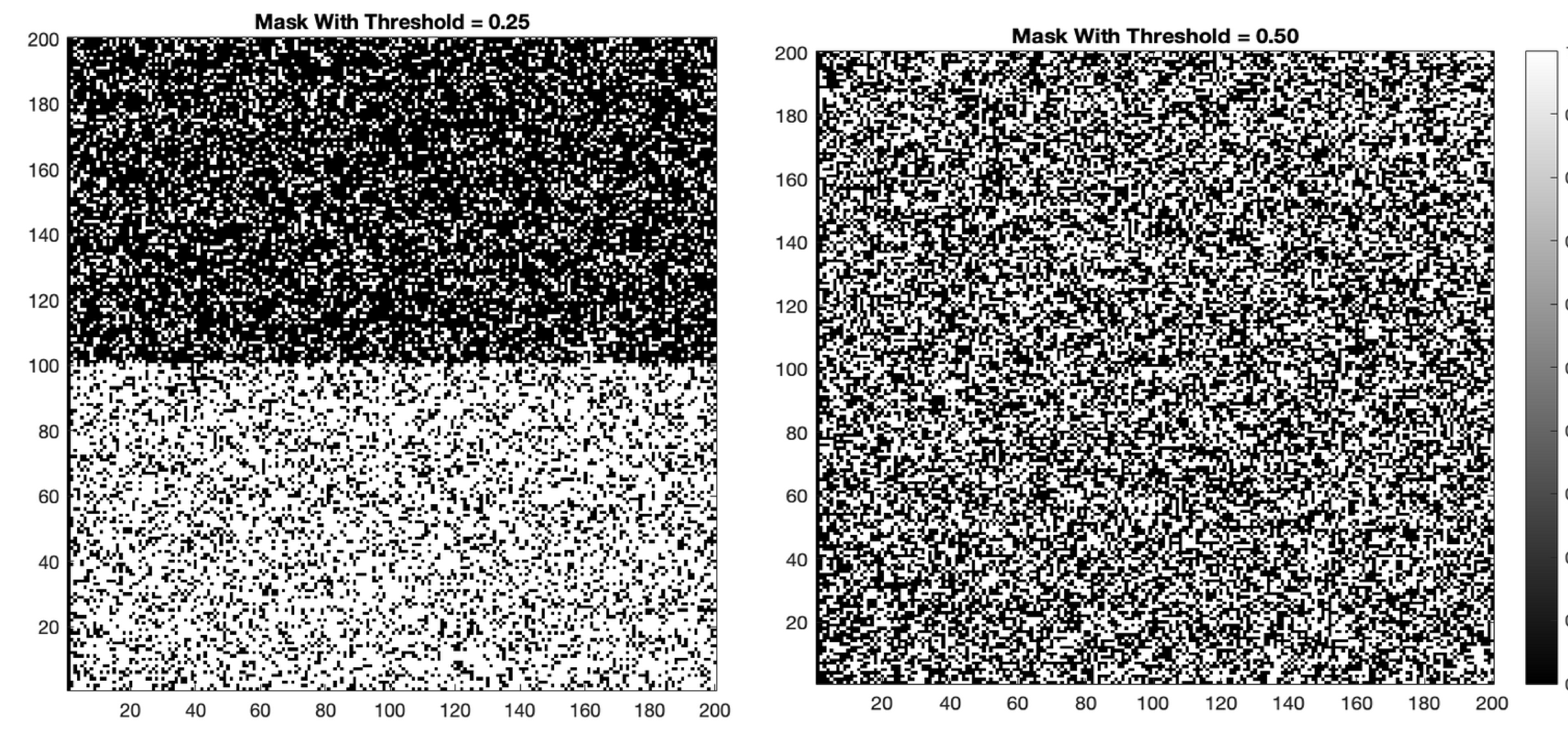
Technical Approach

- MURA ghost artifact can be seen below. This is due to the redundant nature of the MURA.
- To design a random mask that maintains mask anti-mask symmetry, 50% of the mask is generated randomly with a specified open-hole fraction (OHF) then flipped 180° and inverted.



Visualization of the reconstructed "ghost" source in the fully coded field of view when the source is in the partially coded field of view.

- Example random masks are shown with two different OHF. The right is 50% OHF and the left is 25% OHF shown for visualization of mask anti-mask symmetry.

