

IEQ Bot

Ming Jin, Costas Spanos
EECS Department, UC Berkeley

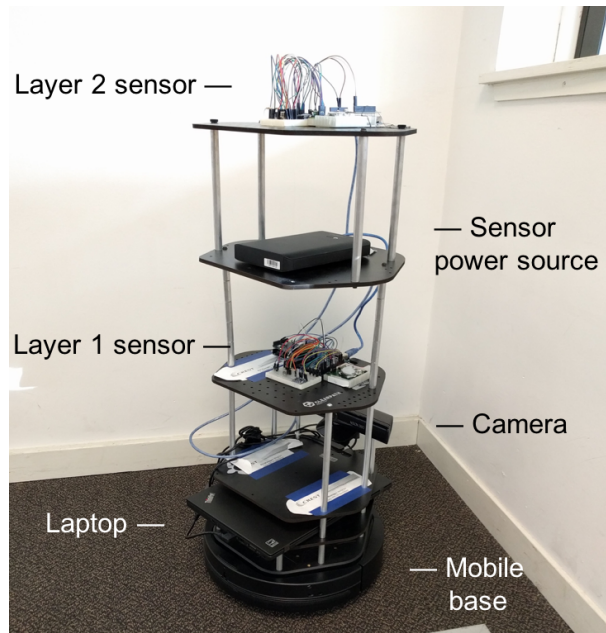
Shichao Liu, Stefano Schiavon
CBE, UC Berkeley



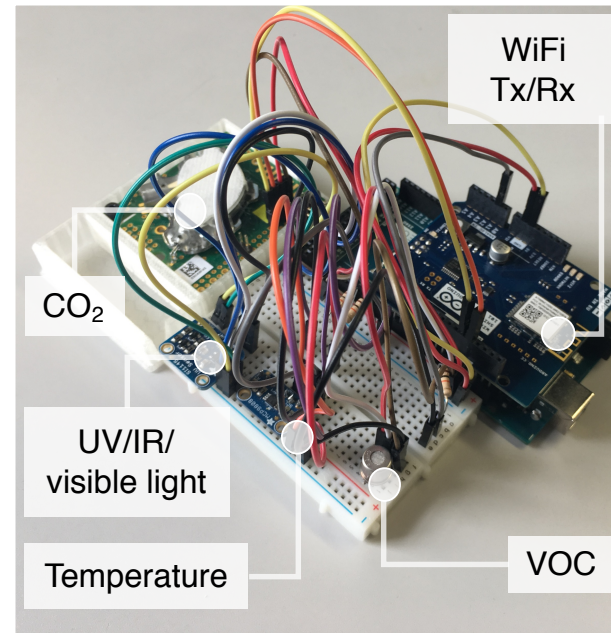
Robots are slowly entering the home and office space



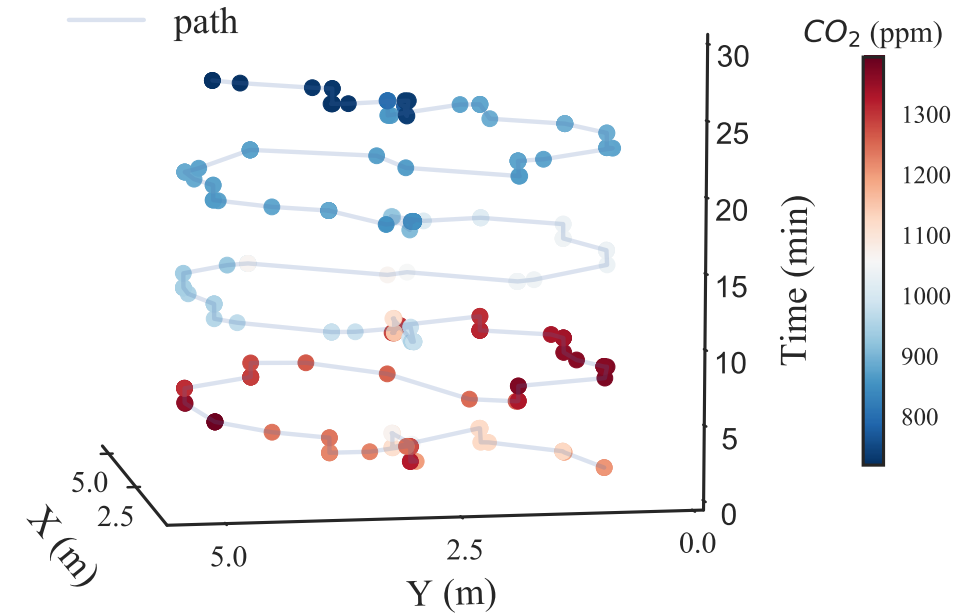
Enabling technology: mobile robot, sensor, and data analytics



