Demo: Liquid Identification via Vision-Guided mmWave Imaging and LLM Reasoning
## #10
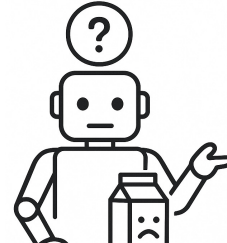
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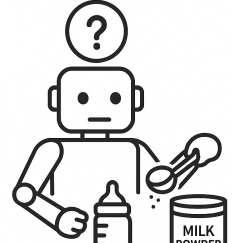
WAIS LAB
WIRELESS AI FOR SCIENCE

Motivation

- **Most robots** can distinguish different liquids only based on appearance, which leads to **failures in many daily tasks**.
- **Wireless liquid sensing**—specifically, inferring physical properties of liquids through their interaction with electromagnetic waves—can enable robots to better **understand and interact with liquids**.
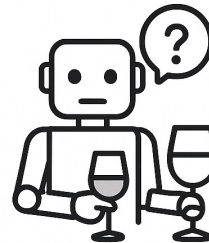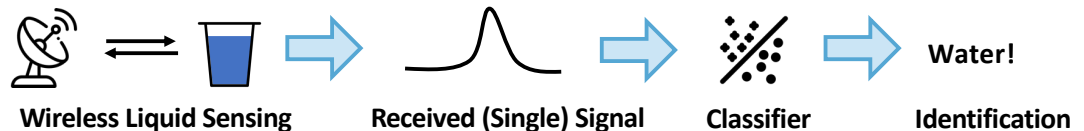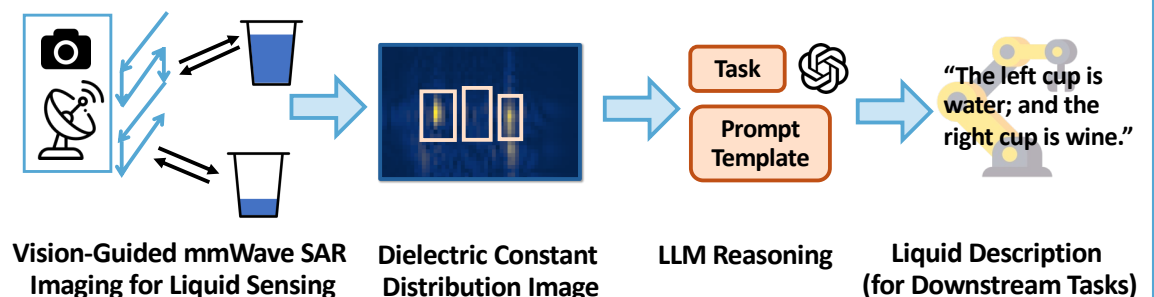

Water OR Wine?   **Normal OR Spoiled?**   **Add More Water OR Milk Powder?**

Methodology

Previous

Wireless Liquid Sensing   Received (Single) Signal   Classifier   Water!
                                                                      Identification

Ours

Vision-Guided mmWave SAR Imaging for Liquid Sensing   Dielectric Constant Distribution Image   LLM Reasoning   "The left cup is water; and the right cup is wine."

Liquid Description (for Downstream Tasks)

Task / Prompt Template

Key Insights

New Features!
- *Location-independent*
- *Multi-cup Sensing*
- *Small-volume Compatible*
- *Task-adaptive via Prompts*

SAR-based mmWave Imaging
The system first uses RGB-D input to localize regions of interest, reducing scanning time and **eliminating the need for fixed location setup** required in prior methods. mmWave imaging then captures high-resolution signals, enabling **accurate sensing across multiple containers**—even with **very small liquid volumes.**

LLM-based Reasoning
Large Language Models (LLMs) can leverage task descriptions and visual context to reframe complex n-liquid classification into simplified tasks—such as binary decisions—**enhancing both robustness and accuracy**. Their outputs are also naturally interpretable for both humans and robots, facilitating seamless collaboration.