

# Robotics Perception and Manipulation via Full-Spectral Wireless Sensing

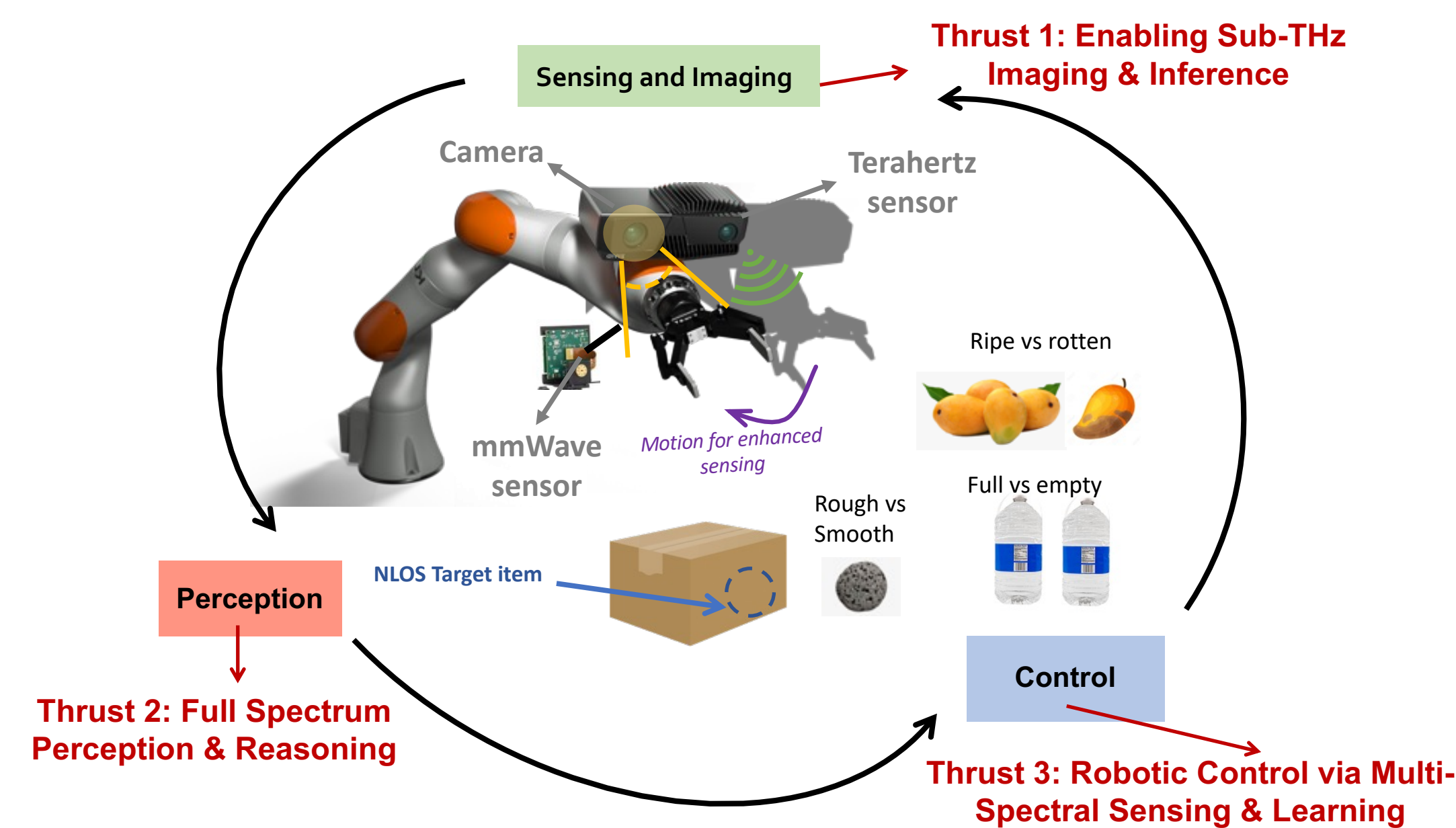
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## Key Problems & Objective