Robot with indoor positioning, navigation capability



Internet-connected **sensor platform** with IEQ sensing modules



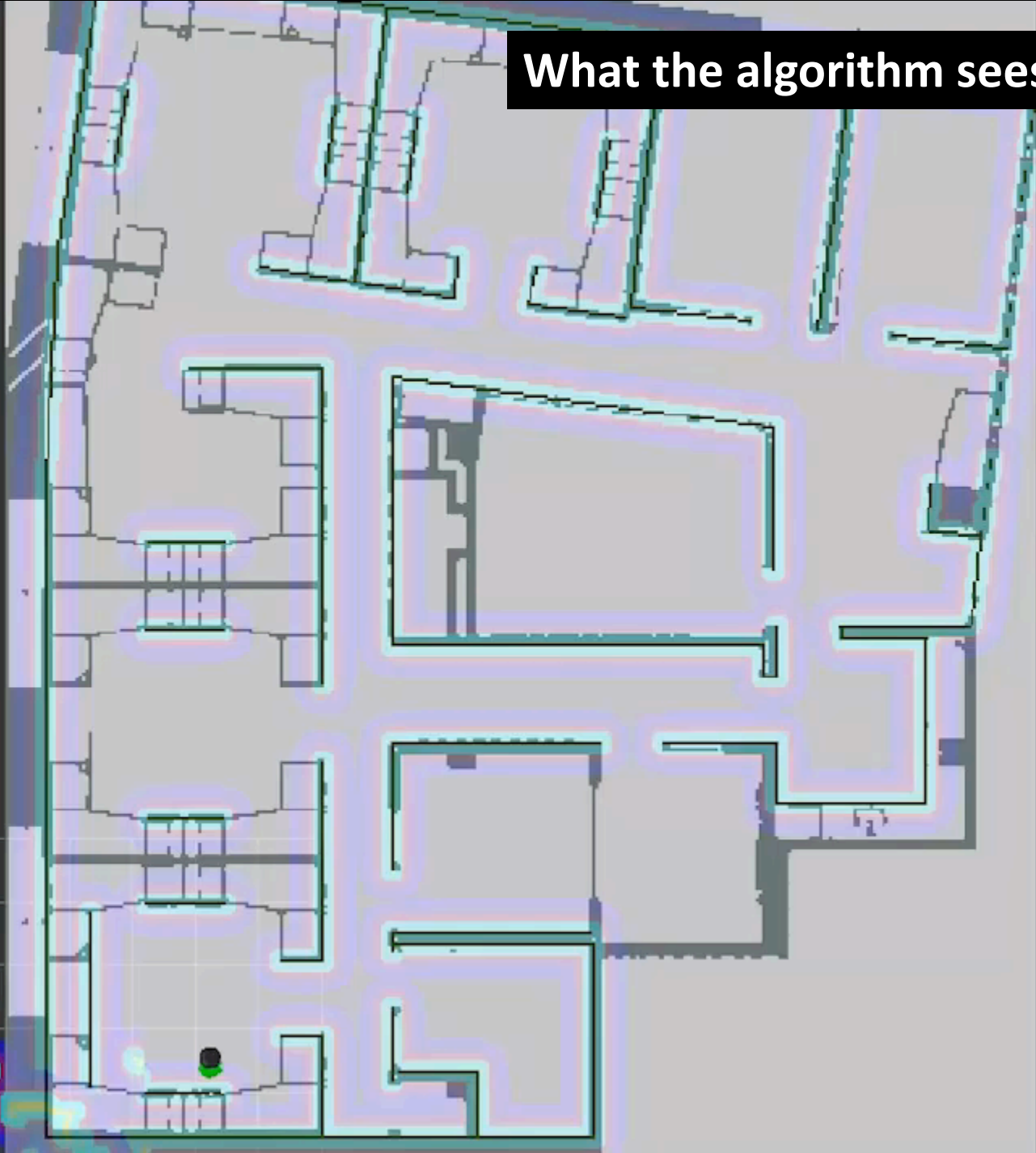
Data analytics to derive valuable insights from samples that are sparse in time and spatial domains

