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Northeastern University

High capacity millimeter wave sensing for quasi-real-time imaging

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SICA-LAB

ALERT
AWARENESS AND LOCALIZATION OF EXPLOSIVES-RELATED THREATS

Abstract

- Current checkpoints are unable to keep up with the number of air travelers through security screening
- New standoff threat detection mechanisms can solve this problem such as millimeter waves
- New innovations in the field such as compressive sensing and metamaterials can increase the probability of detection of threats
- This work highlights the development of these technologies into a quasi-real-time 3D imaging system

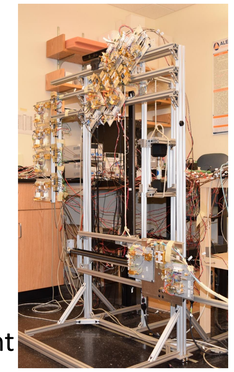


Figure 1. Millimeter wave Imaging System

Background

Current Checkpoint

- Millimeter wave scanning detector capable of ~300 people per hour
- Significant passenger divesture and re-collection
- Threat detection is not automated
- No cooperation amongst the different technologies used

Future Checkpoint

- Screening of 300+ passengers and carry-on belongings
- Passengers walk at a normal pace through checkpoint
- No divesture of clothing or removal of electronics from carry-on


Figure 2. Current Checkpoint


Figure 3. Future Checkpoint

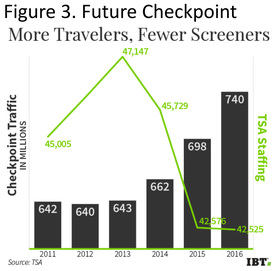


Figure 4. TSA Screeners

Methodology

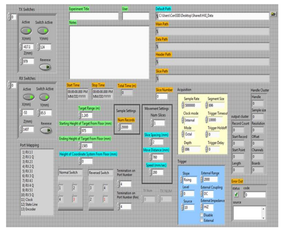


Figure 5. Custom DAQ Interface

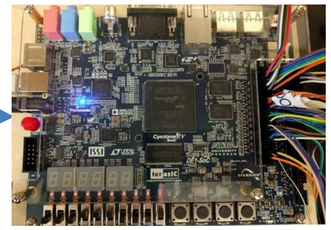


Figure 6. Custom Switching Controller

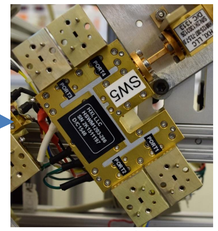


Figure 7. Switch Data Collection

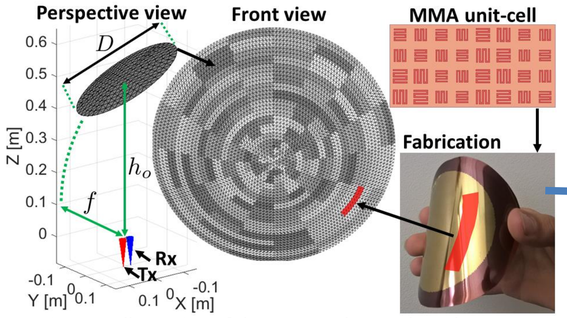


Figure 8. Illustration of the proposed MMA-based compressive reflector antenna (CRA)