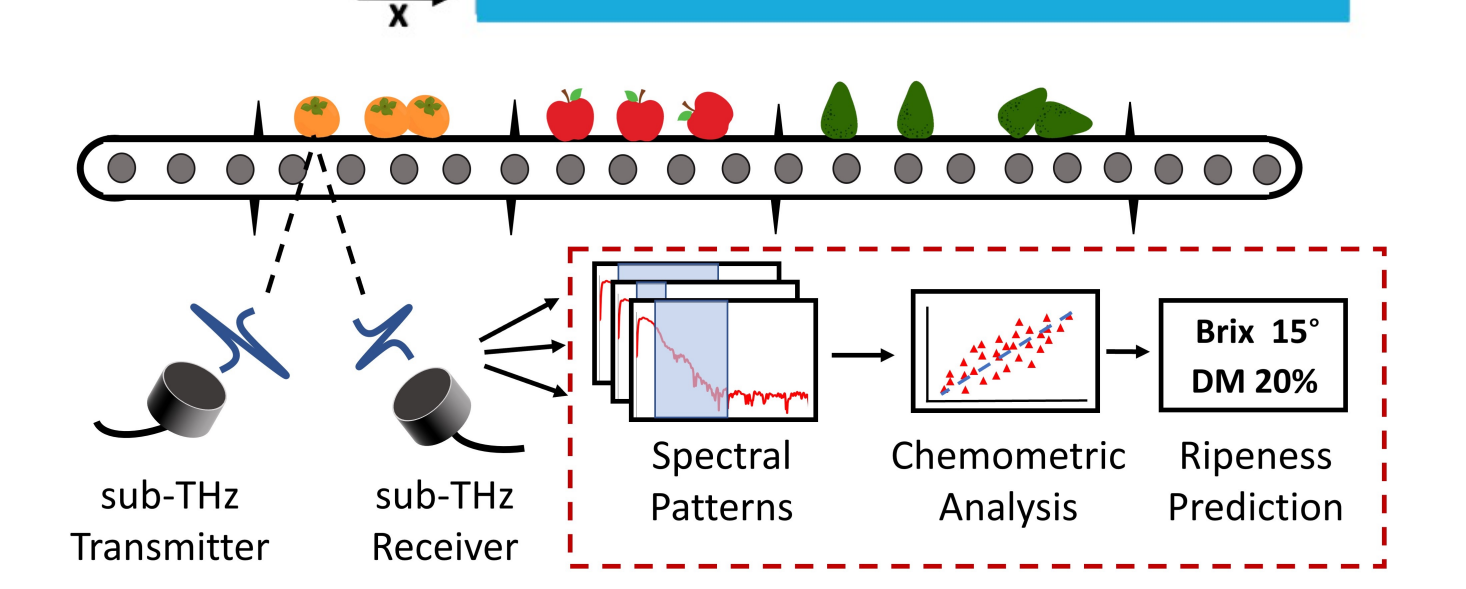
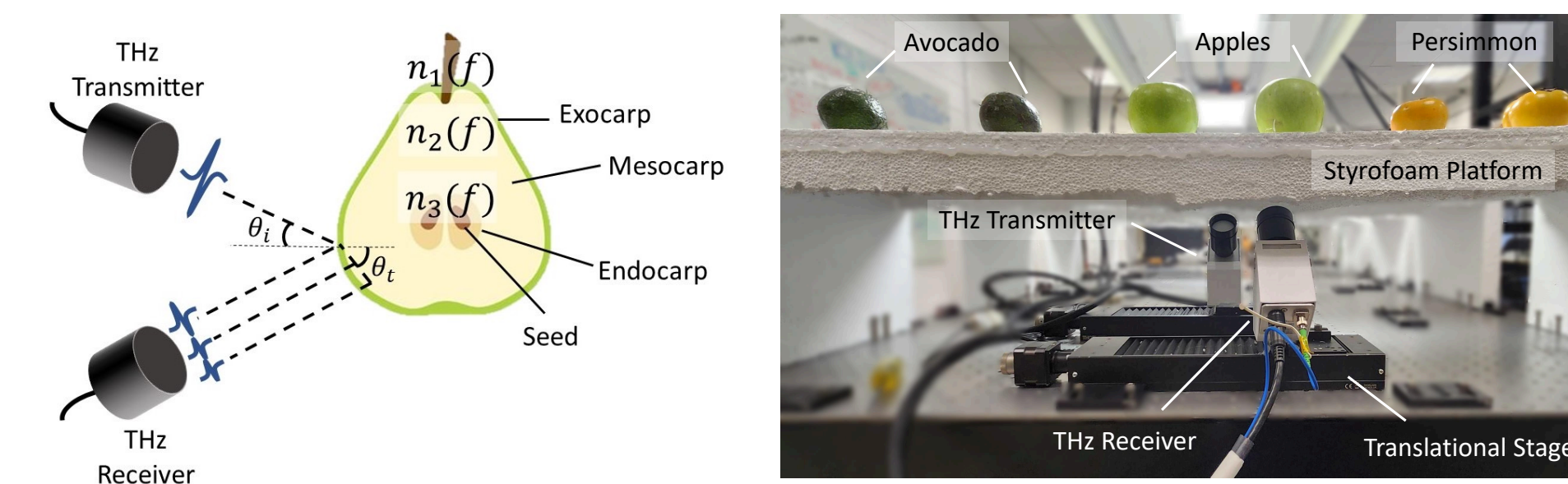
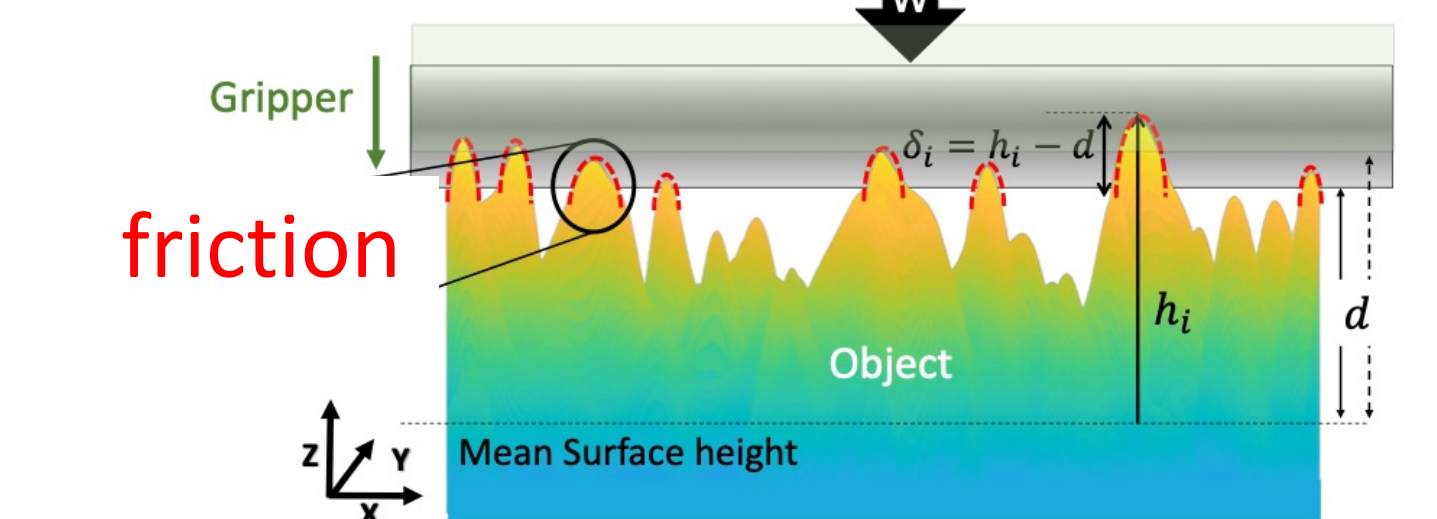
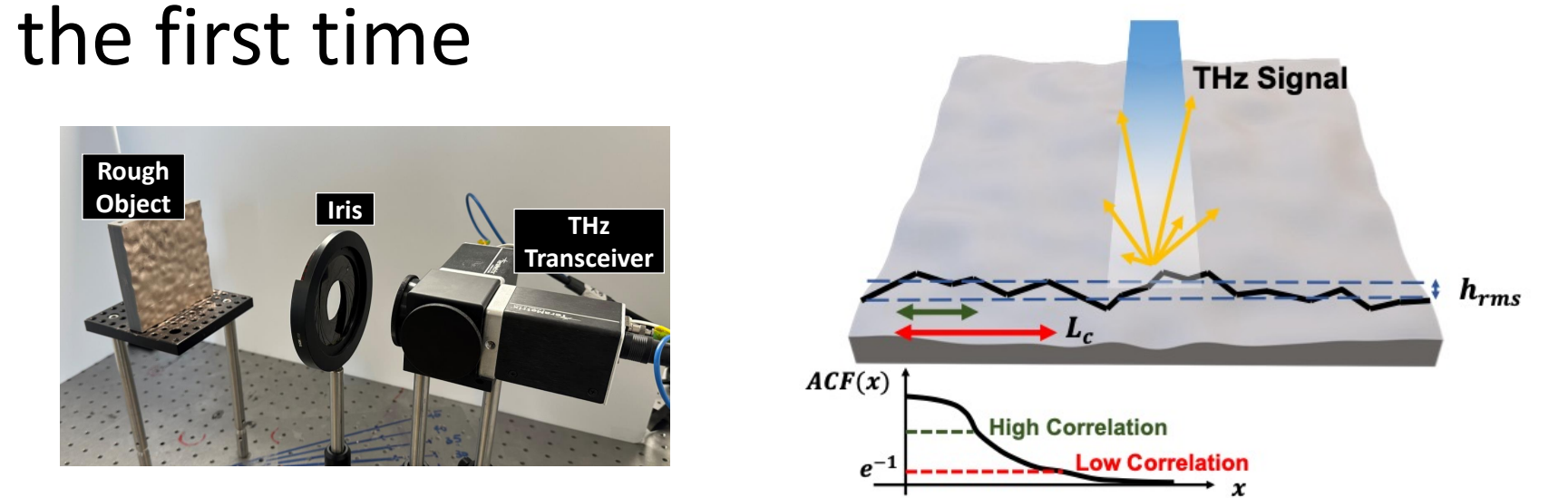
- Current robotic manipulation systems rely only on cameras and haptic gloves to “see” and “feel” the environment
- Inefficient and challenging to complete complex tasks that may require perception and reasoning outside of the immediate FoV and contact zone