What the person sees

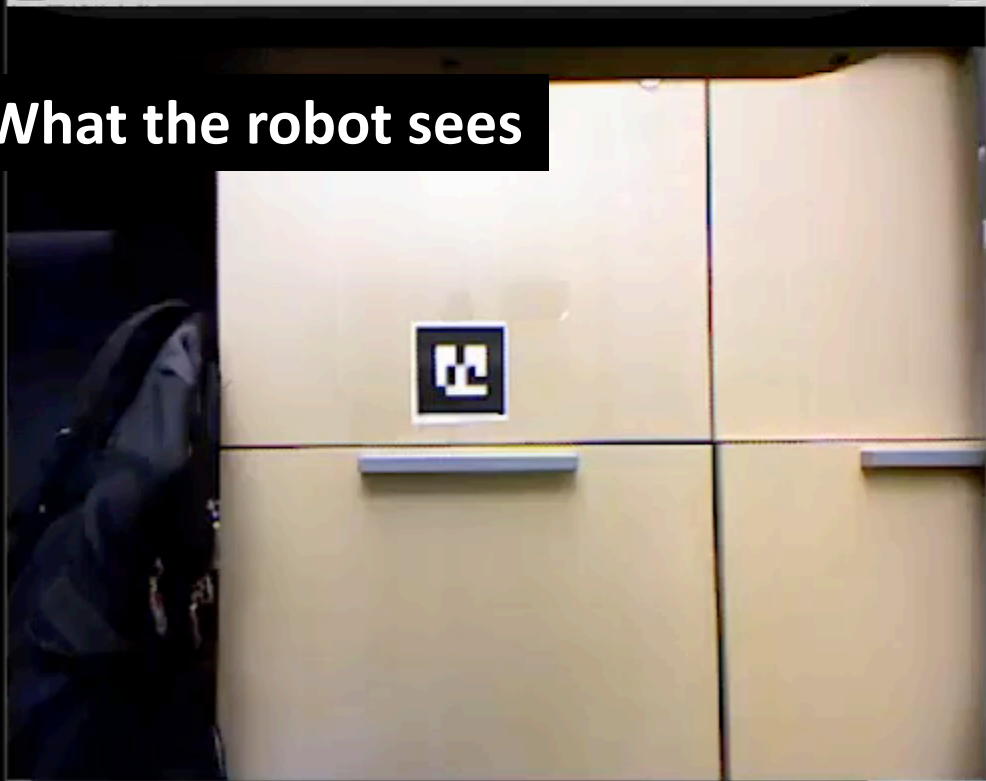


Camera

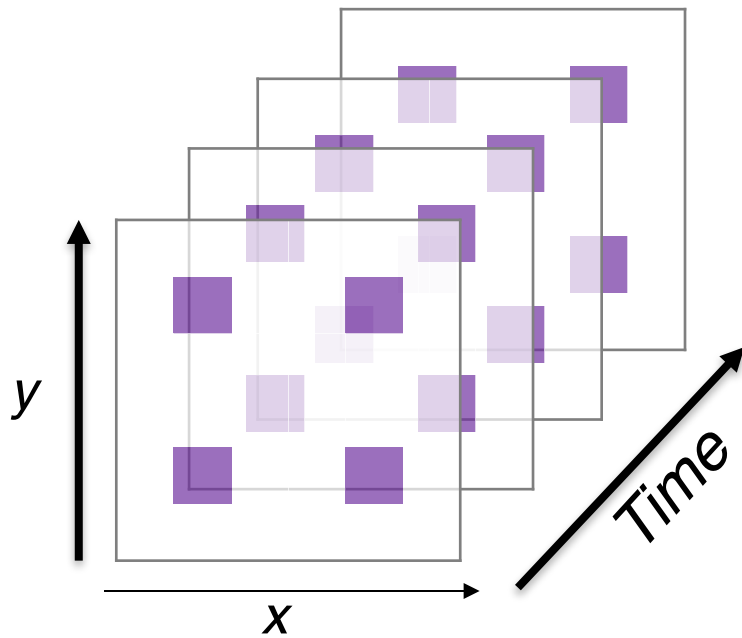
What the algorithm sees



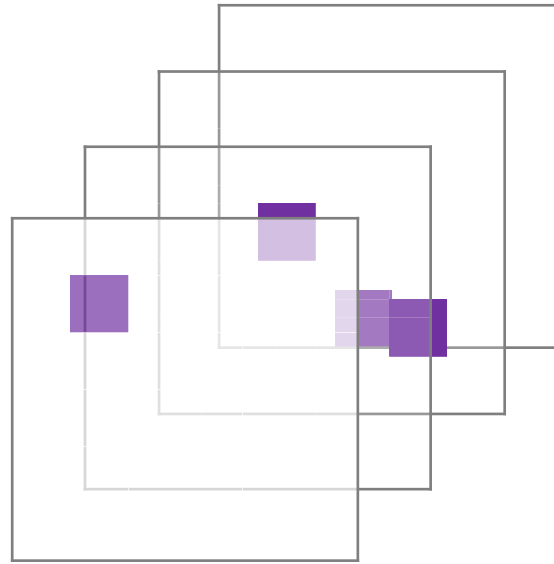
What the robot sees



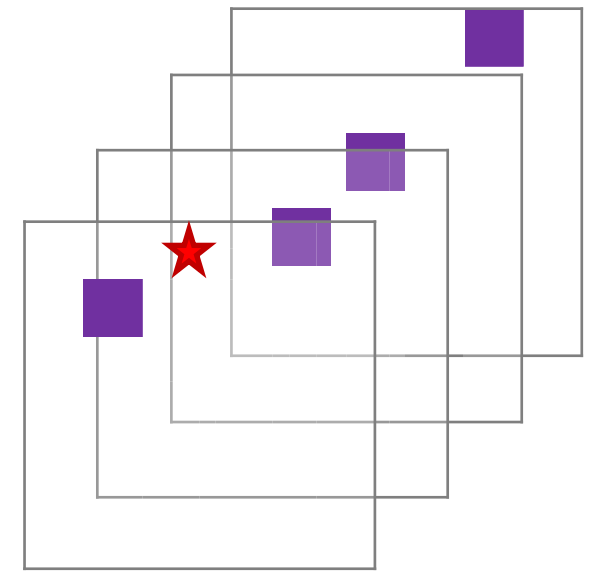
How does “mobility” augment indoor sensing capability?



Static sensors measure IEQ at fixed locations continuously