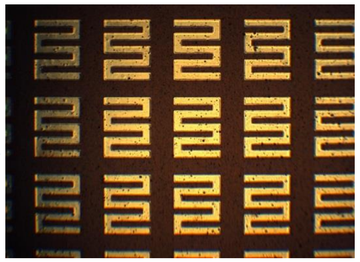


Figure 9. Fabricated Meander-line MMA

Data and Analysis

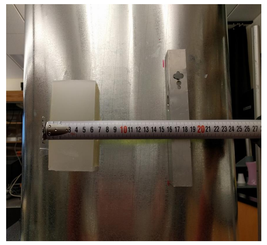


Figure 10. Imaging Geometry

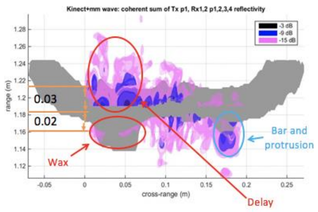


Figure 11. 3D Imaging with Kinect Overlay

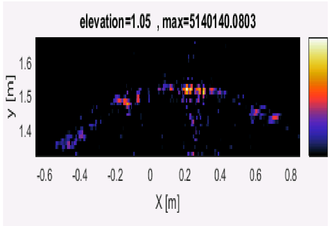


Figure 12. Static Imaging of Plate

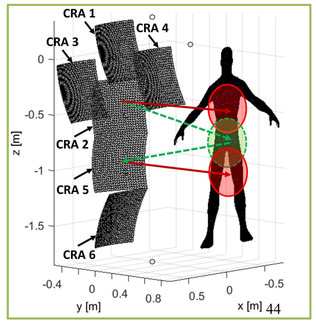
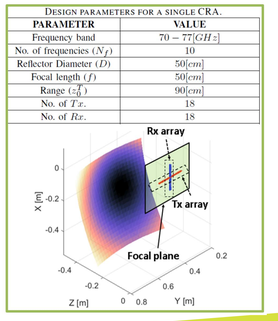


Figure 13. High capacity array of CRAs


DESIGN PARAMETERS FOR A SINGLE CRA.

PARAMETER	VALUE
Frequency band	$70-77[GHz]$
No. of frequencies (N_f)	10
Reflector Diameter (D)	$50[cm]$
Focal length (f)	$50[cm]$
Range ($z_0^{\max}$)	$90[cm]$
No. of Tx.	18
No. of Rx.	18

Figure 14. Design parameters of a Single CRA

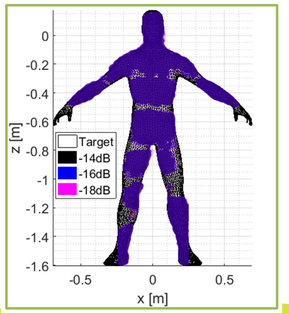


Figure 15. Reconstructed image

Data and Analysis

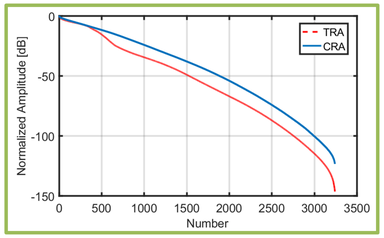


Figure 16. Singular value distribution

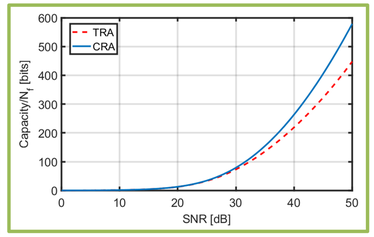


Figure 17. Sensing capacity

Conclusion

- Baseline work to perform static imaging has been performed
- Future work will include improving this imaging by using high capacity multi-coded compressive sensing system

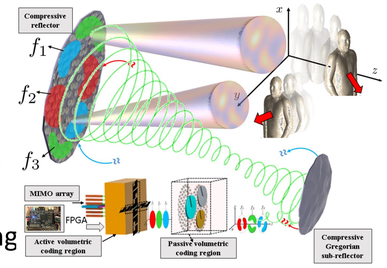


Figure 18. Multi-coded sensing system

References

- Molaei, Ali, et al. "Active imaging using a metamaterial-based compressive reflector antenna." Antennas and Propagation (APSURSI), 2016 IEEE International Symposium on. IEEE, 2016.
- Bisulco, Anthony, et al. "Massive MIMO Millimeter Wave Radar Imaging System." Antennas and Propagation (APSURSI), 2016 IEEE International Symposium on. IEEE, 2016.

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