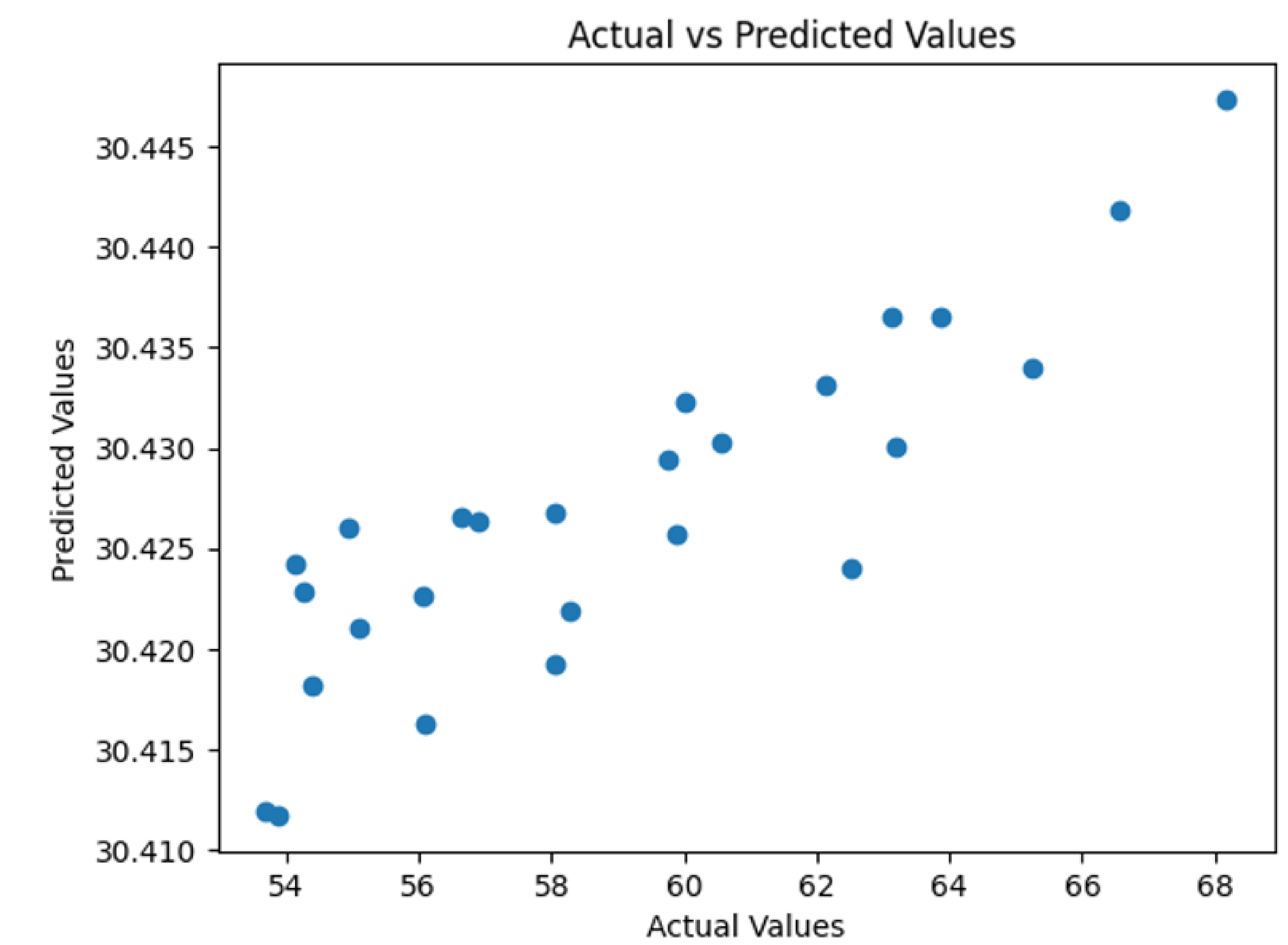


Two random coded aperture masks, the left has the a starting OHF of 25% the right has an OHF of 50%.

- Cross-correlation is used to determine background noise which is used for a mask performance metric.
- The recorded mask pattern is smaller than the true mask pattern, so multiple measurements are taken for all possible recorded mask patterns, and the background noise is averaged for all mask patterns.
- A convolutional neural network (CNN) is being implemented to estimate the background noise for a generated mask.

Results

- There is a clear linear relationship between actual value and predicted value for the CNN.
- The predicted value is still too small and concentrated.
- Proves the data is trainable on the existing CNN.



Visualization of the training data fitting the correct trend for random coded aperture mask's performances.

Impact/Next Steps

- Increase the amount of training data and optimize the CNN and its hyper parameters.
- This work will provide a superior alternative to MURA masks for gamma-ray imaging allowing for more accurate measurements to be taken for low energy gamma-ray sources.

Conclusion/MTV Impact

- This work shows the ability to train a CNN to estimate performance of pseudo-random coded-aperture masks.
- The MTV consortium has facilitated in learning from other universities and national labs by hosting conferences where novel work and results are presented.

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