Mobile sensor can survey IEQ at high spatial granularity, but samples are discontinuous in time



Samples are taken as-needed, where-needed, and event-driven

$$\text{\$} \times N > \text{\$} + \text{\$}$$

sensor $\times N$ > robot + sensor

 Response to emergency
Indoor pollution identification

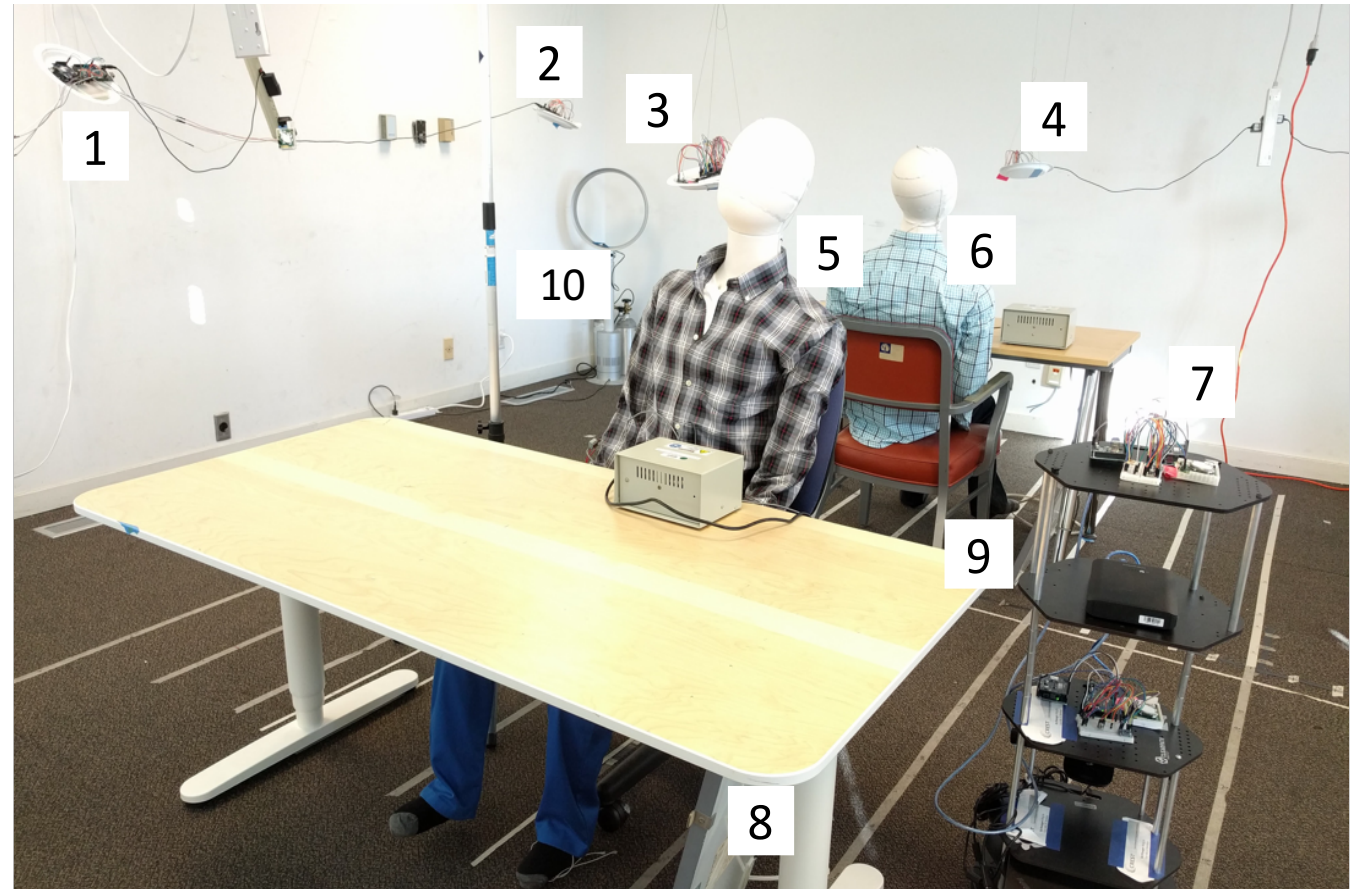
Validation of air-change effectiveness (ACE) by static and mobile sensors

