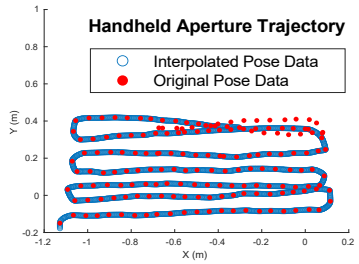
ViSAR: A Mobile Platform for Vision-Integrated Millimeter-Wave Synthetic Aperture Radar

UNIVERSITY OF South Carolina

Jacqueline Schellberg
Sanjib Sur

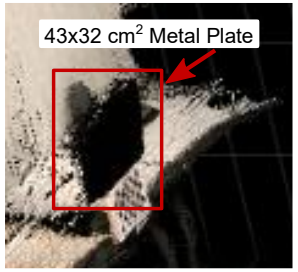
Handheld Millimeter-Wave Imaging: Motivation and Challenges

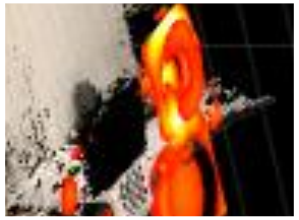
- Handheld through-obstruction 3D imaging can be used to survey construction sites without damaging property, enable nonintrusive package inspection, aid disaster relief efforts, monitor post-surgery progress beneath the skin, and more.
- **Synthetic Aperture Radar (SAR) imaging is difficult to implement on portable devices**
  - SAR uses the motion of a radar to generate a through-obstruction millimeter-wave (mmWave) image
  - **Precise motion tracking equipment is often bulky and expensive**



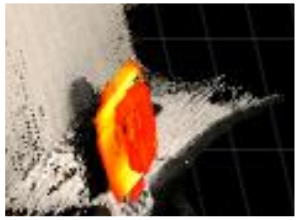
Challenges with Smartphone to Radar Synchronization

- **We propose that ViSAR collects pose data using a smartphone while a radar samples the scene**
- The radar collects samples at a higher rate than the smartphone
- The radar cannot be triggered at the same time as the smartphone
- **ViSAR synchronizes the radar and pose data during post-processing**





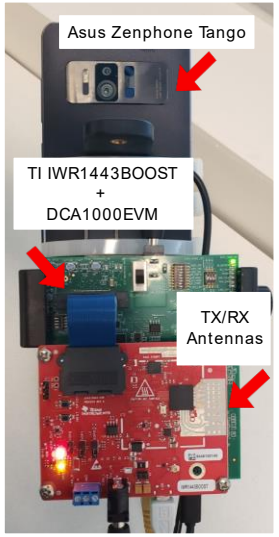
mmWave image without synchronization



mmWave image with correct synchronization

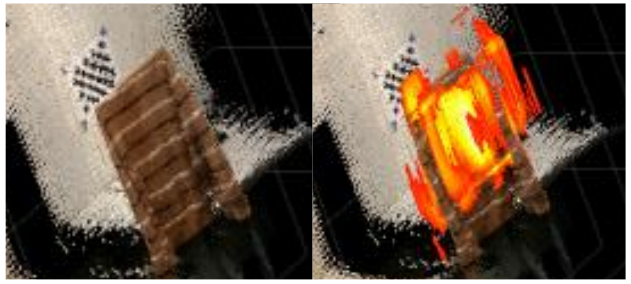
ViSAR Design

- **ViSAR leverages off-the-shelf components and algorithms to account for non-linear handheld motion**
- ViSAR includes a mmWave radar and a smartphone capable of self-positioning and visual point cloud (PCD) generation
- The user generates a handheld aperture in front of a region of interest while the vision PCD forms in real-time
- ViSAR uses a **Time Domain Backprojection algorithm** that generates a mmWave image directly onto the PCD



Conclusion and Future Works

- **ViSAR enables handheld vision-augmented mmWave imaging**
- **mmWave images reveal the location of objects in the context of the vision PCD**
- Compressed sensing and SAR autofocus can improve image resolution
- Hyperspectral images can provide additional insight to material properties



ViSAR identifies metal plate hidden beneath sweater