AgriSense

Battery-Free Soil Sensing for Next-Gen Connected Agriculture

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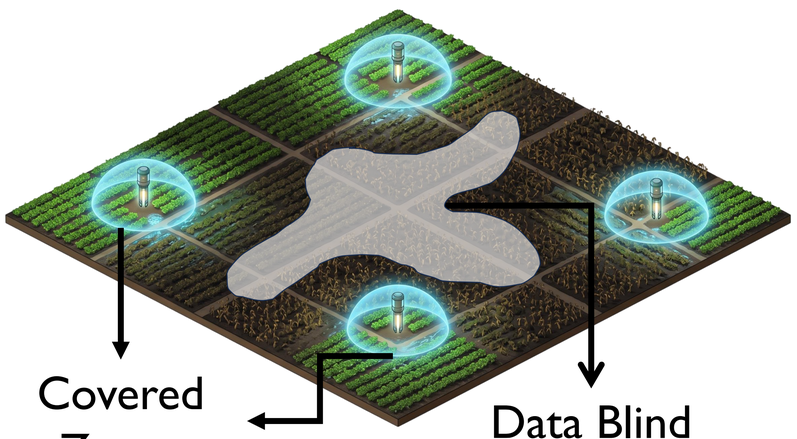
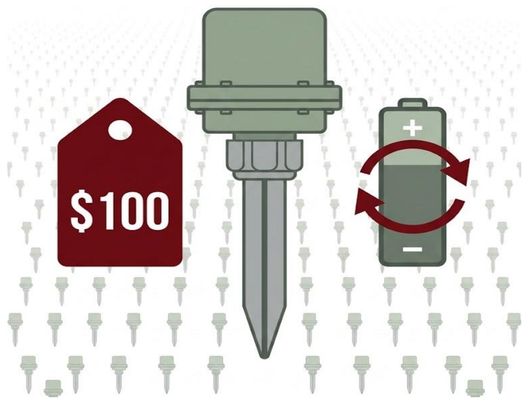
AI is only as Smart as the Data



AI Decision Error: 35% water wasted because of missing data streams

Sparse data forces AI to guess & hallucinate

Bottleneck in Data Harvesting

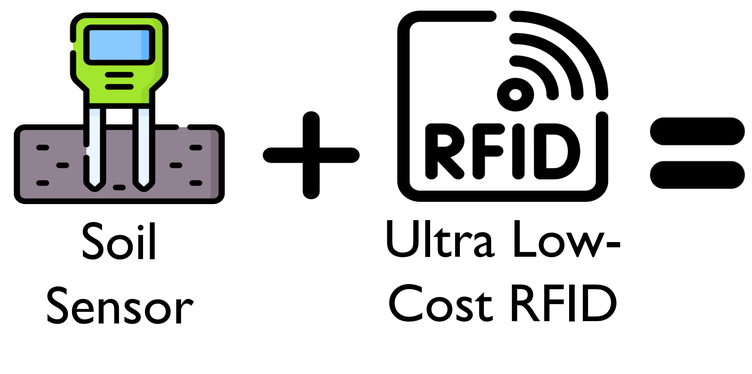


Prohibitive Cost : Costly sensor nodes *bankrupt* large-scale field deployments

Battery Trap : Replacing 1000s of buried batteries makes long-term maintenance *impossible*

Dense coverage is virtually unscalable today

The Core Technical Solution



Soil Sensor + Ultra Low-Cost RFID =

Ultra Low-Cost Battery-free Soil Sensor capable of Mobile Readout

Decoupling sensing from power using RFID

The $1 Deploy & Forget Sensor

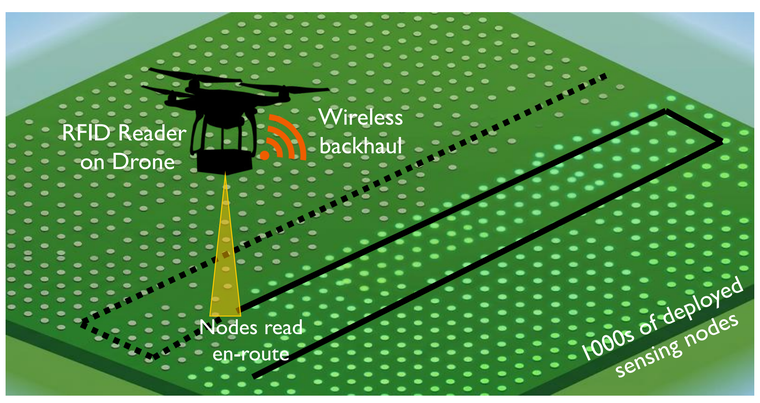
ZenseTag Battery-free Sensing Platform

Best runner-up demo (ACM MobiCom'24)

Best paper award (IEEE RFID'25)

Low-cost passive tags replace active nodes

Data Harvesting at Field Scale



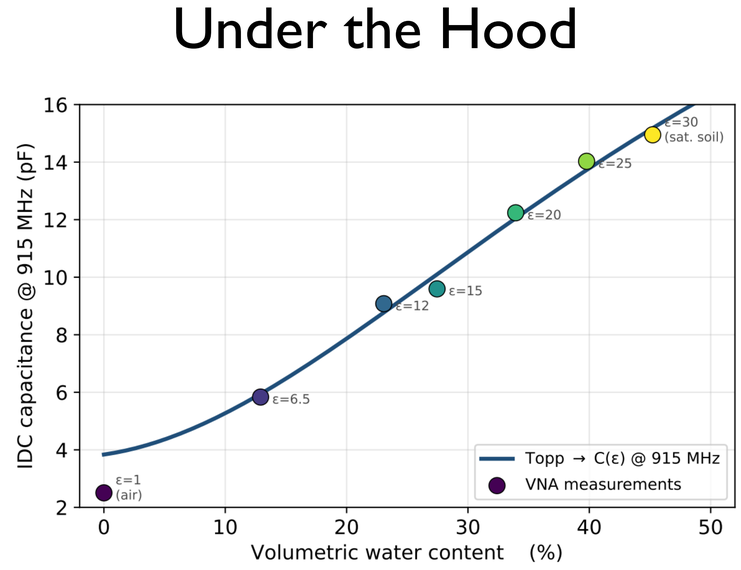
Field: 5ha (50,000m²) @ 250m x 200m
Sensor Grid: 2000 nodes @ 50 x 40