Objective

- Demonstrate the mobile sensing platform by comparing with static sensor network
- Air-change effectiveness (ACE) is “a measure of ventilation efficiency”

Approach

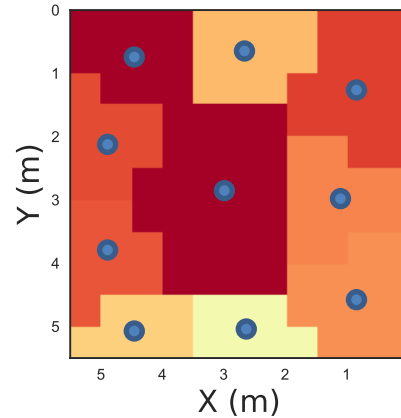
- Standard tracer-gas decay procedure by ASHRAE 129
- Side-by-side measurements by static sensors and mobile robot



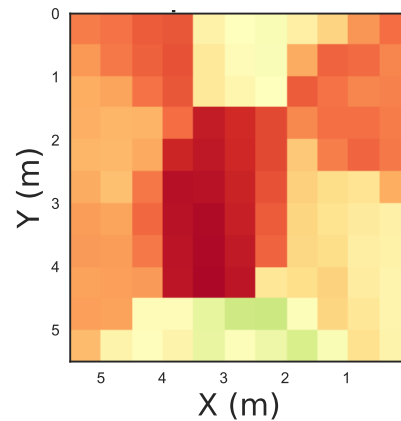
Testbed snapshot, showing the static sensor stations (1--4), thermal manikins to model realistic heat sources (5,6), robot (7), floor heaters (8,9), and CO₂ source (10).

