# Vision-Precision Ubiquitous Indoor Localization Using Conventional Lights

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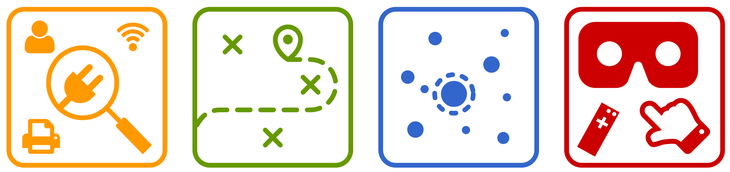
## Indoor Localization




Current Practice: Wi-Fi

*Inaccurate* Meters of error

*Fragile* Easily affected by dynamics

Future Promise: **Visible Light Positioning**

*Accurate* *Robust* *Ubiquitous*

Approach ①: Camera + Photogrammetry

*Narrow View* *Low Sensitivity*

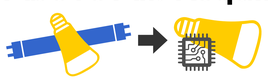
*Energy-Hungry* *Long Latency*

Approach ②: Photodiode + Intensity Model

*Model is Unrealistic*

*Obstruction Breaks model*

**Above All: Require Extra Beacon Hardware**



= ***Huge Retrofitting Cost!***

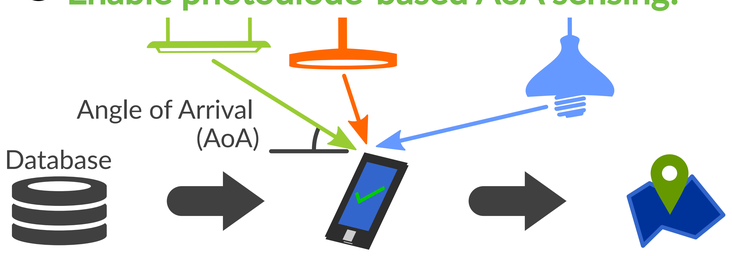
## Departure from the Regime

*Retrofitting is costly?*

Reuse existing lights!

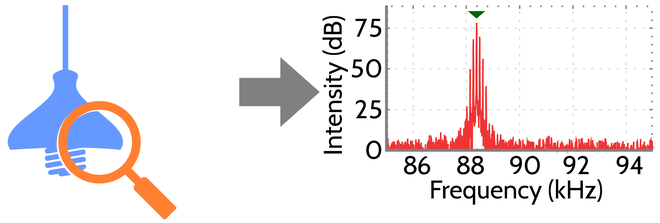
*Intensity is unreliable?*

Enable photodiode-based AoA sensing!




## Reusing Existing Lights

How to **Identify** Lights without Beacons?




Oscillation in Driver → High Frequency Flicker

*Ubiquitous* *Stable*

Manufacturing Error → Diversity in Oscillators

*Unique*

"***Characteristic Frequency*** **(CF)**"

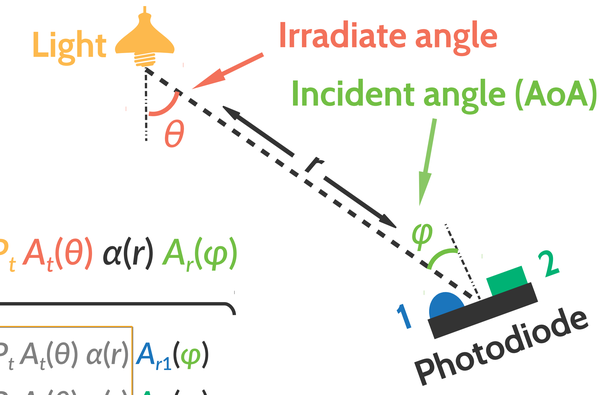
**Turn Existing Lights into Location Landmarks**

## AoA from Photodiodes

Visible Light: No Phase!

Photodiodes: No Spatial Resolution!

**Need New Tricks**




$$RSS = P_t\, A_t(\theta)\, \alpha(r)\, A_r(\varphi)$$

$$RSS_1 = P_t\, A_t(\theta)\, \alpha(r)\, A_{r1}(\varphi)$$

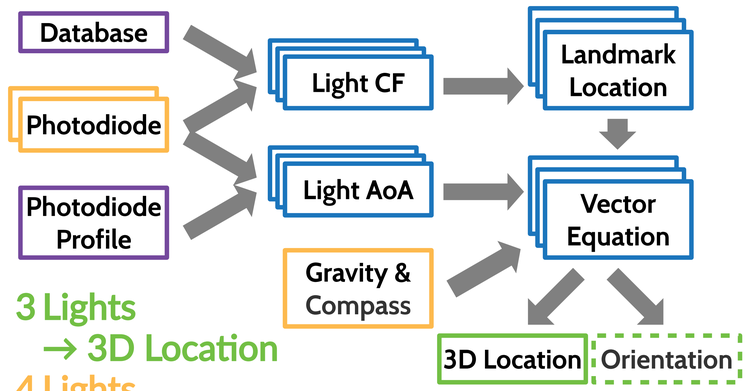
$$RSS_2 = P_t\, A_t(\theta)\, \alpha(r)\, A_{r2}(\varphi)$$

$$\frac{RSS_1}{RSS_2} = \frac{A_{r1}(\varphi_1)}{A_{r2}(\varphi_2)} = A_c(\varphi)$$

$$f^{-1}: \quad \varphi = A_c^{-1}\left(\frac{RSS_1}{RSS_2}\right)$$

**Obtain AoA from 2 Different Photodiodes**

## Localization

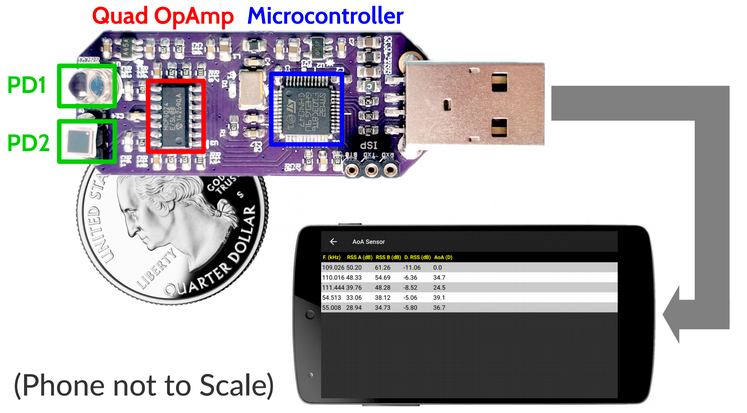



3 Lights → 3D Location

4 Lights → 3D Location + Orientation

Accuracy: 10cm / 5°


## Prototype




(Phone not to Scale)

## Resources

Chi Zhang, Xinyu Zhang, "**Pulsar: Towards Ubiquitous Visible Light Localization**", *ACM MobiCom'17*

Chi Zhang, Xinyu Zhang, "**LiTell: Robust Indoor Localization Using Unmodified Light Fixtures**", *ACM MobiCom'16*

http://dword1511.info