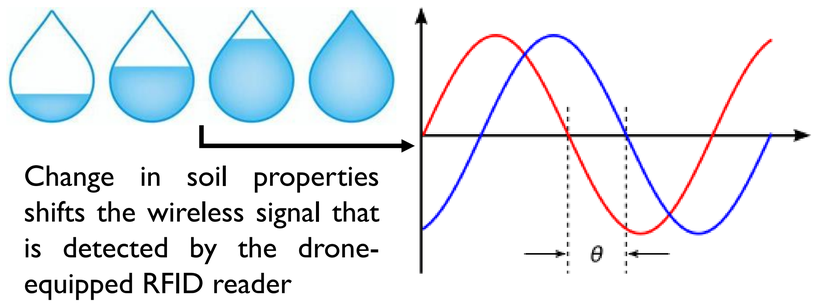
Drone Path: 10km @ 3m/s
Duration: 60min

Cost Category	Active Sensor Networks	Battery-free Networks	Our Approach
Nodes	$200,000 ($100/node)	$2,000 ($1/node)	**$2,000** ($1/node)
Gateways / Equipment	$10,000 (4-5 LoRa-WANs)	$200,000 (200 fixed readers)	**$2,000** (drone + reader)
Long Term Maintenance	$150,000 (batteries + labor)	~$20,000 (readers + labor)	**~$1,000** (basic servicing)
Total Gross	~$350,000	~$225,000	**~$5,000**

Scale to 1000s of nodes at 70x lower cost

Under the Hood



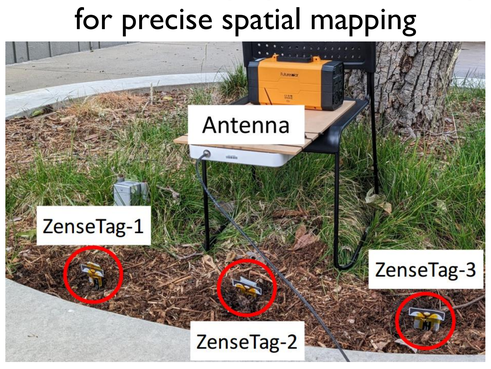


Change in soil properties shifts the wireless signal that is detected by the drone-equipped RFID reader

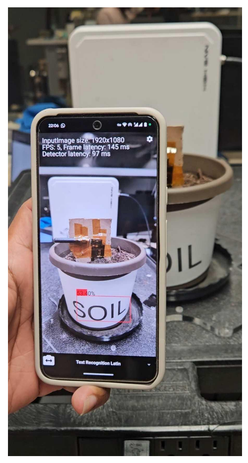
Soil changes directly alter wireless signals

From Lab to Landscape

Dense sensor deployment necessary for precise spatial mapping



AR-app showing real-time sensor data



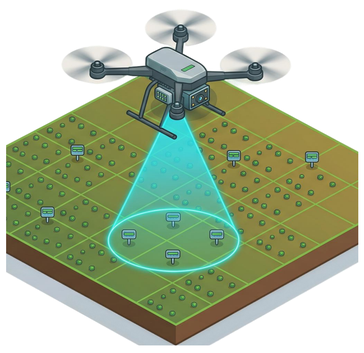
Aerial readout of battery-free sensors

Best runner-up demo (SenSys'25)

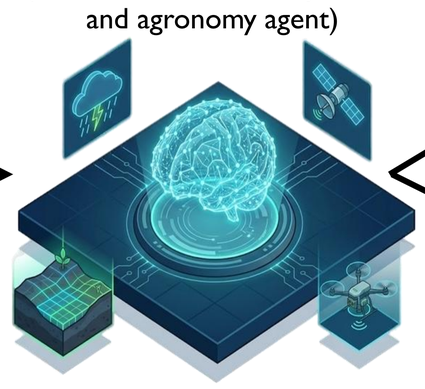
We show robust passive sensing in the field

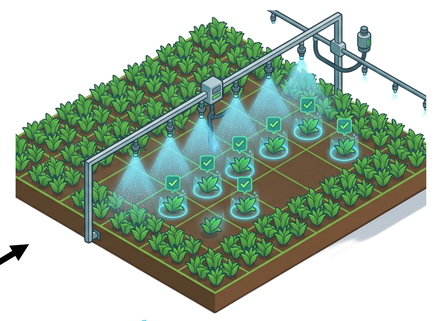
Closing the Loop: Sensor Language Foundation Models for Automated Farm Orchestration

Stage 1: Data harvested from dense sensor deployments (On-demand soil maps)



Stage 2: Sensor LLMs & Spatial Foundation Models (Predictive root-zone dynamics and agronomy agent)





Stage 3: Automated closed-loop Precision Actuation (Delivers water and nutrition based on exact spatial needs)

Grower kept in the Loop through smart Augmented Reality applications

High-density battery-free sensing provides the ubiquitous data foundation for physical AI