Static and mobile sensors have good agreement on ACE evaluation

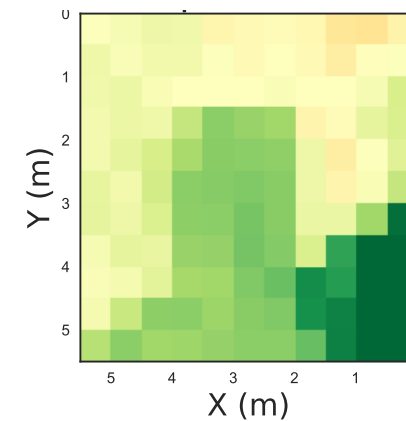
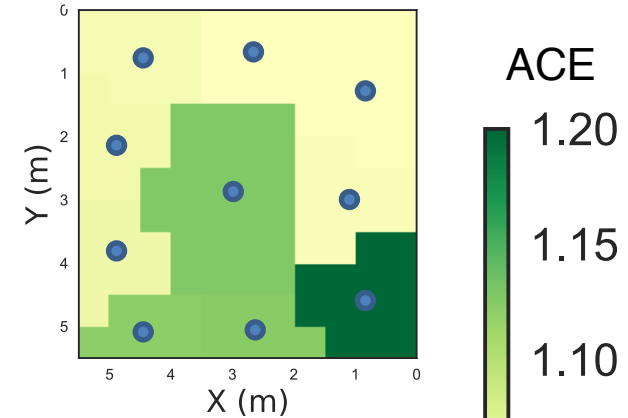
Estimation by
10 static stations



