Accurate Device Self-Tracking for Robust Millimeter-Wave Imaging on Handheld Smart Devices

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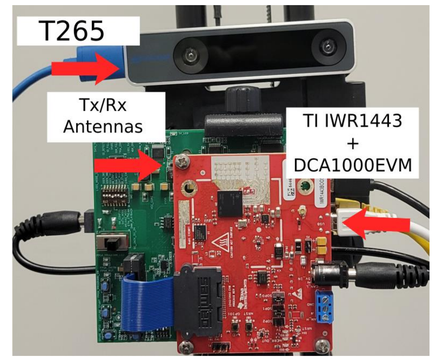
Handheld Millimeter-Wave Imaging Challenges

- Handheld millimeter-wave imaging would enable through-obstruction object identification for inventory accounting and physical screening
- The Synthetic Aperture Radar (SAR) technique generates millimeter-wave (mmWave) images using the motion of a mmWave device
- **The SAR technique is difficult to adapt to handheld mobile devices**
  - SAR requires poses that have millimeter-scale accuracy
  - Most precise motion tracking devices are too bulky and expensive

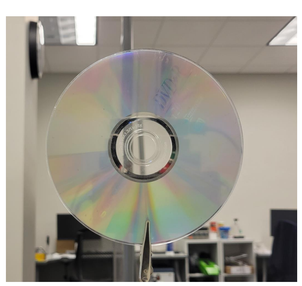
MmWave-Based Pose Corrections Challenges

- **Device pose error is too large for traditional SAR motion compensation**
- Incorrect poses cause the mmWave signals to combine destructively
- MmWave-based motion tracking methods only work along an antenna separation
- **We propose CompenSAR that leverages the mmWave signals to correct large pose errors**

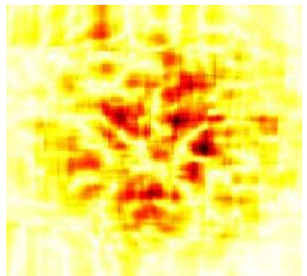


Velocity Estimation and Pose Corrections

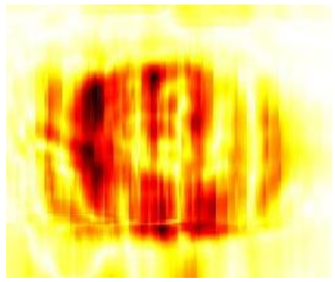
- System includes vision-based self-tracking device and multi-antenna mmWave device to simultaneously collect poses and mmWave reflections
- CompenSAR divides the initial pose trajectory into segments
- Velocity estimation from multiple antennas generates locally accurate poses
- **Global pose correction registers pose segments to coherently combine**



Ground truth optical image



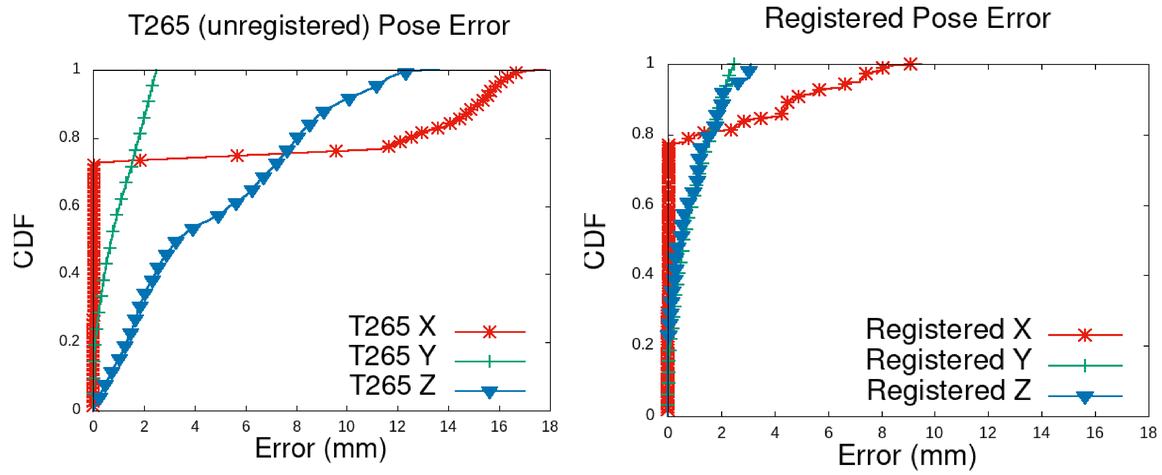
MmWave image using uncorrected poses



MmWave image using corrected poses

Conclusion and Future Work

- **CompenSAR reveals features in the mmWave shape**
- It performs drift correction on the pose and accurately self-tracks the device
- **Future Work:** Conditional Generative Adversarial Networks could be used to recover features fundamentally lost through mmWave imaging



CompenSAR reduces pose error produced by the vision-based self-tracking device