**Goal:** Designing and building an end-to-end system for intelligent multi-spectral sensing, learning, and reasoning to enable NLOS and contact-less perception for enhanced robotic manipulation and control



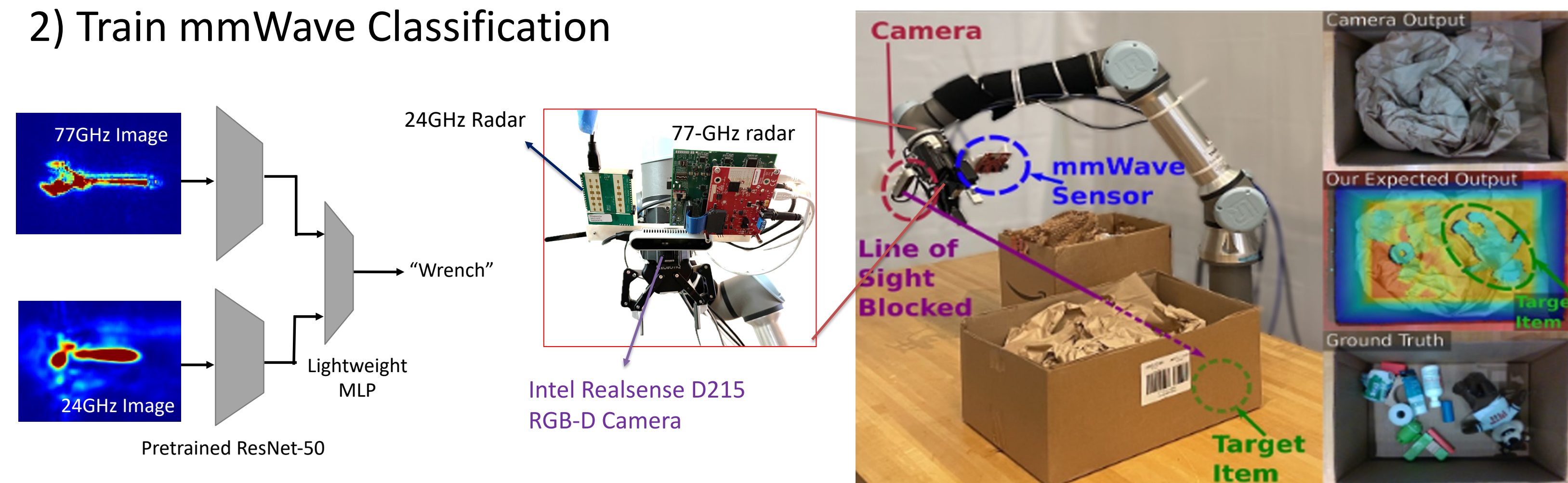
## Terahertz Perception for Robotics

- Exploiting sub-THz frequencies for Robotics for the first time
  - Surface roughness estimation
  - Material inference
  - High-resolution imaging
- Developing a framework for the coefficient of friction estimation by integrating THz perception with applications in grasping & locomotion
- AgriTera: Non-invasive Fruit Ripeness Sensing using THz sensors at distribution lines and smart factories



## Enabling NLOS Perception via Multi-Spectral Imaging

- mmWave signals can traverse occlusions, enabling them to see occluded objects
- Existing models for robotic perception & manipulation are not trained on mmWave images
- Developing a new perception pipeline for mmWave-based reasoning
  - 1) Collect Multi-Spectral Dataset
  - 2) Train mmWave Classification



## Scientific Impacts

- Unlocking new robotic perception and manipulation capabilities
- Introducing a fundamentally new perception modality for industrial robotics
- Learning synergies between sensing control to optimize end-to-end CPS tasks
- Impacting a broad CPS domain –from grasping to locomotion and target identification and retrieval in unstructured and occluded settings
- Enhancing manipulation efficiency through non-contact and NLOS perception and reasoning

## Broader Impacts

- Multi-spectral fusion for industrial robotics, warehousing, smart home robotics, and augmented reality systems
- Creating public-facing videos to increase public education and engagement
- Training students and workforce developments
- Outreach activities to various academic communities and showcasing our demos to industry partners
- K-12 student engagement through summer workshops