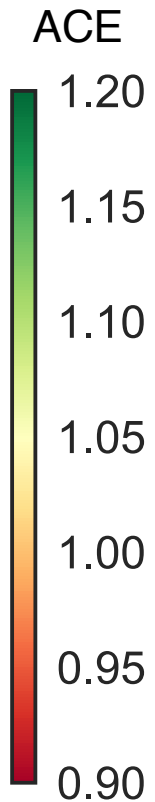
Estimation by
1 mobile robot



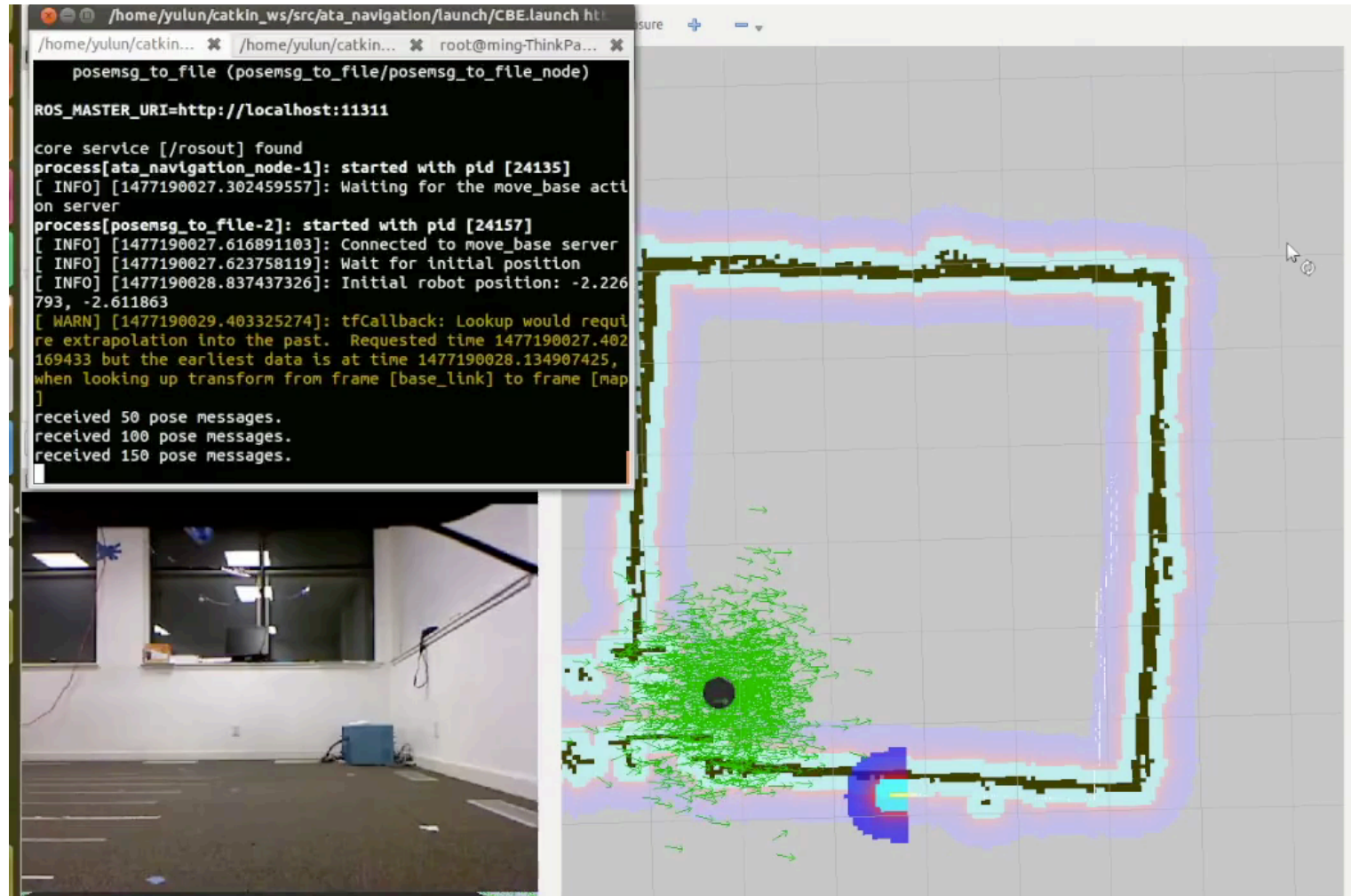
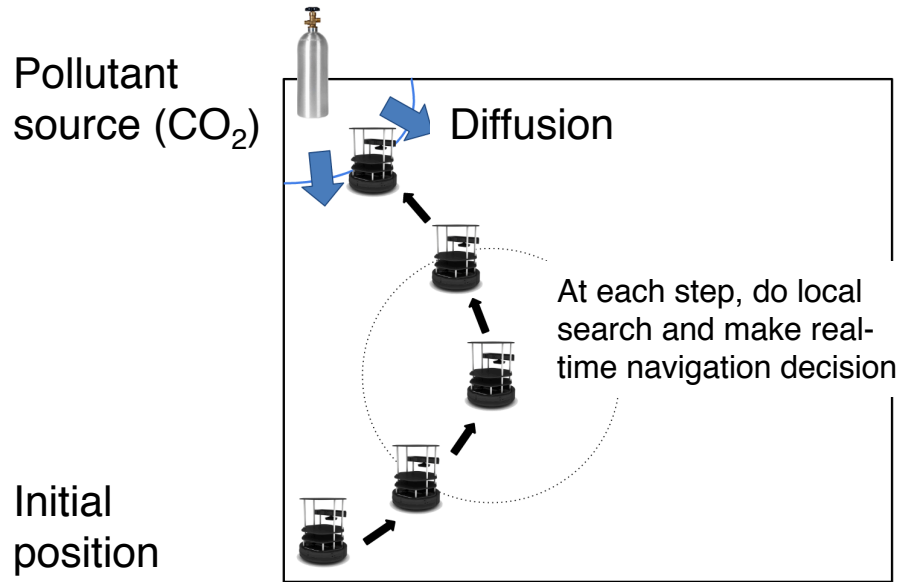
Poor ventilation



Good ventilation

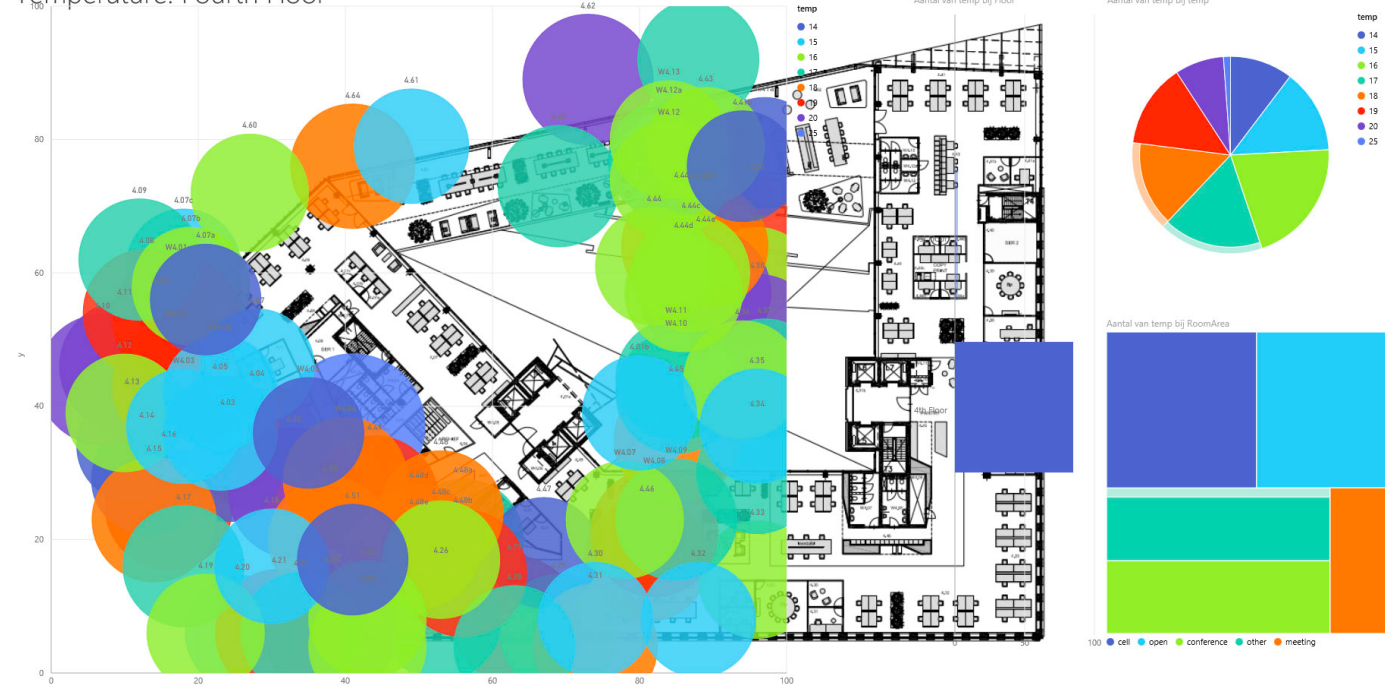


Automated mobile sensing enables numerous applications



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Temperature: Fourth Floor



Full space temperature/humidity sensing



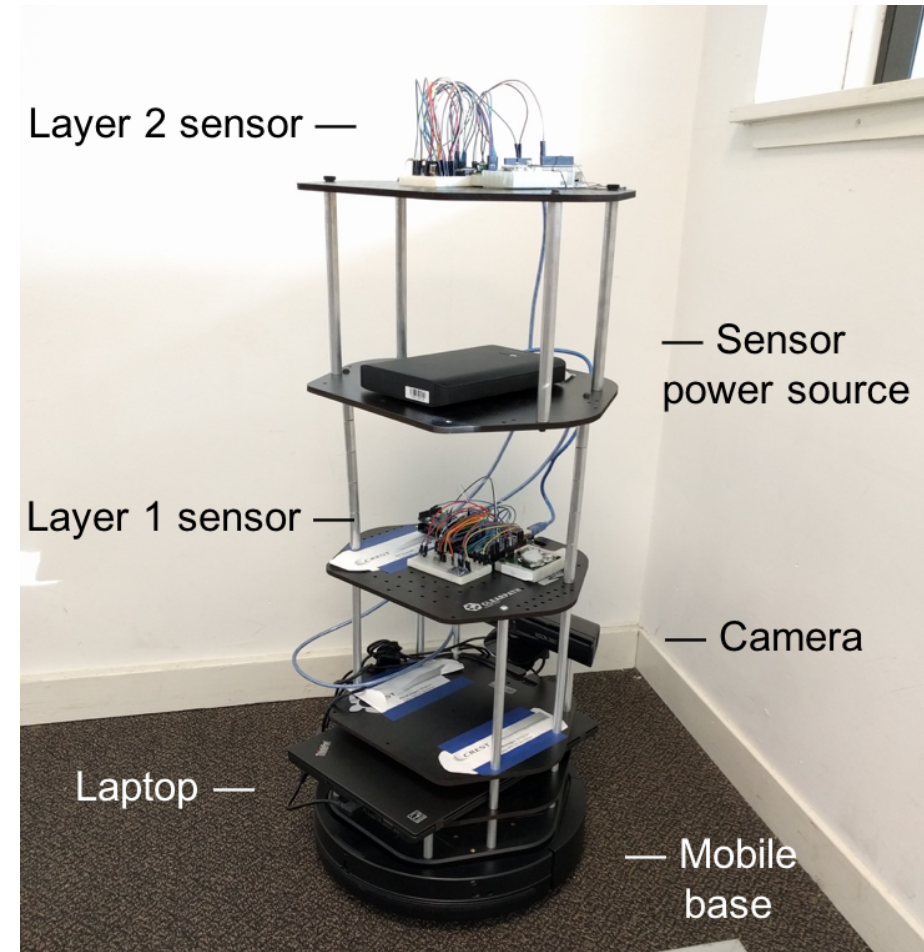
Automatic building commissioning

Thank you

Ming Jin
jinming@berkeley.edu

Stefano Schiavon
schiavon@berkeley.edu

*Please take a moment to fill out
the feedback form.*



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